A Hydrobiological Evaluation of the Minimum Flows for the Lower Hillsborough River for the Second Five-Year Assessment Period - October 2012 to May 2018

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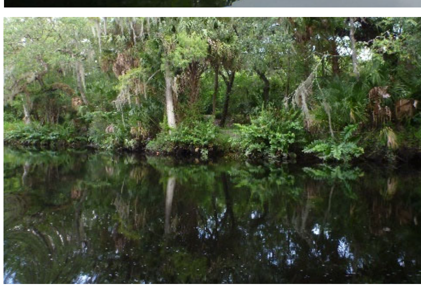

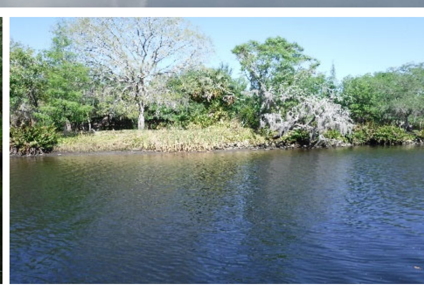

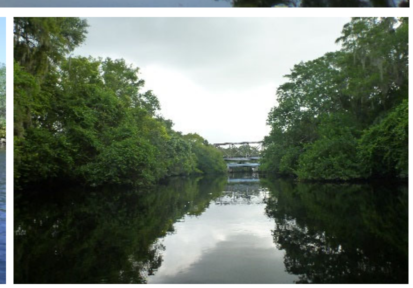

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List of Abbreviations and Acronyms

ASR	aquifer storage recovery
CDOM	colored dissolved organic matter
CFI	Cooperative Funding Initiative
cfs	cubic feet per second
City	City of Tampa
District	Southwest Florida Water Management District
DO	dissolved oxygen
EPCHC	Environmental Protection Commission of Hillsborough County
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FIM	Florida's Fisheries-Independent Monitoring
HBMP	Hydrobiological Monitoring Program
km^2	square kilometer
LAMFE	Laterally Averaged Model for Estuaries
LHFDA	Lower Hillsborough Flood Detention Area
LHR	Lower Hillsborough River
LHWP	Lower Hillsborough Wilderness Preserve
m/s	meters per second
MFLs	minimum flows and minimum water levels
mgd	million gallons per day
mi^2	square mile
nMDS	non-metric multidimensional scaling
ppt	parts per thousand
RIBs	rapid infiltration basins
RKm	river kilometer
SWFWMD	Southwest Florida Water Management District
TAP	Tampa Augmentation Project
TBC	Tampa Bypass Canal
USGS	United States Geological Survey
Water & Air	Water & Air Research, Inc.
WUP	water use permit

List of Conversions

1 cfs to m^3/s = 0.02832 m^3/s
1 km = 0.621371 miles
1 km^2 = 247.105 acre
1 gpd = 1.5 ft^3/s

Executive Summary

The objective of this report is to evaluate the impacts and effects of minimum flows implemented for the Lower Hillsborough River (LHR). Specifically, the report assesses the effects of the LHR recovery strategy included in Southwest Florida Water Management District rules (Rule 40D-80.073(8), Florida Administrative Code (F.A.C.), on water quality and quantity both above and below the Hillsborough River Dam for a current hydrobiological assessment period, defined as October 1, 2012 through May 31, 2018. As part of the recovery strategy, the District is to evaluate the hydrology, dissolved oxygen, salinity, temperature, pH, and biologic results or effects achieved from implementation of the recovery strategy for the prior five years including the duration, frequency, and impacts of the adjusted minimum flow described for the LHR in Rule 40D-8.041(1)(b), F.A.C.

The current minimum flows rule specifies a flow of 20 cfs of freshwater equivalent at the base of the Hillsborough River Reservoir dam from July 1 through March 31 and 24 cfs from April 1 through June 30. These minimum flows are based on extending a salinity range of less than 5 parts per thousand (ppt) from the dam towards Sulphur Springs. The total volume of water necessary to meet the seasonal minimum flow requirements should be augmented with additional flows to account for higher salinity water from Sulphur Springs, which serves as the primary source of recovery flows.

The LHR recovery strategy identifies several water resource projects, their order of priority for development and use as sources for river recovery, and for most, the quantities of water that the projects/source can or are expected to provide to recover and maintain the established minimum flows. These projects are listed below.

1) Sulphur Springs—involves lower weir modifications and Sulphur Springs pool upper weir and pump station modifications to supply up to 18 cfs (has provided supplemental water to the LHR below the dam since 2002 with system modifications in 2012);
2) Blue Sink—analysis shows it can supply up to 3.1 cfs (brought online in March 2018);
3) Tampa Bypass Canal (TBC) and Hillsborough River Reservoir—diversions to supply up to 11 cfs from the middle pool of the TBC to the Hillsborough River Reservoir, of which 75% of this water (8.3 cfs) is diverted to the LHR at the base of the Hillsborough River Dam (has provided supplemental water to the LHR since 2008);
4) Morris Bridge Sink—to supply up to 6 cfs (permitted – not currently in use);
5) Transmission pipeline evaluation (per Chapter 40D-8.073[8][b][2], F.A.C.) (completed [SWFWMD 2018]); and
6) Investigation of water storage or additional water supply options – the Tampa Augmentation Project (TAP) proposed an unspecified volume of water to be used to assist in meeting MFL requirements more consistently. However, the project is still progressing through regulatory requirements and funding challenges.

In this report, water flow below the dam including minimum flow supplementation data is assessed by year. It is noted that for 2018, minimum flows implementation has generally been

sufficient to meet minimum flow requirements, with exceptions. A flow deficit occurred in early 2018 due to a miscommunication between the City and the District regarding minimum flow supplementation pumping responsibilities and volume determinations. This was during a period when pump ownership at the dam and S-161 was being transferred from the District to the City. In addition, water needed to meet the overall salinity goal due to the use of brackish water from Sulphur Springs (freshwater equivalent) has not been provided to the river. Original analysis performed by the District indicated an additional 3 cfs needed to be added to the 20 and 24 cfs to meet the salinity improvement goal. Additional analysis is being conducted to validate the additional flow necessary to achieve the salinity improvement goal.

Now that minimum flow pumping responsibilities at Structures S-161, S-162, the dam, Sulphur Springs and Blue Sink are aligned with those specified in the recovery strategy, and Blue Sink has been brought online as a minimum flow supplementation resource it is expected that minimum flow targets, including the freshwater equivalent, are more likely to be achieved.

For this minimum flows recovery strategy assessment, data were parsed into four minimum flow (MFL) periods based on the implemented minimum flows, as follows:

- Minimum flow (MFL) Period 1 – No established minimum flows.
    - October 1, 1979 to February 28, 2002;
- MFL Period 2—Minimum flows requiring 10 cfs.
    - March 1, 2002 to December 31, 2007;
- MFL Period 3—Minimum flows requiring 20 or 24 cfs freshwater equivalents, adjusted for Hillsborough River flow at Zephyrhills.
    - January 1, 2008 to September 30, 2012 (previous hydrobiological assessment period); and
- MFL Period 4—Minimum flows requiring 20 or 24 cfs freshwater equivalents, adjusted for Hillsborough River flow at Zephyrhills.
    - October 1, 2012 to May 31, 2018 (current 5-year assessment period).

Assessed water quality variables for MFL period 1 were significantly different compared to MFL periods 2, 3, and 4. This indicates recovery strategy implementation has had an impact on the water quality of the LHR. Specifically, salinity was significantly lower during MFL periods 2, 3, and 4 as compared to MFL period 1), an indication that recovery strategy implementation is successfully extending the <5 ppt salinity zone from the base of the dam towards Sulphur Springs.

In reference to zooplankton, on average 16 percent of trophic-state indicators suggested declining conditions, but 42 percent suggested improving habitat conditions in response to differing flow conditions. Furthermore, 42 percent of the trophic-state indicators did not show detectable change. The weight of evidence from this analysis thus suggests habitats within the LHR improved after minimum flows implementation.

The nekton community was significantly different with respect to species composition and abundance in all comparisons between time periods with no flows and those with implementation of minimum flows. Specifically, time periods with a minimum flows of 20 or 24 cfs (freshwater equivalents) did not significantly differ in ANOSIM analysis, but all other pairs were different. Samples from the period before minimum flows were implemented appear the most different with higher abundances of some taxa (menhaden and grass shrimp), higher salinity in the river segment just below the dam, and the absence (or near absence) of other taxa (largemouth bass and the Seminole killifish). In general, the dominant taxa were somewhat consistent across all flow conditions, but their rankings within the most abundant 15 species fluctuated. Earlier periods (with less minimum flow supplementation) had significantly higher catch per unit effort, but not higher species diversity or species richness. Higher catch per unit effort was significantly correlated with higher salinity, and decreasing catch was correlated with geographic location (RKm) closer to the dam.

Like the nekton samples, benthic macroinvertebrate samples showed significant differences between MFL periods, though in this case, the only two periods that were not significantly different were the second and third periods; mandated minimum flows were increased in the third period. However, the different laboratories processing the samples may have contributed in part to this effect. Samples from the lower and upper segments had significantly different benthic macroinvertebrate communities, likely reflecting different salinity regimes. In contrast to the nekton (or possibly because of being prey for nekton), the density of macroinvertebrates increased after the implementation of minimum flows. Both macroinvertebrate richness and diversity were positively correlated with increasing minimum flow implementation.

Several factors to be considered in relation to the current recovery strategy were identified during the completion of this five-year assessment report. Identification of these factors led to the development of several key issues or actions for consideration to potentially improve the ability of the District and City to assess and/or consistently meet minimum flow criteria established for the LHR.

- Discuss and seek agreement on any issues related to City and District responsibilities for monitoring, operation and reporting for projects and other activities

- Further evaluate the additional flow quantities needed to address the freshwater equivalent noted within the minimum flows rule (40D-80.041(1)(b), F.A.C.

- As discussed, and currently being evaluated by the District, implement a strategy to reduce (i.e., supplement) Sulphur Springs and Blue Sink as the primary sources for minimum flow supplementation. Sulfur Springs is subject to water quality and quantity fluctuations. The primary sources under consideration are the TAP and the TBC. Sulphur Springs and Blue Sink could remain as back-up sources.

- Complete biannual (i.e., twice yearly) biological sampling events during the next 5 years to provide a better view of the response of biological communities to minimum flows implementation. Biannual monitoring (spring and fall) during the next 5-year assessment period would allow a better understanding of the status of the biological community in the LHR and how it has changed over time.

- In light of the results that 10 to 15 percent of the water pumped from the TBC into the reservoir is re-circulated to the TBC, from where it can again be pumped back into the reservoir, and that at most a few tens of thousands to a few hundred thousand gallons per day is lost to evaporation/transpiration (Motz et al. 2008, SWFWMD 2008), there is a need to discuss and seek agreement on a few of the minimum flows rule issues. Specifically, the rule-specified delivery to the base of the Hillsborough River Dam of only 75 percent (8.3 cfs) of the 11 cfs diverted from the TBC to the reservoir for LHR recovery, and the requirement that the City provide an additional 1.9 mgd from some permittable source to address the 25 percent difference between the quantities pumped from the TBC and released to the LHR. The 1.9 mgd quantity, which approximates the hypothesized 25 percent loss associated transfer of water from the TBC through the reservoir to the LHR, is expected to help address any minimum flow deficits. According to the recovery strategy, the 1.9 mgd from a permittable source is to be used in preference to all other recovery flow sources except Sulphur Springs and Blue Sink.

1.0 Introduction

The objective of this report is to evaluate the impacts and effects of minimum flows implemented for the LHR. Specifically, the rule provides the following:

In 2013, and for each five-year period through 2023, the District shall evaluate the hydrology, dissolved oxygen, salinity, temperature, pH and biologic results achieved from implementation of the recovery strategy for the prior five years, including the duration, frequency and impacts of the adjusted minimum flow as described in paragraph 40D-8.041(1)(b), F.A.C. As part of the evaluation, the District will assess the recording systems used to monitor these parameters. The District shall also monitor and evaluate the effect the Recovery Strategy is having on water levels in the Hillsborough River above the City's dam to at least Fletcher Avenue. The District will evaluate all projects described in this Recovery Strategy relative to their potential to cause unacceptable adverse impacts prior to their implementation."

This report assesses the effects of the LHR recovery strategy on water quality and quantity both above and below the Hillsborough River Dam for a current hydrobiological assessment period, defined as October 1, 2012 through May 31, 2018. This report also provides a comparison of information collected prior to and subsequent to the implementation of recovery efforts reported in a previous 5-year hydrobiological assessment (SWFWMD and Atkins 2015). Dates for the historical hydrobiological assessment period extend from October 1, 1979 through September 30, 2012.

Discussion of the biological impacts associated with implementation of the recovery strategy during the current assessment period are also included in this report. These impacts are discussed in detail by Water & Air Research, Inc. (Water & Air 2018). This discussion also includes a comparison with the previous assessment period completed by Atkins from 2008 through 2012.

This report fulfills the Southwest Florida Water Management District (District) requirements specified in Rule 40D-80.073(8)(h) of the F.A.C. These requirements include assessment of the recording systems, primarily United States Geological Survey (USGS) and Environmental Protection Commission Hillsborough County (EPCHC) stations that monitor water quality and flow, as well as evaluation of the hydrology and water-quality parameters including dissolved oxygen (DO), salinity, temperature, and pH during the current 5-year assessment period. The report also evaluates the effects and impacts of the recovery strategy on the ecology of the LHR and water quality above the dam to Fletcher Avenue for the current assessment period. Specifically, the report discusses the effects and impacts on LHR water levels up to the reach above the dam. Finally, the report offers discussion and recommendations for existing and/or future projects described in the recovery strategy. It also evaluates the potential adverse impacts of such projects.

The LHR Assessment Area relative to the Hillsborough River Watershed is shown in Figure 1.0-1. The reach of the LHR Assessment Area and significant watershed features that impact the study area and provide water supply and minimum flow resources to the LHR are shown in Figure 1.0-2.

1.1 Purpose of Flows Evaluation

Minimum flow and recovery strategy rules were first adopted by the District for the LHR in 2000. These rules were substantially amended in 2007, based on completion of a rule-required study of the biological communities below the dam which included additional numerical salinity modeling that supported the need for revision of the minimum flows adopted in 2000. Amendments to the recovery strategy rules in 2014 included minor formatting/word changes and changes regarding reference to the District's Water Use Permitting information manual, which has been replaced by the Water Use Permitting Applicant's Handbook.

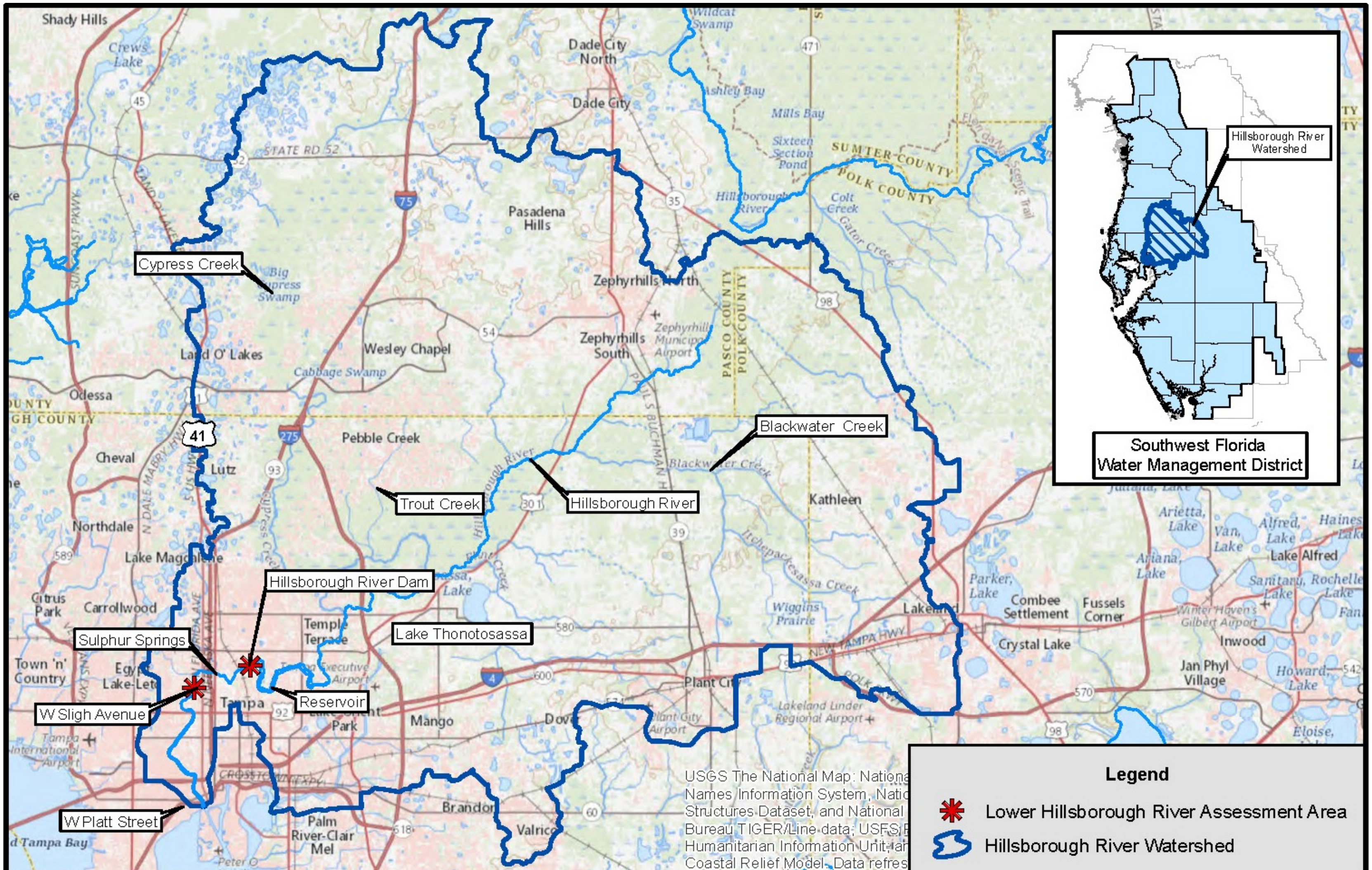

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Figure 1.0-1.
The Hillsborough River Watershed and the Lower Hillsborough River Assessment Area
Hillsborough, Pasco, and Polk Counties, Florida

Source: SWFWMD, 2003; Water & Air Research, Inc., 2018.

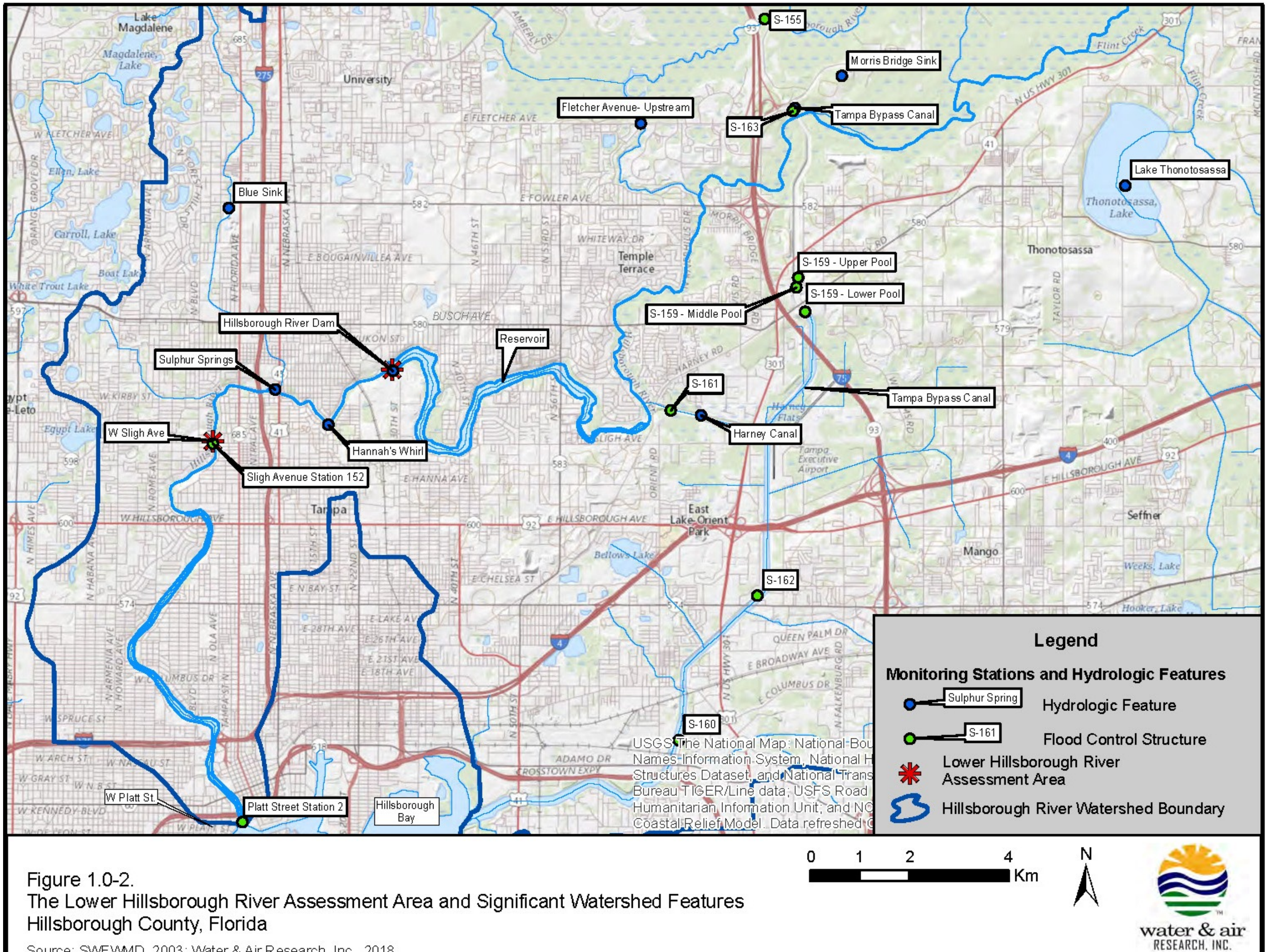

Figure 1.0-2.
The Lower Hillsborough River Assessment Area and Significant Watershed Features
Hillsborough County, Florida

Source: SWFWMD, 2003; Water & Air Research, Inc., 2018.

The current minimum flows rule for the LHR (Rule 40D8-041(1), F.A.C.) is included in the District's Water Levels and Rates of Flow rules. Current recovery strategy rules applicable to the LHR are included in the Comprehensive Environmental Resources Recovery Plan for the Northern Tampa Bay Water Use Caution Area and the Hillsborough River Strategy (Rule 40D-80.073, F.A.C.) within the District's Recovery and Prevention Strategies for Minimum Flows and Levels rules. Recovery strategy rules specific to the Hillsborough River are included in Rule 40D-80.073(8), F.A.C.

The current minimum flows for the LHR, established in 2007, are based on extending a salinity range less than 5 ppt from the Hillsborough River Dam toward Sulphur Springs. The established minimum flows are 20 cubic feet per second (cfs) of freshwater equivalent flow from July 1 through March 31, and 24 cfs freshwater equivalent flow from April 1 through June 30 at the base of the reservoir dam. For purposes of the rule and implementation of minimum flows, freshwater equivalent means water that has a salinity concentration of 0.0 ppt for modeling purposes.

The minimum flows are adjusted according to flow at the U.S. Geological Survey (USGS) Station No. 02303000, Hillsborough River near Zephyrhills, Florida. This station (USGS station 02303000) is located ~41 km (25.5 miles) upstream of the Hillsborough River Dam, just west of U.S. Highway 301, and flows measured at the site provide information on upper watershed contributions to the reservoir inflow and flow to the LHR. The adjustment in required minimum flows for the LHR based on flows at the "near Zephyrhills" station is defined as follows: for each cfs of Hillsborough River flow at the Zephyrhills Gauge below 58 cfs, when 20 cfs freshwater equivalent is otherwise required, the minimum flow is reduced by 0.35 cfs; when 24 cfs freshwater equivalent is otherwise required, the minimum flow is reduced by 0.40 cfs.

The recovery strategy for the Lower Hillsborough River specifies several sources of water that may be used to provide minimum flows and the schedules and requirements for their use. The strategy also requires (Rule 40D-80.073(8)(h), F.A.C.), that beginning in 2013 and for each five-year period through 2023 (a total of three consecutive five-year assessments), the District will evaluate specific environmental results achieved from implementation of the recovery strategy for the prior 5 years.

The purpose of each of the required 5-year assessments is for the District to evaluate the hydrology, DO, salinity, temperature, pH, and biologic results or effects achieved from implementation of the recovery strategy for the prior five years including the duration, frequency, and impacts of the adjusted minimum flow as described in Paragraph 40D-8.041(1)(b), F.A.C. As part of the 5-year assessments, the District is required to assess the recording systems used to monitor these parameters, and to also evaluate the effect of the recovery strategy on water levels in the Hillsborough River above the City's dam to at least Fletcher Avenue. In addition, the District will evaluate all projects described in the recovery strategy relative to their potential for unacceptable adverse impacts prior to their implementation.

This second of the three, rule-required 5-year assessments first assesses the LHR recovery strategy implementation for the period between October 1, 2012 to May 31, 2018 and then compares these findings to historical information, with a focus on the reach of the LHR extending from downstream of the reservoir dam to the West Sligh Avenue bridge, located downstream of Sulphur Springs.

The primary resources used to conduct this assessment included the following:

1. Assessment of the LHR biological communities including zooplankton, nekton, and benthic macroinvertebrates. These data are presented in a *Biological Assessment of the Lower Hillsborough River Report* (Water & Air 2018).

2. Review, data analysis and interpretation, and cataloging of historical and recent biological, hydrologic, and water quality information. This information was obtained from a variety of sources including the District, the City, Environmental Protection Commission of Hillsborough County, Tampa Bay Water, and the U.S. Geological Survey.

3. The first of three required 5-year assessments of the LHR recovery strategy, as summarized in *A Hydrobiological Assessment of the Phased Implementation of Minimum Flows for the Lower Hillsborough River* (Southwest Florida Water Management District and Atkins, North America, Inc., 2015).

4. The *Lower Hillsborough River Dissolved Oxygen Study* (Cardno 2017).

5. The *Hillsborough River Laterally Averaged Model for Estuaries (LAMFE) Post-Processing Project (H-4000*) (Janicki Environmental, Inc. 2015).

6. The most recent recovery strategy rule-required annual update to the District Governing Board (Southwest Florida Water Management District 2018).

This report contains a summary of the results and findings on recent biological data collected by Water & Air as well as extensive historical hydrologic and water quality data sets. This evaluation includes a review and compilation of these data to ensure that all necessary data are comparable to the more recent data collected and used for the current 5-year assessment.

Water & Air did not, however, conduct a detailed quality assurance audit to determine if adequate quality assurance assessments were conducted by all the various data sources. Such an audit, requiring onsite examination of facilities and records, as well as examination of standard operating procedures, data objectives, sample collection, chain-of-custody protocols, laboratory analyses, data management procedures, and a variety of other quality assurance procedures and standards specific for each measurement or analytical approach, is beyond the scope of work identified for this 5-year recovery strategy project. Although a detailed audit could not be performed, to the best of our knowledge, the information provided appears to have been collected in accordance with standard procedures and protocols.

1.2 Geographic Range of the Lower Hillsborough River Study

The purpose of the minimum flow and recovery strategy implementation is to extend a zone of water of less than 5 ppt salinity from the Hillsborough River dam at river kilometer 16.2

(RKm 16.2) toward Sulphur Springs, which flows into the Hillsborough River approximately 3.5 kilometers (km) below the dam. In this report, RKm denotes the distance from the river mouth beginning at the Hillsborough Bay. The focus area of this assessment was primarily limited to the reach of the river from the dam at RKm 16.2 extending downstream to RKm 10.6 at Sligh Avenue (Figure 1.2-1).

Biological and water quality data were divided into river segments (lower, middle, and upper) for graphical and statistical analyses (Figures 1.2-1 and 1.2-2), for the 5.6 km (3.5 miles) reach below the Hillsborough River Dam. It should be noted that these river segments are not the same as the strata used in the Hydrobiological Monitoring Program (HBMP) conducted by Tampa Bay Water as part of water use permit requirements; however, this study does include a large portion of stratum 5 and all of stratum 6, which extends to the dam. The geographic locations of the LHR segments are indicated below.

1. Lower segment – RKm 10.6 to 12.6 (mouth of river to just above Interstate I-275)
2. Middle segment – RKm 12.6 to 14.49 (just above I-275 to Hanna's Whirl)
3. Upper segment – RKm 14.5 to 16.2 (just above Hanna's Whirl to the dam)

1.3 Recovery Strategy for the Lower Hillsborough River and the Phased Implementation of Minimum Flows

A recovery strategy and a revised minimum flow rule were necessary because the LHR was not meeting the minimum flow levels adopted in 2007 (Rule 40D-8.041(1), F.A.C.). Section 373.0421(2) of the Florida Statutes states that if the actual flow of the water course falls below the adopted minimum flow criteria or is projected to fall below the criteria over the next 20 years, adoption and implementation of a recovery or prevention strategy is required. For flowing water bodies, the strategies are intended to achieve recovery to the established minimum flow as soon as practicable or prevent the existing from falling below the established minimum flow or minimum water level. Recovery or prevention strategies must include a phased-in approach or a timetable which will allow for the provision of sufficient water supplies for all existing and projected reasonable-beneficial uses. The current recovery strategy that is applicable to the LHR was approved by the District Governing Board in August 2007 and adopted into a rule that became effective in November 2007. Minor formatting changes to the rule were adopted and became effective in May 2014.

The LHR recovery strategy identifies several water supply projects, their order of priority for development and use as sources for river recovery, and for most, the quantities of water that the projects/source can or are expected to provide to recover and maintain the established minimum flow levels. These projects are itemized below and discussed in greater detail in Section 3.0 of this report.

1) Sulphur Springs, involving lower weir modifications and Sulphur Springs pool upper weir and pump station modifications, to supply up to 18 cfs for minimum flow supplementation at the base of the dam (has provided supplemental water to the LHR below the dam since 2002, with system modifications in 2012);

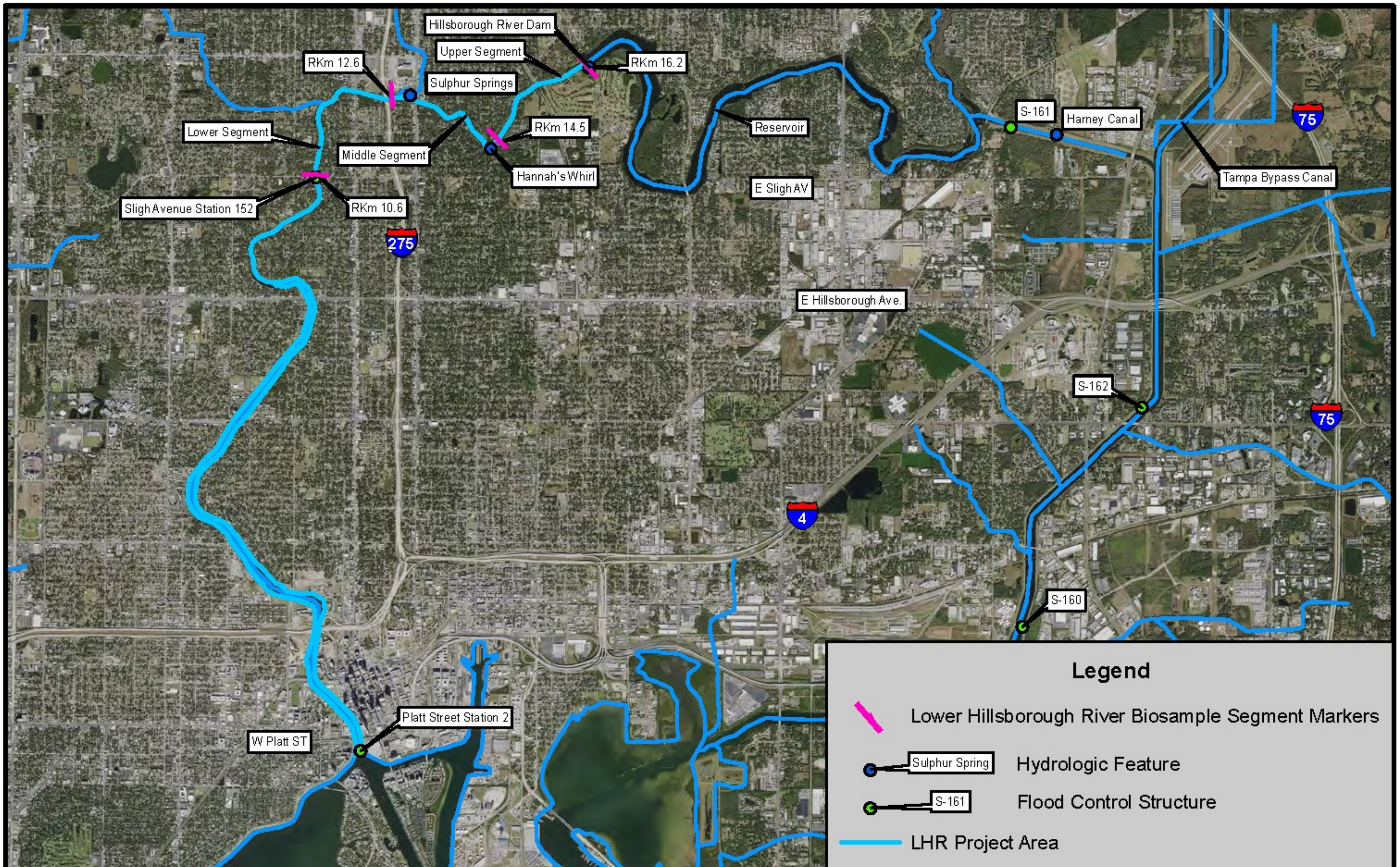

Figure 1.2-1.
Lower Hillsborough River Assessment Area and Upper, Middle, and Lower Hillsborough River Segments
Hillsborough County, Florida

Source: FDOT, 2017; Water & Air Research, Inc., 2019.

0 1 2 4 Km

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water & air RESEARCH, INC.

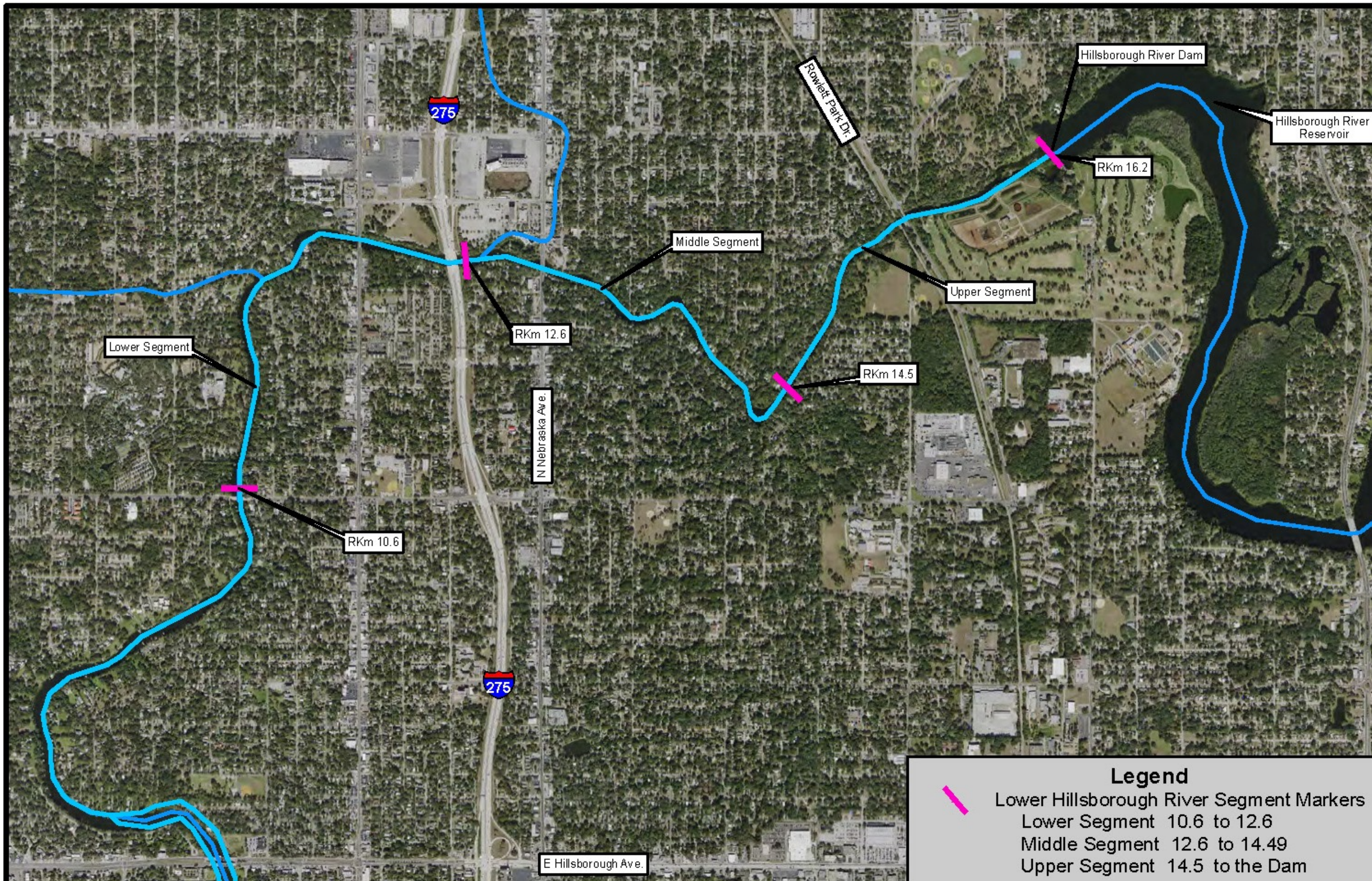


Figure 1.2-2.
Lower Hillsborough River Segments
Hillsborough County, Florida

Source: FDOT, 2017; Water & Air Research, Inc., 2018.

water & air RESEARCH, INC.

2) Analysis and subsequent use of Blue Sink to facilitate supply of up to 3.1 cfs for minimum flow supplementation at the base of the dam (recently operational and providing supplemental water beginning March 27, 2018);

3) Tampa Bypass Canal (TBC) and Hillsborough River Reservoir diversions to supply up to 11 cfs to the base of the dam to the Hillsborough Reservoir, of which 8.3 cfs is diverted to the LHR (has provided supplemental water to the LHR since 2008);

4) Morris Bridge Sink to supply up to 6 cfs for minimum flow supplementation at the base of the dam via diversion through the TBC and Hillsborough River Reservoir (proposed water resource is permitted, temporary pumps could be used to operate this source);

5) Transmission pipeline project to convey water from the TBC middle pool to the base of the dam (no longer considered a viable project as of 2008); and

6) Investigation of storage or additional supply options to provide minimum flow supplementation at the base of the dam (currently includes the TAP that may potentially provide up to 50 million gallons per day (mgd; 1 mgd = 1.5 cfs) of water to the reservoir for water supply, with some of the quantity available for minimum flow supplementation).

The LHR recovery strategy outlines a timeline for the implementation of these projects. Four of the projects (Sulphur Springs, Blue Sink analysis, transmission pipeline project, and additional storage/supply investigations) were identified for joint funding by the District and the City, and two projects (TBC/Hillsborough River Reservoir diversions and Morris Bridge Sink) were to be implemented by the District. Implementation of one of these two projects, the TBC/Hillsborough River Reservoir diversion, was to be initiated by the District, with subsequent project implementation by the City. Implementation of specific projects is subject to applicable diagnostic/feasibility studies and contingent on obtaining any required permits.

The recovery strategy requires the submission of an annual report to the District Governing Board on the progress of implementation of the strategy. The strategy also requires that beginning in 2013, and every five years through 2023, the District will evaluate specific environmental results achieved from implementation of the recovery strategy for the prior 5 years. As part of the 5-year assessments, the District is required to assess the recording systems used to monitor these parameters, and to also evaluate the effect of the recovery strategy on water levels in the Hillsborough River above the City's dam to at least Fletcher Avenue. In addition, the District will evaluate all projects described in the recovery strategy relative to their potential for unacceptable adverse impacts prior to their implementation.

2.0 Hydrologic Characteristics of the Lower Hillsborough River/Tampa Bypass Canal System (in Relation to Minimum Flows for the Lower River)

2.1 Watershed Overview

The Hillsborough River watershed covers more than 1,748 square kilometers (km^2), equivalent to 675 square miles, in Hillsborough, Pasco, and Polk counties and is the largest river drainage system discharging into Tampa Bay (Figure 1.0-1). The river course is approximately 87 km, equivalent to 54 miles, beginning in the southwestern corner of the Green Swamp, and the river flows generally from the northeast to the southwest into Tampa Bay. The northern and central portions of the watershed are generally rural and include public conservation and privately-owned agricultural lands, while the southern portion is primarily urban in nature.

The Hillsborough River is the most urbanized river discharging into Tampa Bay and provides a substantial amount of freshwater flow that is critical to mitigating the impacts of salinity and supporting the habitat needs of Tampa Bay, which is Florida's largest open water estuary. The Hillsborough River is the primary surficial source of drinking water for the City and has two water quality and resource classifications, Class I and Class III. The Class I designation covers the area upstream of the dam because it is a public potable water-supply source. Regulations pertaining to water quality for this portion of the river are more stringent because of the public water supply use. Downstream of the dam, the river is classified as Class III water, which is subject to less-stringent standards but does provide some level of protection as defined in Rule 62-302.400, F.A.C., for fish consumption, recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife.

The *Lower* Hillsborough River is defined as the reach of the river extending downstream from the base of the dam to its mouth discharging into Tampa Bay as indicated in Figure 1.0-2. The middle reach of the *entire* river extends from the river dam up to Fletcher Avenue, and the upper reach of the *entire* river is the reach extending north of Fletcher Avenue to its origin in the Green Swamp near the Pasco and Polk county lines. Furthermore, it is important to note that for the sake of the 5-year assessment that the reach of the *Lower* Hillsborough River was also divided into three segments (upper, middle, and lower as indicated in Figures 1.2-1, 1.2-2, and 2.1-1), and that these given titles should not be confused with the lower, middle, and upper reaches of the *entire* Hillsborough River.

The watershed contains several springs and sink features including Crystal Springs, Sulphur Springs, and Morris Bridge Sink and Blue Sink, among others. Crystal Springs is a natural spring near Zephyrhills that is a major source of fresh water for the Hillsborough River. While the Hillsborough River is partially spring fed, it is primarily a blackwater river that drains pine flatwoods and cypress swamps at its origin in the Green Swamp. Sulphur Springs is in metropolitan Tampa, immediately adjacent to the right bank (north side) of the Hillsborough River between U.S. Highway 41/Nebraska Avenue and Interstate 275 (I-275), as indicated in

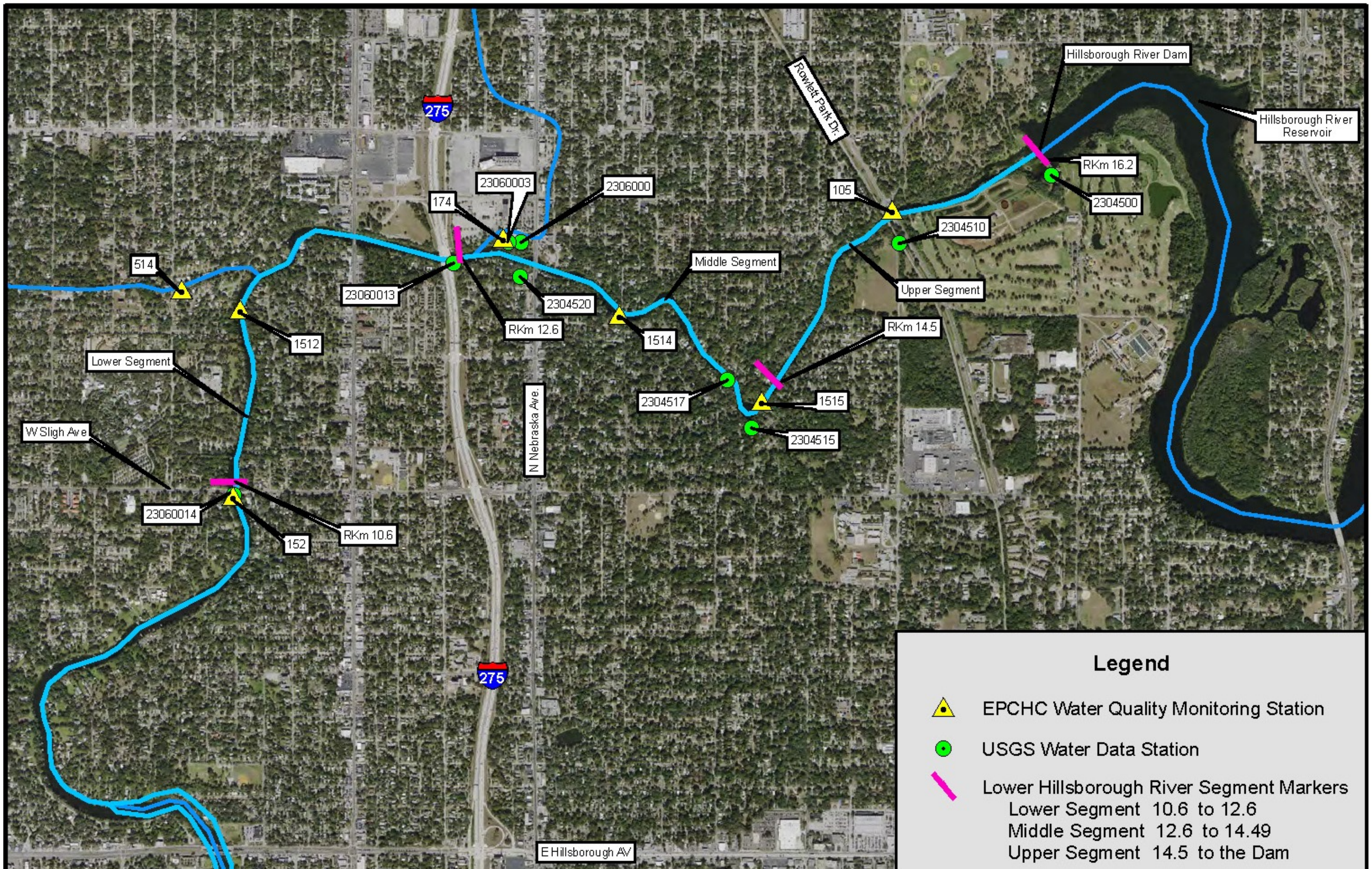


Figure 2.1-1.
Lower Hillsborough River USGS and EPCHC Stations
Hillsborough County, Florida

Source: FDOT, 2017; Water & Air Research, Inc., 2018.

Figure 1.2-1. Sulphur Springs is a critical component of the LHR recovery strategy, contributing up to 18 cfs via a pump station and pipeline that delivers water to the base of the dam. The Hillsborough River is impounded by a dam approximately 16 km (9.9 miles) upstream from where it discharges into Tampa Bay. The Hillsborough River and reservoir have served as the City's primary source of drinking water since the mid-1920s, with the original dam constructed in the late 1890s. Located to the east of the dam, the reservoir covers approximately 5.3 km^2 (2 square miles) (mi^2) and can hold up to 1.2 billion gallons of water for use as the major drinking water supply for the City.

2.2 Tampa Bypass Canal Construction and Use

The TBC (shown in Figures 1.0-2 and 1.2-1) is a 22.5-km (14 mile) waterway designed and constructed by the U.S. Army Corps of Engineers to divert floodwaters around Temple Terrace and downtown Tampa and serves as one component of the Four River Basins drainage project that commenced following widespread flooding in the wake of Hurricane Donna in 1960.

The TBC connects the Lower Hillsborough Wilderness Preserve (LHWP)/ Lower Hillsborough Flood Detention Area (LHFDA) with McKay Bay. The TBC begins northeast of Temple Terrace at Cow House Creek in the LHFDA and passes south, crossing I-4 at East Hillsborough Avenue and State Route 60 near Orient Road, then heads west and empties into McKay Bay at the mouth of the Palm River. The canal generally follows the course of the Palm River to McKay Bay, but channelization of the river significantly increased its flow capacity.

The canal system contains multiple flood control structures and is designed to impound flood waters from the Hillsborough River into the LHWP/LHFDA water detention area. As the detention area fills with water from the Hillsborough River and the surrounding watershed, the floodwaters enter the TBC and are diverted to McKay Bay, bypassing the Cities of Temple Terrace and Tampa, thereby effectively reducing the threat of flooding. As shown in Figure 1.0-2, the system includes multiple canals, structures, and monitoring systems including the S-155; S-159 Lower, Middle, and Upper structures; S-160; S-161; S-162; and S-163 water control structures.

Based on these structures and their operation, the TBC is divided into lower, middle and upper pools. The upper pool is that portion upstream of the S-159 structures, the middle pool extends from the S-159 structures downstream to S-162, and the lower pool extends from S-162 downstream to Structure S-160. The middle pool of the TBC is connected to the Hillsborough River reservoir by the Harney Canal about 9.7 km (6 miles) upstream of the dam.

Excavation of the canal resulted in cutting into the confining bed that separates the Upper Florida Aquifer from the overlying surficial aquifer, and in several places, breached the Upper Floridan aquifer (Geraghty and Miller, Inc. 1982. Knutilla and Corral 1984). This resulted in groundwater discharge to the canal between structures S-159 and S-160, which lowered the potentiometric surface of the Upper Floridan aquifer near the canal and eliminated flow from two springs in the Harney Flats area. As a result of this development, Structure S-162 on the TBC was constructed to maintain higher surface water levels in the middle pool of the canal to partially reduce the groundwater discharge to the canal (Motz, 1975). Knutilla and Coral (1984) analyzed data from the late 1970s to the early 1980s and estimated that average groundwater discharge to the canal was approximately 31 cfs (equivalent to 20 million gallons per day). However, groundwater discharge to the canal varies with hydrologic conditions and was less in several very dry years that occurred after that study period.

In addition to providing flood control, the TBC also serves as a drinking water supply resource and is used to maintain minimum flows for the LHR, although this was not part of its original design or intent. The TBC is used help to meet minimum flow needs for the LHR by providing up to 11 cfs of water for delivery to the base of the dam (of which 8.25 cfs are currently diverted to the LHR to contribute to minimum flows).

2.3 Water Supply Use from the Hillsborough River Reservoir, the Tampa Bypass Canal, and Sulphur Springs

Hillsborough River Reservoir

Water for public supply is withdrawn from the reservoir by the City of Tampa Water Department and treated at the David L. Tippin Water Treatment Facility. The water withdrawal for the City's public supply from the Hillsborough River Reservoir is regulated under Water Use Permit (WUP) No. 20002062.006 issued in December 2004 and expiring in December 2024. Permit conditions allow for an average annual daily withdrawal of 82 mgd and a maximum daily withdrawal of 120 mgd. Prior to 2004, the maximum daily withdrawal rate was 104 mgd, but implementation of the Aquifer Storage Recovery (ASR) Program increased groundwater storage capacity during the wet season within the Upper Floridan aquifer, allowing for greater storage capacity and use in the dry season if needed.

According to information provided on the City's website, the facility treats and distributes approximately 80 mgd of water and has the capacity to treat and distribute up to 120 mgd. The water supply service area covers 546.5 km^2 (211 mi^2) and serves a population of approximately 600,000 customers. Water (based on daily pumping data from the City provided by the District) that was pumped from the reservoir for public use for the period of October 1, 1979 through May 31, 2018 is shown in Figure 2.3-1. An average increase in water supply from 1979 through present day corresponds to the growth and population increase for the service area. For example, in 1980, an average of approximately 50 mgd was supplied; in 2016 (latest year with a completed daily pumping data set), an average of nearly 74 mgd was pumped. The pumping for the current period from October 1, 2012 through May 31, 2018 is shown in Figure 2.3-2. This time period indicates an increase in daily water pumping volume with an average daily water use of 73 mgd. No data for December 2013 were reported.

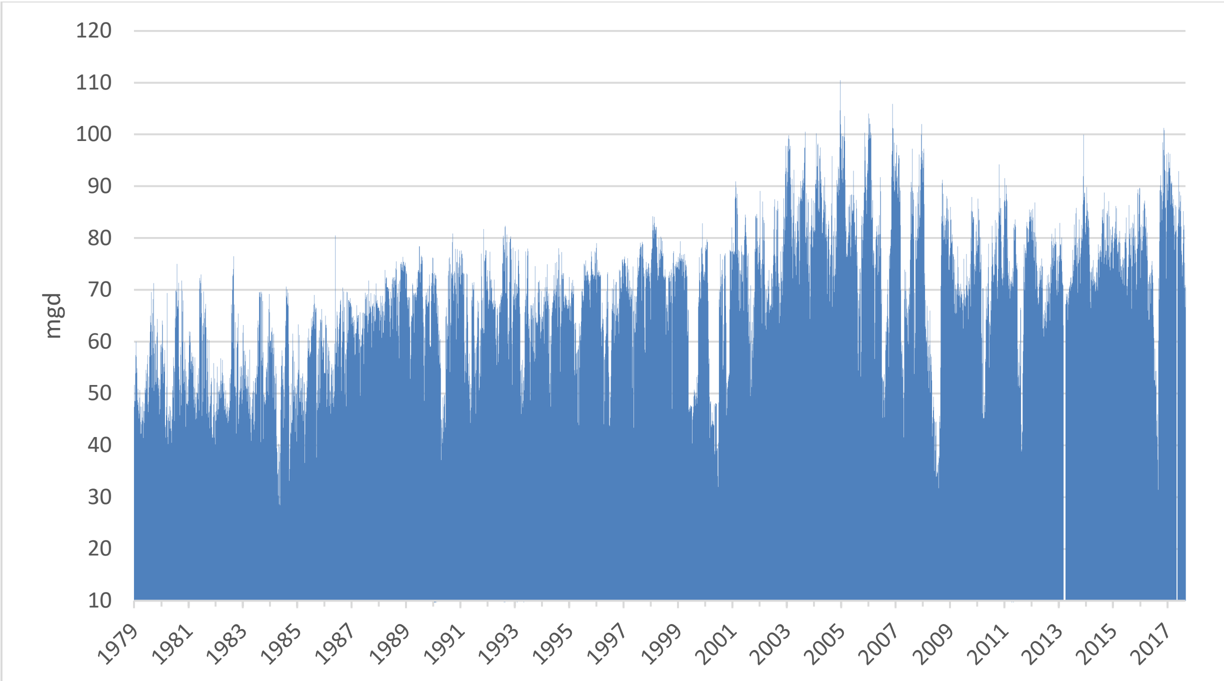


Figure 2.3-1 Long-term mean daily water supply (mgd) from the Hillsborough River Reservoir pumping station from October 1979 through May 2018.

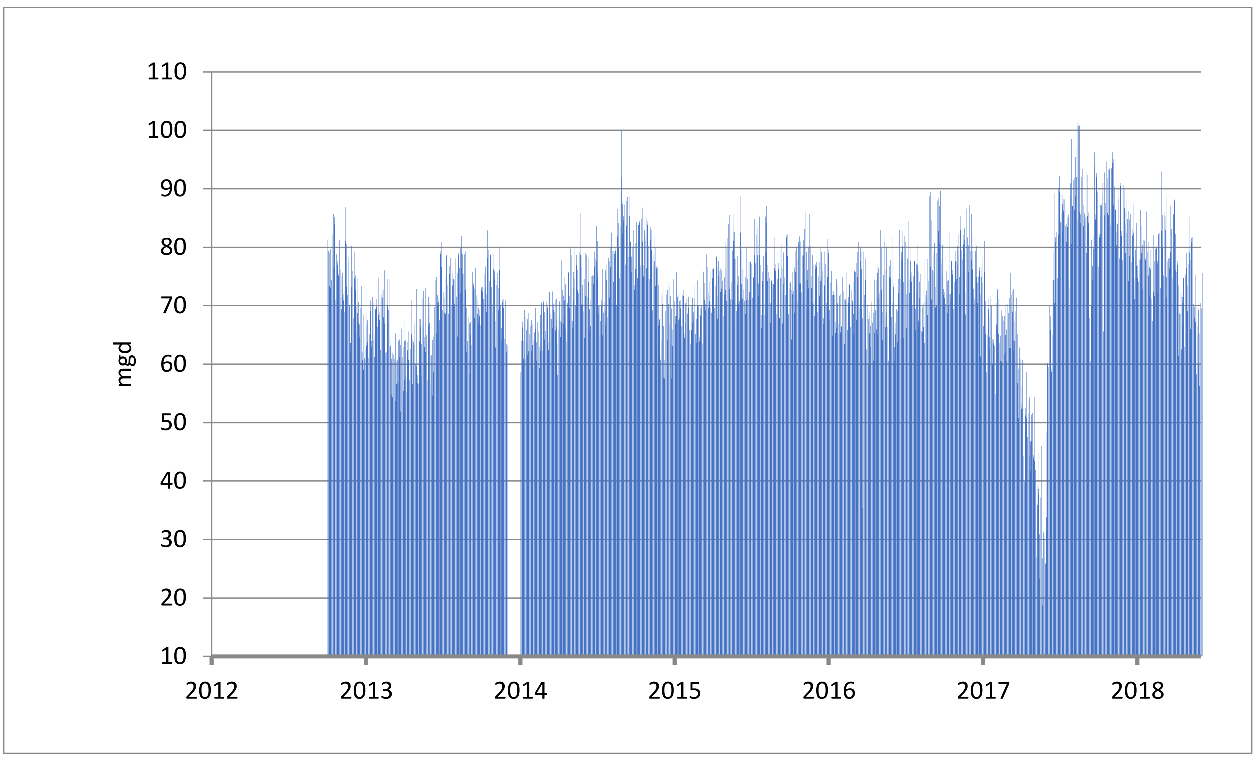


Figure 2.3-2 Mean daily water supply (mgd) from the Hillsborough River Reservoir pumping station for the assessment period from October 2012 through May 2018. Pumping data missing for December 2013.

Tampa Bypass Canal

Since 1985, the TBC has been used as a public water supply through augmentation of the reservoir in support of withdrawals by the City authorized under WUP No. 20002062.006. The current WUP (No. 20006675.006) authorizing the augmentation, was issued to Tampa Bay Water in May 2011 and expires in May 2031. An average annual daily withdrawal rate of 20 mgd and a maximum peak monthly withdrawal volume of 40 mgd are permitted from the Harney Canal area of the middle pool of the TBC for reservoir augmentation. The City determines the daily times and rates for pumping into the reservoir based on the decrease in water level elevation below the dam crest spillway at an elevation of 22.5 feet. Figure 2.3-3 indicates monthly water supply augmentation to the reservoir from the TBC from 1985 through 2018, while Figure 2.3-4 indicates water augmentation for the current hydrobiological assessment period of October 1, 2012 through May 31, 2018. It is evident that TBC augmentation pumping increases during dry periods, but that there are also periods of no augmentation when the dam crest elevation is maintained and there is flow over the dam.

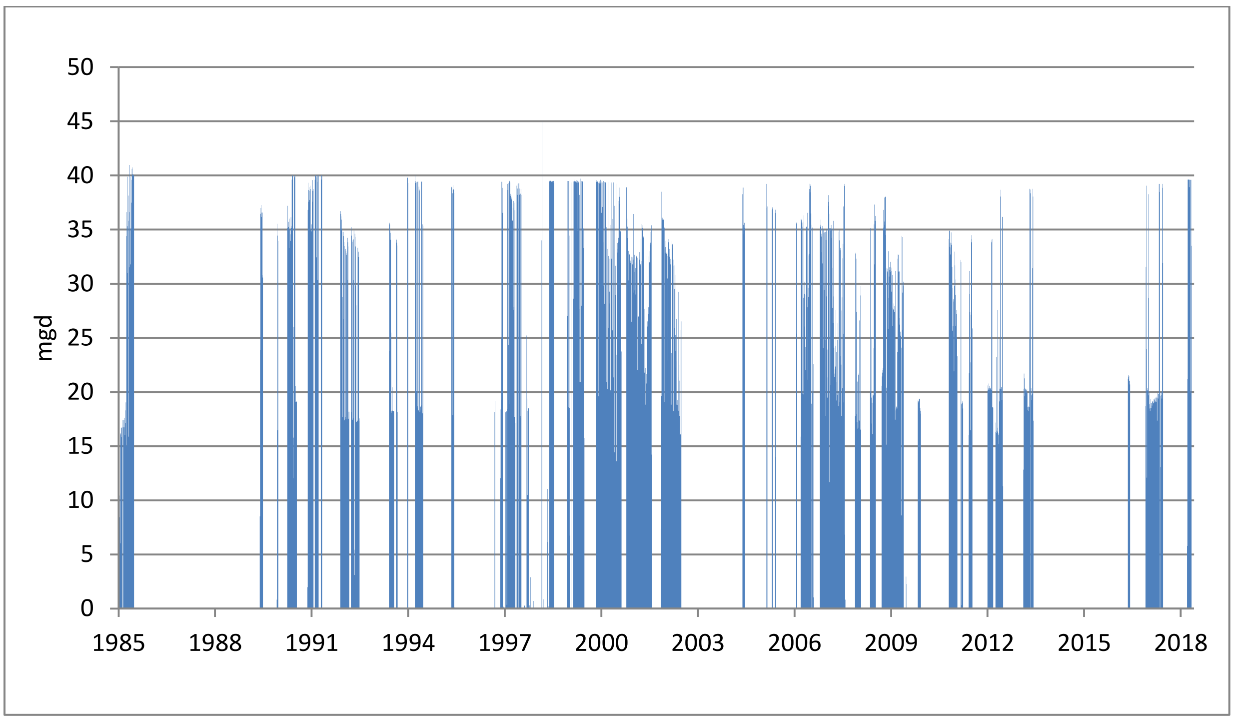


Figure 2.3-3 Long-term mean daily water supply (mgd) from the Tampa Bypass Canal to the Hillsborough River Reservoir from January 1985 through May 2018.

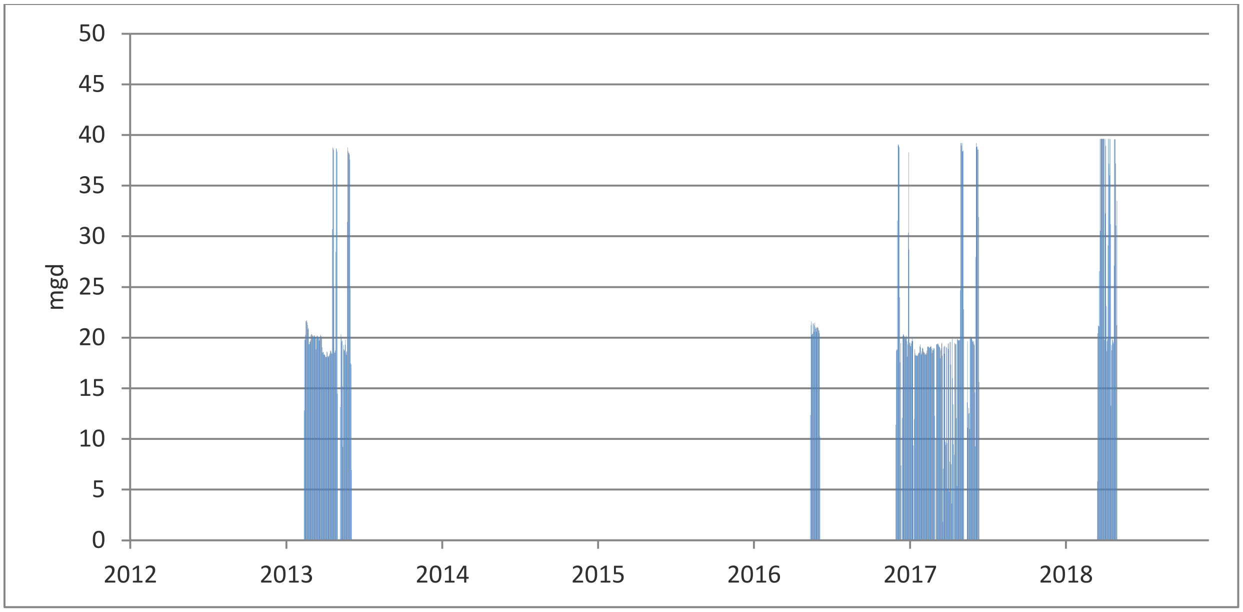


Figure 2.3-4 Mean daily water supply (mgd) from the Tampa Bypass Canal to the Hillsborough River Reservoir for the period from October 2012 through May 2018. Increased pumping occurred during dry periods; no pumping indicates conditions when the dam crest elevation did not require augmentation.

The TBC also directly supplies water for public supply per permit conditions that were originally implemented in 1999. The current WUP (No. 20111796.002) for these withdrawals was issued to Tampa Bay Water in August 2007 and expires in December 2030. Water is pumped directly from the lower and middle pools at water control structure S-159 to the Tampa Water Plant to the east of the TBC for treatment and distribution. During high water occurrences of over 100 cfs at the dam, water can be diverted from the reservoir to the TBC via the Harney Canal and then directly withdrawn for water supply.

Since the late 2000s, water has also been withdrawn from the TBC to directly support LHR recovery. As specified in the LHR recovery strategy, minimum flow releases from the reservoir are to be replenished by pumpage from the TBC. Using a temporary pumping facility on the north bank of the Harney Canal, the District began pumping up to 11 cfs from the middle pool of the TBC around Structure S-161 to the reservoir on December 31, 2007. Based on concerns expressed by the City regarding loss terms from the reservoir, twenty-five percent of the minimum flow water pumped from the Harney Canal was considered lost from the reservoir system, so 75 percent of the water pumped from the Harney Canal pool for recovery of the river was diverted from the reservoir to the lower river. Therefore, a maximum pumpage rate of 11 cfs from the Harney Canal resulted in a release of 8.3 cfs to the lower river.

By October 1, 2013, the City was to assume operation of pumping facilities used to divert water from the TBC middle pool to the reservoir and from the reservoir to the LHR. However, the District continued to implement these diversions through November 2017, at which time the City assumed responsibility pumping and reporting the flow diversions. During this interim period, a consumptive water use permit (No. 20020575.000) for pumping from the TBC to the reservoir in support of LHR recovery was issued to the District by Florida Department of Environmental Protection (FDEP) in December 2015. The City is currently in the process of acquiring a permit from the District for the diversions from the TBC to the reservoir that were formerly implemented by the District.

<u>Sulphur Springs</u>

Sulphur Springs is located approximately 3.5 km (2.2 miles) downstream of the reservoir dam (Figure 1.2-1) and is a major water resource that is diverted to supplement water supply to the reservoir and augment flow to the LHR. Water has been pumped from the springs via a pipeline to the reservoir since the mid-1960s. Water withdrawal for the City's public supply from Sulphur Springs is also regulated under WUP No. 20002062.006 issued in December 2004 and expiring in December 2024. Permit conditions allow for an average annual daily withdrawal of 10 mgd and a maximum day withdrawal of 20 mgd. Although this water can be used as a potable source, it is only used during times of water shortages because Sulphur Springs water is mineralized and exceeds certain Class I potable water quality standards until blended with the reservoir water. Moreover, records of daily pumping volumes provided by the District indicate that very limited and sporadic pumping to the reservoir occurred from December 1984 through August 2009. Based on pumping records provided by the District, no water for potable supply from Sulphur Springs has occurred since August 2009; however, the spring remains a primary minimum flows resource that is pumped and then discharged via a flume on the north bank of the river just downstream of the dam.

2.4 Flow to the Lower Hillsborough River

The USGS has recorded daily flow volumes from the Hillsborough River Reservoir to the lower river at the base of the dam since 1939 at USGS Station No. 02304500. The gauge is located near the south end of the dam on the left bank at the upstream side of the control structure for the reservoir (latitude 28°01'25", longitude 82°25'40"; North American Elevation Datum 1927). According to information on the USGS website for this gauge, both daily and monthly discharge data measured in cfs have been collected since October 1938, and annual discharge information has been collected since 1939. This gauge is instrumental for providing water quantity parameters due to its length of service and location at the dam site where the LHR minimum flows are implemented.

Discharges to the lower river, without minimum flow supplementation, are shown in Figures 2.4-1 and 2.4-2, respectively, and Table 2-4.1. These discharges are represented as the monthly average beginning at the historic period from October 1979 through May 2018 and covering the current assessment period from October 2012 through May 2018. It is important to note that this expanse of time also correlates with an increased demand for potable water supplies as the area became heavily urbanized.

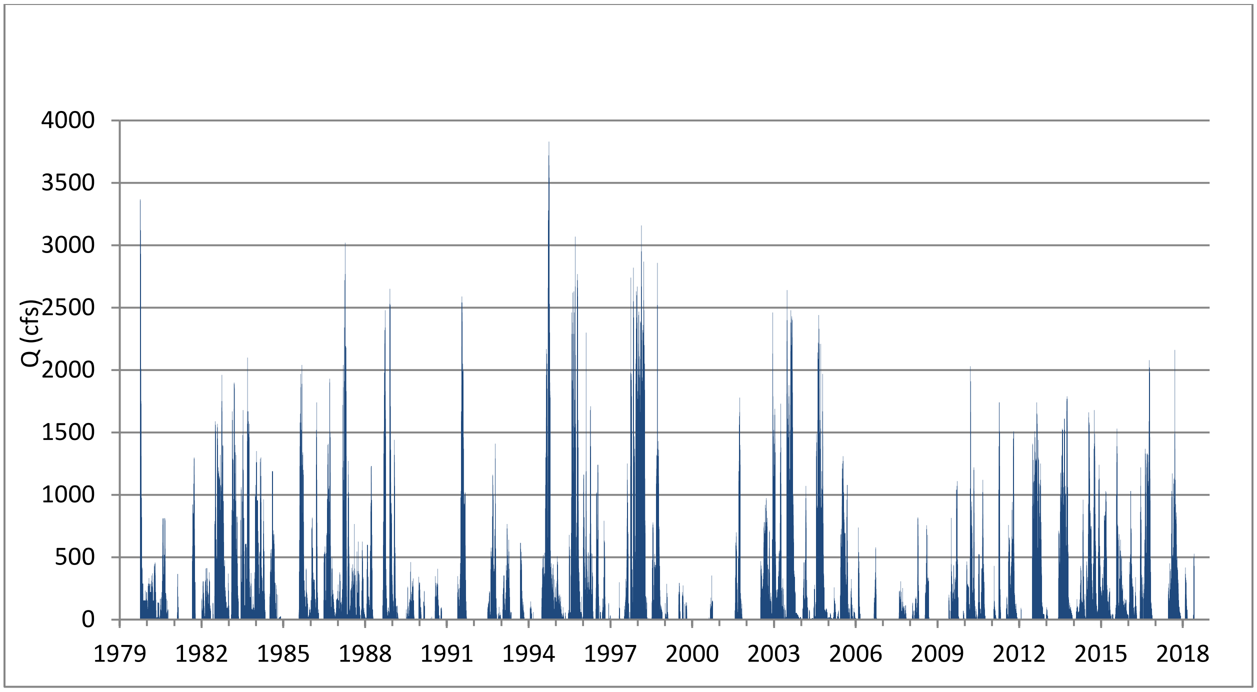


Figure 2.4-1 Daily mean discharge (cfs) for the USGS Gauge 02304500 at the Hillsborough River Dam without minimum flow supplementation from October 1979 through May 2018.

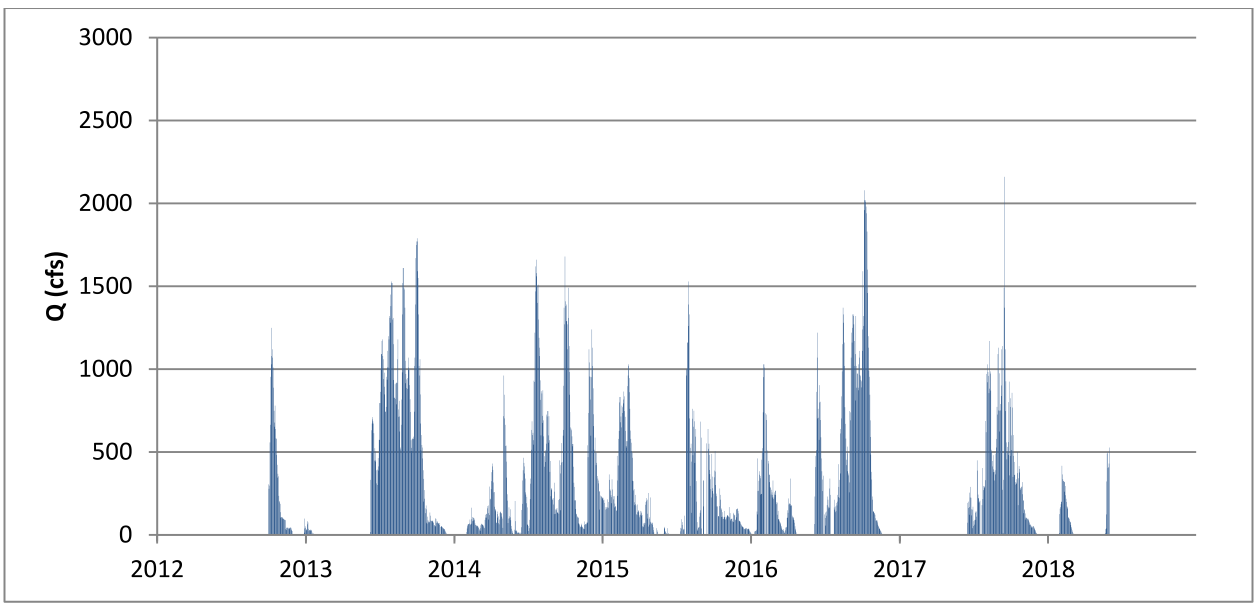


Figure 2.4-2 Daily mean discharge (cfs) for the USGS Gauge 02304500 at the Hillsborough River Dam without minimum flow supplementation from October 2012 through May 2018.

Table 2.4-1 The number of days the that discharge at the Hillsborough River Dam was ≤ 1 cfs, without minimum flow supplementation , for the current assessment period of October 1, 2012 through May 31, 2018.

Year	Days in Assessment Period	Missing Data Days	Days where Flow >1 cfs	Days where Flow ≤1 cfs	Percentage of Days when Flow ≤1 cfs
2012	92	0	66	26	28
2013	365	1	213	151	41
2014	365	4	330	31	9
2015	365	27	292	36	11
2016	366	15	264	87	25
2017	365	5	168	191	53
2018	151	0	47	104	69

For full years included in the current assessment period, the average number of days when flow over the dam was reported to be ≤ 1 cfs, not including minimum flow supplementation, ranged from 9 to 53%.

Water levels (Figure 2.4-3) in the Hillsborough River Reservoir primarily fluctuate based on rainfall, inflow, augmentation from the TBC, and withdrawals by the City of Tampa. Above-average rainfall in several recent years supported consistent, high water levels in the reservoir (Figure 2.4-4) and reduced need for augmentation from the TBC.

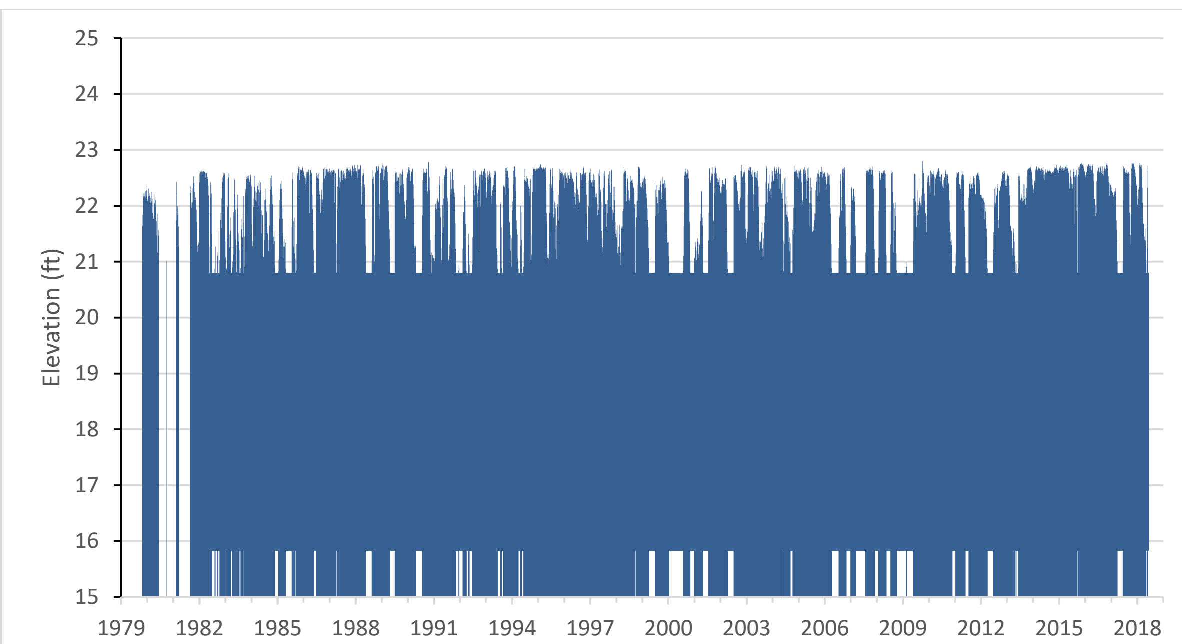


Figure 2.4-3 Stage elevation (ft) at the Hillsborough River Dam USGS Gauge 02304500, October 1979 through May 2018. Missing data responsible for periods with no elevation measurements.

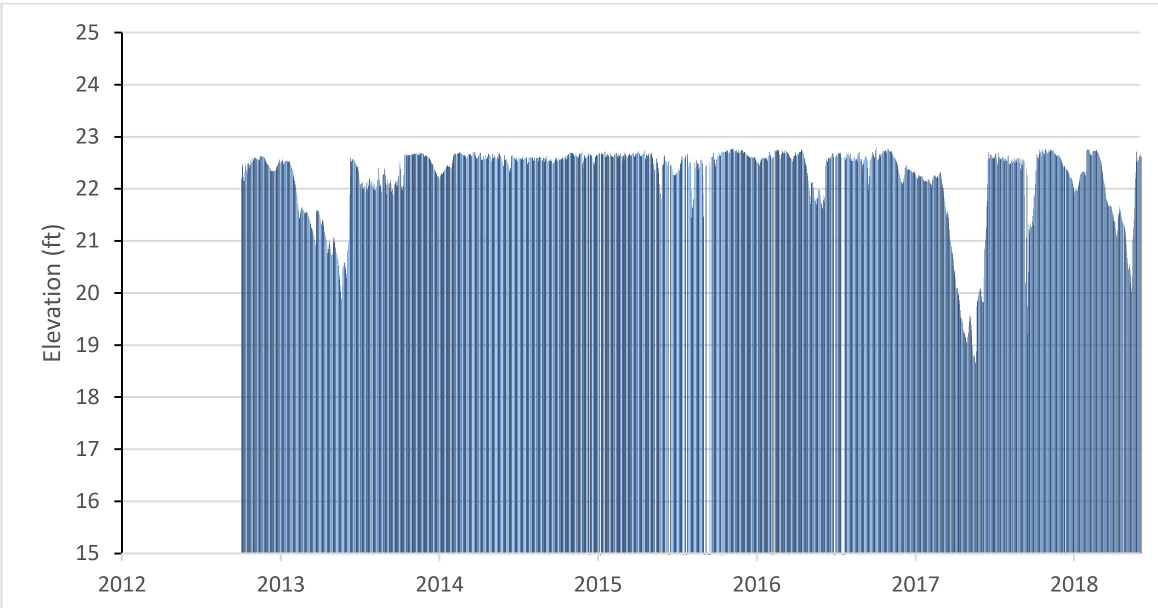


Figure 2.4-4 Stage elevation (ft) at the Hillsborough River Dam USGS Gauge 02304500, October 2012 through May 2018. Missing data for periods in 2015 and 2016 account for apparent low water levels or data gaps.

The number of no-flow days (i.e., flows ≤ 1 cfs), not including minimum flow supplementation for river recovery, for October 1, 1979 through May 31, 2018 and the current 5-year assessment period are shown in Figures 2.4-5 and 2.4-6, respectively. Prior to August 7, 2000 no minimum flow rate was established. Since August 7, 2000, a 10 cfs minimum flow was required; and since November 25, 2007, minimum flow maximums of 20 cfs freshwater equivalent were required from July 1 through March 31, and 24 cfs freshwater equivalent flows were required from April 1 through June 30. Current minimum flow requirement maxima are reduced based on flow conditions in the Hillsborough River at Zephyrhills.

On average, there were 137 no-flow days per year for the entire historic period versus 89 no-flow days per year for the current 5-year assessment period. The graphs and average no-flow days show a general decrease in the number of no-flow days since minimum flow supplementation for river recovery was initiated in 2007 when the minimum flows rule went into effect. There are thirteen years that experienced more than 200 days of ≤ 1 cfs flow measured at the Hillsborough River Dam Gauge 02304500 from October 1979 through May 2018.

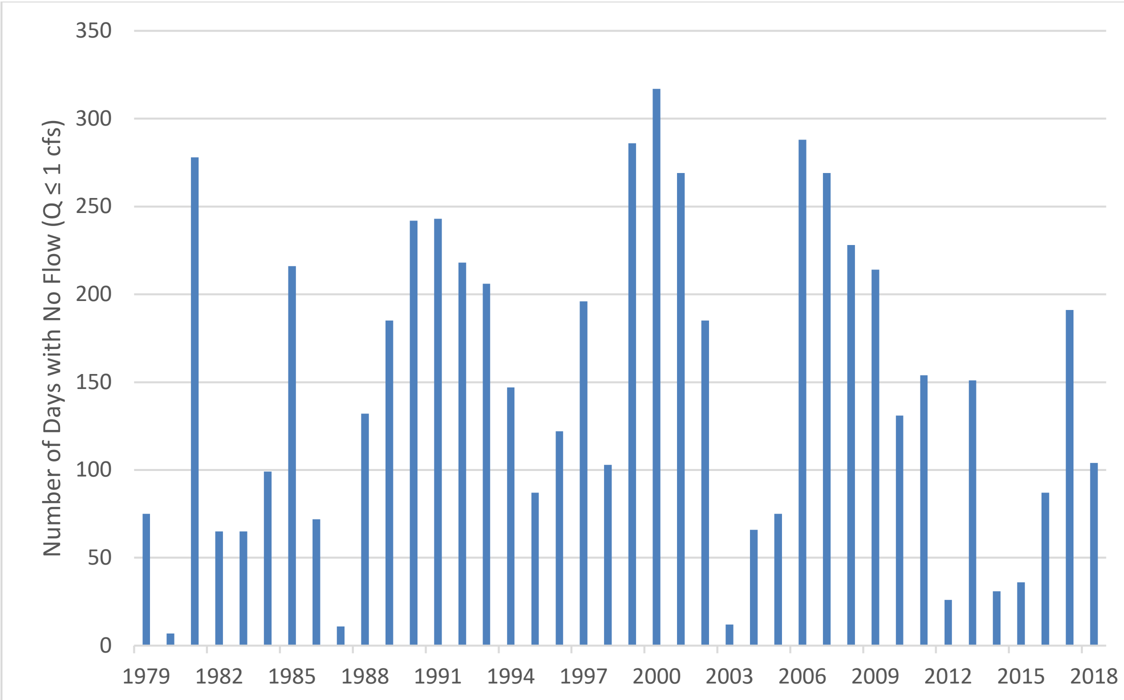


Figure 2.4-5 No-flow days, where discharge ≤ 1 (cfs), at the Hillsborough River Dam Gauge 02304500, October 1979 through May 2018.

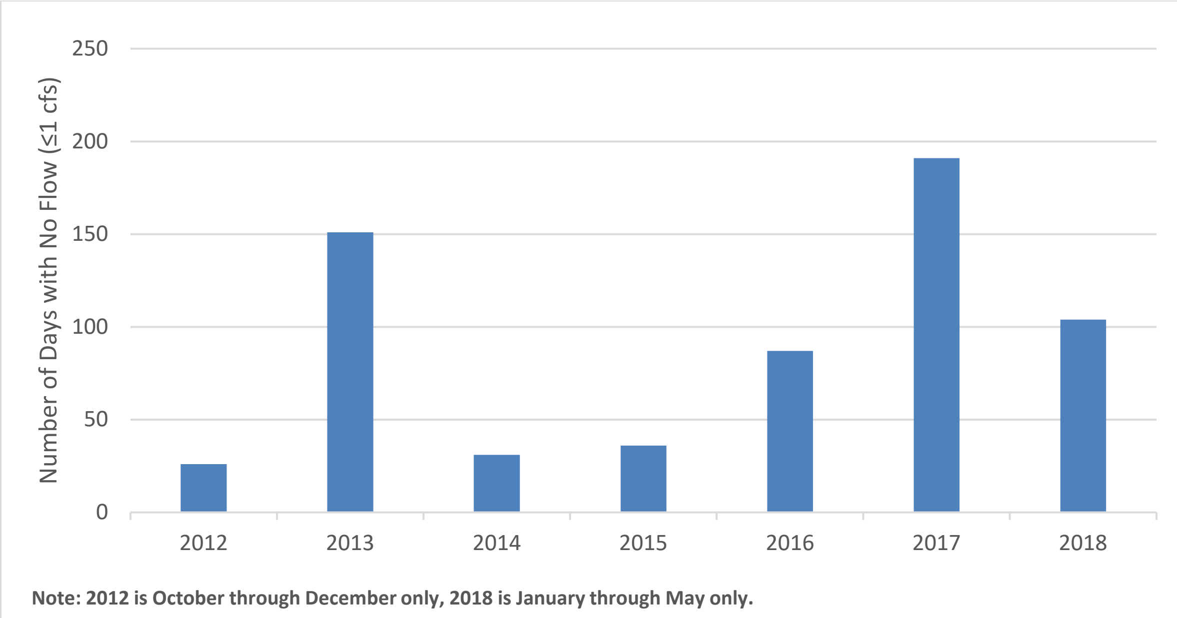


Figure 2.4-6 No-flow days, where discharge ≤ 1 (cfs), at the Hillsborough River Dam Gauge 02304500, October 2012 through May 2018.

Another variable to consider is that the LHR also receives stormwater flow from the urbanized area downstream of the dam. According to information determined by the District in 2006, ungauged flow from an approximately 25-square mile area and 10 drainage sub-basins occurs mostly immediately after large rain events and during the wet season. Ungauged flow corresponds to rainfall events and the summer rainy season, when dam discharge is also greatest. No recent measurements were readily available to determine these flow contributions; however, the previous 5-year assessment report (SWFWMD and Atkins 2015) used modeled values to determine that ungauged flow contributions were <1 cfs 62 percent of the time, <10 cfs 72 percent of the time, and <50 cfs 84 percent of the time.

2.5 Minimum Flow Rates for the Lower Hillsborough River Since October 2012

This section focuses on minimum flows, inclusive of supplemental resources for minimum flow implementation, for the current assessment period of October 1, 2012 through May 31, 2018 and summarizes historical data provided in the previous report (SWFWMD and Atkins 2015). The recovery strategy for minimum flows is presented as combined recovery flows from all source flows (Table 2.5.1-1 and Figure 2.5.1-1) and contributions for each source.

The current minimum flows established for the LHR is 20 cubic feet per second (cfs) of freshwater equivalent flow from July 1 through March 31, and 24 cfs freshwater equivalent flow from April 1 through June 30 at the base of the reservoir dam, adjusted based on a proportionate amount that flow at the U.S. Geological Survey (USGS) Station No. 0203000, Hillsborough River near Zephyrhills, Florida is below 58 cfs. For purposes of the rule and implementation of minimum flows, freshwater equivalent means water that has a salinity concentration of 0.0 ppt for modeling purposes.

Per the minimum flow rule, when flows upstream at the Hillsborough River Zephyrhills Station are less than 58 cfs, minimum flow rates are reduced by a coefficient specific to each established time period, and these reduced flows are known as adjusted minimum flows. The coefficients used to reduce, i.e., adjust the minimum flow requirements are 0.35 per 1 cfs when 20 cfs freshwater equivalent flow is required and 0.40 per 1 cfs when the 24 cfs freshwater equivalent flow is required.

The goals of the minimum flows are to effectively supply a total of 20 or 24 cfs of freshwater from all sources to the base of the dam during the two periods identified in the rule. However, when water from Sulphur Springs is used as a recovery source, it must be taken into account that delivery of 20 or 24 cfs to the base of the dam will likely yield a smaller oligohaline zone than would occur with the delivery of 20 or 24 cfs of freshwater. This is because the portion of water delivered from Sulphur Springs is brackish (specific conductance ≥ 5000 $\mu S\ cm^{-1}$; generally 1 to 3 ppt).

Based on the hydrodynamic modeling of water conditions of < 5 ppt downstream from the dam towards Sulphur Springs, it was determined that a freshwater equivalency factor should be incorporated into the minimum flows. For freshwater equivalency, the addition of 3 cfs to the 20 or 24 cfs seasonal flow requirements was identified for periods when flows from Sulphur Springs are used to significantly contribute to minimum flows implementation (SWFWMD 2006). Since this original work was completed, the District has continued to model effects of varying flow rates and mixtures of recovery source water on salinity conditions in the lower river JEI, Inc. 2915; see Section 2.6 below for additional information). As part of the next five-year recovery strategy assessment (2018-2023), the district intends to further review the freshwater equivalency issue based on additional LAMFE modeling and observed response of the LHR to implemented projects.

2.5.1 Supplemental Augmentation to Achieve Minimum Flows

In addition to water provided for public potable supply, water resources are used to maintain minimum flows for the LHR. Water supplied from the Tampa Bypass Canal, Hillsborough River Reservoir, Sulphur Springs, and Blue Sink (as of March 27, 2018) is used to supplement the LHR as indicated in Figure 2.5.1-1 and Table 2.5.1-1.

Minimum flows are provided to the base of the dam when flows at the USGS station 02304500 at the dam go below the regulatory minimum flows within each of the two seasons (July – March and April –May). Minimum flows rates that were implemented averaged 20.7 cfs, reaching daily maximum values near 27 cfs in 2013 and 2017 (Figure 2.5 1-1).

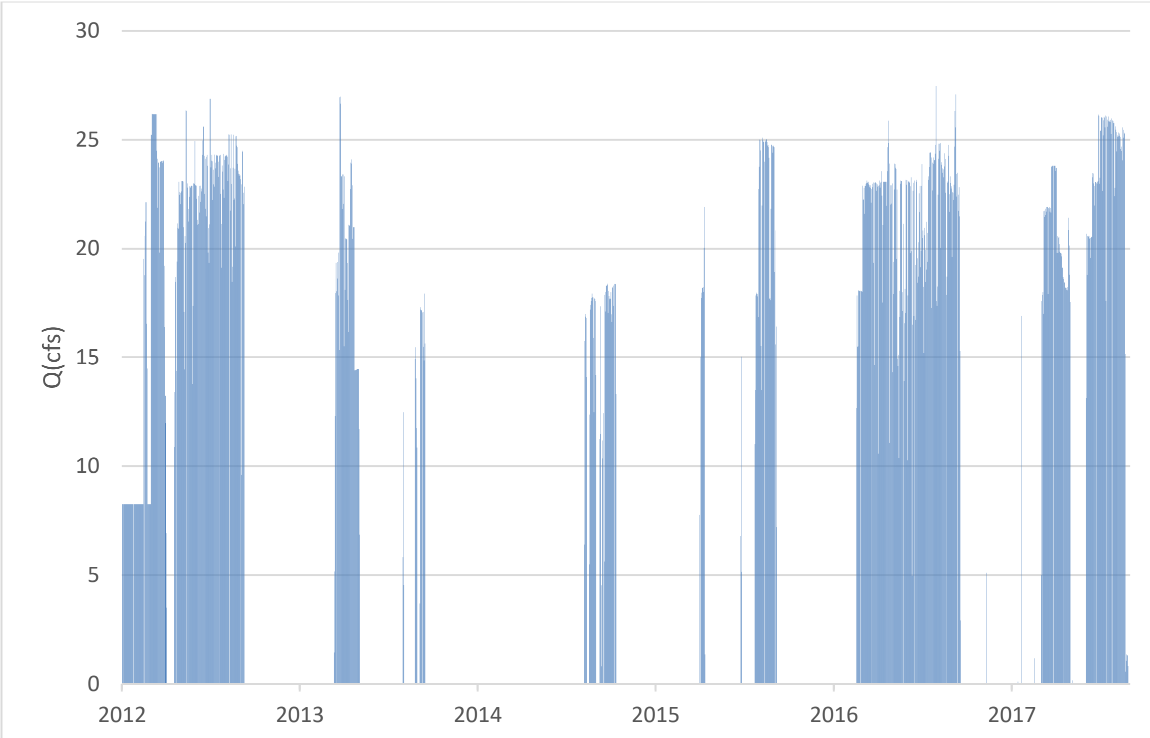


Figure 2.5.1-1 Mean daily minimum flow supplementation (cfs) to the LHR from the Tampa Bypass Canal, Hillsborough River Reservoir, Sulphur Springs, and Blue Sink for the period from October 2012 through May 2018. Increased pumping occurred during dry periods; no pumping indicates conditions when minimum flow implementation was not conducted.

Table 2.5.1-1 Water flow below the dam including minimum flow supplementation (Supp. Aug.) assessed by year. The analysis is based on meeting the MFL of 20 and 24 cfs and does not account for flows needed to meet the freshwater equivalent requirements. Number of days included in assessment period, numbers of days with missing data, number and percentage of days supplemental flow was required by regulation (excludes missing data days), mean daily flow (cfs) deficit ± standard error (S.E.), and the range of daily deficits (cfs) that occurred in that year. Number of days that the regulated minimum flow below the dam was achieved and was not achieved (all days in period with data) by either releases from the dam, minimum flow supplementation, or a combination of both. Deficits included were a minimum of 0.1 cfs from target.

Year	Assessment Period Days	Missing Data Days	Days Supp. Aug. Needed	Percentage Supp. Aug. Needed Days	Percentage of Supp. Aug. Days w/ Deficit	Mean Deficit (cfs) ± S.E.			Deficit Range (cfs)	Days Min. Flow Achieved	Days Min. Flow Not Achieved
2012	92	0	29	31.5	3.4	-0.2	±	0.0	-0.2	91	1
2013	365	1	165	45.3	21.8	-2.2	±	0.4	-14.4 to -0.1	328	36
2014	365	4	48	13.3	47.9	-5.0	±	0.6	-12.2 to -0.4	338	23
2015	365	27	55	16.3	94.5	-6.5	±	0.5	-23.2 to -1.0	286	52
2016	366	15	104	29.6	34.6	-4.2	±	0.5	-10.5 to -0.2	315	36
2017	365	5	197	54.7	31.0	-3.3	±	0.4	-15.0 to -0.1	299	61
2018	151	0	109	72.2	22.9	-1.3	±	0.2	-6.4 to -0.1	126	25

Note that for 2018, minimum flow implementation was generally sufficient to meet minimum flow requirements of 20 and 24 cfs. However, additional flow originally identified in the LHR recovery strategy necessary to meet the freshwater equivalent (3 cfs) was not achieved 60 percent of the time (days) for the period from January 01, 2018 through May 31, 2018. The 2018 pumping data indicates that the mean deficit for these days when the minimum flow was not achieved was by an average of 2.3 cfs. Additional small deficits occurred in early 2018 due to a miscommunication between the City and the District regarding minimum flow supplementation pumping responsibilities and volume determinations. This was during a period when pump ownership at the dam and S-161 was being transferred from the District to the City. A review of missing data periods for 2014 through 2017 indicates that these missing data were due to equipment problems and equipment maintenance when pumps were offline.

From a historical perspective, it is important to note that a minimum flow of 10 cfs was established for the LHR from August 2000 through most of November 2007. Beginning on November 25, 2007, the currently established minimum flow requirements became effective. For both periods, flow from the reservoir to the LHR occurred when the surface water elevation at USGS Station 02304500 was above the 22.5 ft NGVD crest elevation of the dam. When minimum flow supplementation was needed to achieve the established minimum flow targets, water was diverted from the priority sources as specified in the recovery strategy (Sulphur Springs, Blue Sink, and TBC).

The Blue Sink Project was recently brought online by the City March 27, 2018 through the end of the current 5-year assessment period of May 31, 2018. Between March 27, 2013 and May 31, 2018, approximately 104 million gallons of water have been pumped from the sink to the base of the dam for river recovery, providing a daily average discharge rate of 2.43 cfs.

2.5.2 Natural Discharge Rate and Minimum Flow Diversions from Sulphur Springs

Sulphur Springs typically contributes approximately 31 cfs (SWFWMD 2004) to the LHR approximately 3.5 km (2.2 miles) downstream from the Hillsborough River Dam. Mean discharge in cfs from Sulphur Springs for the historical and current 5-year assessment periods is shown in Figures 2.5.2-1 and 2.5.2-2. These figures do not account for flow diversions from Sulphur Springs to the reservoir for water supply augmentation or to the base of the dam for flow supplementation. For the long-term record (Figure 2.5.2-1), there is a general trend in decreasing discharge, as well as large fluctuations in flow ranging from no flow to as much as 50 cfs. Low-flow conditions are most pronounced in the dry season of late winter through spring with flow increases occurring in response to large rainfall events, particularly in the summer and early fall wet season.

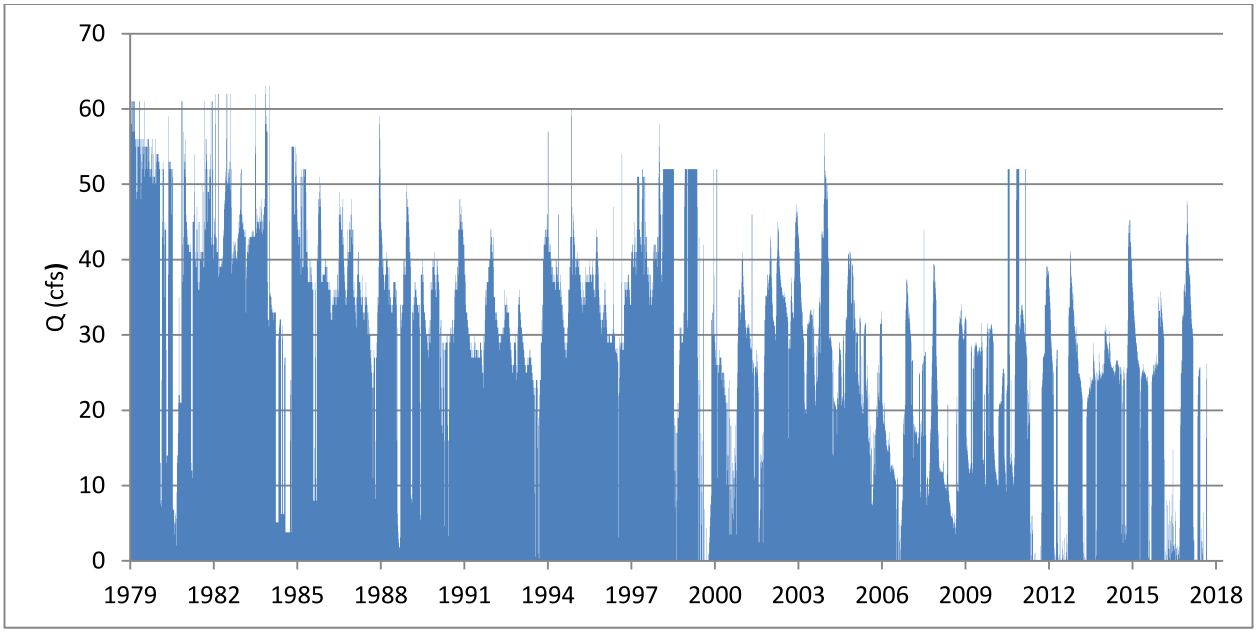


Figure 2.5.2-1 Daily mean discharge (cfs) for the USGS Station 02306000 at Sulphur Springs from October 1979 through May 2018.

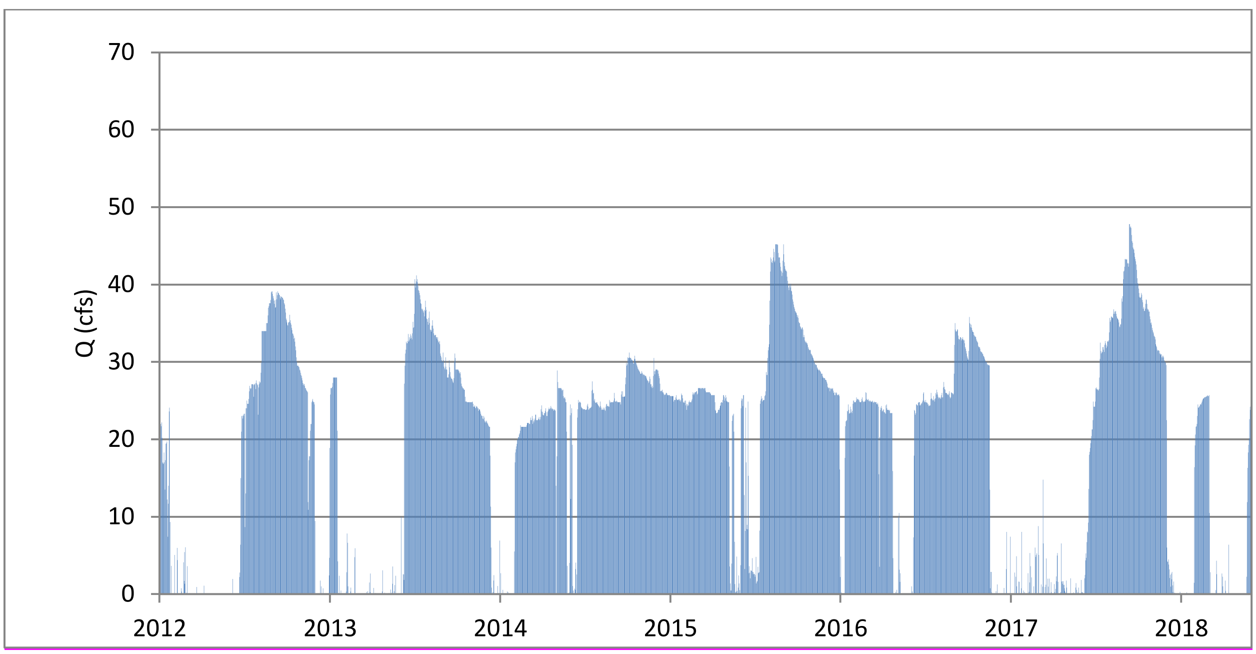


Figure 2.5.2-2 Daily mean discharge (cfs) for the USGS Station 02306000 at Sulphur Springs from October 2012 through May 2018.

In March 2002 the City began diverting 10 cfs from Sulphur Springs to the base of the Hillsborough River Dam for LHR minimum flow recovery. By October 2012, the City was to begin providing all available flow from Sulphur Springs to the base of the dam. Available flows are defined as those in excess of what is needed to meet the minimum flow requirements

Sulphur Springs (40D-80.073(8)(3)(c), F.A.C). For this recovery effort, water is routed by a pipeline and is currently discharged to the river via an aeration flume on the north side (right bank) of the river near the base of the dam. The flume run is approximately 67 meters in length and serves to oxygenate the water before it enters the river. Historical and current minimum flow diversions from Sulphur Springs to the base of the dam are shown in Figures 2.5.2-3 and 2.5.2-4.

Sulphur Springs Pool upper weir and pump station modifications were initiated in November 2008 when the City and District entered into a joint funding agreement to design and construct improvements to the upper weir and pump station. The project was completed in March 2012. It involved modification of the pump station at Sulphur Springs to increase its reliability and efficiently provide for variable pumping rates; replacement and modification of the Sulphur Springs upper weir and gates that control flow between Sulphur Springs Pool and Sulphur Springs Run; installation of provisions to control Sulphur Springs Pool pumping rates based on the temperature and salinity of adjacent monitoring stations; and modification and/or replacement of the Sulphur Springs pump station intake to allow for the range of anticipated water levels in Sulphur Springs Pool.

The adjustable weir can be used to reduce the infiltration of brackish water into the spring run, but it can also be lowered to allow manatee access to thermal refugia at the spring outfall. The weir is located approximately 23 meters upstream of the outlet to the Hillsborough River.

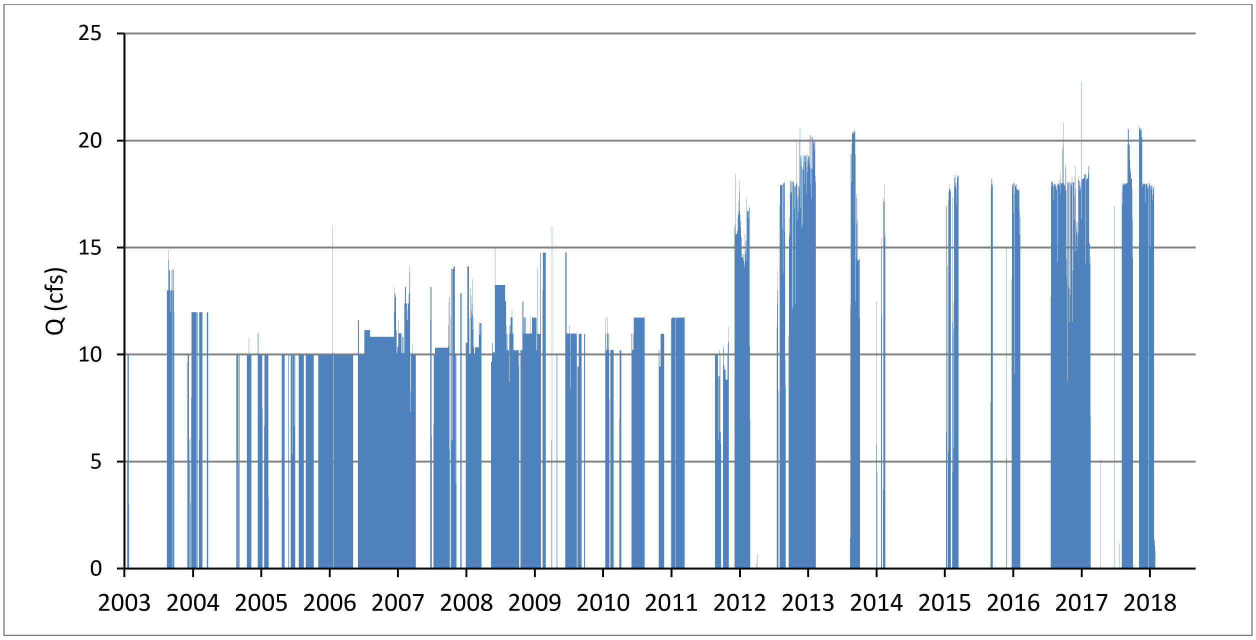


Figure 2.5.2-3 Daily mean discharge (cfs) from Sulphur Springs to the base of the dam for the Lower Hillsborough River minimum flow recovery from May 2003 through May 2018.

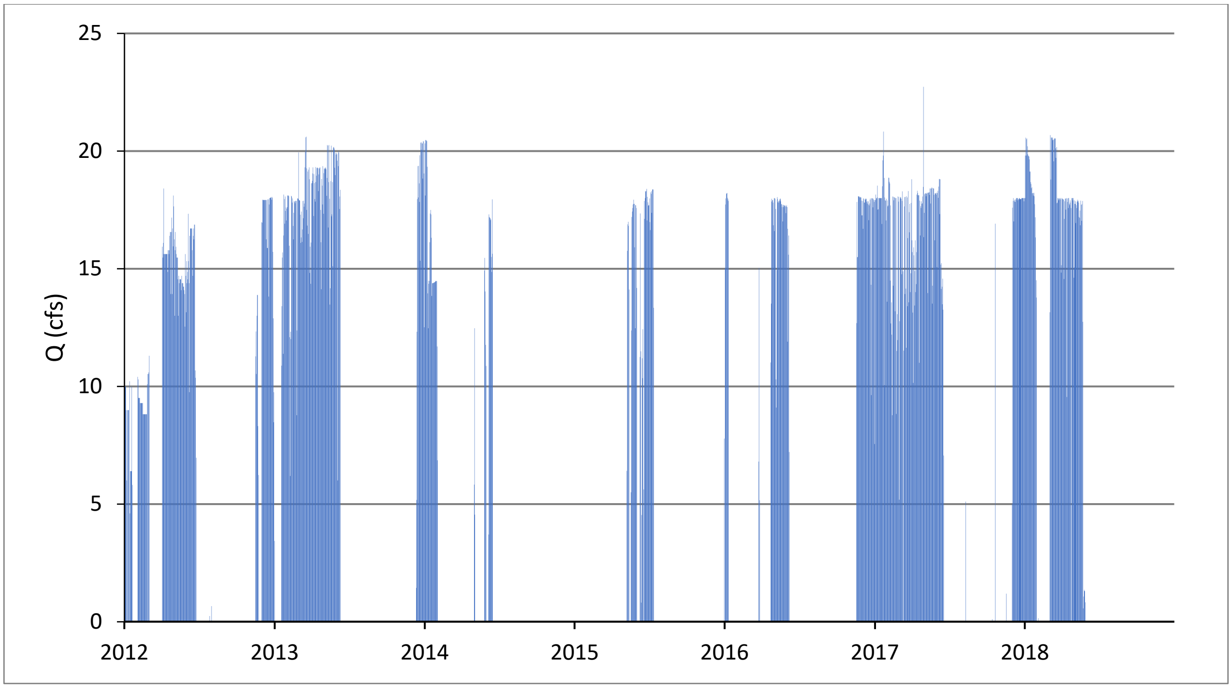


Figure 2.5.2-4 Daily mean discharge, Q (cfs), from Sulphur Springs to the base of the dam for Lower Hillsborough River minimum flow recovery from October 2012 through May 2018.

2.5.3 Minimum Flow Releases from the Hillsborough Reservoir/Tampa Bypass Canal System Since December 2007 and for October 2012 Through May 2018

In accordance with the revised LHR recovery strategy adopted in 2007, releases of fresh water to the base of the dam from the Tampa Bypass Canal via the reservoir to augment the flow were initiated in December 2007. The District implemented these initial releases, with a typical maximum value of 8.25 to 8.3 cfs using a pumping facility on the north bank of the reservoir at the dam to divert water over the dam to the lower river. More recently, the City has assumed responsibility for releases to the lower river for minimum flow recovery. These releases by the City are currently accomplished through use of a recently installed water control gate in the reservoir dam (additional information regarding TBC/reservoir diversions is provided in Section 3.3 of this report). Historical and current flow diversions from the reservoir to the base of the dam for the current 5-year assessment period are shown in Figure 2.5.3-1, and the current 5-year assessment period flow diversion is provided in Figure 2.5-3-2.

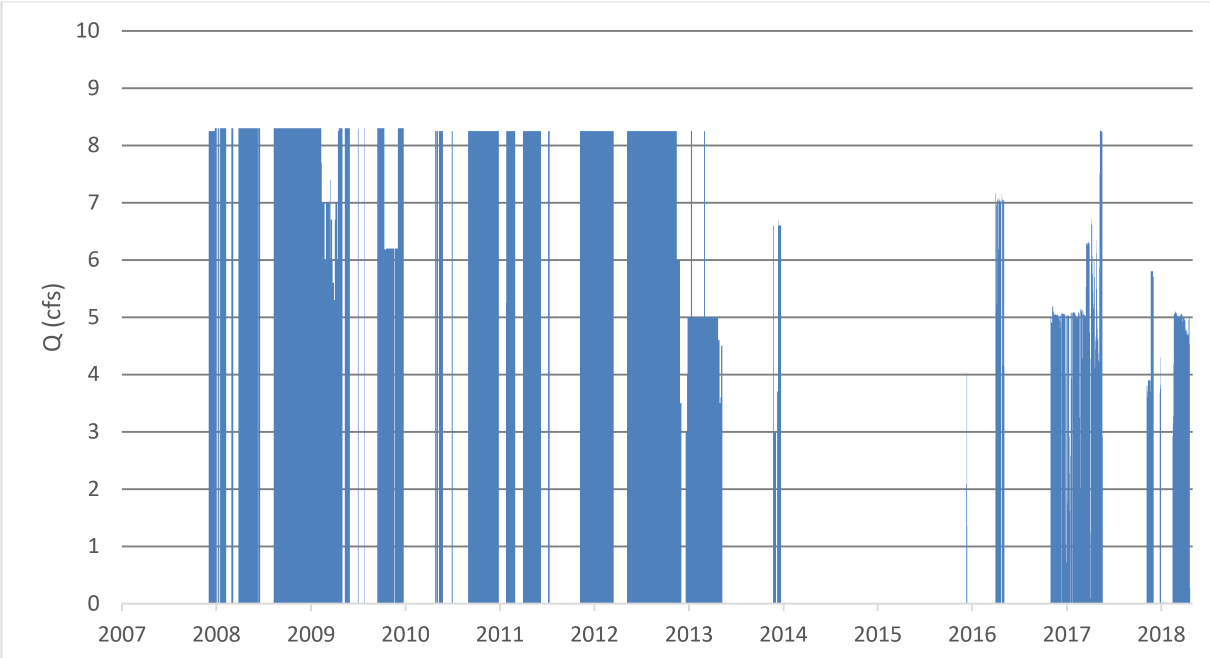


Figure 2.5.3-1 Daily mean discharge, Q (cfs), to the base of the dam from the Hillsborough River Reservoir for Lower Hillsborough River minimum flow recovery from December 2007 through May 2018. Start date of 2007 selected based on implementation of current minimum flow criteria.

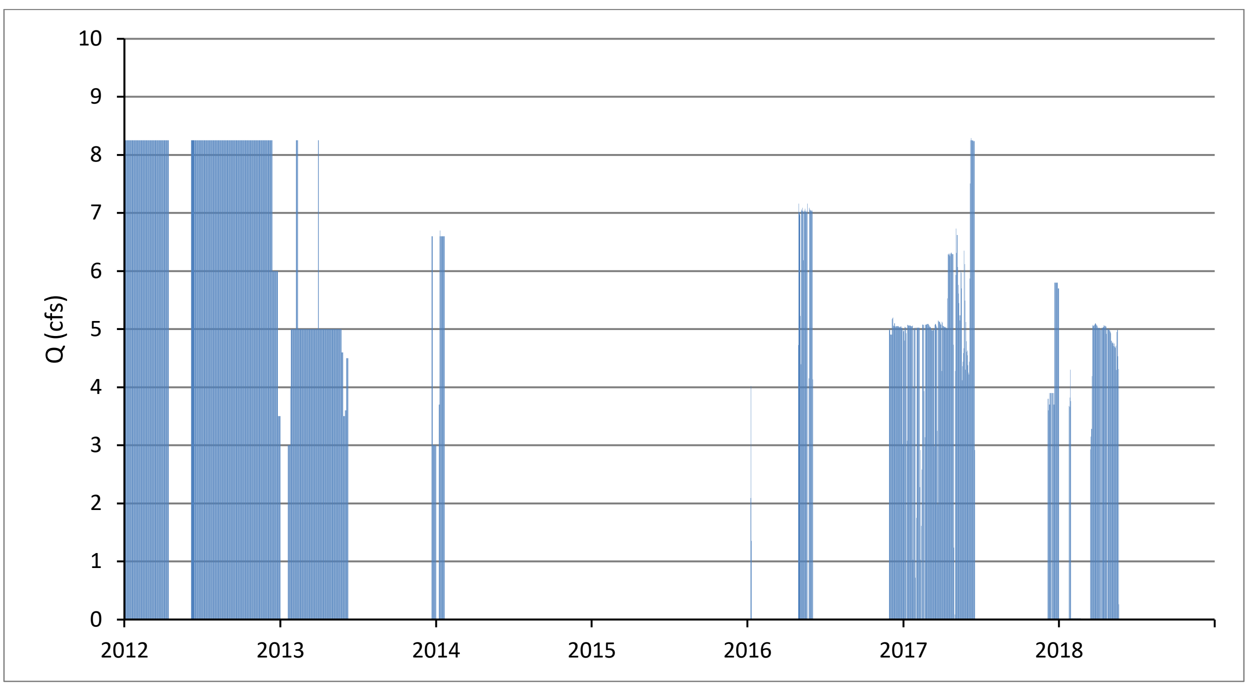


Figure 2.5.3-2 Daily mean discharge, Q (cfs), to the base of the dam from the Hillsborough River Reservoir for lower Hillsborough minimum flow recovery from October 2012 through May 2018.

The LHR recovery strategy effectively requires that releases from the reservoir to the LHR are to be replenished from the TBC via a pumping facility on the north bank of the Harney Canal. On December 31, 2007 the District began pumping up to 11 cfs from the middle pool of the TBC around Structure S-161 to the reservoir. Initially and without scientific justification, it was estimated that 25 percent of this 11 cfs was being lost and that the City should not be responsible for making up this 25 percent deficit by transferring the entire 11 cfs to the base of the dam. Thus, based on "…concerns about potential losses due to subsurface leakage, evaporation, and transpiration…" (Rule 40D-80.073(8)(I)(A), F.A.C.,) that could reduce the diversion from the TBC before water contributed by the diversion reaches the Hillsborough River Dam, only 75 percent of the water diverted from the TBC to the reservoir has been pumped from the reservoir to the LHR at the base of the dam.

The LHR strategy specified a pipeline project and feasibility study to address this loss term. A peer review (SWFWMD 2008) was conducted as part of feasibility assessment for a transmission pipeline that would have routed water from the TBC to the Reservoir and thus have avoided water losses due to evaporation, transpiration, or subsurface leakage. The review determined that water loss was negligible and that the pipeline project was not feasible. Based on these findings, the City and the District discontinued pursuit of this project; however, the District continued to implement the delivering 75 percent of the 11 cfs that are being routed from the TBC to the Reservoir. More importantly, the recovery strategy notes that the City must account for the full quantity (the additional 25 percent or 1.9 mgd from some permittable source). The City was supposed to assume pumping responsibilities in 2013, but this transfer of pumping responsibilities did not occur on schedule. The City took over pumping responsibilities in November 2017 and continues the 75 percent approach as well as the requirement to provide 1.9 mgd from a permittable resource.

The recovery strategy also specifies that when water is pumped from the Harney Canal to the reservoir as described above, this water being pulled from the middle pool of the TBC is to be replenished by water pumped from the lower pool to the middle pool. In 2008, the District began pumping up to 11 cfs around Structure S-162 (Figure 1.0-2) to the middle pool for this purpose (SWFWMD and Atkins 2015). The availability of water to be used from the TBC middle pool to help meet the minimum flow of the LHR is dependent upon flows at District Structure 162 and stage height of the lower and middle pools in the TBC (Rule 40D-80.073(8)2.c. I-IV. Briefly summarized, water pumped from the TBC middle pool to the Reservoir must not exceed 7.1 mgd (11 cfs) and must be able to be replaced by water in the lower pool. Accordingly, pumping from the middle pool must cease if the lower pool stage is expected to go below 6.0 ft or if the elevational difference between the TBC middle and lower pools is to exceed 7.0 ft measured at Structure 162.

2.5.4 Minimum Flow Diversions from Blue Sink

The Blue Sink Project was recently brought online by the City on March 27, 2018 through the end of the current 5-year assessment period of May 31, 2018. Over this time, approximately 104 million gallons of water have been pumped from the sink to the base of the dam, providing a daily average discharge rate of 2.43 cfs. The recovery strategy specifies up to 3.1 cfs may be utilized for minimum flow supplementation, after Sulphur Springs.

2.6 Discussion of Numerical Flow Modeling Previously Completed

Janicki Environmental, Inc. (2015) completed numerical model simulations using the LAMFE (Laterally Averaged Model for Estuaries) model to investigate the effectiveness of the LHR MFLs set by the District in 2007. The goal of this modeling task was to determine the effect that the minimum flows have on extending the salinity range of < 5 ppt below the dam on the Hillsborough River toward Sulphur Springs. The LAMFE model was developed by District staff (Chen 1999, 2003, 2004a, 2004b, and 2011) and recalibrated and verified based on controlled-flow experiments conducted by the City and the District between 2002 and 2005. The model was used to evaluate the effectiveness of the LHR flows by simulating and comparing the relative effects that 13 alternate flow regimes would have on three key metrics in the LHR, i.e., volume of water ≤ 5 ppt; river bottom area≤ 5 ppt; and shoreline length ≤ 5 ppt. The three metrics were considered to be highly correlated, and, therefore, the volume of water metric was the primary metric addressed in the Janicki (2015) investigation. The spatial extent of the Hillsborough River examined in the investigation extended from the Hillsborough River Dam downstream to Sulphur Springs, and the model simulation time period for the scenarios was from January 1, 2000 through May 31, 2013.

Thirteen model scenarios were simulated using the LAMFE model. Scenario 1 consisted of no minimum flows, all flows from Sulphur Springs entering the Hillsborough River at the spring outfall, and no augmentation from the TBC. Scenario 2 consisted of existing flows recorded during the period January 1, 2000 through May 31, 2013, a period during which minimum flow recovery projects were initiated. Scenarios 3 – 13 consisted of simulating various combinations of three salinity regimes at Sulphur Springs, flows from Sulphur Springs to the base of the dam, freshwater flows over the dam, minimum flow adjustments based on flows in the river at the USGS Zephyrhills gages, no augmentation from the TBC, consideration of river temperature above or below 20°C (a United States Corps of Engineers Sulphur Springs permit requirement for the City of Tampa), and pool levels at Sulphur Springs.

The study included pairwise comparisons of the various model scenarios. For example, scenario 1 results were compared with those for scenario 2 to assess effects of the ongoing phasing-in of minimum flow recovery projects associated with diversions from Sulphur Springs and the TBC/reservoir system relative to conditions that would have existed in the absence of minimum flows implementation. Comparisons of scenario 1 versus scenario 4 were completed to characterize intended effects of the currently established minimum flows as compared to river conditions in the absence of minimum flows implementation. Scenario 2 and scenario 4 were compared to examine effects of ongoing minimum flow implementation relative to effects based on full compliance with the currently established minimum flows. Six additional pairwise comparisons were made to compare the effects of the Zephyrhills flow adjustment, different mixes of flow at Sulphur Springs and at the dam, different flows at the dam, Sulphur Springs flows with and without restrictions, and different methods of managing the Sulphur Springs pool elevations. Multiple scenario comparisons were also completed.

Scenarios 10 through 13 modeled increased flows ranging between 26 to 28 cfs in April and May, and between 22 and 24 cfs from July through March based on salinity concentrations in Sulphur Springs. Other variables included assumptions regarding water temperature, spring pool stage level and spring flow discharge. The flow discharges modeled bracket the established recovery strategy seasonal flow requirement discharges; however, modeling of actual 23 cfs and 27 cfs, inclusive of the 3 cfs discharge to account for salinity of Sulphur Springs may be useful.

The results of the numerical simulations described in the Janicki report (2015) demonstrate that the beneficial influence of the minimum flow target is clearly evident, even during the period (2003 through 2012) when the minimum flow recovery projects were being phased-in. It was concluded that the minimum flows adopted for the LHR have resulted in improved conditions in the LHR based on the numerical simulations of increased volume of water, river bottom area, and shoreline length with salinity ≤ 5 ppt. These findings are supported with various improvements in water quality parameters and biological communities in response to the minimum flow supplementation contributions described in this report.

2.7 Summary of Streamflow Conditions During the Minimum Flow Study Period

The LHR is a tidally influenced river that has been impacted by a variety of anthropogenic factors such as the construction of the dam, proliferation of urban development and water withdrawals, as well as by natural factors including drought and above-average precipitation events, tidal fluctuations, and changes in spring flow contribution and water quality. Due to these impacts, it is necessary to illustrate and understand how stream conditions may vary according to their flow, which in turn, is heavily dependent upon the system's water inputs. In the case of the Hillsborough River, the two major inputs into the system stem not only from its watershed collecting rainfall but also flow from Sulphur Springs. It is also important to understand the relationships between streamflow, water quality and hydrobiology. Hence, the implementation of the recovery strategy is analyzed to identify changes in the river's flow, water quality and hydrobiological characteristics.

A major source of water to the LHR system is rainfall. Tampa, Florida averages approximately 46.3 inches of rain per year (U.S. climate data, 2018). Rainfall volumes recorded at USGS Station 02304500 at the dam for 2013, 2014, 2015, and 2017, which had complete annual records, were used to determine that an average rainfall of 53.5 inches per year occurred in this 4-year period. This information showed that an average of 7.2 inches of above normal precipitation was received for at least 4 years of the current 5-year assessment period. Precipitation records for 2016 are incomplete, with records missing from May 15 through October 16, which is typically when the heaviest precipitation occurs. Thus, these records were not used. Also, 2012 (January through May) and 2018 (October through December) only represent partial years with typically dry times of year recorded. Thus, they were likewise not considered.

Another major water source to the LHR is Sulphur Springs, which discharges naturally into the river via the spring run between RKms 12.7 and 12.8. For the current 5-year assessment (Oct. 2012 – May 2018), flow to the spring run at USG Station 02306000 ranged from 0 to nearly 50 cfs over the study period. Variation in flow to the spring run is likely associated with seasonal variation in rainfall, diversions of water from the spring pool to the base of the dam for minimum flows supplementation, and increased spring flow induced by diversion-related decreases in spring pool water levels. A general trend of decreasing flow discharge from Sulphur Springs is indicated for the period from 1979 through 2018.

3.0 Status of Water Sources Identified to Provide Minimum Flows

This section discusses and summarizes the current status of the existing and proposed water sources identified in the LHR recovery strategy to be used to provide minimum flows to the LHR. The four primary water sources are listed in order of priority in the recovery strategy: 1) Sulphur Springs, 2) Blue Sink, 3) the TBC, and 4) Morris Bridge Sink, along with other potential resources including the Transmission Pipeline and the TAP. Both Sulphur Springs and the TBC were used throughout the current 5-year assessment period as sources for minimum flow implementation. Use of Blue Sink as a source for recovery flows was initiated in March 2018. Morris Bridge Sink is listed as a recovery strategy source and various water quantity and quality studies have been conducted to support its potential use for river recovery, but construction of permanent facilities for pumping and distribution of water from the sink for delivery to the LHR have not been initiated. The District has indicated that temporary pumping systems could be used to meet MFL needs if required.

The LHR recovery strategy identifies several water resource projects, their order of priority for development and use as sources for river recovery, and for most, the quantities of water that the projects/source can or are expected to provide to recover and maintain the established minimum flows. These projects are listed below and discussed in greater detail in the following sub-sections of this section.

1) Sulphur Springs—involves lower weir modifications and Sulphur Springs pool upper weir and pump station modifications to supply up to 18 cfs (has provided supplemental water to the LHR below the dam since 2002 with system modifications in 2012);

2) Blue Sink—analysis shows it can supply up to 3.1 cfs (brought online in March 2018);

3) TBC and Hillsborough River Reservoir—diversions to supply up to 11 cfs from the middle pool of the TBC to the Hillsborough River Reservoir, of which 75% of this water (8.3 cfs) is diverted to the LHR at the base of the Hillsborough River Dam (has provided supplemental water to the LHR since 2008);

4) Morris Bridge Sink—to supply up to 6 cfs (permitted – not in use), TAP may eliminate the need for Morris Bridge as a minimum flow supplementation resource);

5) Transmission pipeline evaluation (per Chapter 40D-8.073[8][b][2]) (completed [SWFWMD 2018]); and

6) Investigation of water storage or additional water supply options – TAP up to 50 mgd for minimum flow supplementation with unspecified allocations for minimum flow purposes (feasibility analysis by the City currently underway).

A description of the details regarding the projected quantities, priority, flows, and water level conditions related to the use or proposed use of these four water sources is included. The recovery strategy also requires the District to evaluate potential unacceptable adverse impacts prior to implementation of these uses. The recovery strategy also specifies that the District monitor and evaluate the effect of the recovery strategy on water levels in the reservoir and Hillsborough River upstream of the dam to Fletcher Avenue.

A recent alternative under consideration is the TAP, which proposes to use treated wastewater from the Howard F. Curren Advanced Wastewater Treatment Plant to generate between 20 to 50 mgd of treated wastewater to be used primarily for water supply purposes. Development of this water supply could supplement and/or reduce the need for natural sources such as Sulphur Springs and Blue Sink and could eliminate the need to construct a permanent pumping station and water distribution system at Morris Bridge Sink.

3.1 Sulphur Springs

In March 2002, the City began diverting Sulphur Springs flows of up to 10 cfs to the base of the Hillsborough River Dam for recovery of minimum flows in the LHR. Currently, the water is routed by a pipeline and discharges via an aeration flume on the north side (right bank) of the river near the base of the dam. The pumping facility and a weir system that controls flow between the Sulphur Spring pol and spring run were modified in 2012 to allow better management of flow diversions to the base of the dam. This pump system has remained in service through the current assessment period. Another modification supporting use of Sulphur Springs as a recovery source for the LHR was completed in 2011 and included installation of an operable weir at the mouth of the spring run. These enhancements to the weir are used to reduce incursions of brackish water into the spring run, allow manatees seasonal access to the thermal refuge at the spring outfall, and improve flow management for LHR recovery and compliance with minimum flows established for Sulphur Springs.

The modified Sulphur Springs facilities are currently operational and have proven to be effective for providing variable rates of flow to both the spring run and the LHR. A review of water pumping records indicates that water from Sulphur Springs is sporadically used to augment flows to maintain minimum flows in the LHR during times of low flow. Since Spring 2012, the City has been able to route as much as 18 cfs in accordance with Rule 40D-80.073(3)(c & d), F.A.C., and on some days more than 20 cfs, to the base of the Hillsborough River Dam to provide minimum flows to the LHR while ensuring that minimum flow requirements for Sulphur Springs are met.

Review of spring flow discharge not used for minimum flow supplementation indicate a general trend of decreasing flows for the historic period of October 1979 through May 2018; however, the flows appear to be relatively constant for the current 5-year assessment period. Low flow conditions are expectedly most pronounced during drought periods. Flow increases in response to large rainfall events, particularly in the summer and early fall wet season.

The following USGS Stations are in the immediate vicinity of Sulphur Springs and were/are used to collect data on various parameters that support implementation of minimum flow for the LHR and Sulphur Springs.

1. Hillsborough River at Sulphur Springs USGS Station 02304520 (also referred to as Nebraska Avenue)– on a private dock on the south (left) bank of the Hillsborough River at 818 East Hollywood Drive, 30.5 meters downstream/west from Nebraska Avenue/U.S. 41, and approximately 3.2 km (2 miles) downstream from the Hillsborough River Dam. Measures and records water temperature, stream gauge level, and specific conductance. This station is no longer operational but provided gauge height information until October 3, 2014.

2. Sulphur Springs at Sulphur Springs USGS Station 02306000 - on the east side of the spring pool approximately 30.5 meters west of U.S. Nebraska Avenue/ U.S. Highway 41, and 152 meters upstream from mouth of outlet channel at Hillsborough River and approximately 3.2 km (2 miles) downstream from the control structure for the reservoir. Measures and records water temperature, precipitation, discharge (cfs) stream gauge level, and specific conductance.

3. Sulphur Springs Run at Sulphur Springs USGS Station 023060003 - on the north side (right bank) of the spring run approximately 160 meters west of U.S. Nebraska Avenue/ U.S. Highway 41, and 46 meters upstream from mouth of outlet channel at Hillsborough River and approximately 3.2 km (2 miles) downstream from the control structure for the reservoir. Measures and records water temperature, stream gauge level, and specific conductance.

4. Hillsborough River at I-275 Bridge at Sulphur Springs USGS Station 023060013 – attached to a concrete pier on the eastern side of the I-275 northbound bridge, approximately 59 feet from the south side (left bank) of the river. Measures and records gauge height, water temperature and specific conductance.

3.2 Blue Sink

Blue Sink is located within an urbanized area of North Tampa northwest of Sulphur Springs and west of I-275 and receives runoff from the 9 km^2 Curiosity Creek watershed within the Hillsborough River Basin. The sink is part of the Curiosity Creek/Blue Sink Complex, which is comprised of a series of sinkholes located east of the creek (Schreuder 2001 and SWFWMD 2009). Water from the Curiosity Creek watershed and Ewanowski Spring both discharged into Blue Sink and ultimately to Sulphur Springs via a natural underground conduit within the Upper Floridan Aquifer. Sometime during the 1970s, the connection between Blue Sink and Sulphur Springs began to deteriorate due to trash, debris, and sediment accumulation until it was determined to be fully blocked in the 1980s (SWFWMD 2009). As a result, water in Curiosity Creek began to back up and caused an increase in localized flooding. In response, the City constructed a retention pond adjacent to Blue Sink, and in 2002, installed a permanent lift station at the south end to convey excess water out of the watershed to the Hillsborough River.

The City sponsored a feasibility study of how Blue Sink could be used to provide minimum flows to the lower river (MWH 2009). Options included the following:

1. Diverting water from Blue Sink via a pump and pipeline to the nearby Jasmine or Orchid sinks and relying on natural underground conduits to transmit water to Sulphur Springs for flow diversion, and
2. Construction of a pump and pipe system to the Sulphur Springs pump station or directly to the base of the dam.

These feasibility studies were completed in the Spring of 2008 and 2009 by the District and consisted of pumping tests that evaluated the potential yield of Blue Sink. The pumping test conducted in 2008 was compromised by a mechanical failure that interrupted pumping for approximately 36 hours, and according to the measurements, water levels in Blue Sink quickly recovered to pre-pumping levels. A second pumping test was conducted from March 2 to April 1, 2009, when pumping at a rate of 2 mgd (3.1 cfs) was sustained for 30 days. Water levels in Blue Sink, Ewanowski Spring, and number of wells and lakes in the area were monitored during the pumping test for potential drawdown impacts. Based on these findings, the District concluded that Blue Sink could likely provide up to 2 mgd (3.1 cfs) as a minimum flow supplementation resource for LHR recovery.

Subsequently, the City and the District entered into a cooperative funding agreement in October 2010 to fund the Blue Sink project. The agreement addressed construction of a pump station at Blue Sink and a pipeline for transfer of water pumped from the sink to the existing pipeline used to transfer water from Sulphur Springs to the LHR, with project construction to be completed in October 2011. The Governing Board (SWFWMD 2011) approved a variance to the recovery strategy rule in June 2011 to extend the deadline for the Blue Sink project from October 1, 2011 to October 31, 2013. In September 2012, the cooperative funding agreement was amended to also include a completion date of October 31, 2013 and an expiration date of April 30, 2014. The distribution method, based on pumping test results, comprises the construction of a pump station at Blue Sink and a pipeline from the sink to the transmission pipeline at Sulphur Springs, which extends to the discharge flume at the base of the dam. A number of factors were considered in the analysis of alternatives (e.g., costs, permitting, and water quality), but a critical factor for the selection of this option is that it provides a high level of efficiency and reliability for transporting the water pumped from Blue Sink directly to the base of the dam while utilizing existing infrastructure at Sulphur Springs.

A water use permit (WUP No. 20020382.000) for pumping from Blue Sink was issued to the City by the District in December 2013. The permit, which expires in December 2027, allows a peak monthly withdrawal of up to 2 mgd and an annual average withdrawal rate of approximately 1.7 mgd. Because the City also needed to obtain applicable permits for construction of project elements using various municipal right-of-ways, the City requested that the completion date for the project be changed to December 31, 2015. Accordingly, a new cooperative agreement with the City with an expiration date of October 1, 2017 was developed in July 2014 to accommodate the revised timeline. The agreement was subsequently amended in February 2016 to include a construction completion date of January 14, 2017.

Construction activities for the Blue Sink pipeline were completed in May 2016. Initial pump station testing began in March 2017, and pumping evaluations identified a leak in the transmission line used for delivery of pumped water to the LHR. Once this issue was corrected and additional testing by the City was conducted, the project construction was completed in September 2017.

In November 2017, the City began operation of the Blue Sink pumping facility and based on pumping records provided by the District, minimum flow supplementation pumping was initiated on March 27, 2018 and implemented daily through May 21, 2018. No pumping from Blue Sink was performed for the remainder of May 2018. Between March 27, 2018 and May 21, 2018, a total of 104.3 million gallons were pumped from Blue Sink at a daily average rate of 2.43 cfs over this period.

3.3 Tampa Bypass Canal and Hillsborough River Diversions

Minimum flow Rule 40D-80.073(8)(b)(2), F.A.C., establishes how diversions from the lower and middle pools of the TBC are to be used to provide minimum flows to the LHR depending on the water level of the lower pool. In the priority ranking of the four water sources, if the TBC lower pool is > 9 feet the sources are used in the following order: Sulphur Springs, Blue Sink, TBC, then Morris Bridge Sink. However, under certain low-water conditions when the water level in the lower pool of the TBC is ≤ 9 feet the order of priority is Sulphur Springs, Blue Sink, then Morris Bridge Sink is to be prioritized for use over the TBC. The Blue Sink pump station and distribution system was only recently constructed, and permanent facilities for pumping and distributing water from Morris Bridge Sink have not been constructed. Prior to the recent use of Blue Sink water sources, the TBC and Sulphur Springs had been the primary minimum flow supplementation sources for the current hydroperiod.

The recovery strategy required the District to divert up to 7.1 mgd or 11 cfs of water from the middle pool of the TBC to the Hillsborough River Reservoir at the District's S-161 structure and then deliver 75 percent of this water to the LHR at the base of the Hillsborough River Dam by January 1, 2008. Using temporary pumping facilities, the District initiated this recovery activity, on December 31, 2007.

Diversions from the TBC to the lower river are intended to supplement diversions from Sulphur Springs, Blue Sink, and Morris Bridge Sink, as they are implemented, and as described in subparagraphs 40D-80.073(8)(b)1, 3, 6, and 8, F.A.C. The delivery of 75 percent of the water diverted from the TBC to the lower river was specified in the recovery strategy to address concerns about potential losses of water diverted to the reservoir due to subsurface leakage, evaporation, and transpiration – more information on these potential losses is provided in sub-section 3.5 below.

The City was to assume operation of pumping facilities used to divert water from the TBC middle pool to the reservoir and from the reservoir to the LHR on October 1, 2013. To meet the recovery strategy requirement, the City submitted a Cooperative Funding Initiative (CFI) application for Fiscal Year 2013 to the District to fund the construction of permanent pumping facilities for these diversions. The City completed an assessment of the pumping capabilities in

April 2013 and concluded that a new pump was necessary at the S-161 structure to supply adequate water to meet both minimum flows and potable supply. In February 2014, the Governing Board approved this finding and authorized execution of a cooperative funding agreement with the City to construct facilities at the S-161 structure on the middle pool of the TBC and at the dam to divert minimum flows to the LHR.

In support of a draft agreement for construction of the planned pumping facilities, the City completed a draft basis of design report for the replacement of the District's temporary pumping station at the S-161 structure and replacement of the District's temporary pumping facility at the Hillsborough River Dam with a siphon system (District Project N492). The District accepted the City's final basis of design report in August 2015. Starting in January 2016, the City requested a transfer of ownership of District pumping facilities at the S-161 structure and the dam to the City and requested continuance of the CFI request submitted for funding the construction of permanent pumping facilities at the two sites.

In January 2017, the City requested a scope change to the original CFI project application, which eliminated the replacement of the pump station at the S-161 structure because the City determined that using the District's temporary pump station would be the preferred alternative and would allow additional time to evaluate whether a new pump station would be necessary in the future. Following this request, the Governing Board approved changes in July 2017 that eliminated the new pump station at the S-161 structure and siphon structure at the Hillsborough River Dam. At that time, the Board also approved a request to enter into an agreement with the City to transfer operation of the temporary pump station at the S-161 structure and an easement to the City from the District. This transfer also included the operation, maintenance, and management of the pump station and operation and maintenance and management of the temporary District pump station at the Hillsborough River Dam. Transfer of the District pumping facilities at the S-161 structure to the City and transfer of pump station operations at the dam occurred in November 2017.

In addition to eliminating the new pump station, the scope changes for the CFI project included replacement of the planned siphon system at the dam with a new control gate that was determined to be more cost effective and provide greater flexibility in meeting minimum flow requirements. An agreement between the City and District for the LHR Dam Control Gate Facilities was finalized in October 2017. A notice to proceed with construction of the proposed gate facilities was issued by the City in November 2017. Construction and operational tests for the gate were completed in the summer of 2018 per information provided by Mary K. Spence, P.E. with the District via email. A transfer or issuance of a District WUP to the City for the diversion of water from the TBC to the reservoir is currently in progress.

Although it has not yet been applied, Rule 40D-80.073(8)(b)(7), F.A.C., stipulates that the City should provide 1.9 mgd (a volume of water that would have been prevented from being lost had the transmission pipeline been constructed for transporting the 11 cfs from the TBC to the LHR) from some permittable source if needed to help meet the minimum flow for the LHR and that this source should be used in preference to all other sources except Sulphur Springs and Blue Sink. The transmission pipeline was deemed to be not feasible, but the additional 1.9 mgd is not currently being routed to the base of the dam by the City.

3.4 Morris Bridge Sink

Morris Bridge Sink is located within the Lower Hillsborough River Wilderness Preserve, approximately 1 km (0.6 miles) south of the Hillsborough River, just east of the Interstate 75 (I-75) and the upper reaches of the TBC in a rural area northeast of Tampa (Figure 1.0-2). The sink is approximately 41 meters in diameter and 61 meters deep (SWFWMD 2010). Rule 40D-80.073(8)(b)(8), F.A.C., within the LHR recovery strategy as defined in Chapter 40D-8.041(4) establishes how diversions from Morris Bridge Sink shall be used to provide minimum flow water up to a rate of 3.9 mgd (6 cfs). The USGS Hillsborough River at Morris Bridge near Thonotosassa, Florida station (No. 02303330), located at latitude 28°05'55" and longitude 82°18'41" on the downstream side of the bridge on State Highway 579 approximately 4.7 km (2.9 miles) north of Thonotosassa, 5.5 km (3.4 miles) upstream from Trout Creek, and 46.7 km (29 miles)upstream from mouth, is used to measure and record discharge (cfs), precipitation (inches), and stream gauge level (ft) in the immediate vicinity of Morris Bridge Sink.

During a 30-day pumping test in 2009, it was determined that Morris Bridge Sink could sustain a withdrawal rate of 6 cfs during extremely dry conditions (SWFWMD 2010). The District subsequently completed analyses to support a permit application for withdrawals from the sink, including calculation of the monthly quantities that will be needed from the sink for LHR recovery, modeling of drawdowns in the Upper Floridan and surficial aquifers associated with the withdrawals, and potential wetland impacts that could result from sink withdrawals.

In May 2015, the Governing Board authorized District staff to repeal the reservation rule concerning use of water from Morris Bridge Sink for recovery of minimum flows in the LHR. Completion of this rulemaking is anticipated upon completion of the Morris Bridge Sink project, i.e., when the pumping facilities necessary for the planned diversions from the sink to the TBC be permitted, constructed, and operational.

Although the District initiated a project in 2016 for consultant services addressing the design of a pump station at Morris Bridge Sink for diversion of water from the sink to the upper pool of the TBC, a pipeline, and a second pump station at the District's S-159 structure for diversion of water from the upper to the middle pool of the TBC, neither pump station or distribution delivery system has been constructed.

A permit for withdrawals from the sink was, however, issued to the District in January 2016, following a lengthy review and public comment period (SWFWMD 2018). If diversions of water from Morris Bridge Sink for LHR recovery occur, Consumptive Use Permit No. 20020574.000 issued to the District by FDEP would allow for a maximum pumping rate of 3.9 mgd and a daily average of approximately 2 mgd from Morris Bridge Sink. Completion of future project activities is contingent upon the possibility of the City's proposed TAP project becoming operational thereby potentially negating the need for the proposed Morris Bridge Sink Project facilities. Water from Morris Bridge Sink could be used during times when the MFL is not met by the use of temporary pumping facilities. These temporary pumping facilities could be used until the final disposition of the TAP project is determined. As a part of the District's permit, water quality and biological data have been collected to document the current status of Morris Bridge Sink (ADA Engineering 2016, 2017, 2018).

3.5 Water Transmission Pipeline and Calculation of Water Loss from the Hillsborough River Reservoir Due to Augmentation from the Tampa Bypass Canal

Water is pumped from the Harney Canal and the TBC into the reservoir to supplement the City's potable water supply, but it is also pumped into the reservoir and then released by the new dam gate installed by the City for minimum flow purposes. At the time the recovery strategy was developed, there were concerns about significant losses in the quantity of water pumped from the TBC into the reservoir prior to it flowing to either the water treatment facility or to the dam for delivery to the LHR., To address these concerns, the recovery strategy contains a discussion of the possible construction of a water transmission pipeline that would run from the middle pool of the TBC to the David L. Tippin Water Treatment Facility (located on the south bank of the reservoir approximately 7.7 km (4.8 miles) downstream from where the Harney Canal intersects the reservoir) with a spur or additional pipeline running to a location just downstream of the dam. It was thought that construction of a transmission pipeline possibly would serve to eliminate the hypothesized hydrologic loss associated with movement of water from the TBC through the reservoir and result in a water savings, which was estimated at 1.9 mgd (2.9 cfs) for minimum flow purposes. Because there was no consensus about the rate of water loss that was occurring, the District and the City agreed that the hydraulic efficiency of the proposed pipeline should be subject to peer review to determine the projected water savings that might be expected to result from the construction of the pipeline.

The peer review of the pipeline project conducted for SWFWMD and the City addressed potential water savings associated with the use of the pipeline versus use of the reservoir for conveyance of water to be used for augmenting LHR flows. The peer review panel concluded that "…the projected water savings [that could be achieved] by transporting the augmentation water in a pipeline rather than through the Reservoir is relatively small." (p. 13, Motz et al. 2008), because pumping directly from the TBC into the reservoir does not increase evaporation or groundwater leakage to the underlying groundwater system from the reservoir. District and City staff concurred with the findings of the peer review panel, and, as result, the transmission pipeline project is no longer considered a viable project under the recovery plan. The peer review panel also concluded that as much as 10 to 15 percent of the water pumped from the TBC into the reservoir may be derived from the reservoir through groundwater seepage when water levels in the TBC are lowered during pumping because of the proximity of the TBC to the reservoir. It is important to note that this re-circulation of water from the reservoir to the TBC occurs when water is pumped from the TBC into the reservoir and also would occur if water were pumped from the TBC directly into a pipeline.

Because the transmission pipeline project was determined to not be feasible, per Rule 40D-80.073(7)(d & e), F.A.C., which states that in the event that this pipeline is not substantially completed by October 1, 2013, or that the City fails to provide the District with a minimum 90 days notice prior to October 1, 2013, of the delay of completion of the pipeline due to circumstances beyond its control, the City will be responsible for delivering the flows the District was previously obligated to divert from the TBC middle pool to the Hillsborough River and then to immediately below the City's dam (under subparagraphs 40D-80.073[8][b]2. and 8., F.A.C). However, the District shall continue to be responsible for pumping water from the TBC lower pool to the middle pool as described in sub-subparagraph 40D-80.073[8][b]2.b., F.A.C., and from Morris Bridge Sink to the TBC middle pool as described in subparagraph 40D-80.073(8)(b)8., F.A.C. The City shall also provide the 1.9 million gallons each day needed to help meet the flow described in this provision from some other permitable source and is obligated to do so pursuant to sub-subparagraph (8)(b)2.d.

3.6 Investigation of Storage or Additional Supply Options, Including the Tampa Augmentation Project

Consistent with the LHR recovery strategy, the City and the District entered into a joint funding agreement in July 2010 to investigate other storage and supply options to meet recovery plan objectives for the LHR. The first components of the project, which involved review of the status of other recovery projects and identification of the need for additional storage or supply projects to meet the LHR minimum flow requirements, were completed in April 2011 and indicate the identified sources of water in the recovery strategy may be sufficient for achieving minimum flow requirements in the LHR (MHW 2011).

A project completion report (Weber 2018) submitted to the District by the City in October 2018 also suggests that the City is positioned and committed to implementing and investigating projects that will ensure the LHR minimum flows are met. Weber (2018) documents the development and implementation of the Hillsborough River Reservoir Dam Low Flow Control Gate for releases to the river for LHR recovery and highlights recent modelling completed as part of a feasibility assessment for the proposed TAP (SWFWMD Lower Hillsborough River Recovery Strategy Implementation – Annual Update, 2018).

The TAP proposal involves using treated wastewater from the Howard F. Curren Advanced Wastewater Treatment Plant to generate up to 50 mgd of highly-treated wastewater to be for augmentation of the potable water supply in the Hillsborough River Reservoir. Results from TAP feasibility modeling reported by Weber (2018) indicate the project will support meeting projected 2035 water supply demand and allow the City to more consistently meet LHR minimum flow requirements.

Furthermore, TAP is expected to affect future activities associated with other recovery projects. As indicated in the Morris Bridge Sink Project update above (see Section 3.4), completion of the TAP may have implications for future Morris Bridge Sink Project activities, including elimination of the need to construct the planned permanent pump stations and transfer pipeline for diversion of water from Morris Bridge Sink to the TBC for subsequent delivery to the LHR through the reservoir. Development of the TAP may also defer or eliminate the need for new, permanent pumping facilities at the S-161 structure for transfer of water from the middle pool of the TBC to the Hillsborough Reservoir to provide for minimum flows recovery.

Two proposed alternative delivery locations for water distribution from the TAP have been identified (SDI, December 2017):

1. *The vicinity of the Upper Pool of the TBC into a natural wetland treatment system and Rapid Infiltration Basins (RIBs)*—Water from Howard F. Curren Advanced Wastewater Treatment Plant would be delivered to RIBs and wetlands located adjacent to TBC to improve groundwater and surface water levels, which in turn would increase recharge to the TBC. This will allow additional surface water withdrawal from the TBC by the City or Tampa Bay Water.
2. *In the general vicinity of David L Tippin Water Treatment Facility and the Roger's Park Golf Course Area near the dam*—The intent would be to deliver water to the aquifer recharge/recovery (ARR) system and ultimately to the Hillsborough River Reservoir or to the intake of David L Tippin Water Treatment Facility. The concept of the ARR system is to convey highly treated water, up to 50 mgd, from the Howard F. Curren Advanced Wastewater Treatment Plant to several ARR sites.

3.7 Recovery Project Status Summary

In summary, all activities and projects proposed in the adopted recovery strategy are either underway, completed, or as in the case of the transmission pipeline, have been determined not to be feasible, with the exception of the Morris Bridge Sink project (as noted, this project could become operational through temporary pumping facilities, if needed). Acquisition of necessary permits and other unforeseen issues have delayed construction and full implementation of some recovery strategy projects. However, important components of the recovery strategy are currently in operation by the City (Sulphur Springs, Blue Sink, and the TBC) or potentially available (Morris Bridge Sink) as minimum flow recovery sources for the LHR.

4.0 Methods for Water Quality and Biological Analyses

4.1 Overview of Methods

As outlined in Section 1.2, the focus of this report is to evaluate the efficacy of the District's MFL recovery strategy for the LHR using a combination of historical and current data. In this 5-year assessment (which also considers historical conditions) of the LHR, several types of information were obtained from multiple sources including the District, the City, EPCHC, Tampa Bay Water, USGS, and Water & Air. Some of this data includes hydrological measurements (river flow, spring and reservoir dam discharges, staff gauge heights, precipitation, pumping rates, etc.) which were collected mainly by USGS and the City (see Table 4.1.1). These data were used to understand the status of water sources and compliance with the minimum flow recovery strategy. To further assess the response of the LHR to the recovery strategy, current and historic water quality data (salinity, DO, color, and nutrient parameters) were analyzed (see Table 4.1-2).

Another type of data used for this assessment was the hydrobiological data. Evaluation of this type of data was a multi-step process intended to review and analyze historical data pre-2013; compile, analyze and interpret data for the current 5-year period; and incorporate recent biological assessment data submitted by Water & Air in December 2018. To perform this assessment, Water & Air first received relevant historical reports and pre-2013 water quality and biological data sets (with metadata) from the District, similar to data used in the first 5-year assessment report (SWFWMD and Atkins 2015). This initial inventory inspected the historical data for its completeness and sought to identify missing data or any other associated problems. Next, data for the current assessment period were acquired from other sources including the City, EPCHC, Tampa Bay Water, and the USGS; the most current biological data are summarized in Water & Air's Biological Assessment of the LHR Report submitted in December 2018 to the District. In addition to evaluating the efficacy of the LHR MFL, this report offers recommendations and discusses additional data collection and review to better refine and evaluate the LHR MFL recovery strategy.

Table 4.1-1. USGS Station and Parameter Information for LHR 5-year Hydrobiological Assessment															
Site Name	**Station #**	**Descriptive Location**	**Latitude (decimal degrees)**	**Longitude (decimal degrees)**	**Discharge (cfs)**	**Gage height (ft)**	**Stream level above NAVD 1988 (ft)**	**Temp on TOP (ºC)**	**Temp in MIDDLE (ºC)**	**Temp on BOTTOM (ºC)**	**Specific conductance on TOP (µS/cm)**	**Specific conductance in MIDDLE (µS/cm)**	**Specific conductance on BOTTOM (µS/cm)**	**Precipitation (inches)**	**DO on Top/Bottom (mg/L)**
Above the Dam - Upper River Segment															
Hillsborough River Near Zephyrhills	02303000	NA	28.48333333	-82.23194444	Y	Y	Y	N	N	N	N	N	N	N	N
Hillsborough River at Fowler Avenue Near Temple Terrace, FL	02304000	Fowler Ave	28.05416667	-82.36388889	N	Y	Y	N	N	N	N	N	N	Y	N
Hillsborough River Near Tampa, FL	02304500	Top of dam	28.02361111	-82.42777778	Y	Y	N	N	N	N	N	N	N	Y	N
Below the Dam - Upper River Segment (RKm 14.5 to 16.2(base of dam))															
Hillsborough River at Rowlett Park Drive Near Tampa, FL	02304510	RKm 15.45	28.02083333	-82.43472222	N	Y	N	Y	N	Y	Y	N	Y	N	N
Middle River Segment (RKm 12.6 to 14.49)															
Hillsborough River at Hanna's Whirl at Tampa, FL*	02304515	RKm 14.35	28.01333333	-82.44138889	N	N	N	Y	N	Y	Y	N	Y	N	Y
Hillsborough River Bl Hannahs Whirl Near Sulphur Springs, FL	02304517	RKm 14.05	28.01527778	-82.44250000	N	N	N	Y	N	Y	Y	N	Y	N	Y
Hillsborough River at Sulphur Springs, FL (aka Nebraska Ave)	02304520	Nebraska Ave	28.01944444	-82.45194444	N	Y	N	Y	Y	Y	Y	Y	Y	N	N
Lower River Segment (RKm 10.6 to river mouth)															
Hillsborough River at I-275 Bridge at Sulphur Spgs, FL	023060013	RKm 12.10	28.02000000	-82.45500000	N	Y	N	Y	N	Y	Y	N	Y	N	N
Hillsborough River at Sligh Avenue at Tampa, FL**	02306014	RKm 10.55	28.14388889	-82.46500000	N	N	N	N	N	N	N	N	N	N	N
Hillsborough River at Platt Street at Tampa, FL	02306028	River Mouth	27.94166667	-82.45888889	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Tributary															
Sulphur Springs at Sulphur Springs, FL	02306000	Pool	28.02083333	-82.45194444	Y	Y	Y	N	N	Y	N	N	Y	Y	N
Sulphur Springs Run at Sulphur Springs, FL	023060003	Run	28.02083333	-82.45250000	N	Y	Y	N	N	N	N	N	N	N	N

Table 4.1-2. EPCHC Station and Parameter Information for LHR 5-year Hydrobiological Assessment. Water quality samples were collected monthly *in situ* from the top, middle, and bottom of the water column.

Street/Location	Station #	Site Type	Descriptive Location	Latitude (decimal degrees)	Longitude (decimal degrees)	Water Temp (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Percent Saturation	pH	Salinity (ppt)	Nitrates/ Nitrites (mg/L)	Ortho-phosphate (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll *a* uncorrected (ug/L)	Water Color (pcu)
Above the Dam - Upper River Segment																
Hillsborough River at Fowler Avenue Near Temple Terrace, FL	106	Stream	Fowler Ave	28.0540	-82.3638	10/1979-05/2018	10/1979-05/2018	07/2002-05/2018	10/1979-05/2018	10/1979-05/2018	03/1983-05/2018	01/1982-05/2018	01/1981-05/2018	10/1979-05/2018	01/1982-05/2018	10/1979-05/2018
Hillsborough River at Temple Terrace Hwy Near Temple Terrace, FL	266	Stream	Temple Terrace Hwy	28.0327	-82.3820	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018
Hillsborough River at N 56th Street Near Tampa, FL	265	Stream	N 56th St	28.0246	-82.3933	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018	06/2016-05/2018
Below the Dam - Upper River Segment (RKm 14.5 to 16.2 (base of dam))																
Hillsborough River at Rowlett Park Drive Near Tampa, FL	105	Stream	RKm 15.45	28.0222	-82.4350	10/1979-05/2018	10/1979-05/2018	10/1979-05/2018	10/1979-05/2018	10/1979-05/2018	03/1983-05/2018	05/1991-05/2018	01/1981-05/2018	10/1979-05/2018	10/1979-05/2018	10/1979-05/2018
Middle River Segment (RKm 12.6 to 14.49)																
Hillsborough River at Hanna's Whirl at Tampa, FL	1515	Stream	RKm 14.40	28.0145	-82.4409	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	No Data	No Data	No Data	No Data	No Data	No Data
Hillsborough River Near N 12th Street/ E Patterson Street at Tampa, FL	1514	Stream	RKm 13.40	28.0179	-82.4474	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	No Data	No Data	No Data	No Data	No Data	No Data
Lower River Segment (RKm 10.6 to river mouth)																
Hillsborough River Near N River Shore Drive at Tampa, FL	1512	Stream	RKm 11.4	28.0181	-82.4647	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	01/2009-05/2018	No Data	No Data	No Data	No Data	No Data	No Data
Hillsborough River at Sligh Avenue at Tampa, FL	152	Stream	RKm 10.55	28.0105	-82.4650	08/1999-05/2018	08/1999-05/2018	07/2002-05/2018	08/1999-05/2018	08/1999-05/2018	08/1999-05/2018	08/1999-05/2018	08/1999-05/2018	08/1999-05/2018	08/1999-05/2018	08/1999-05/2018
Hillsborough River at Platt Street at Tampa, FL	2	Stream	RKm 0.00	27.9418	-82.4585	10/1979-05/2018	10/1979-05/2018	07/2002-05/2018	10/1979-05/2018	10/1979-05/2018	03/1983-05/2018	10/1979-05/2018	01/1981-05/2018	10/1979-05/2018	10/1979-05/2018	10/1979-05/2018
Tributary																
Sulphur Springs at Sulphur Springs, FL	174	Spring	Spring Run	28.0210	-82.4528	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018	01/2007-05/2018
Twin Lake Outlfall at North Blvd at Tampa, FL	616	Canal	North Blvd	28.0189	-82.4674	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017	04/2016-10/2017

4.2 Water Quality Methods

4.2.1 Data Sources

Water quality data were comprised of *in-situ* water column profile measurements (salinity, temperature, pH, DO), laboratory data (chlorophyll *a*, color, and nutrients), and continuous recorder data (temperature and specific conductance). These *in-situ* water column profile data and laboratory data were obtained from 1) Tampa Bay Water through their HBMP, which is required as part of the conditions of a water use permit issued to Tampa Bay Water for diverting high flows from the Hillsborough River reservoir to the TBC for subsequent withdrawal and use for public supply purposes, 2) from the EPCHC through their long-term water quality monitoring program, 3) and from the District through their long-term water quality monitoring program. In addition to the *in-situ* data, USGS gauges were used to obtain natural discharge, flow, stage level, and water quality for the Hillsborough River. EPCHC monitoring stations were used to also collect water quality data.

Monthly routine water monitoring data from EPCHC stations on the Hillsborough River as shown in Figure 2.1-1 were obtained for water quality analysis. The water quality measurements used for analysis were water temperature (°C), DO (mg/L), DO percent saturation, specific conductance (µmho/cm), pH, salinity (ppt), nitrates/nitrites (mg/L), orthophosphate (mg/L), total nitrogen (mg/L), total phosphorus (mg/L), chlorophyll *a* uncorrected (µg/L), and water color (see Tables 4.1-1 and 4.1-2).

Water quality samples were collected from the top, middle, and bottom of the water column, with middle sample data collected more consistently and with fewer missing sample dates. Due to the greater number of sample dates for the middle water column samples, these data were used for all of the water quality analyses.

Daily specific conductance values (µS/cm at 25°C) for the time period October 1, 1979 to May 31, 2018) were obtained from the USGS website (https://waterdata.usgs.gov/nwis/qw) for USGS continuous recorder Stations 02304520 (Nebraska Avenue bridge) and 023060013 (I-275 bridge). These data were converted to salinity values using the equation Salinity = 0.0006 x (SC – 0.292) (Water and Air Research, Inc, 1995). The daily salinity data were then converted to monthly means for comparison with the EPCHC water quality data.

A new USGS continuous recorder, 02304517 (Hannah's Whirl near Sulphur Springs) became operational on October 26, 2017. Available specific conductance, dissolved oxygen, and temperature data between the date of operation and end of the reporting period (October 26, 2017 through May 31, 2018) were obtained from the USGS website. Due to the abbreviated period of record for this gage, these data are not included in the statistical analysis of water quality parameters in this report, however, they have been summarized as part of this current five-year assessment and will be further analyzed during the third five-year assessment.

Mean daily discharge (cfs) from USGS Station 02304500 at the Hillsborough River dam was converted to monthly means. Monthly dates when the mean discharge rate was $\leq$ 1 cfs were used to separate the water quality data into two data sets: without-flow data (including all dates when the discharge rate was $\leq$ 1 cfs) and with-flow data (including all dates when the discharge rate was > 1 cfs). All water quality analyses were performed on both data sets to determine the effects of the with-flow and without-flow periods. Site locations were classified for both the with-flow and without-flow data sets into four MFL periods to discern the effects of the minimum flow strategy on water quality. These four MFL periods and data exclusions are defined as follows:

- Water quality data prior to October 1, 1979 will not be included in this report;
- MFL Period 1 - No minimum flow rule in place: October 1, 1979 to February 28, 2002;
- MFL Period 2 - 10 cfs from Sulphur Springs: March 1, 2002 to December 31, 2007;
- MFL Period 3 - 20 or 24 cfs freshwater equivalents from Sulphur Springs and dam release: January 1, 2008 to September 30, 2012; and
- MFL Period 4 - 20 or 24 cfs freshwater equivalents from Sulphur Springs and dam release: October 1, 2012 to May 31, 2018.

For descriptive purposes, site locations were also classified into upper, middle, and lower river segments, as defined previously in this report.

4.2.2 Statistical Methods

4.2.2.1 Station Water Quality Data and Statistics

Mean, standard deviation (SD), and sample number (n) were calculated for the water quality variables at the EPCHC and USGS stations and separated by MFL period and river segment using Minitab 18.1 (©2017 Minitab, Inc. https://www.minitab.com/en-us/). Minitab 18.1 was used for all additional water quality statistical analysis. The results of a Shapiro-Wilk test for normal distribution on the water quality variables for each of the EPCHC stations showed that the majority of the variables lacked a normal distribution (55 of 103 for the no-flow data set, 87 of 114 for the with-flow data set). Due to the seasonality of the data, attempts to perform a normal transformation were generally unsuccessful. Therefore, non-parametric statistical methods were used for the water quality analysis.

4.2.2.2 Discharge Rate and Water Quality

A Spearman Rho correlation analysis was performed between mean monthly discharge without flow (< 1 cfs) and with flow (> 1 cfs) at USGS Station 02304500 at the Hillsborough River dam and discrete monthly water quality variables at Rowlett Park Drive (EPCHC 105) below the dam from October 1979 to May 2018. This analysis was chosen because the majority of the water quality variables had non-normal, yet ordinal, data distributions. A Bonferroni correction for multiple comparisons was applied for each analysis. This location was chosen due to its proximity to the dam and the completeness of the water quality dataset from October 1979 to May 2018.

4.2.3 Minimum Flow Periods and Water Quality

A Kruskal-Wallis analysis with multiple comparison Dunn's Tests was performed for water quality variables by MFL period for each EPCHC or USGS station from October 1979 to May 2018. A Bonferroni correction for multiple comparisons was applied to each analysis. A Kruskal-Wallis analysis with multiple comparison Dunn's Tests was performed for DO and salinity variables comparing EPCHC and USGS stations within each MFL period from October 1979 to May 2018. A Bonferroni correction for multiple comparisons was applied to each analysis.

The number of monthly sampling days that the recorded water quality value exceeded the Florida state water quality standard (https://www.flrules.org/gateway/RuleNo.asp?ID=62-302.530) for Class III surface waters in rivers for DO percent saturation, or that salinity exceeded the 5.0 (ppt) MFL goal, was calculated at the EPCHC and USGS stations by MFL period from October 1979 to May 2018 The DO percent saturation standard is for freshwater systems, and though the lower river segment is tidally influenced, the upper river segment above the dam is not tidally influenced. Thus, due to the tidal influence, the lower river segment stations at I-275, North River Shore Drive, Sligh Avenue, and West Platt Street were not included in the analysis.

4.3 Assessment of Biological Communities Methods

4.3.1 Overview

Three faunal communities sampled between 2000 and 2012 for the Tampa Bay Water HBMP in the LHR were zooplankton, nekton (fish and large mobile invertebrates), and benthic macroinvertebrates. In 2018, these three faunal communities were sampled again by Water & Air in the LHR between Sligh Avenue and The Tampa Dam using similar methods (details to follow in the sections for each type of sample) not the same as the strata used in the HBMP program.

The 2018 study divided the sampling area into the aforementioned (Section 1.2) three segments (Appendix 4.3.1-1, Figure 1.2-2, Water & Air 2018). It should be noted that these river segments are not the same as the strata used in the HBMP program. The area covered by the 2018 study includes a large portion of HBMP stratum 5 and all of stratum 6 which extends to the dam. The 2000 to 2012 HBMP data set obtained from Tampa Bay Water (through their consultant, ESA) was trimmed to include just the stations between RKm 10.55 and the dam and sorted into the 2018 sampling segments for comparison with 2018 data.

To examine aquatic faunal communities that had been subjected to no-flow conditions, Water & Air collected the faunal samples between Sligh Avenue and the dam in April and May of 2018 after a minimum of 30 days of no flow (daily average ≤ 1 cfs) over the Hillsborough Dam (USGS 02304500). Similarly, the HBMP data sets obtained by Water & Air were reduced to only include samples collected following a minimum of 30 days of no-flow to make them comparable. These no-flow sample dates were categorized into the four MFL periods described in this report in the preceding methods section.

In-situ water quality data collected with the faunal samples both during the HBMP program and by Water & Air in 2018 are included in analysis of the zooplankton, nekton, and benthic macroinvertebrate communities in this report. The abiotic variables measured at each sampling station include total depth (m), water temperature (°C), pH, DO (mg/L), and salinity (ppt). In 2018, these water quality parameters were collected in a profile at 0.2 m below the water surface (Top), above the bottom (Bottom), and at a mid-point between the surface and the bottom (Mid) with a handheld YSI Pro Plus that was calibrated and/or verified daily. During the HBMP program, the water quality measures were also collected in a profile using a handheld sonde, starting 0.2 m below the water surface and then at every meter or every half meter after that until the bottom was reached. To make up for this discrepancy in methods, the HBMP data were reduced to Top (always the 0.2 m below the surface measurement), Bottom (always the deepest reading collected in the profile), and Mid which was the measurement collected closest to halfway between the surface and bottom.

In PRIMER 7, the following standard community level metrics (equations follow) were calculated: species (actually taxa) richness, Shannon diversity index, Simpson's dominance index (results range from 0 to 1, which indicates the likelihood that two organisms selected randomly from the population will be of the same species/taxa), and Pielou's evenness index (results can range from 0 to 1) which measures how evenly individuals are spread among species/taxa with the highest value of 1 indicating individuals are spread evenly among species.

- Richness (includes the total number of taxa and the total number of genera)
- Shannon Diversity (H', base *e*)
  - $H' = -\Sigma [(n_i / N) * \ln (n_i / N)]$
- Simpson's Dominance Index (D)
  - $D = \Sigma [(n_i(n_i - 1) / N(N - 1)]$
- Pielou's Evenness (J')
  - $J' = H' / H'_{max}$

Note: N = total number of individuals in the sample, n_i = number of individuals of each species

Multivariate statistical analyses of the sampled animal communities were completed using the PRIMER 7 software package on animal density data by terminal taxon with replicates unpooled for all types of samples. Because some of the seine and ponar samples had no organisms, zero-adjusted Bray-Curtis was used because standard Bray-Curtis coefficients are undefined for two samples containing no species and two samples with a single individual can fluctuate between 0 and 100 percent similarity based on whether or not the animal is the same species. Inserting a very small dummy variable when creating the Bray-Curtis similarity matrix in PRIMER damps down this behavior and has next to no effect when there are a modest number of individuals in either sample (Clarke and Gorley 2015).

Bray-Curtis similarity matrices, which calculate the similarity between samples for all possible pairings of samples (Clarke and Gorley 2015; Clarke et al. 2014), were created from fourth-root transformed density data. The fourth-root transformation was used because it is a moderate transformation that compromises between the influence of a few dominant taxa and rare taxa (Clarke and Gorley 2015). The success of the transformation was checked using PRIMER's "shade plot" function (Clarke and Gorley 2015). These Bray-Curtis similarity matrices were used to construct non-metric multidimensional scaling (nMDS) ordination plots. The MDS ordinations were generated using the Kruskal fit scheme 1 with 999 iterations, the minimum and maximum dimensions set at 2, and the minimum stress was set at 0.01. These plots show the non-metric rank-based distance between samples in a two-dimensional space based on their pairwise similarity and show the stress value associated with the optimal two-dimensional arrangement. Stress below 0.05 indicates an excellent fit while stress below 0.1 indicates a clearly useful representation. Stress between 0.1 and 0.2 indicates the ordination may still be useful but should be interpreted in tandem with the clustering method (Clarke et al. 2014).

The nekton and benthic macroinvertebrate communities were assessed using PRIMER ANOSIM two-way crossed procedure which analyzes the Bray-Curtis similarity matrix using the Spearman rank correlation method (with a maximum of 999 permutations) and was used to test for differences in patterns of species composition by MFL period and river segment. The R test statistic (ranges from 0 to 1) generated by the test indicates the amount of separation based on the factor (MFL period or river segment) with higher test statistics indicating more differences between the factor groups. Pairwise tests were also conducted among MFL periods and among river segments.

The nekton and benthic macroinvertebrate communities were also assessed using the PRIMER SIMPER procedure on the fourth-root transformed data was used to examine the average similarity of samples within factor groups (MFL period and river segment) and the average dissimilarity between factor groups (in a pairwise analysis). It also indicates the percentage contribution of taxa that most influenced the similarity or dissimilarity. The cutoff for low contributions was set at 70 percent, meaning the software would continue to identify taxa until 70 percent of the similarity or dissimilarity was explained. In this way, we can identify potentially important (dominant or characteristic) taxa that are indicative of an MFL period or river segment.

Using the statistical software JMP v. 14, Spearman's rank-based correlation tests were used to analyze the relationship between some of the animal community results (total density of animals in the samples, Shannon index values, and taxon richness in the samples), MFL period, and some of the water quality parameters collected concurrently with the samples. These analyses were conducted on untransformed data, and results of all tests were considered significant at the $p \leq 0.05$ level. More details of the data analyses performed for the different faunal communities are described in the relevant sections below.

4.3.2 Zooplankton Methods

4.3.2.1 Collection and Processing of Zooplankton Samples from HBMP Program and 2018 Study

The HBMP used fixed stations in each stratum to collect plankton during the monitoring program that took place from 2000 through 2012. Four of these stations fell in the 2018 study area (specifically, these stations were located in the Lower and Middle river segments, in HBMP strata 5 and 6) described in the scope of work and were used for this assessment (Figure 4.3.2.1-1; Appendix 4.3.1-1). Zooplankton samples were collected at all four of these fixed stations on the nights of April 11 and May 9 in 2018 and on the sample dates from the HBMP program that met the 30 day no-flow criteria (Appendix 4.3.2-1). These sampling events were timed for flood tides with sample collection beginning within 2 hours after sunset and ended within a few hours as was done in the HBMP program.

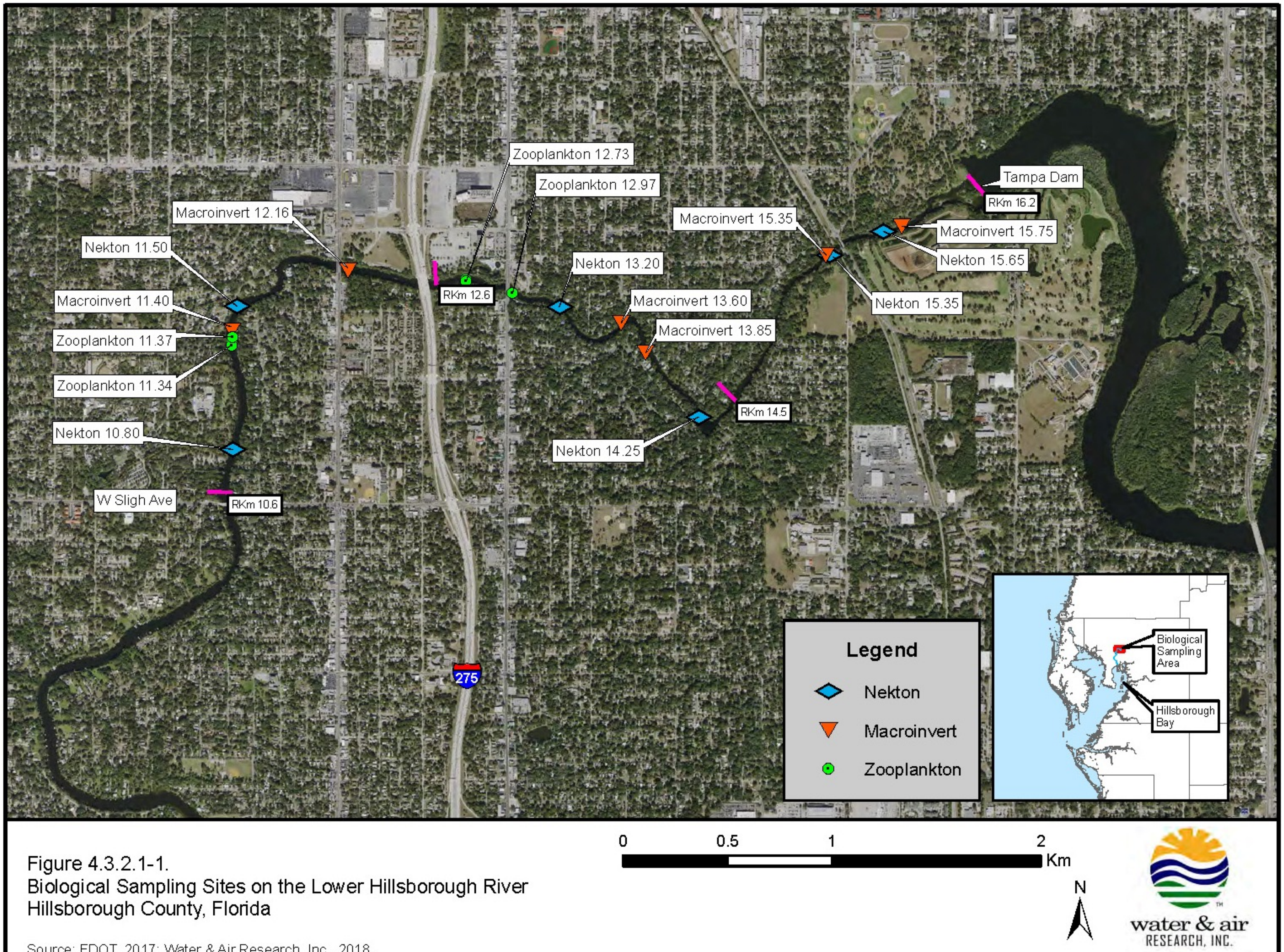


Figure 4.3.2.1-1.
Biological Sampling Sites on the Lower Hillsborough River
Hillsborough County, Florida

Source: FDOT, 2017; Water & Air Research, Inc., 2018.

water & air RESEARCH, INC.

Plankton was collected using a conical net (with a 3:1 ratio of bag length to mouth diameter) made of 500 µm Nytex mesh equipped with a three-point nylon bridle, a mechanical flow meter, a 1-liter plastic cod-end jar, and a 9-kilogram weight which was attached to the mouth ring of the net. Tow durations were 5 minutes divided equally among bottom, mid-water, and near-surface depths with a tow speed of 1.0 to 1.5 meters per second (m/s). The tow line was marked so tow depth could be established. Once at the proper depth, the tow line was tied to a cleat on the back of the boat. Before deployment and upon retrieval of the net, the flow meter value was recorded. Once on board the net was hung vertically, and the contents of the net rinsed carefully into the cod-end jar using a hose connected to an electric wash-down pump. The volume in the cod-end jar was reduced to 500 to 800 mL and 50 mL of formaldehyde was added to the cod-end jar, resulting in a 6 to 9 percent formalin solution diluted in ambient water. Sticks caught in the samples were rinsed inside the net and discarded.

Samples were separated into two size fractions using stacked sieves with mesh openings of 4 mm and 250 µm. In most cases, the fish and macroinvertebrates in the > 4 mm fraction were identified and enumerated without the aid of microscopes. Generally, magnification of 7 to 12 X was used to enumerate organisms in the > 250 µm fraction, with zoom magnifications as high as 90 X being used for identifying individual specimens. The > 250 µm fraction was sorted in two stages. In the first sorting stage, the entire sample was processed as 10 to 15 mL aliquots that are scanned in succession using a gridded Petri dish. Only relatively uncommon taxa (n < 50) were enumerated during this first stage. After the entire sample was processed in this manner, the collective volume of the aliquots was recorded within a graduated mixing cylinder, the sample was inverted repeatedly, and a single 30 to 60 mL aliquot was poured. The aliquot volume typically represents about 12 to 50 percent of the entire sample volume. The second sorting stage consisted of enumerating the relatively abundant taxa within this single aliquot.

Zooplankton organisms found in these samples were identified and enumerated by Dr. Ernst Peebles of the University of South Florida for both the 2018 Water & Air sample collection as well as during the HBMP program. All aquatic vertebrate and invertebrate taxa collected by the plankton net were identified and counted, except invertebrate eggs and organisms that were attached to debris. Organisms were enumerated and recorded by taxonomic identifiers and life stage information, e.g., “gobiid pre-flexion larvae”, “gobiid flexion larvae”, “decapod zoeae”, or “decapod megalopae”. Because taxa were counted at multiple life stages (eggs, larvae, juveniles, etc.) diversity measures were not calculated on these data.

4.3.2.2 Analysis of Zooplankton Data from HBMP Program and 2018 Study

Taxon/lifestage-specific organism abundance was represented as density in the form of the number of individuals per 1,000 m^3 of water. Using 1,000 m^3 as the reference volume allows expression of density at familiar orders of magnitude (tens, hundreds, thousands) rather than at small decimal values. The actual volumes filtered by each plankton-net deployment averaged 72.0 m^3 and ranged from 22.1 to 99.1 m^3, as determined from flow meter readings from inside the mouth of the plankton net.

Using PRIMER 7 software (v. 7.0.13), organism densities were fourth-root transformed to down-weight overly abundant taxa, preventing overly abundant taxa from dominating the outcome of the analyses. Bray-Curtis (S17) similarity was calculated for all possible pairings of samples, producing a triangular similarity matrix. All pairwise similarities among samples were then visualized using non-metric multi-dimensional scaling (nMDS), which was flattened to a representation in two dimensions (2D) by an algorithm that minimized distortion of actual similarity "distances" among samples. The resulting 2D stress, an indicator of the amount of distortion that occurs during conversion to 2D representation, was 0.2, an acceptable level of distortion provided only the major trends in the resulting plot are interpreted.

Abundance (i.e., density) associations among taxa were visualized through cluster analysis using the group average clustering mode and 999 permutations, with significance level set at 5 percent. The resulting dendrogram was used to ordinate taxa within a heatmap ("shade plot" routine in PRIMER 7). Samples in the heatmap were then reordered by MFL period to constrain samples within MFL periods in the graphical output, followed by seriation within MFL periods based on 99 seriate restarts. The resulting heatmap was limited to the top 50 most important taxa, with importance based on proportional dominance within samples. The most important taxon is that which comprised the highest proportion of the total number of individuals (all taxa combined) in any sample, followed by the taxon with the next highest proportion, and so forth until 50 taxa had been selected.

Among the 50 most important taxa, a subset of indicator taxa was identified using Table 4 in Burghart et al. (2013). The indicator taxa were indicators of either relatively oligotrophic or relatively eutrophic habitat conditions. Nineteen of the 50 most important taxa (38 percent) were listed as indicators by Burghart et al. (2013). Each of these indicator taxa was tested for differences in median density among the four MFL periods using the rank-based, nonparametric Kruskal-Wallis ANOVA in Statgraphics Centurion 18 (v. 18.1.05). To determine whether there was a first-order trend in density during the four MFL periods, Spearman's rank-based correlations between individual sample densities and MFL period (dummy variables 1, 2, 3, and 4) were examined. Aside from ranking, no data transformations were used in the ANOVA or correlation analyses, as rank-based statistical tests are insensitive to mathematical transforms.

An increase in the density of a positive (oligotrophic-oriented) indicator (i.e., a positive correlation with $p < 0.05$) was considered an improvement in trophic state (i.e., habitat condition). An increase in a negative (eutrophic-oriented) indicator was considered a decline in trophic state. A decrease in an oligotrophic-oriented indicator was considered a decline in trophic state, and a decrease in a eutrophic-oriented indicator was considered an improvement in trophic state. The number of improving, no-change, and declining indicators was tallied and expressed as a percentage, which was interpreted as a weight-of-evidence approach toward determining whether habitat conditions had changed since MFL implementation, with increasing eutrophication being considered habitat degradation due to the tidal Hillsborough River frequently experiencing extensive hypoxia (MacDonald et al. 2005).

4.3.3 Nekton Methods

4.3.3.1 Collection and Processing of Nekton Samples from HBMP Program and 2018 Study

The HBMP used random locations for two seine samples monthly in each stratum to collect nekton (mainly adult and juvenile fish and decapod crustaceans) from May 2000 until June 2012. Samples from stratum 5 (that were collected above RKm 10.55) and stratum six of the HBMP monitoring program (Figure 6; Appendix 4.3.3-1) collected on dates that met the no-flow criteria were used for analysis. In April and May 2018, two seine samples were collected in each river segment (six seine samples total per month) and to avoid having both spatial and temporal variation among the samples (as sample size was low), these locations were used for both sampling events (Water & Air 2018). In 2018, seining sites were selected on the first trip for feasibility of operating the seine (no large rocks, appropriate water depth, and exposed/shallow banks). Though the sites were randomly selected for the HBMP sampling, sites that were not suitable were not used and alternate sites were selected (Independent Monitoring Program, Florida Marine Research Institute 2017).

Seine hauls were made with a 21.3-m long center-bag seine (1.8-m deep with 3.2 mm knotless nylon Delta mesh) set into the prevailing current. Fish and large invertebrates caught were kept alive in buckets of river water awaiting counts/identification. Animals were released back into the river at the collection site. Sample collection and processing techniques were based on protocols used state-wide by Florida's Fisheries-Independent Monitoring Program (Florida Marine Research Institute 2017) consistent between HBMP sampling and 2018 sampling by Water & Air. Identifications were generally made to the species level with some exceptions (e.g. *Menidia* spp., *Brevoortia* spp.). In hauls with over 1,000 individuals of a single species (or species complex), a Motoda box splitter was used to create subsamples and final numbers were estimated by fractional expansion of the sub-sampled portion of the total catch (Florida Marine Research Institute 2017).

4.3.3.2 Analysis of Nekton Data from HBMP Program and 2018 Study

Before statistical analysis of the data, some taxa designations were combined with the goal of keeping identification level consistent across the two studies and to account for changes in nomenclature. For example, all armored catfish (*Pterygoplichthys* species) were combined into *Pterygoplichthys* spp. (as that was the designation used in 2018). Turtle data were not included.

In PRIMER 7, the aforementioned standard community level metrics (see above) were calculated and then ANOSIM and SIMPER analyses were conducted. For analysis of the relationship between some of the nekton community results, MFL period, and water quality parameters collected concurrently with the seine samples Spearman rank-based correlation tests were used. For these analyses, the average DO and salinity readings from the profile were used. Average DO, pH, and salinity were calculated by taking the mean of those measurements collected from the top, middle, and bottom readings of the water quality profile. This was done because the seine net reached from the bottom of the river to the surface of the water and collected organisms from the entire water column.

4.3.4 Benthic Macroinvertebrate Methods

4.3.4.1 Collection and Processing of Benthic Macroinvertebrate Samples from HBMP Program and 2018 Study

The HBMP used random sampling to collect two benthic macroinvertebrate dredge samples in each stratum using a Young-modified Van Veen sampler which sampled a 0.04 m^2 (400 cm^2) area of the sediment surface. Stations that were located between RKm 10.55 (Sligh Avenue) and the Hillsborough River Dam (all of HBMP Stratum 6 and most of Stratum 5) are included in this analysis if they were sampled on dates that meet the 30 day no-flow criteria (Appendix 4.3.4-1). These no-flow sample dates were then assigned to the proper MFL period (see Section 2.3). In 2018, six randomly-selected stations between Sligh Avenue and the dam were sampled twice (to avoid having both spatial and temporal variation among the samples since sample size was low), once in April 2018 and again in May 2018 (Appendix 4.3.4-1; Water & Air 2018). These samples were collected with using a petite ponar grab which sampled a 0.023 m^2 (230 cm^2) area of the sediment surface. Because of the difference in equipment used, all macroinvertebrate abundances were standardized to per square meter so comparisons could be made.

In 2018, samples were fixed in 10 percent buffered formalin and stained with rose bengal dye on the boat. Samples were processed in Water & Air's laboratory, where they were rinsed with tap water in a 500 µm sieve and sorted in their entirety to remove any aquatic macroinvertebrates. For quality assurance, 10 percent of the samples were re-sorted by a qualified technician to look for missed animals. Macroinvertebrates found in the samples were placed in 75 percent ethanol or mounted on a glass microscope slide with CMC-10™ mounting medium for identification (chironomids and oligochaetes require mounting). Organisms were identified to the lowest practical taxonomic level (in most cases species or genus level, but sometimes family or higher due to poor quality of the specimens or other limitations) using both dissecting and compound microscopes. For quality assurance, 5 percent of the samples were re-examined by another qualified taxonomist after identifications were complete to ensure all macroinvertebrates had been counted and properly identified to the lowest taxonomic level possible. Details are not available, but it is likely similar procedures were used to preserve and identify the organisms by the other two laboratories that processed HBMP samples. The Milligan laboratory processed the samples from the start of the program through March 2002 and the laboratory at Terra processed them from July 2006 to March 2009.

4.3.4.2 Analysis of Benthic Macroinvertebrate Data from HBMP Program and 2018 Study

Before statistical analysis of the data, Water & Air taxonomists made some combinations of taxa with the goal of keeping identification level consistent across the three laboratories that processed these samples. Combinations and corrections (one spelling change) are documented in the data file.

In PRIMER 7, the aforementioned standard community level metrics (see above) were calculated and the ANOSIM and SIMPER analyses conducted. For analysis of the relationship between some of the benthic macroinvertebrate community results, MFL period, and water quality parameters collected concurrently with the ponar samples Spearman rank-based correlation tests were used. For these analyses, only the bottom readings (DO and salinity) from the water quality profile were used. This was done because the benthic macroinvertebrate community is minimally mobile and is generally under constant exposure to the conditions on the bottom of the river.

5.0 Lower Hillsborough River Water Quality Analysis Results

5.1 Station Water Quality Data and Statistics

Mean, standard deviation (SD), and sample number (n) were calculated for the water quality variables at the EPCHC and USGS stations and separated by MFL period and river segment from October 1979 to May 2018 (Appendix 5.1-1: Tables 5.1-1 and 5.1-2). Boxplots were calculated for the water quality variables at the EPCHC and USGS stations and separated by MFL period and river segment from October 1979 to May 2018 (see Appendix 5.1-2: Figures 5.1-1 to 5.1-84). Sites are shown on the x axis by longitudinal order of their spatial location on the Hillsborough River. While not included in the statistical analysis due to the brevity of the period of record, plots of the available daily average salinity, specific conductance, and dissolved oxygen for the USGS gage 02304517 (Hannah’s Whirl near Sulphur Springs) are included in Appendix 5.1-2: Figures 5.1-85-87.

5.1.1 Salinity

5.1.1.1 Salinity when river flow was not over the dam

In the upper river segment above the dam average monthly salinity ranged from a maximum of 0.49 (ppt) at East Fowler Avenue during MFL period 1 to a minimum of 0.18 (ppt) at East Fowler Avenue during MFL periods 1 and 2 (Table 5.1-1, Figure 5.1-1). In the upper river segment below the dam average monthly salinity ranged from a maximum of 3.63 (ppt) at Rowlett Park Drive during MFL period 1 to a minimum of 0.64 (ppt) at Rowlett Park Drive during MFL period 3 (Table 5.1-1, Figure 5.1-1). In the middle river segment average monthly salinity ranged from a maximum of 13.30 (ppt) at Nebraska Avenue during MFL period 1 to a minimum of 3.58 (ppt) at Hanna’s Whirl during MFL period 4 (Table 5.1-1, Figure 5.1-2). In the lower river segment average monthly salinity ranged from a maximum of 16.91 (ppt) at Sligh Avenue during MFL period 1 to a minimum of 9.31 (ppt) at North River Shore Drive during MFL period 4 (Table 5.1-1, Figure 5.1-3). At the lower river mouth station of West Platt Street average monthly salinity ranged from a maximum of 28.56 (ppt) during MFL period 1 to a minimum of 25.43 (ppt) at during MFL period 2 (Table 5.1-1, Figure 5.1-3). In the tributaries average monthly salinity ranged from a maximum of 3.01 (ppt) at Sulphur Springs during MFL period 2 to a minimum of 0.20 (ppt) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-4).

As expected, salinity increased from upstream to downstream (i.e. towards the bay) in the LHR (as measured at the stations included in this report). Due to salinity incursions from the mouth of the river, it is not surprising that salinity was higher during all MFL periods at all of the stations when freshwater discharge was not occurring at the dam. With the implementation of minimum flow requirements and the recovery strategy, the increase in freshwater flows have resulted in lower salinities. More specifically, salinity was significantly lower during MFL periods 2, 3, and 4 as compared to MFL period 1.

Salinity results in the LHR below the dam indicate good progress has been made in establishing a salinity range of less than 5 ppt from the dam towards Sulphur Springs based on the current operation of the recovery strategy projects. Additional analysis will be performed by the District over the next five-year assessment period to determine if the requirements of the LHR recovery strategy and rule have been achieved.

5.1.1.2 Salinity when river flow was over the dam

In the upper river segment above the dam average monthly salinity ranged from a maximum of 0.30 (ppt) at East Fowler Avenue during MFL period 1 to a minimum of 0.13 (ppt) at East Fowler Avenue during MFL period 2 and North 56th Street during MFL period 4 (Table 5.1-2, Figure 5.1-5). In the upper river segment below the dam average monthly salinity ranged from a maximum of 1.40 (ppt) at Rowlett Park Drive during MFL period 1 to a minimum of 0.52 (ppt) at Rowlett Park Drive during MFL period 4 (Table 5.1-2, Figure 5.1-1). In the middle river segment average monthly salinity ranged from a maximum of 5.01 (ppt) at Nebraska Avenue during MFL period 1 to a minimum of 1.01 (ppt) at Hanna's Whirl during MFL period 4 (Table 5.1-2, Figure 5.1-6). In the lower river segment average monthly salinity ranged from a maximum of 5.68 (ppt) at North River Shore Drive during MFL period 3 to a minimum of 2.62 (ppt) at Hwy I-275 during MFL period 2 (Table 5.1-2, Figure 5.1-7). At the lower river mouth station of West Platt Street average monthly salinity ranged from a maximum of 23.82 (ppt) during MFL period 3 to a minimum of 17.53 (ppt) at during MFL period 2 (Table 5.2-1, Figure 5.1-7). In the tributaries average monthly salinity ranged from a maximum of 2.62 (ppt) at Sulphur Springs during MFL period 4 to a minimum of 0.14 (ppt) at Twin Lake Outfall during MFL period 4 (Table 5.2-1, Figure 5.1-8).

5.1.2 Specific Conductance

5.1.2.1 Specific conductance when river flow was not over the dam

In the upper river segment above the dam average monthly specific conductance ranged from a maximum of 583.65 (µmho/cm) at East Fowler Avenue during MFL period 1 to a minimum of 381.53 (µmho/cm) at East Fowler Avenue during MFL period 2 (Table 5.1-1, Figure 5.1-9). In the upper river segment below the dam average monthly specific conductance ranged from a maximum of 12,822.66 (µmho/cm) at Rowlett Park Drive during MFL period 1 to a minimum of 3246.67 (µmho/cm) at Rowlett Park Drive during MFL period 3 (Table 5.1-1, Figure 5.1-9). In the middle river segment average monthly specific conductance ranged from a maximum of 12,357.00 (µmho/cm) at North 12th Street during MFL period 3 to a minimum of 6,513.92 (µmho/cm) at Hanna's Whirl during MFL period 4 (Table 5.1-1, Figure 5.1-10). In the lower river segment average monthly specific conductance ranged from a maximum of 27,538.10 (µmho/cm) at Sligh Avenue during MFL period 1 to a minimum of 15,858.46 (µmho/cm) at North River Shore Drive during MFL period 4 (Table 5.1-1, Figure 5.1-11). At the lower river mouth station of West Platt Street average monthly specific conductance ranged from a maximum of 44,063.24 (µmho/cm) during MFL period 1 to a minimum of 39,836.84 (µmho/cm) at during MFL period 2 (Table 5.1-1, Figure 5.1-11). In the tributaries average monthly specific conductance ranged from a maximum of 5,502.50 (µmho/cm) at Sulphur Springs during MFL period 2 to a minimum of 414.00 (µmho/cm) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-12).

5.1.2.2 Specific conductance when river flow was over the dam

In the upper river segment above the dam average monthly specific conductance ranged from a maximum of 311.00 (µmho/cm) at East Fowler Avenue during MFL period 1 to a minimum of 272.63 (µmho/cm) at East Fowler Avenue during MFL period 2 (Table 5.1-2, Figure 5.1-13). In the upper river segment below the dam average monthly specific conductance ranged from a maximum of 2,031.95 (µmho/cm) at Rowlett Park Drive during MFL period 1 to a minimum of 1,010.11 (µmho/cm) at Rowlett Park Drive during MFL period 4 (Table 5.1-2, Figure 5.1-13). In the middle river segment average monthly specific conductance ranged from a maximum of 5,432.89 (µmho/cm) at North 12th Street during MFL period 4 to a minimum of 1,887.96 (µmho/cm) at Hanna's Whirl during MFL period 4 (Table 5.1-2, Figure 5.1-14). In the lower river segment average monthly specific conductance ranged from a maximum of 9,619.89 (µmho/cm) at North River Shore Drive during MFL period 3 to a minimum of 6,900.95 (µmho/cm) at North River Shore Drive during MFL period 4 (Table 5.1-2, Figure 5.1-15). At the lower river mouth station of West Platt Street average monthly specific conductance ranged from a maximum of 35,779.63 (µmho/cm) during MFL period 4 to a minimum of 28,088.98 (µmho/cm) at during MFL period 2 (Table 5.2-1, Figure 5.1-15). In the tributaries average monthly specific conductance ranged from a maximum of 4,896.55 (µmho/cm) at Sulphur Springs during MFL period 4 to a minimum of 281.00 (µmho/cm) at Twin Lake Outfall during MFL period 4 (Table 5.2-1, Figure 5.1-16).

5.1.3 Dissolved Oxygen Concentration

5.1.3.1 DO Concentration when river flow was not over the dam

In the upper river segment above the dam average monthly DO concentration ranged from a maximum of 8.07 (mg/L) at East Fowler Avenue during MFL period 4 to a minimum of 6.33 (mg/L) at East Fowler Avenue during MFL period 2 (Table 5.1-1, Figure 5.1-17). In the upper river segment below the dam average monthly DO concentration ranged from a maximum of 5.80 (mg/L) at Rowlett Park Drive during MFL period 4 to a minimum of 3.50 (mg/L) at Rowlett Park Drive during MFL period 1 (Table 5.1-1, Figure 5.1-17). In the middle river segment average monthly DO concentration ranged from a maximum of 4.65 (mg/L) at Hanna's Whirl during MFL period 4 to a minimum of 2.29 (mg/L) at North 12th Street during MFL period 3 (Table 5.1-1, Figure 5.1-18). In the lower river segment average monthly DO concentration ranged from a maximum of 2.50 (mg/L) at North River Shore Drive and Sligh Avenue during MFL period 4 to a minimum of 1.72 (mg/L) at North River Shore Drive during MFL period 3 (Table 5.1-1, Figure 5.1-19). At the lower river mouth station of West Platt Street average monthly DO concentration ranged from a maximum of 6.44 (mg/L) during MFL period 4 to a minimum of 4.86 (mg/L) at during MFL periods 2 and 3 (Table 5.1-1, Figure 5.1-19). In the tributaries average monthly DO concentration ranged from a maximum of 8.25 (mg/L) at Sulphur Springs during MFL period 2 to a minimum of 6.02 (mg/L) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-20).

5.1.3.2 DO Concentration when river flow was over the dam

In the upper river segment above the dam average monthly DO concentration ranged from a maximum of 3.57 (mg/L) at East Fowler Avenue during MFL period 1 to a minimum of 2.72 (mg/L) at Temple Terrace Hwy during MFL period 4 (Table 5.1-2, Figure 5.1-21). In the upper river segment below the dam average monthly DO concentration ranged from a maximum of 6.27 (mg/L) at Rowlett Park Drive during MFL period 2 to a minimum of 5.87 (mg/L) at Rowlett Park Drive during MFL period 1 (Table 5.1-2, Figure 5.1-21). In the middle river segment average monthly DO concentration ranged from a maximum of 5.42 (mg/L) at Hanna's Whirl during MFL period 4 to a minimum of 4.43 (mg/L) at North 12th Street during MFL period 3 (Table 5.1-2, Figure 5.1-22). In the lower river segment average monthly DO concentration ranged from a maximum of 4.16 (mg/L) at North River Shore Drive during MFL period 4 to a minimum of 2.56 (mg/L) at Sligh Avenue during MFL period 1 (Table 5.1-2, Figure 5.1-23). At the lower river mouth station of West Platt Street average monthly DO concentration ranged from a maximum of 4.66 (mg/L) during MFL period 1 to a minimum of 4.17 (mg/L) at during MFL period 4 (Table 5.2-1, Figure 5.1-23). In the tributaries average monthly DO concentration ranged from a maximum of 6.42 (mg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 5.78 (mg/L) at Sulphur Springs during MFL period 4 (Table 5.2-1, Figure 5.1-24).

5.1.4 DO Saturation

5.1.4.1 DO Saturation when river flow was not over the dam

In the upper river segment above the dam average monthly DO saturation ranged from a maximum of 92.51 (%) at East Fowler Avenue during MFL period 4 to a minimum of 73.30 (%) at East Fowler Avenue during MFL period 1 (Table 5.1-1, Figure 5.1-25). In the upper river segment below the dam average monthly DO saturation ranged from a maximum of 68.94 (%) at Rowlett Park Drive during MFL period 4 to a minimum of 52.98 (%) at Rowlett Park Drive during MFL period 2 (Table 5.1-1, Figure 5.1-25). In the middle river segment average monthly DO saturation ranged from a maximum of 55.47 (%) at Hanna's Whirl during MFL period 4 to a minimum of 27.94 (%) at North 12th Street during MFL period 3 (Table 5.1-1, Figure 5.1-26). In the lower river segment average monthly DO saturation ranged from a maximum of 89.70 (%) at Sligh Avenue during MFL period 1 to a minimum of 21.45 (%) at North River Shore Drive during MFL period 3 (Table 5.1-1, Figure 5.1-27). At the lower river mouth station of West Platt Street average monthly DO saturation ranged from a maximum of 87.39 (%) during MFL period 4 to a minimum of 66.88 (%) at during MFL period 2 (Table 5.1-1, Figure 5.1-27). In the tributaries average monthly DO saturation ranged from a maximum of 101.30 (%) at Sulphur Springs during MFL period 2 to a minimum of 72.20 (%) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-28).

5.1.4.2 DO Saturation when river flow was over the dam

In the upper river segment above the dam average monthly DO saturation ranged from a maximum of 38.55 (%) at East Fowler Avenue during MFL period 4 to a minimum of 33.11 (%) at Temple Terrace Hwy during MFL period 4 (Table 5.1-2, Figure 5.1-29). In the upper river segment below the dam average monthly DOS ranged from a maximum of 74.21 (%) at Rowlett Park Drive during MFL period 4 to a minimum of 71.86 (%) at Rowlett Park Drive during MFL period 3 (Table 5.1-2, Figure 5.1-29). In the middle river segment average monthly DO saturation ranged from a maximum of 64.32 (%) at Hanna's Whirl during MFL period 4 to a minimum of 52.69 (%) at North 12th Street during MFL period 3 (Table 5.1-2, Figure 5.1-30). In the lower river segment average monthly DO saturation ranged from a maximum of 50.59 (%) at North River Shore Drive during MFL period 4 to a minimum of 44.54 (%) at Sligh Avenue during MFL period 3 (Table 5.1-2, Figure 5.1-31). At the lower river mouth station of West Platt Street average monthly DO saturation ranged from a maximum of 59.62 (%) during MFL period 3 to a minimum of 56.30 (%) at during MFL period 4 (Table 5.2-1, Figure 5.1-31). In the tributaries average monthly DO saturation ranged from a maximum of 79.12 (%) at Twin Lake Outfall during MFL period 4 to a minimum of 71.48 (%) at Sulphur Springs during MFL period 4 (Table 5.2-1, Figure 5.1-32).

5.1.5 pH

5.1.5.1 pH when river flow was not over the dam

In the upper river segment above the dam average monthly pH ranged from a maximum of 7.92 at North 56th Street during MFL period 4 to a minimum of 7.73 at East Fowler Avenue during MFL period 2 (Table 5.1-1, Figure 5.1-33). In the upper river segment below the dam average monthly pH ranged from a maximum of 7.49 at Rowlett Park Drive during MFL period 3 to a minimum of 7.25 at Rowlett Park Drive during MFL period 1 (Table 5.1-1, Figure 5.1-33). In the middle river segment average monthly pH ranged from a maximum of 7.43 at Hanna's Whirl during MFL period 4 to a minimum of 7.21 at North 12th Street during MFL period 3 (Table 5.1-1, Figure 5.1-34). In the lower river segment average monthly pH ranged from a maximum of 7.29 at Sligh Avenue during MFL period 4 to a minimum of 7.19 at North River Shore Drive during MFL period 3 (Table 5.1-1, Figure 5.1-35). At the lower river mouth station of West Platt Street average monthly pH ranged from a maximum of 7.93 during MFL period 4 to a minimum of 7.74 at during MFL period 2 (Table 5.1-1, Figure 5.1-35). In the tributaries average monthly pH ranged from a maximum of 7.57 at Twin Lake Outfall during MFL period 4 to a minimum of 7.48 at Sulphur Springs during MFL period 4 (Table 5.1-1, Figure 5.1-36).

5.1.5.2 pH when river flow was over the dam

In the upper river segment above the dam average monthly pH ranged from a maximum of 7.18 at East Fowler Avenue during MFL period 1 to a minimum of 7.01 at East Fowler Avenue during MFL period 2 (Table 5.1-2, Figure 5.1-37). In the upper river segment below the dam average monthly pH ranged from a maximum of 7.46 at Rowlett Park Drive during MFL period 3 to a minimum of 7.38 at Rowlett Park Drive during MFL period 1 (Table 5.1-2, Figure 5.1-37). In the middle river segment average monthly pH ranged from a maximum of 7.43 at Hanna's Whirl during MFL period 3 to a minimum of 7.32 at North 12th Street during MFL period 4 (Table 5.1-2, Figure 5.1-38). In the lower river segment average monthly pH ranged from a maximum of 7.34 at Sligh Avenue during MFL period 3 to a minimum of 7.02 at Sligh Avenue during MFL period 1 (Table 5.1-2, Figure 5.1-39). At the lower river mouth station of West Platt Street average monthly pH ranged from a maximum of 7.83 during MFL period 3 to a minimum of 7.62 at during MFL period 2 (Table 5.2-1, Figure 5.1-39). In the tributaries average monthly pH ranged from a maximum of 7.40 at Twin Lake Outfall during MFL period 4 to a minimum of 7.20 at Sulphur Springs during MFL period 2 (Table 5.2-1, Figure 5.1-40).

5.1.6 Nitrates/Nitrites

5.1.6.1 Nitrates/Nitrites when river flow was not over the dam

In the upper river segment above the dam average monthly nitrates/nitrites ranged from a maximum of 0.64 (mg/L) at East Fowler Avenue during MFL period 3 to a minimum of 0.04 (mg/L) at North 56th Street during MFL period 4 (Table 5.1-1, Figure 5.1-41). In the upper river segment below the dam average monthly nitrates/nitrites ranged from a maximum of 0.13 (mg/L) at Rowlett Park Drive during MFL period 2 to a minimum of 0.05 (mg/L) at Rowlett Park Drive during MFL period 4 (Table 5.1-1, Figure 5.1-41). In the middle river segment nitrates/nitrites were not sampled. In the lower river segment average monthly nitrates/nitrites ranged from a maximum of 0.12 (mg/L) at Sligh Avenue during MFL period 2 to a minimum of 0.06 (mg/L) at Sligh Avenue during MFL period 4 (Table 5.1-1, Figure 5.1-42). At the lower river mouth station of West Platt Street average monthly nitrates/nitrites ranged from a maximum of 0.03 (mg/L) during MFL period 3 to a minimum of 0.02 (mg/L) at during MFL periods 1, 2 and 4 (Table 5.1-1, Figure 5.1-42). In the tributaries average monthly nitrates/nitrites ranged from a maximum of 0.15 (mg/L) at Sulphur Springs during MFL period 3 to a minimum of 0.03 (mg/L) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-43).

5.1.6.2 Nitrates/Nitrites when river flow was over the dam

In the upper river segment above the dam average monthly nitrates/nitrites ranged from a maximum of 0.20 (mg/L) at East Fowler Avenue during MFL period 1 to a minimum of 0.06 (mg/L) at North 56th Street during MFL period 4 (Table 5.1-2, Figure 5.1-44). In the upper river segment below the dam average monthly nitrates/nitrites ranged from a maximum of 0.12 (mg/L) at Rowlett Park Drive during MFL periods 1 and 2 to a minimum of 0.06 (mg/L) at Rowlett Park Drive during MFL period 3 (Table 5.1-2, Figure 5.1-44). In the middle river segment nitrates/nitrites were not sampled. In the lower river segment average monthly nitrates/nitrites ranged from a maximum of 0.20 (mg/L) at Sligh Avenue during MFL period 2 to a minimum of 0.10 (mg/L) at Sligh Avenue during MFL period 4 (Table 5.1-2, Figure 5.1-45). At the lower river mouth station of West Platt Street average monthly nitrates/nitrites ranged from a maximum of 0.08 (mg/L) during MFL period 2 to a minimum of 0.04 (mg/L) at during MFL period 3 (Table 5.2-1, Figure 5.1-45). In the tributaries average monthly nitrates/nitrites ranged from a maximum of 0.25 (mg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 0.20 (mg/L) at Sulphur Springs during MFL period 2 (Table 5.2-1, Figure 5.1-46).

5.1.7 Total Nitrogen

5.1.7.1 Total Nitrogen when river flow was not over the dam

In the upper river segment above the dam average monthly total nitrogen ranged from a maximum of 1.10 (mg/L) at East Fowler Avenue during MFL period 2 to a minimum of 0.51 (mg/L) at North 56th Street during MFL period 4 (Table 5.1-1, Figure 5.1-47). In the upper river segment below the dam average monthly total nitrogen ranged from a maximum of 1.16 (mg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 0.33 (mg/L) at Rowlett Park Drive during MFL period 4 (Table 5.1-1, Figure 5.1-47). In the middle river segment total nitrogen was not sampled. In the lower river segment average monthly total nitrogen ranged from a maximum of 1.00 (mg/L) at Sligh Avenue during MFL period 1 to a minimum of 0.44 (mg/L) at Sligh

Avenue during MFL period 4 (Table 5.1-1, Figure 5.1-48). At the lower river mouth station of West Platt Street average monthly total nitrogen ranged from a maximum of 0.77 (mg/L) during MFL period 1 to a minimum of 0.60 (mg/L) at during MFL period 2 (Table 5.1-1, Figure 5.1-48). In the tributaries average monthly total nitrogen ranged from a maximum of 0.73 (mg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 0.22 (mg/L) at Sulphur Springs during MFL period 4 (Table 5.1-1, Figure 5.1-49).

5.1.7.2 Total Nitrogen when river flow was over the dam

In the upper river segment above the dam average monthly total nitrogen ranged from a maximum of 1.03 (mg/L) at East Fowler Avenue during MFL period 1 to a minimum of 0.91 (mg/L) at North 56th Street during MFL period 4 (Table 5.1-2, Figure 5.1-50). In the upper river segment below the dam average monthly total nitrogen ranged from a maximum of 1.15 (mg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 0.82 (mg/L) at Rowlett Park Drive during MFL period 4 (Table 5.1-2, Figure 5.1-50). In the middle river segment total nitrogen was not sampled. In the lower river segment average monthly total nitrogen ranged from a maximum of 1.28 (mg/L) at Sligh Avenue during MFL period 1 to a minimum of 0.74 (mg/L) at Sligh Avenue during MFL period 4 (Table 5.1-2, Figure 5.1-51). At the lower river mouth station of West Platt Street average monthly total nitrogen ranged from a maximum of 0.99 (mg/L) during MFL period 1 to a minimum of 0.56 (mg/L) at during MFL period 4 (Table 5.2-1, Figure 5.1-51). In the tributaries average monthly total nitrogen ranged from a maximum of 0.97 (mg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 0.36 (mg/L) at Sulphur Springs during MFL period 4 (Table 5.2-1, Figure 5.1-52).

5.1.8 Orthophosphate

5.1.8.1 Orthophosphate when river flow was not over the dam

In the upper river segment above the dam average monthly orthophosphate ranged from a maximum of 0.11 (mg/L) at East Fowler Avenue during MFL period 1 to a minimum of 0.03 (mg/L) at North 56th Street during MFL period 4 (Table 5.1-1, Figure 5.1-53). In the upper river segment below the dam average monthly orthophosphate ranged from a maximum of 0.17 (mg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 0.09 (mg/L) at Rowlett Park Drive during MFL period 4 (Table 5.1-1, Figure 5.1-53). In the middle river segment orthophosphate was not sampled. In the lower river segment average monthly orthophosphate ranged from a maximum of 0.14 (mg/L) at Sligh Avenue during MFL period 1 to a minimum of 0.12 (mg/L) at Sligh Avenue during MFL period 4 (Table 5.1-1, Figure 5.1-54). At the lower river mouth station of West Platt Street average monthly orthophosphate ranged from a maximum of 0.18 (mg/L) during MFL period 1 to a minimum of 0.10 (mg/L) at during MFL period 3 (Table 5.1-1, Figure 5.1-54). In the tributaries average monthly orthophosphate ranged from a maximum of 0.10 (mg/L) at Sulphur Springs during MFL period 4 to a minimum of 0.02 (mg/L) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-55).

5.1.8.2 Orthophosphate when river flow was over the dam

In the upper river segment above the dam average monthly orthophosphate ranged from a maximum of 0.24 (mg/L) at East Fowler Avenue during MFL period 1 to a minimum of 0.17 (mg/L) at East Fowler Avenue during MFL periods 2 and 4 (Table 5.1-2, Figure 5.1-56). In the upper river segment below the dam average monthly orthophosphate ranged from a maximum of 0.23 (mg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 0.15 (mg/L) at Rowlett Park Drive during MFL periods 2, 3, and 4 (Table 5.1-2, Figure 5.1-56). In the middle river segment orthophosphate was not sampled. In the lower river segment average monthly orthophosphate ranged from a maximum of 0.20 (mg/L) at Sligh Avenue during MFL period 2 to a minimum of 0.10 (mg/L) at Sligh Avenue during MFL period 4 (Table 5.1-2, Figure 5.1-57). At the lower river mouth station of West Platt Street average monthly orthophosphate ranged from a maximum of 0.08 (mg/L) during MFL period 2 to a minimum of 0.04 (mg/L) at during MFL period 3 (Table 5.2-1, Figure 5.1-57). In the tributaries average monthly orthophosphate ranged from a maximum of 0.25 (mg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 0.20 (mg/L) at Sulphur Springs during MFL period 2 (Table 5.2-1, Figure 5.1-58).

5.1.9 Total Phosphorus

5.1.9.1 Total Phosphorus when river flow was not over the dam

In the upper river segment above the dam average monthly total phosphorus ranged from a maximum of 0.20 (mg/L) at East Fowler Avenue during MFL period 2 to a minimum of 0.08 (mg/L) at East Fowler Avenue during MFL period 3 and North 56th Street during MFL period 4 (Table 5.1-1, Figure 5.1-59). In the upper river segment below the dam average monthly total phosphorus ranged from a maximum of 0.25 (mg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 0.11 (mg/L) at Rowlett Park Drive during MFL period 4 (Table 5.1-1, Figure 5.1-59). In the middle river segment total phosphorus was not sampled. In the lower river segment average monthly total phosphorus ranged from a maximum of 0.21 (mg/L) at Sligh Avenue during MFL period 1 to a minimum of 0.16 (mg/L) at Sligh Avenue during MFL period 4 (Table 5.1-1, Figure 5.1-60). At the lower river mouth station of West Platt Street average monthly total phosphorus ranged from a maximum of 0.32 (mg/L) during MFL period 1 to a minimum of 0.18 (mg/L) at during MFL periods 3 and 4 (Table 5.1-1, Figure 5.1-60). In the tributaries average monthly total phosphorus ranged from a maximum of 0.11 (mg/L) at Sulphur Springs during MFL periods 3 and 4 to a minimum of 0.06 (mg/L) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-61).

5.1.9.2 Total Phosphorus when river flow was over the dam

In the upper river segment above the dam average monthly total phosphorus ranged from a maximum of 0.32 (mg/L) at East Fowler Avenue during MFL period 1 to a minimum of 0.19 (mg/L) at East Fowler Avenue during MFL period 4 (Table 5.1-2, Figure 5.1-62). In the upper river segment below the dam average monthly total phosphorus ranged from a maximum of 0.30 (mg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 0.18 (mg/L) at Rowlett Park Drive during MFL periods 3 and 4 (Table 5.1-2, Figure 5.1-62). In the middle river segment total phosphorus was not sampled. In the lower river segment average monthly total phosphorus ranged from a maximum of 0.27 (mg/L) at Sligh Avenue during MFL period 1 to a minimum of 0.18 (mg/L) at Sligh Avenue during MFL period 3 (Table 5.1-2, Figure 5.1-63). At the lower river mouth station of West Platt Street average monthly total phosphorus ranged from a maximum of 0.43 (mg/L) during MFL period 1 to a minimum of 0.20 (mg/L) at during MFL period 4 (Table 5.2-1, Figure 5.1-63). In the tributaries average monthly total phosphorus ranged from a maximum of 0.16 (mg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 0.11 (mg/L) at Sulphur Springs during MFL periods 2, 3, and 4 (Table 5.2-1, Figure 5.1-64).

5.1.10 Chlorophyll *a*

5.1.10.1 Chlorophyll *a* uncorrected when river flow was not over the dam

In the upper river segment above the dam average monthly chlorophyll *a* uncorrected ranged from a maximum of 29.59 (µg/L) at East Fowler Avenue during MFL period 2 to a minimum of 11.43 (µg/L) at East Fowler Avenue during MFL period 1 (Table 5.1-1, Figure 5.1-65). In the upper river segment below the dam average monthly chlorophyll *a* uncorrected ranged from a maximum of 24.90 (µg/L) at Rowlett Park Drive during MFL period 1 to a minimum of 4.48 (µg/L) at Rowlett Park Drive during MFL period 4 (Table 5.1-1, Figure 5.1-65). In the middle river segment chlorophyll *a* uncorrected was not sampled. In the lower river segment average monthly chlorophyll *a* uncorrected ranged from a maximum of 36.55 (µg/L) at Sligh Avenue during MFL period 3 to a minimum of 13.34 (µg/L) at Sligh Avenue during MFL period 2 (Table 5.1-1, Figure 5.1-66). At the lower river mouth station of West Platt Street average monthly chlorophyll *a* uncorrected ranged from a maximum of 10.83 (µg/L) during MFL period 1 to a minimum of 7.75 (µg/L) at during MFL period 3 (Table 5.1-1, Figure 5.1-66). In the tributaries, average monthly chlorophyll *a* uncorrected ranged from a maximum of 11.30 (µg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 1.56 (µg/L) at Sulphur Springs during MFL period 3 (Table 5.1-1, Figure 5.1-67).

5.1.10.2 Chlorophyll *a* uncorrected when river flow was over the dam

In the upper river segment above the dam average monthly chlorophyll a uncorrected ranged from a maximum of 9.94 (µg/L) at North 56th Street during MFL period 4 to a minimum of 2.74 (µg/L) at East Fowler Avenue during MFL period 2 (Table 5.1-2, Figure 5.1-68). In the upper river segment below the dam average monthly chlorophyll *a* uncorrected ranged from a maximum of 11.30 (µg/L) at Rowlett Park Drive during MFL period 2 to a minimum of 10.70 (µg/L) at Rowlett Park Drive during MFL period 1 (Table 5.1-2, Figure 5.1-68). In the middle river segment chlorophyll *a* uncorrected was not sampled. In the lower river segment average monthly chlorophyll *a* uncorrected ranged from a maximum of 19.04 (µg/L) at Sligh Avenue during MFL period 2 to a minimum of 10.29 (µg/L) at Sligh Avenue during MFL period 3 (Table 5.1-2, Figure 5.1-69). At the lower river mouth station of West Platt Street average monthly chlorophyll *a* uncorrected ranged from a maximum of 14.19 (µg/L) during MFL period 4 to a minimum of 7.71 (µg/L) at during MFL period 2 (Table 5.2-1, Figure 5.1-69). In the tributaries, average monthly chlorophyll *a* uncorrected ranged from a maximum of 5.24 (µg/L) at Twin Lake Outfall during MFL period 4 to a minimum of 1.18 (µg/L) at Sulphur Springs during MFL period 2 (Table 5.2-1, Figure 5.1-70).

5.1.11 Water Color

5.1.11.1 Water Color when river flow was not over the dam

In the upper river segment above the dam average monthly water color ranged from a maximum of 28.78 (pcu) at East Fowler Avenue during MFL period 2 to a minimum of 10.84 (pcu) at Temple Terrace Hwy during MFL period 4 (Table 5.1-1, Figure 5.1-71). In the upper river segment below the dam average monthly water color ranged from a maximum of 22.53 (pcu) at Rowlett Park Drive during MFL period 1 to a minimum of 9.95 (pcu) at Rowlett Park Drive during MFL period 4 (Table 5.1-1, Figure 5.1-71). In the middle river segment water color was not sampled. In the lower river segment average monthly water color ranged from a maximum of 16.58 (pcu) at Sligh Avenue during MFL period 3 to a minimum of 9.87 (pcu) at Sligh Avenue during MFL period 4 (Table 5.1-1, Figure 5.1-72). At the lower river mouth station of West Platt Street average monthly water color ranged from a maximum of 8.72 (pcu) during MFL period 2 to a minimum of 5.41 (pcu) at during MFL period 4 (Table 5.1-1, Figure 5.1-72). In the tributaries average monthly water color ranged from a maximum of 47.80 (pcu) at Twin Lake Outfall during MFL period 4 to a minimum of 6.28 (pcu) at Sulphur Springs during MFL period 4 (Table 5.1-1, Figure 5.1-73).

5.1.11.2 Water Color when river flow was over the dam

In the upper river segment above the dam average monthly water color ranged from a maximum of 86.51 (pcu) at East Fowler Avenue during MFL period 3 to a minimum of 64.71 (pcu) at East Fowler Avenue during MFL period 4 (Table 5.1-2, Figure 5.1-74). In the upper river segment below the dam average monthly water color ranged from a maximum of 75.54 (pcu) at Rowlett Park Drive during MFL period 1 to a minimum of 60.14 (pcu) at Rowlett Park Drive during MFL period 4 (Table 5.1-2, Figure 5.1-74). In the middle river segment water color was not sampled. In the lower river segment average monthly water color ranged from a maximum of 74.40 (pcu) at Sligh Avenue during MFL period 1 to a minimum of 49.65 (pcu) at Sligh Avenue during MFL period 4 (Table 5.1-2, Figure 5.1-75). At the lower river mouth station of West Platt Street average monthly water color ranged from a maximum of 33.75 (pcu) during MFL period 2 to a minimum of 25.83 (pcu) at during MFL period 1 (Table 5.2-1, Figure 5.1-75). In the tributaries average monthly water color ranged from a maximum of 63.20 (pcu) at Twin Lake Outfall during MFL period 4 to a minimum of 6.61 (pcu) at Sulphur Springs during MFL period 4 (Table 5.2-1, Figure 5.1-76).

5.1.12 Water Temperature

5.1.12.1 Water Temperature when river flow was not over the dam

In the upper river segment above the dam average monthly water temperature ranged from a maximum of 24.28 (°C) at East Fowler Avenue during MFL period 2 to a minimum of 21.70 (°C) at East Fowler Avenue during MFL period 3 (Table 5.1-1, Figure 5.1-77). In the upper river segment below the dam average monthly water temperature ranged from a maximum of 24.73 (°C) at Rowlett Park Drive during MFL period 2 to a minimum of 23.33 (°C) at Rowlett Park Drive during MFL period 1 (Table 5.1-1, Figure 5.1-77). In the middle river segment average monthly water temperature ranged from a maximum of 25.00 (°C) at Hanna's Whirl during MFL period 3 to a minimum of 23.38 (°C) at Hanna's Whirl during MFL period 4 (Table 5.1-2, Figure

5.1-78). In the lower river segment average monthly water temperature ranged from a maximum of 25.60 (°C) at North River Shore Drive during MFL period 3 to a minimum of 23.60 (°C) at Sligh Avenue during MFL period 4 (Table 5.1-1, Figure 5.1-79). At the lower river mouth station of West Platt Street average monthly water temperature ranged from a maximum of 24.80 (°C) during MFL period 2 to a minimum of 22.87 (°C) at during MFL period 4 (Table 5.1-1, Figure 5.1-79). In the tributaries average monthly water temperature ranged from a maximum of 25.39 (°C) at Sulphur Springs during MFL period 4 to a minimum of 24.45 (°C) at Twin Lake Outfall during MFL period 4 (Table 5.1-1, Figure 5.1-80).

5.1.12.2 Water Temperature when river flow was over the dam

In the upper river segment above the dam average monthly water temperature ranged from a maximum of 24.23 (°C) at North 56th Street during MFL period 4 to a minimum of 21.97 (°C) at East Fowler Avenue during MFL period 2 (Table 5.1-2, Figure 5.1-81). In the upper river segment below the dam average monthly water temperature ranged from a maximum of 24.69 (°C) at Rowlett Park Drive during MFL period 3 to a minimum of 23.39 (°C) at Rowlett Park Drive during MFL period 2 (Table 5.1-2, Figure 5.1-81). In the middle river segment average monthly water temperature ranged from a maximum of 24.71 (°C) at North 12th Street during MFL period 4 to a minimum of 24.24 (°C) at North 12th Street during MFL period 3 (Table 5.1-2, Figure 5.1-82). In the lower river segment average monthly water temperature ranged from a maximum of 26.67 (°C) at Sligh Avenue during MFL period 1 to a minimum of 24.09 (°C) at Sligh Avenue during MFL period 2 (Table 5.1-2, Figure 5.1-83). At the lower river mouth station of West Platt Street average monthly water temperature ranged from a maximum of 25.39 (°C) during MFL period 3 to a minimum of 24.26 (°C) at during MFL period 2 (Table 5.2-1, Figure 5.1-83). In the tributaries average monthly water temperature ranged from a maximum of 26.49 (°C) at Twin Lake Outfall during MFL period 4 to a minimum of 25.25 (°C) at Sulphur Springs during MFL period 3 (Table 5.2-1, Figure 5.1-84).

5.2 Analysis of the Recovery Strategy to Water Quality

5.2.1 Discharge Rate and Water Quality

To evaluate the relationship between river flow rates and water quality, a Spearman Rho correlation analysis was performed between mean monthly discharge with flow (> 1 cfs) and without flow ($\leq$ 1 cfs) at USGS Station 02304500 at the Hillsborough River dam and monthly water quality variables without flow (< 1 cfs) and with flow (> 1 cfs) at Rowlett Park Drive (EPCHC 105) below the dam from October 1979 to May 2018 (see Appendix 5.1-1: Table 5.2.1-1). This location was chosen due to its proximity to the dam and the completeness of the water quality dataset from October 1979 to May 2018.

At Rowlett Park Drive when flows over the dam were < 1 cfs, a significant negative correlation was observed between discharge rate and DO concentration and pH (Table 5.2.1-1). Significant positive correlations were observed between discharge rate and conductivity, salinity, orthophosphate, total nitrogen, total phosphorus, and water color.

At Rowlett Park Drive when flows over the dam were > 1 cfs, a significant negative correlation was observed between discharge rate and conductivity, salinity, and pH (Table 5.2.1-1).

Significant positive correlations were observed between discharge rate and DO concentration orthophosphate, total nitrogen, total phosphorus, and water color.

These results suggest that as flow over the dam increased, the nutrient concentrations of orthophosphate, total nitrogen, and total phosphorus also increased, possibly due to increased land surface runoff. The increase in water color values with increased flow over the dam is possibly due to an increase in turbidity from increased land surface runoff, and/or an increase in tannic water from increased water flow from the Green Swamp. Physiochemical DO concentration appeared to increase with increasing flow over the dam, but DO concentration appeared to decrease without flow at the dam. This possibly reflects the increased aeration of the water with flow at the dam.

5.2.2 Minimum Flow Level Periods and Water Quality

To evaluate the relationship between MFL periods and water quality, a Kruskal-Wallis analysis with multiple comparison Dunn's Test was performed of water quality variables by MFL period for each EPCHC or USGS station from October 1979 to May 2018 (see Appendix 5.1-1: Tables 5.2.2.1-1 to 5.2.2.1-19, Appendix 5.1-3: Figures 5.2.2.1-1 to 5.2.2.1-63).

5.2.2.1 Upper River Segment (≥14.5 RKm) Above Dam When Water Was Not Flowing at the Dam

At East Fowler Avenue there were no statistically significant differences between MFL periods for salinity, specific conductance, DO concentration, DO percent saturation, pH, total nitrogen, chlorophyll *a* uncorrected, water color, and water temperature. Temple Terrace Hwy and North 56th Street were only sampled during MFL period 4. Only the following variables were significantly different between MFL periods.

Nitrates/nitrites from MFL period 1 were significantly higher than during MFL period 2 at East Fowler Avenue (Table 5.2.2.1-1, Figures 5.2.2.1-1). Nitrates/nitrites from MFL period 2 were significantly lower than during MFL period 3 at East Fowler Avenue.

Orthophosphate from MFL period 1 was significantly higher than during MFL period 3 at East Fowler Avenue (Table 5.2.2.1-2, Figures 5.2.2.1-2).

Total phosphorus from MFL period 1 was significantly higher than during MFL periods 3 and 4 at East Fowler Avenue (Table 5.2.2.1-3, Figures 5.2.2.1-3 and 5.2.2.1-4). Total phosphorus from MFL period 2 at East Fowler Avenue was significantly higher than during MFL period 3.

5.2.2.2 Upper River Segment (≥ 14.5 RKm) Below Dam When Water Was Not Flowing at the Dam

At Rowlett Park Drive there were no statistically significant differences between MFL periods for chlorophyll *a* uncorrected, water color, and water temperature. Only the following variables were significantly different between MFL periods.

Salinity and specific conductance from MFL period 1 were significantly higher than during MFL periods 2, 3, and 4 at Rowlett Park Drive (Tables 5.2.2.1-4 and 5.2.2.1-5, Figures 5.2.2.1-5 and 5.2.2.1-6).

DO concentration from MFL period 1 at Rowlett Park Drive was significantly lower than during MFL periods 3 and 4 (Table 5.2.2.1-6, Figures 5.2.2.1-7 and 5.2.2.1-8). DO concentration from MFL period 2 at Rowlett Park Drive was significantly lower than during MFL period 4.

DO percent saturation at Rowlett Park Drive from MFL period 2 was significantly lower than during MFL period 4 (Table 5.2.2.1-7, Figure 5.2.2.1-9).

The pH from MFL period 1 was significantly lower than during MFL periods 3 and 4 at Rowlett Park Drive (Table 5.2.2.1-8, Figure 5.2.2.1-10).

Nitrates/nitrites from MFL period 1 were significantly higher than during MFL period 4 at Rowlett Park Drive (Table 5.2.2.1-1, Figure 5.2.2.1-11). Nitrates/nitrites from MFL period 2 were significantly higher than during MFL period 4 at Rowlett Park Drive.

Total nitrogen, orthophosphate, and total phosphorus from MFL period 1 were significantly higher than during MFL periods 2, 3, and 4 at Rowlett Park Drive (Tables 5.2.2.1-2, 5.2.2.1-3, and 5.2.2.1-9, Figures 5.2.2.1-12 to 5.2.2.1-14).

5.2.2.3 Middle River Segment (12.6 RKm to < 14.5 RKm) When Water Was Not Flowing at the Dam

At Hanna's Whirl and North 12th Street there were no statistically significant differences between MFL periods for salinity, specific conductance, DO concentration, DO percent saturation, pH, and water temperature. Both these stations were only sampled during MFL periods 3 and 4. Only the following variables were significantly different between MFL periods.

Salinity from MFL period 1 was significantly higher than during than at MFL periods 2 and 4 at Nebraska Avenue (Table 5.2.2.1-5, Figure 5.2.2.1-15).

5.2.2.4 Lower River Segment (< 12.6 RKm) When Water Was Not Flowing at the Dam

At North River Shore Drive there were no statistically significant differences between MFL periods for salinity, specific conductance, DO concentration, DO percent saturation, pH, and water temperature. This station was only sampled during MFL periods 3 and 4. At Sligh Avenue there were no statistically significant differences between MFL periods for DO concentration, DO percent saturation, pH, nitrate/nitrites, orthophosphate, total phosphorus, chlorophyll *a* uncorrected, and water temperature. At West Platt Street there were no statistically significant differences between MFL periods for nitrate/nitrites, chlorophyll *a* uncorrected, and water temperature. Only the following variables were significantly different between MFL periods.

Salinity from MFL period 1 was significantly higher than during periods 2 and 4 at Sligh Avenue and West Platt Street; and during MFL period 4 at I-275 (Table 5.2.2.1-5, Figures 5.2.2.1-16 to 5.2.2.1-19). Salinity from MFL period 2 at West Platt Street was significantly lower than during MFL period 3.

Specific conductance from MFL period 1 at Sligh Avenue was significantly higher than during MFL periods 2 and 4 at Sligh Avenue, and during MFL period 2 at West Platt Street (Table 5.2.2.1-4, Figures 5.2.2.1-20 and 5.2.2.1-21). Specific conductance from MFL period 2 at West Platt Street was significantly lower than during MFL period 3.

DO concentration and percent saturation from MFL period 2 at West Platt Street was significantly lower than during MFL period 4 (Tables 5.2.2.1-6 and 5.2.2.1-7, Figures 5.2.2.1-22 and 5.2.2.1-23). DO concentration and percent saturation from MFL period 3 at West Platt Street was significantly lower than during MFL period 4.

The pH from MFL period 1 was significantly lower than during MFL period 4 at West Platt Street (Table 5.2.2.1-8, Figure 5.2.2.1-24). pH from MFL period 2 at West Platt Street was significantly lower than during MFL period 4.

Total nitrogen from MFL period 1 was significantly higher than during MFL periods 2, 3, and 4 at West Platt Street, and higher than during MFL periods 2 and 3 at Sligh Avenue (Table 5.2.2.1-9, Figures 5.2.2.1-25 to 5.2.2.1-27). Total nitrogen from MFL period 2 at Sligh Avenue was significantly higher than during MFL period 4.

Orthophosphate from MFL period 1 was significantly higher than during MFL period 3 at West Platt Street (Table 5.2.2.1-2, Figure 5.2.2.1-28).

Total phosphorus from MFL period 1 was significantly higher than during MFL periods 2 and 3 at West Platt Street (Table 5.2.2.1-3, Figure 5.2.2.1-29).

Water color levels from MFL periods 1 and 2 at Sligh Avenue and West Platt Street were significantly higher than at MFL period 4 (Table 5.2.2.1-10, Figures 5.2.2.1-30 and 5.2.2.1-31).

5.2.2.5 Tributaries When Water Was Not Flowing at the Dam

At Sulphur Springs there were no statistically significant differences between MFL periods for DO concentration, DO percent saturation, pH, total nitrogen, total phosphorus, chlorophyll *a* uncorrected, water color, and water temperature. Twin Lake Outfall was only sampled during MFL period 4. Only the following variables were significantly different between MFL periods.

Salinity and specific conductance from MFL period 3 were significantly lower than during MFL period 4 at Sulphur Springs (Tables 5.2.2.1-4 and 5.2.2.1-5, Figures 5.2.2.1-32 to 5.2.2.1-33).

Nitrates/nitrites from MFL period 3 at Sulphur Springs were significantly higher than during MFL period 4 (Table 5.2.2.1-1, Figures 5.2.2.1-34).

Orthophosphate from MFL period 2 at Sulphur Springs was significantly higher than during MFL period 4 (Table 5.2.2.1-2, Figures 5.2.2.1-35).

Significant differences between MFL periods for the water quality variables occurred primarily at the upper river locations of East Fowler Avenue and Rowlett Park Drive, the lower river locations of Sligh Avenue and West Platt Street, and the tributary Sulphur Springs. This pattern was the same both with flow and without flow at the dam. Data were only available for the middle locations of Hanna's Whirl and North 12th Street from January 2009 to May 2018 (representing MFL periods 3 and 4), whereas data were available for East Fowler Avenue, Rowlett Park Drive, and West Platt Street from October 1979 to May 2018 (representing all four MFL periods), and for Sligh Avenue from August 1999 to May 2018 (representing all four MFL periods).

For the water quality variables, MFL period 1 differed significantly from MFL periods 2, 3, or 4 in 82 comparisons. MFL 2 significantly differed from MFL periods 3 or 4 in 31 comparisons, and MFL period 3 differed significantly from MFL periods 4 in 7 comparisons (2 at West Platt Street and 5 at Sulphur Springs). During MFL period 1, no existing MFL existed for the river. In MFL period 2, the MFL was 10 cfs MFL for the river, and in MFL periods 3 and 4 the MFL was 20/24 cfs for the river.

5.2.2.6 Upper River Segment ($\geq$ 14.5 RKm) Above Dam When Water Was Flowing at the Dam

At East Fowler Avenue there were no statistically significant differences between MFL periods for salinity, DO concentration, DO percent saturation, pH, nitrate/nitrites, water color, and water temperature. Temple Terrace Hwy and North 56th Street were only sampled during MFL period 4. Only the following variables were significantly different between MFL periods.

Specific conductance from MFL period 1 was significantly higher than during MFL period 2 at East Fowler Avenue (Table 5.2.2.1-11, Figure 5.2.2.1-36).

Total nitrogen at MFL period 1 was significantly higher than during MFL period 4 at East Fowler Avenue (Table 5.2.2.1-12, Figure 5.2.2.1-37).

Orthophosphate and total phosphorus from MFL period 1 were significantly higher than during MFL periods 2, 3, and 4 at East Fowler Avenue (Tables 5.2.2.1-13 and 5.2.2.1-14, Figures 5.2.2.1-38 and 5.2.2.1-39).

Chlorophyll *a* uncorrected from MFL period 1 was significantly lower than during MFL periods 3 and 4 at East Fowler Avenue (Table 5.2.2.1-15, Figures 5.2.2.1-40 and 5.2.2.1-41). Chlorophyll *a* uncorrected from MFL period 2 was significantly lower than during MFL period 4 at East Fowler Avenue.

5.2.2.7 Upper River Segment ($\geq$ 14.5 RKm) Below Dam When Water Was Flowing at the Dam

At Rowlett Park Drive there were no statistically significant differences between MFL periods for specific conductance, DO concentration, DO percent saturation, pH, chlorophyll *a* uncorrected, water color, and water temperature. Only the following variables were significantly different between MFL periods.

Salinity from MFL period 1 was significantly higher than during MFL period 4 at Rowlett Park Drive (Table 5.2.2.1-3, Figure 5.2.2.1-42).

Nitrates/nitrites from MFL periods 1 and 2 at Rowlett Park Drive were significantly higher than during MFL periods 3 and 4 (Table 5.2.2.1-16, Figure 5.2.2.1-43).

Total nitrogen at MFL periods 1 and 2 were significantly higher than during MFL period 4 at Rowlett Park Drive (Table 5.2.2.1-12, Figure 5.2.2.1-44).

Orthophosphate and total phosphorus from MFL period 1 were significantly higher than during MFL periods 2, 3, and 4 at Rowlett Park Drive (Tables 5.2.2.1-13 and 5.2.2.1-14, Figures 5.2.2.1-45 and 5.2.2.1-46).

5.2.2.8 Middle River Segment (12.6 RKm to <14.5 RKm) When Water Was Flowing at the Dam

At Hanna's Whirl and North 12th Street there were no statistically significant differences between MFL periods for salinity, specific conductance, DO concentration, DO percent saturation, pH, and water temperature. Both these stations were only sampled during MFL periods 3 and 4. At Nebraska Avenue there was no statistically significant differences between MFL periods for salinity.

5.2.2.9 Lower River Segment (<12.6 RKm) When Water Was Flowing at the Dam

At Hwy I-275 there were no statistically significant differences between MFL periods for salinity. At North River Shore Drive there were no statistically significant differences between MFL periods for salinity, specific conductance, DO concentration, DO percent saturation, pH, and water temperature. This station was only sampled during MFL periods 3 and 4. At Sligh Avenue there were no statistically significant differences between MFL periods for salinity, specific conductance, DO concentration, DO percent saturation, pH, orthophosphate, total phosphorus, water color, and water temperature. At West Platt Street there were no statistically significant differences between MFL periods for DO concentration, DO percent saturation, water color, and water temperature. Only the following variables were significantly different between MFL periods.

Salinity and specific conductance from MFL period 1 were significantly higher than during MFL period 2 and significantly lower than during MFL period 3 at West Platt Street (Tables 5.2.2.1-11 and 5.2.2.1-17, Figures 5.2.2.1-47 to 5.2.2.1-50). Salinity and specific conductance from MFL period 2 at West Platt Street were significantly lower than during MFL periods 3 and 4.

The pH from MFL periods 1 and 2 at West Platt Street were significantly lower than during MFL period 3 (Table 5.2.2.1-18, Figure 5.2.2.1-51).

Nitrates/nitrites from MFL period 2 at Sligh Avenue were significantly higher than during MFL periods 3 and 4 (Table 5.2.2.1-16, Figures 5.2.2.1-52 and 5.2.2.1-53). Nitrates/nitrites from MFL period 1 at West Platt Street were significantly lower than during MFL period 2, and levels at MFL period 2 were significantly higher than during MFL period 3.

Total nitrogen at MFL period 1 was significantly higher during MFL periods 3 and 4 at Sligh Avenue, and during MFL periods 2, 3, and 4 at West Platt Street (Table 5.2.2.1-12, Figures 5.2.2.1-54 to 5.2.2.1-57). Total nitrogen from MFL period 2 was significantly higher than during MFL period 4 at Sligh Avenue and West Platt Street.

Orthophosphate and total phosphorus from MFL period 1 were significantly higher than during MFL periods 2, 3, and 4 at West Platt Street (Tables 5.2.2.1-13 and 5.2.2.1-14, Figures 5.2.2.1-58 and 5.2.2.1-59).

Chlorophyll *a* uncorrected from MFL period 1 was significantly higher than during MFL period 2 at West Platt Street (Table 5.2.2.1-15, Figures 5.2.2.1-60 and 5.2.2.1-61). Chlorophyll *a* uncorrected from MFL period 2 was significantly lower than during MFL periods 3 and 4 at West Platt Street. Chlorophyll *a* uncorrected from MFL period 2 was significantly higher than during MFL period 4 at Sligh Avenue.

5.2.2.10 Tributaries When Water Was Flowing at the Dam

At Sulphur Springs there were no statistically significant differences between MFL periods for specific conductance, DO concentration, DO percent saturation, pH, nitrates/nitrites, total nitrogen, orthophosphate, total phosphorus, chlorophyll *a* uncorrected, and water temperature. Twin Lake Outfall was only sampled during MFL period 4. Only the following variables were significantly different between MFL periods.

Salinity from MFL periods 2 and 3 at Sulphur Springs was significantly lower than during MFL period 4 (Table 5.2.2.1-17, Figure 5.2.2.1-62).

Water color from MFL periods 2 and 3 were significantly higher than during MFL period 4 at Sulphur Springs (Table 5.2.2.1-19, Figure 5.2.2.1-63).

5.2.2.11 Minimum Flow Periods Between Sites

To evaluate the relationship between MFL periods and site locations, a Kruskal-Wallis analysis with a multiple comparison Dunn's Test was performed of DO concentration and salinity variables comparing EPCHC and USGS stations during each MFL period from October 1979 to May 2018 (see Appendix 5.1-1: Tables 5.2.2.2-1 to 5.2.2.2-16, Appendix 5.1-3: Figures 5.2.2.2-1 to 5.2.2.2-44).

Salinity increased from the upper river stations downstream to the lower river stations. Salinity was higher in the middle and lower river segments during times of no discharge than when discharge was occurring at the dam.

When discharge was not occurring at the dam, the stations above the dam had higher DO concentration than the middle and lower river segments. DO concentration was lower at below dam stations (Rowlett Park Drive, Hanna's Whirl, North 12th Street, and Nebraska Avenue) at times with no discharge at the dam than when discharge was occurring. When discharge was occurring at the dam, the stations above the dam (East Fowler Avenue, Temple Terrace Highway, and North 56th Street) had lower DO concentration than those below the dam (Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, I-275, North River Shore Drive, Sligh Avenue, and West Platt Street).

5.2.2.12 MFL Period 1 For When Water Was Not Flowing at the Dam

Salinity was significantly lower at East Fowler Avenue above the dam than at the below dam stations of Rowlett Park Drive, Nebraska Avenue, I-275, Sligh Avenue, and West Platt Street (Table 5.2.2.2-1, Figures 5.2.2.2-1 to 5.2.2.2-3). Salinity was significantly lower at Rowlett Park Drive immediately below the dam than at the middle river station Nebraska Avenue, and the lower river stations of I-275, Sligh Avenue, and West Platt Street. Salinity was significantly lower at Nebraska Avenue, I-275, and Sligh Avenue than at the river mouth station of West Platt Street.

DO concentration was significantly higher at East Fowler Avenue above the dam than at the below dam stations of Rowlett Park Drive, Sligh Avenue, and West Platt Street (Table 5.2.2.2-2, Figures 5.2.2.2-4 to 5.2.2.2-5). DO concentration was significantly lower at Rowlett Park Drive immediately below the dam and the lower river station Sligh Avenue than at river mouth station West Platt Street.

5.2.2.13 MFL Period 2 For When Water Was Not Flowing at the Dam

Salinity was significantly lower at East Fowler Avenue above the dam than at the below dam stations of Nebraska Avenue, I-275, Sligh Avenue, and West Platt Street (Table 5.2.2.2-3, Figures 5.2.2.2-36 to 5.2.2.2-38). Salinity was significantly lower at Rowlett Park Drive immediately below the dam than at the lower river stations of Sligh Avenue and West Platt Street. Salinity was significantly lower at the middle river station Nebraska Avenue than at the river mouth station of West Platt Street. Salinity was significantly lower at the tributary Sulphur Springs than at the river mouth station of West Platt Street.

DO concentration was significantly lower at lower river station Sligh Avenue than at East Fowler Avenue above the dam, Rowlett Park Drive immediately below the dam, river mouth station West Platt Street and the tributary Sulphur Springs (Table 5.2.2.2-4, Figures 5.2.2.2-24 and 5.2.2.2-25). DO concentration was significantly lower at Rowlett Park Drive immediately below the dam and river mouth station West Platt Street from the tributary Sulphur Springs.

5.2.2.14 MFL Period 3 For When Water Was Not Flowing at the Dam

Salinity was significantly lower at East Fowler Avenue above the dam than at the below dam stations of North 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, and West Platt Street (Table 5.2.2.2-5, Figures 5.2.2.2-11 to 5.2.2.2-13). Salinity was significantly lower at Rowlett Park Drive immediately below the dam than at the middle river station Nebraska Avenue, and the lower river stations of North River Shore Drive, Sligh Avenue, and West Platt Street. Salinity was significantly lower at the middle river stations of Hanna's Whirl and North 12th Street than at river mouth station of West Platt Street. Salinity was significantly lower at the tributary Sulphur Springs from the middle river station Nebraska Avenue, the lower river stations of North River Shore Drive, Sligh Avenue, and West Platt Street.

DO concentration was significantly higher at East Fowler Avenue above the dam than at below dam stations of Hanna's Whirl, North 12th Street, North River Shore Drive, and Sligh Avenue (Table 5.2.2.2-6, Figures 5.2.2.2-14 to 5.2.2.2-17). DO concentration was significantly higher at Rowlett Park Drive immediately below the dam from lower river stations of North River Shore Drive and Sligh Avenue. DO concentration was significantly higher at mouth station West Platt Street than at lower river station Sligh Avenue. DO concentration was significantly higher at tributary Sulphur Springs from Rowlett Park Drive immediately below the dam, middle river stations Hanna's Whirl and North 12th Street, and lower river stations of North River Shore Drive, Sligh Avenue, and West Platt Street.

5.2.2.15 MFL Period 4 For When Water Was Not Flowing at the Dam

Salinity during MFL period 4 was significantly lower at East Fowler Avenue above the dam than at the below dam stations of North 12th Street, Nebraska Avenue, I-275, North River Shore Drive, Sligh Avenue, and West Platt Street (Table 5.2.2.2-7, Figures 5.2.2.2-18 to 5.2.2.2-20. Salinity was significantly lower at Temple Terrace Highway and North 56th Street above the dam, and Rowlett Park Drive immediately below the dam from the lower river stations of I-275, North River Shore Drive, Sligh Avenue, and West Platt Street. Salinity was significantly lower at the middle river stations of Hanna's Whirl and North 12th Street than at river mouth station of West Platt Street. Salinity was significantly lower at the tributary Sulphur Springs than at river mouth station of West Platt Street.

DO concentration during MFL period 4 was significantly higher at East Fowler Avenue above the dam than at below dam stations of Hanna's Whirl, North 12th Street, North River Shore Drive, and Sligh Avenue (Table 5.2.2.2-8, Figures 5.2.2.2-21 to 5.2.2.2-23). DO concentration was significantly higher at above dam stations of Temple Terrace Highway and North 56th Street than at middle river station North 12th Street, and lower river stations of North River Shore Drive, and Sligh Avenue. DO concentration was significantly higher at Rowlett Park Drive immediately below the dam than at lower river stations of North River Shore Drive and Sligh Avenue. DO concentration was significantly higher at tributary Sulphur Springs than at middle river station Hanna's Whirl. DO concentration was significantly higher at river mouth West Platt Street and tributary Sulphur Springs than at middle river station North 12th Street, and lower river stations of North River Shore Drive, and Sligh Avenue.

5.2.2.16 MFL Period 1 For When Water Was Flowing at the Dam

Salinity was significantly lower at East Fowler Avenue above the dam than at below dam stations of Rowlett Park Drive, Nebraska Avenue, I-275, Sligh Avenue, and West Platt Street (Table 5.2.2.2-9, Figures 5.2.2.2-24 and 5.2.2.2-25). Salinity was significantly lower at Rowlett Park Drive immediately below the dam and middle river station Nebraska Avenue than at river mouth station West Platt Street.

DO concentration was significantly lower at East Fowler Avenue above the dam than at Rowlett Park Drive immediately below the dam and river mouth station West Platt Street (Table 5.2.2.2-10, Figures 5.2.2.2-26 and 5.2.2.2-27). DO concentration was significantly lower at Rowlett Park Drive immediately below the dam from lower river stations Sligh Avenue and West Platt Street. DO concentration was significantly lower at lower river station Sligh Avenue from river mouth station West Platt Street.

5.2.2.17 MFL Period 2 For When Water Was Flowing at the Dam

Salinity was significantly lower at East Fowler Avenue above the dam and Rowlett Park Drive immediately below the dam than at middle river station Nebraska Avenue, and lower river stations I-275, Sligh Avenue, and West Platt Street (Table 5.2.2.2-11, Figures 5.2.2.2-28 and 5.2.2.2-29). Salinity was significantly lower at middle river station Nebraska Avenue, and lower river stations I-275 and Sligh Avenue than at river mouth station West Platt Street.

DO concentration was significantly lower at East Fowler Avenue above the dam than at Rowlett Park Drive immediately below the dam (Table 5.2.2.2-12, Figure 5.2.2.2-30). DO concentration was significantly higher at Rowlett Park Drive immediately below the dam from lower river stations Sligh Avenue and West Platt Street.

5.2.2.18 MFL Period 3 For When Water Was Flowing at the Dam

Salinity was significantly lower at East Fowler Avenue above the dam than at below dam stations of North 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West

Platt Street, and Sulphur Springs (Table 5.2.2.2-13, Figures 5.2.2.2-31 to 5.2.2.2-33). Salinity was significantly lower at Rowlett Park Drive immediately below the dam than at middle river station Nebraska Avenue, lower river stations of North River Shore Drive, Sligh Avenue, West Platt Street, and tributary Sulphur Springs. Salinity was significantly lower at middle river station Hanna's Whirl than at middle river station Nebraska Avenue, lower river stations of North River Shore Drive, Sligh Avenue, West Platt Street, and tributary Sulphur Springs. Salinity was significantly lower at middle river stations North 12th Street and Nebraska Avenue, lower river stations North River Shore Drive and Sligh Avenue than at river mouth station West Platt Street. Salinity was significantly higher at river mouth station West Platt Street than at tributary Sulphur Springs.

DO concentration was significantly lower at East Fowler Avenue above the dam than at Rowlett Park Drive immediately below the dam and tributary Sulphur Springs (Table 5.2.2.2-14, Figures 5.2.2.2-34 and 5.2.2.2-35). DO concentration was significantly higher at Rowlett Park Drive immediately below the dam from middle river station Hanna's Whirl, and lower river stations of North River Shore Drive and Sligh Avenue. DO concentration was significantly lower at lower river stations North River Shore Drive and Sligh Avenue from tributary Sulphur Springs.

5.2.2.19 MFL Period 4 For When Water Was Flowing at the Dam

Salinity was significantly lower at above dam stations East Fowler Avenue and North 56th Street, and Rowlett Park Drive immediately below the dam than at middle river station Nebraska Avenue, lower river stations of I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and tributary Sulphur Springs (Table 5.2.2.2-15, Figures 5.2.2.2-36 to 5.2.2.2-39). Salinity was significantly lower at Temple Terrace Highway above the dam and middle river station Hanna's Whirl than at lower river stations I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and tributary Sulphur Springs. Salinity was significantly lower at lower river station North 12th Street from lower river stations North River Shore Drive, Sligh Avenue, West Platt Street, and tributary Sulphur Springs. Salinity was significantly lower at middle river station Nebraska Avenue, and lower river stations I-275, North River Shore Drive, and Sligh Avenue than at river mouth station West Platt Street. Salinity was significantly higher at river mouth station West Platt Street than at tributaries Sulphur Springs and Twin Lake Outfall.

DO concentration was significantly lower at above dam stations East Fowler Avenue and Temple Terrace Highway than at Rowlett Park Drive immediately below the dam, middle river stations Hanna's Whirl and North 12th Street, and tributaries Sulphur Springs and Twin Lake Outfall (Table 5.2.2.2-16, Figures 5.2.2.2-40 to 5.2.2.2-44). DO concentration was significantly lower at above dam station North 56th Street from Rowlett Park Drive immediately below the dam, middle river station Hanna's Whirl, and tributaries Sulphur Springs, and Twin Lake Outfall. DO concentration was significantly higher at middle river station Hanna's Whirl from lower river station Sligh Avenue. DO concentration was significantly lower at lower river stations North River Shore Drive, Sligh Avenue, and West Platt Street from tributary Sulphur Springs.

5.2.3 MFL Periods — Dissolved Oxygen Water Quality Standard and Salinity Goal

The number of monthly sampling days when the recorded water quality value exceeded the Florida state water quality standard for DO percent saturation for Class III surface waters in rivers (https://www.flrules.org/gateway/RuleNo.asp?ID=62-302.530), or that salinity exceeded the 5.0 (ppt) MFL goal, was calculated at the EPCHC and USGS stations by MFL period from October 1979 to May 2018 (Appendix 5.1-1: Tables 5.2.3-1 and 2, Appendix 5.1-3: Figures 5.2.3-1 to 5.2.3-12).

Salinity exceedance days occurred more frequently during periods without flow at the dam than during periods with flow.

Exceedance calculations are based on discrete monthly sampling days; thus, the actual number of exceedance days is probably greater than that presented in this report.

DO percent saturation exceedance days occurred primarily at the locations above the dam when water was flowing at the dam. Exceedance days shifted primarily to the middle river locations when water was not flowing at the dam.

5.2.3.1 When Water Was Not Flowing at the Dam

More exceedance days for DO percent saturation occurred at the middle river locations than at the upper river locations (Figures 5.2.3-1 to 5.2.3-3). There was little difference in exceedance days between MFL periods.

Rowlett Park Drive during MFL period 1 had the highest number of exceedance days for salinity (Figures 5.2.3-4 to 5.2.3-6). Exceedance days decreased from MFL period 1 to MFL periods 2, 3, and 4.

5.2.3.2 When Water Was Flowing at the Dam

More exceedance days for DO percent saturation from top water samples occurred at the upper river locations East Fowler Avenue, Temple Terrace Highway, and North 56th Street than at the middle river locations (Figures 5.2.3-7 to 5.2.3-9). There was little difference in the exceedance days between MFL periods.

Salinity exceedance days were lower at Rowlett Park Drive and Hanna's Whirl during MFL periods 3 and 4 (Figures 5.2.3-10 to 5.2.3-12).

6.0 Analysis of Biological Communities

6.1 Zooplankton Results

The zooplankton community showed differences between the MFL periods (Figure 6.1-1) Specifically, differences were seen in indicator taxa (Figure 6.1-2). Some water quality variables were significantly correlated with MFL period (Figure 6.1-3). DO (both concentration at the bottom and concentration averaged over the water column) were significantly correlated with MFL period, as were pH (weak correlation) and salinity (Figures 6.1-3 and 6.1-4).

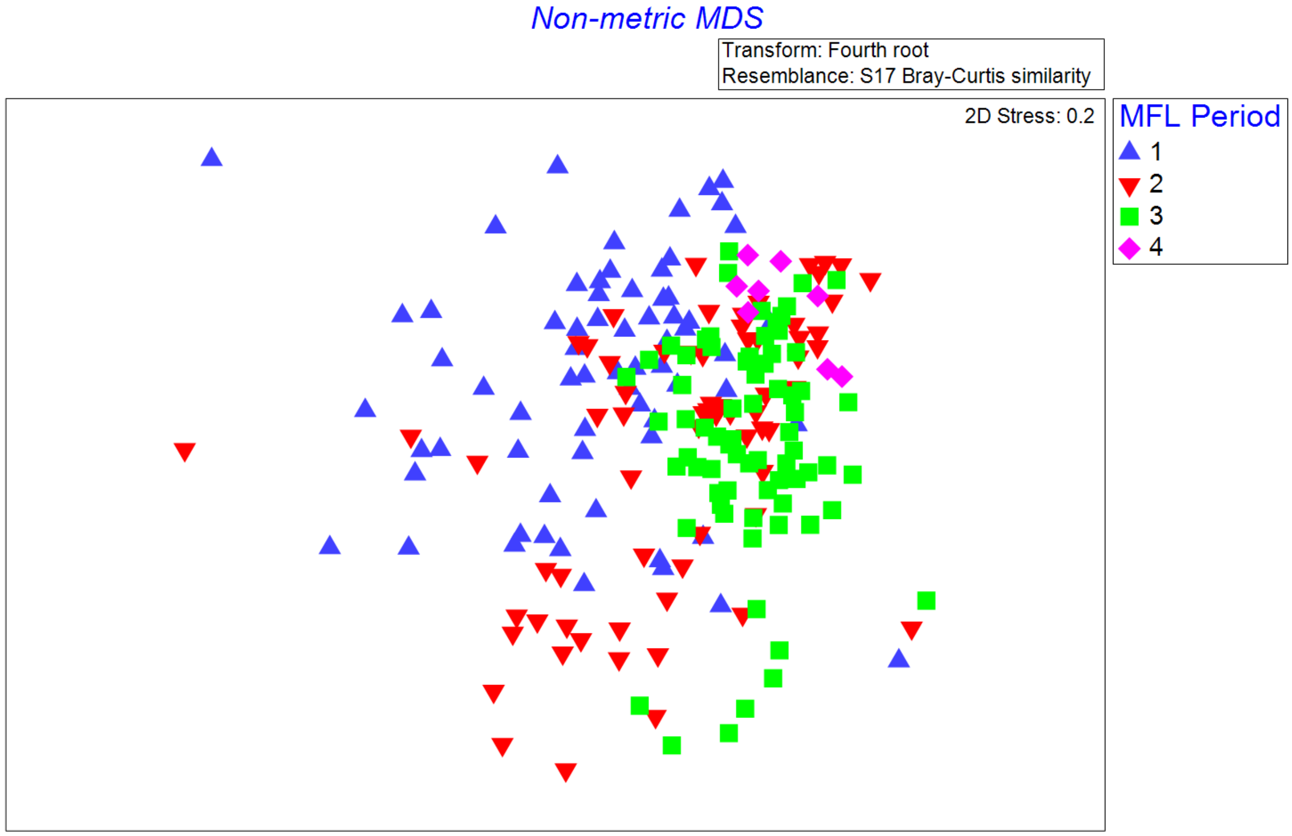


Figure 6.1-1 Non-metric multidimensional scaling (nMDS) plot of plankton-sample similarity (Bray-Curtis similarity among fourth-root-transformed organism densities, as number of individuals per 1,000 m^3 of water). A total of 163 fish and invertebrate taxa contributed to this analysis. The fourth-root transform allows less-abundant taxa to have greater arithmetic weight in the comparison. Each symbol in the figure represents a single plankton-net sample. Symbols that plot close to each other have similar catch compositions. When viewed collectively, the four periods are generally arranged in the sequence 1-2-3-4 from left to right, indicating the plankton-net catch shifted at the community level after the MFL was implemented. A more in-depth analysis of the nature of this community shift is provided in Figure 6.1-2.

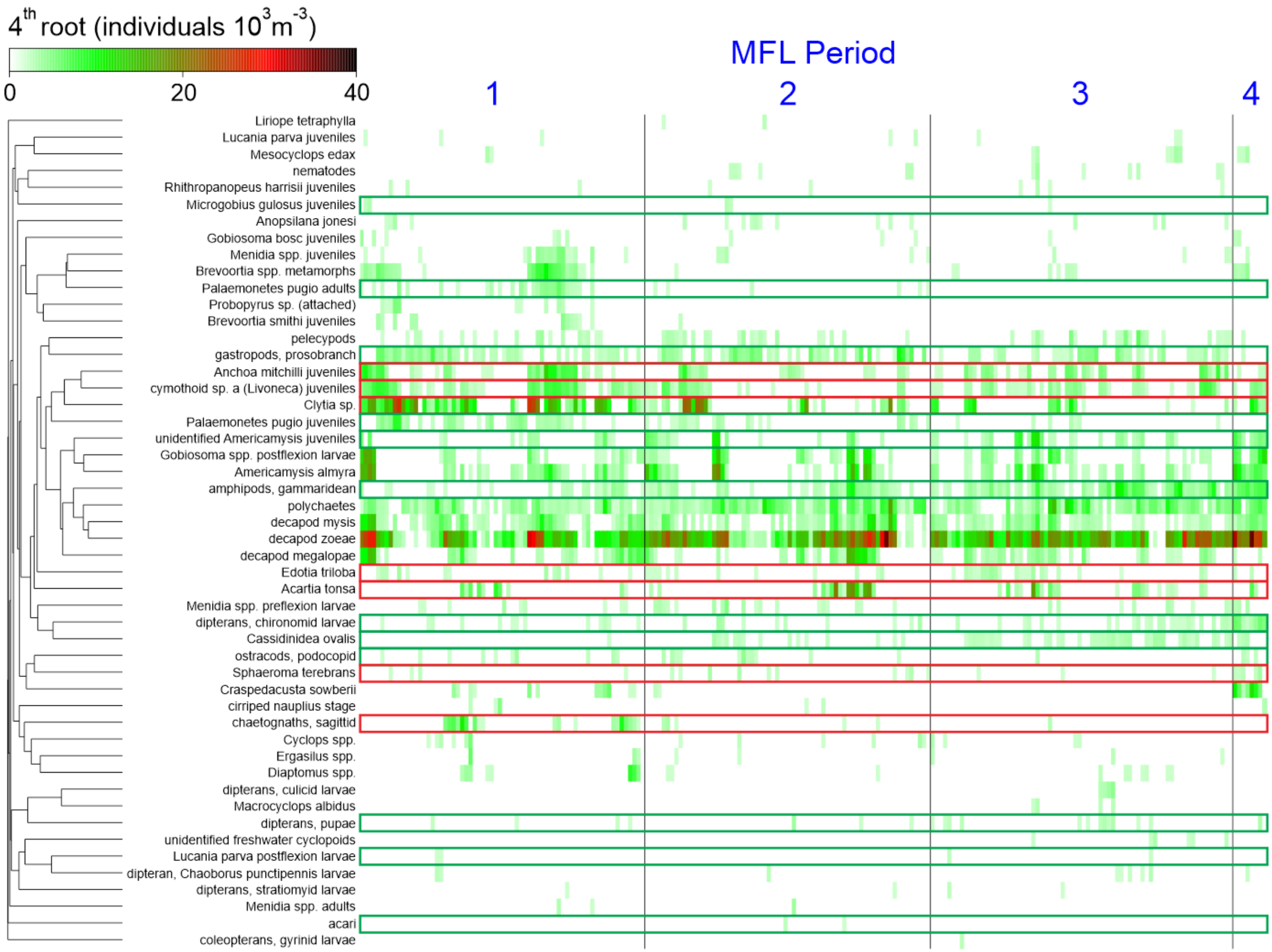


Figure 6.1-2. Heatmap depicting the densities of the 50 most important taxa during the four MFL periods as an aggregate; important taxa are those that comprised the largest percentages of total zooplankton organisms within individual samples. Each column of colored rectangles represents one of the 216 samples in this comparison. Density is number of individuals in 1,000 m^3 of water,

which was fourth-root transformed to allow less-abundant taxa to appear at a visible level of color. Taxa are arranged by their tendencies to associate with each other, as indicated by the dendrogram at the left of the figure. Taxa within green boxes are indicator taxa (Table 4, Burghart et al. 2013) for relatively oligotrophic conditions, and those within red boxes are indicators of relatively eutrophic conditions.

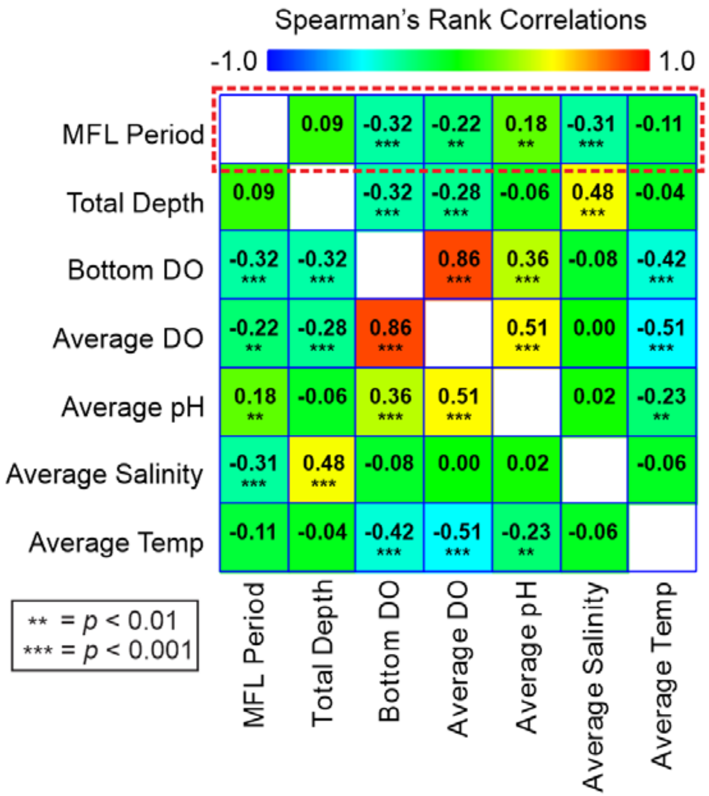


Figure 6.1-3. Spearman's rank correlation coefficients for water-quality variables that were measured concurrently with plankton-net deployment, where *MFL Period* is the dummy variable 1, 2, 3, 4, *Total Depth* is the water depth at plankton-net deployment, *Bottom DO* is dissolved oxygen (DO) near the bottom, and average values for DO, pH, salinity, and water temperature are water-column averages from individual water-column profiles, wherein one water-column profile was obtained for each plankton-net deployment. The red box highlights relationships associated with temporal changes in water quality.

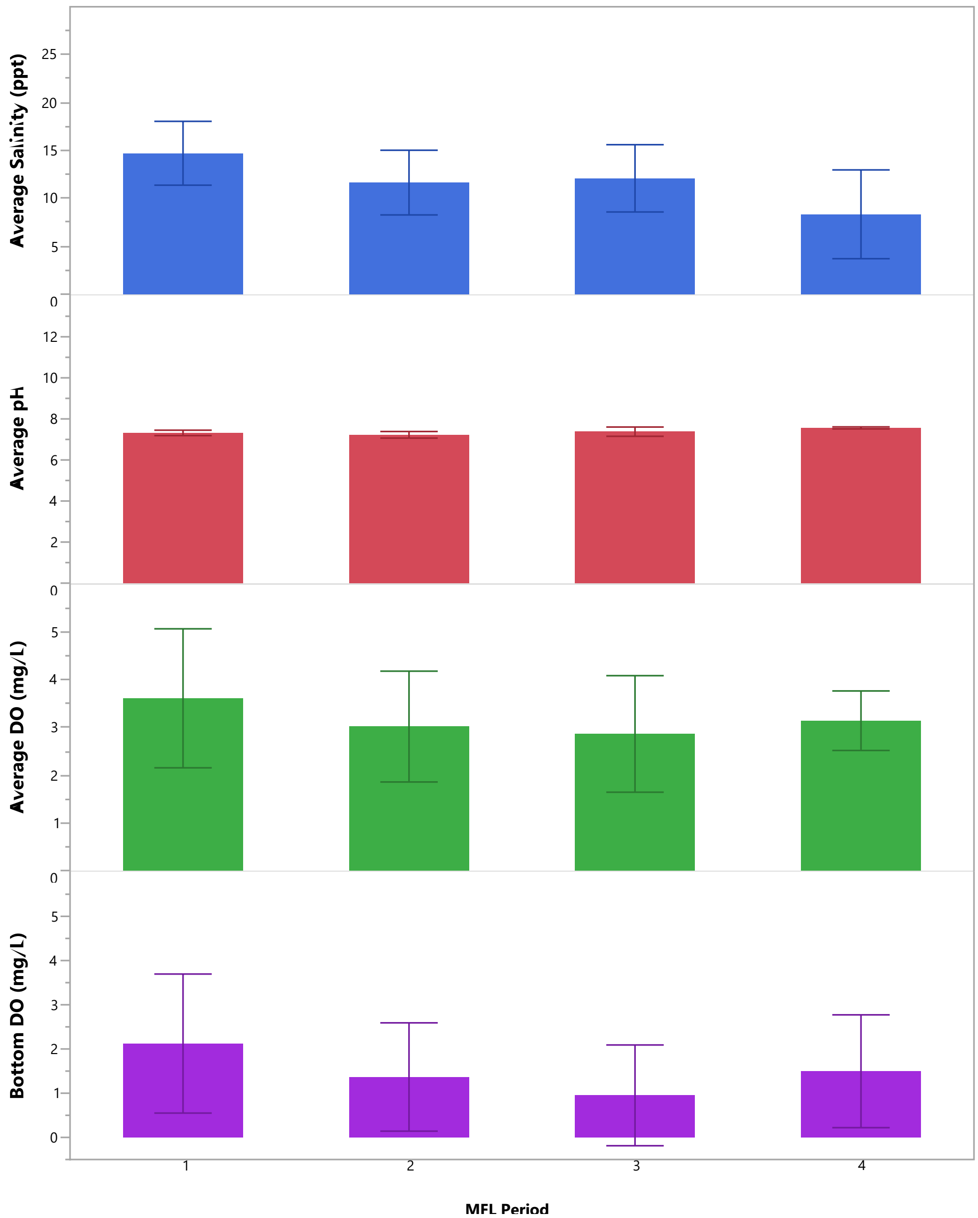


Figure 6.1-4 Mean values (error bars represent standard deviation) for four water quality variables by MFL period. Average dissolved oxygen (DO) represents the mean of the dissolved oxygen concentrations from top, middle, and bottom of the water quality profiles collected with each zooplankton sample.

Table 6.1-1. Trends in trophic-state (eutrophication) indicator density during the four MFL periods. *Indicator taxa* and *Indicator strength* (indicator values, *IV*) were obtained from Table 4 of Burghart et al. (2013) and involve the same taxa that appear within green and red boxes in Figure 6.1-2. *Indicator type* identifies whether the indicator taxon is an indicator of relatively oligotrophic conditions (positive) or relatively eutrophic conditions (negative). The rank-based, nonparametric Kruskal-Wallis ANOVA was used to estimate the probability (*Kruskal-Wallis p*) of no significant differences in median density among the four MFL periods ($p > 0.05$ was considered insignificant in all tests). To determine whether there was a first-order trend in density during the four MFL periods, Spearman's rank-based correlations between individual sample densities and MFL period (dummy variable 1, 2, 3, 4) were examined; these are reported as the correlation coefficient (*Spearman's r*) and its associated *p*-value (*Spearman's p*). Aside from ranking, no data transformations were used in these analyses, as rank-based statistical tests are insensitive to mathematical transforms.

Indicator taxon	Type of organism	Indicator strength (*IV*)	Indicator type	Kruskal-Wallis *p*	Spearman's *r*	Spearman's *p*	Trophic-state trend
Edotia triloba	isopod	92.0	negative	NS	0.11	NS	no change
Cassidinidea ovalis	isopod	91.3	positive	< 0.0001	0.49	< 0.0001	improving
chaetognaths, sagittid	arrow worm	83.5	negative	< 0.0001	-0.34	< 0.0001	improving
Lucania parva postflexion larva	fish	81.0	positive	NS	-0.01	NS	no change
Acartia tonsa	copepod	80.9	negative	NS	0.12	NS	no change
dipterans, pupae	insect larvae	79.9	positive	0.05	0.16	0.02	improving
cymothoid sp. a (*Livoneca*) juveniles	parasitic isopod	79.3	negative	< 0.0001	-0.16	0.02	improving
gastropods, prosobranch	aquatic snails	78.7	positive	0.005	-0.19	0.006	declining
dipterans, chironomid	insect larvae	78.3	positive	< 0.0001	0.28	< 0.0001	improving
Anchoa mitchilli juveniles	fish	77.7	negative	0.02	-0.06	NS	no change
ostracods, podocopid	seed shrimps	75.0	positive	0.002	-0.09	NS	no change
Americamysis juveniles	opossum shrimps	70.4	positive	< 0.0001	0.23	0.0008	improving
amphipods, gammaridean	amphipods	70.2	positive	< 0.0001	0.55	< 0.0001	improving
Palaemonetes pugio adults	shrimp	68.6	positive	< 0.0001	-0.44	< 0.0001	declining
Palaemonetes pugio juveniles	shrimp	68.6	positive	< 0.0001	-0.41	< 0.0001	declining
acari	water mites	65.8	positive	NS	-0.01	NS	no change
Clytia sp.	hydromedusa	61.1	negative	< 0.0001	-0.42	< 0.0001	improving
Microgobius gulosus juveniles	fish	58.1	positive	NS	-0.05	NS	no change
Sphaeroma terebrans	isopod	56.9	negative	< 0.0001	0.09	NS	no change

Some indicator taxa for oligotrophic conditions (Burghart et al. 2013) became significantly more abundant with the more recent MFL periods. These included the isopod, *Cassidinidea ovalis* and chironomid larvae and pupae (Figure 6.1-5).

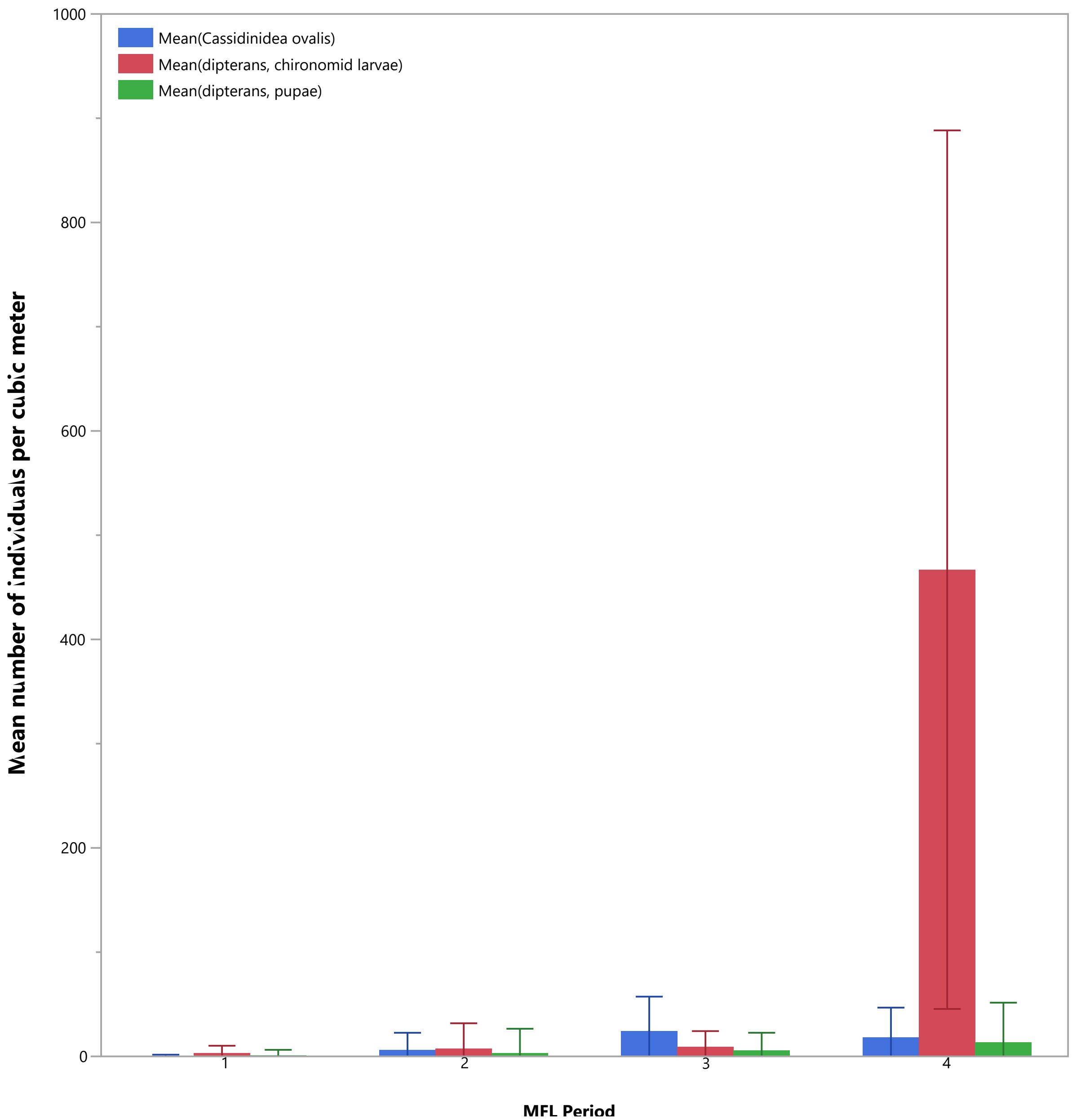


Figure 6.1-5 Mean (error bars represent standard deviation) number of zooplankton individuals per 1,000 m^3 of taxa that are positive indicators for trophic-state (via-à-vis eutrophication, Burghart et al. 2013).

Additionally, some taxa that are indicators of eutrophic conditions decreased in abundance (Figures 6.1-6 and 6.1-7). These include sagittid chaetognaths, parasitic isopods (*Livoneca* sp.), and the hydromedusa, *Clytia*.

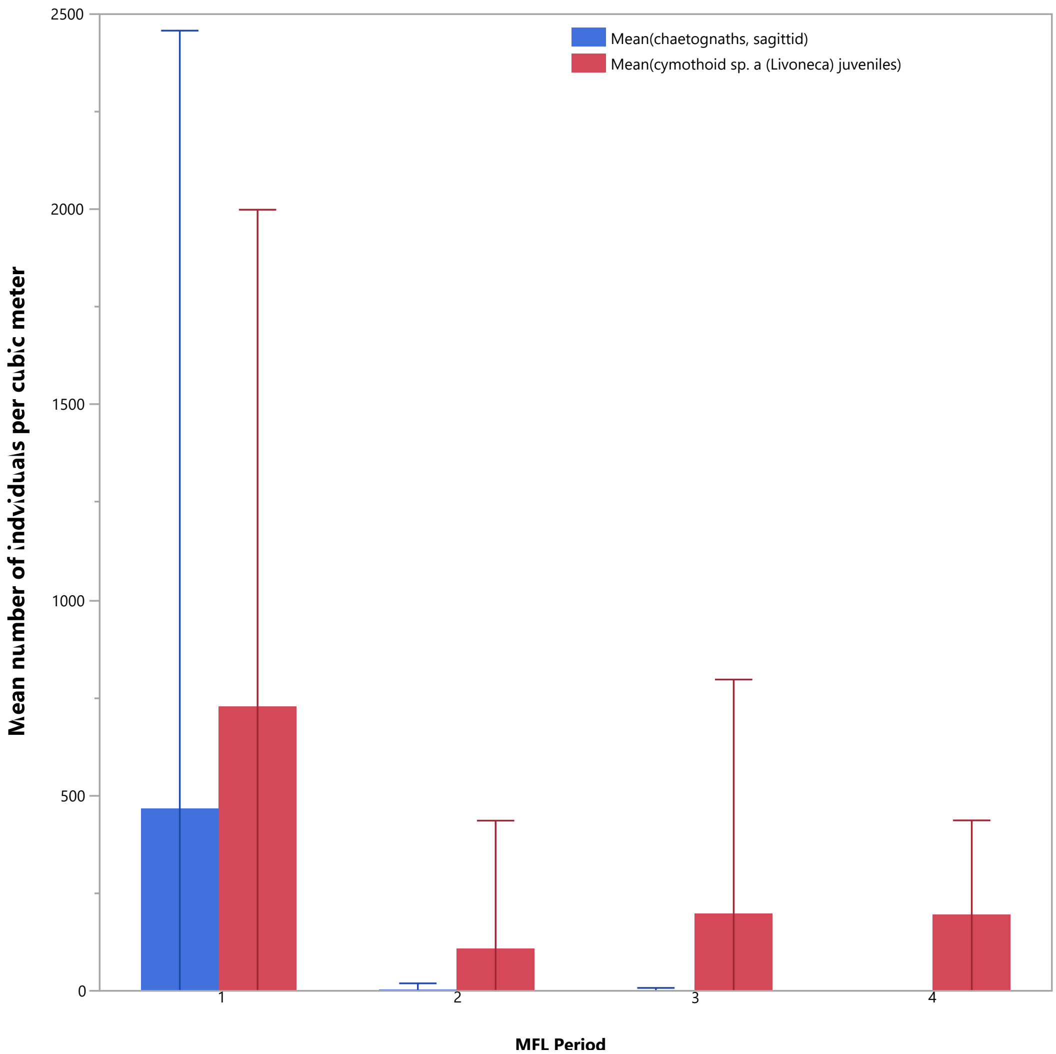


Figure 6.1-6 Mean (error bars represent standard deviation) number of zooplankton individuals per 1,000 m^3 of two taxa that are negative indicators for trophic-state (via-à-vis eutrophication, Burghart et al. 2013).

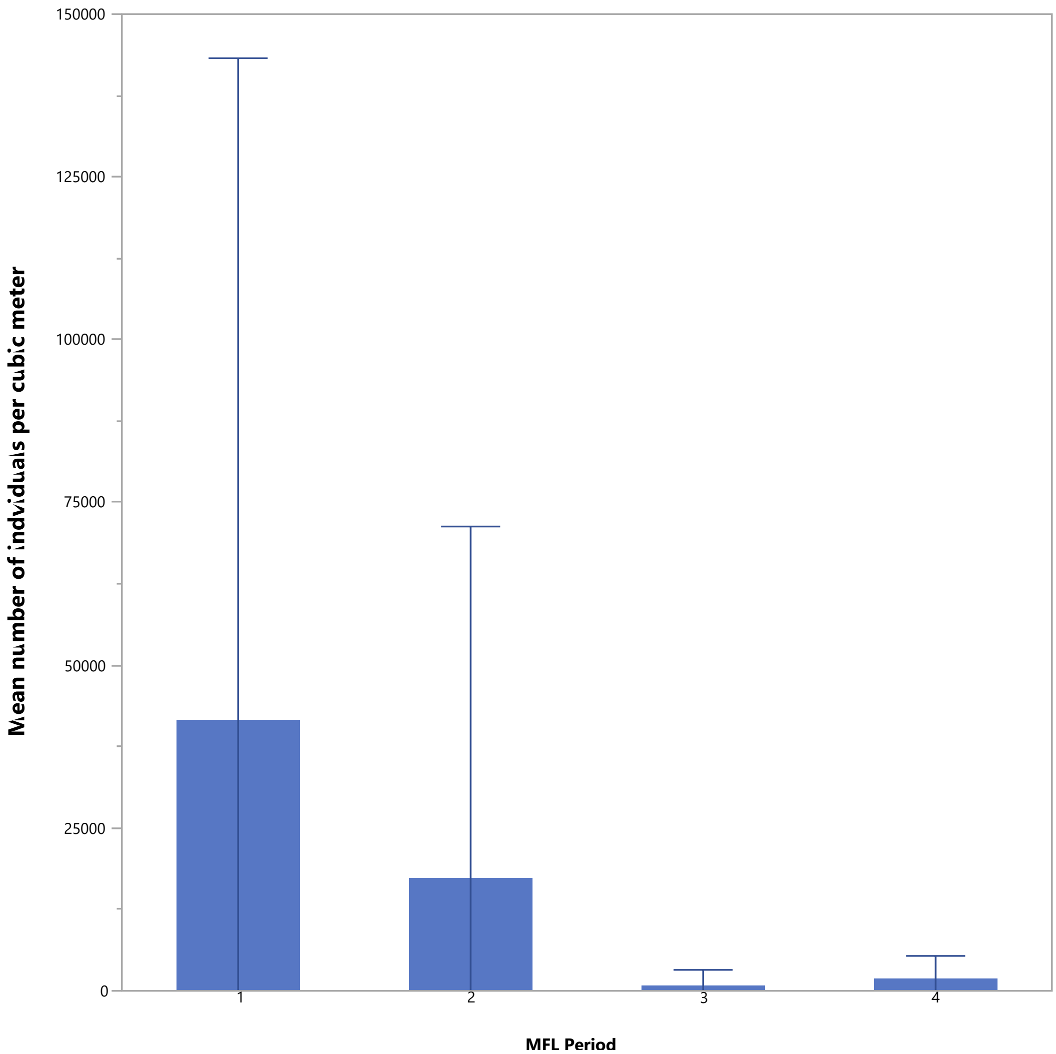


Figure 6.1-7. Mean (error bars represent standard deviation) number of *Clytia* sp. (hydromedusa) per 1,000 m^3 of which is a negative indicator for trophic-state (via-à-vis eutrophication, Burghart et al. 2013) and demonstrated a significant declining trend of abundance (thus improvement of conditions) over the different MFL periods.

In contrast, prosobranch gastropods, a taxon that indicates oligotrophic conditions (Burghart et al. 2013) declined in the more recent MFL periods (Figure 6.1-8).

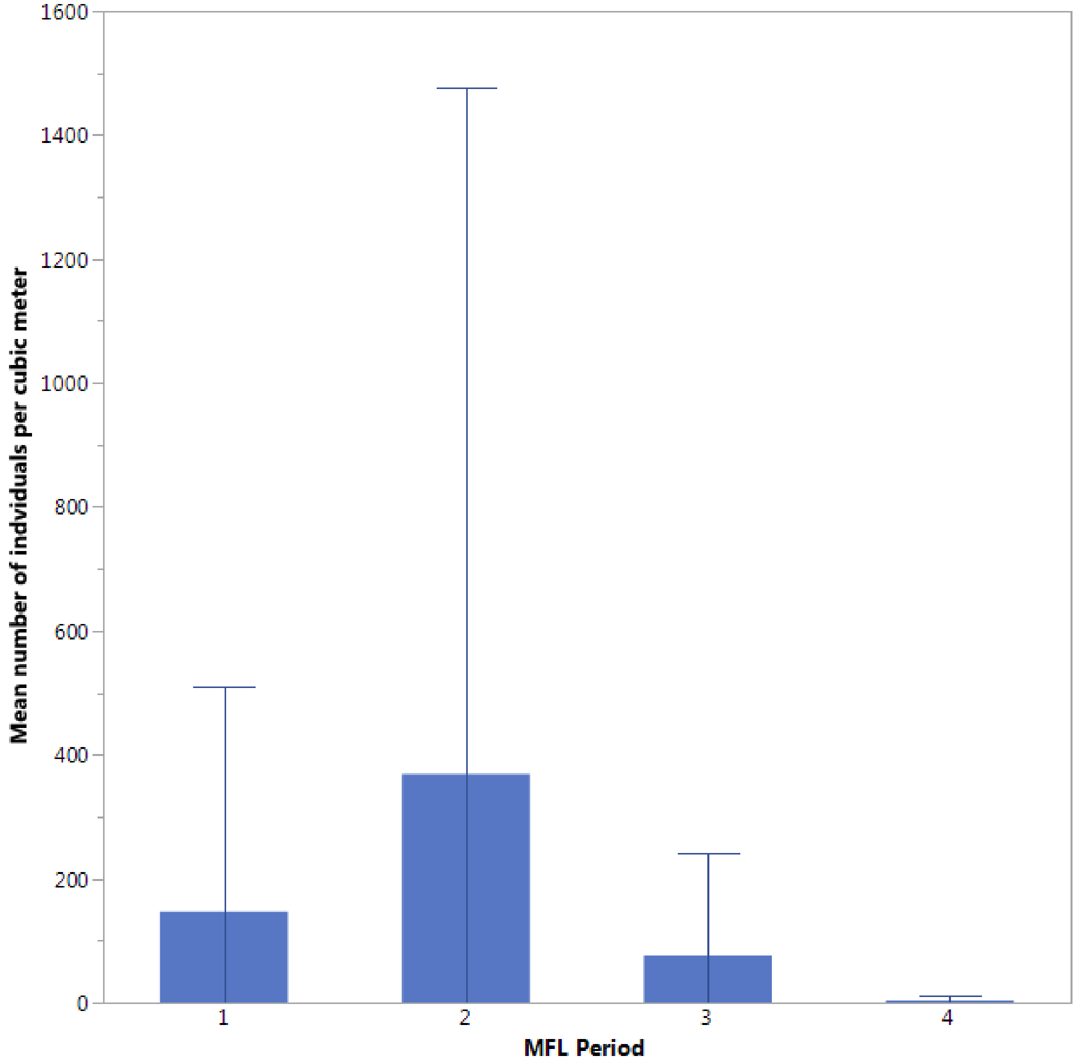


Figure 6.1-8. Mean (error bars represent standard deviation) number of prosobranch gastropods per 1000 m^3 of which is a positive indicator for trophic-state (via-à-vis eutrophication, Burghart et al. 2013) and demonstrated a significant declining trend of abundance over the different MFL periods.

To a large extent, the results presented in Table 1 can also be obtained through visual inspection of Figure 6.1-2 (i.e., the statistical approach used to produce Table 6.1-1 was merely a less subjective means of interpreting Figure 6.1-2). The densities of most (58 percent) indicator taxa had either an increasing or decreasing first-order trend during the MFL time periods that were compared. In Table 6.1-1, an increase in the density of a positive (oligotrophic-oriented) indicator is considered an improvement in trophic state (i.e., habitat condition), an increase in a negative (eutrophic-oriented) indicator is considered a decline in trophic state, a decrease in a positive indicator is considered a decline, and a decrease in a negative indicator is considered an improvement. On average, 42 percent of indicators suggested improving habitat conditions, 16 percent suggested declining conditions, and 42 percent did not exhibit detectable change under the methods employed here. From this analysis, the weight of evidence suggests habitats within the LHR improved after MFL implementation.

In addition to the data analysis summarized in Table 6.1-1, two organism-density trends singularly support the idea that habitat conditions have improved since MFL implementation. The first is the reduction in the density of the hydromedusa *Clytia*[1] sp. which is evident in both Figure 6.1-2 and Table 6.1-1. *Clytia* is a voracious predator on other zooplankton, and commonly clears the water of most other macroscopic organisms once its blooms attain sufficient densities, as illustrated by Figure 6.1-9. This hydromedusa is capable of directly consuming fish eggs, larval fishes, and larval crustaceans, and also competes with young marine organisms of various types and ages for prey. Because the LHR is used as a nursery habitat by young fishes and crustaceans, high densities of *Clytia* and other gelatinous predators are considered detrimental to the quality of nursery habitat (Purcell 1992, Purcell et al. 1994, Rees and Gershwin 2000). It appears likely that the higher flows associated with the MFL effectively displaced and dispersed *Clytia* from the upper portion of the LHR, improving habitat quality for other species.

A second, albeit somewhat less impressive, trend is the reduction in chaetognath density during the four MFL periods (Figure 6.1-2 and 6.1-6, Table 6.1-1). The argument that this trend as constitutes an improvement in habitat quality is similar to that made for *Clytia*, although chaetognaths generally consume smaller prey than do hydromedusae, and thus pose a lesser predation risk to older developmental stages of fishes and crustaceans; the negative competition-for-prey effect, however, is similar. On Florida's west coast, chaetognaths are associated with the open-water plankton communities of bays and the Gulf of Mexico, and only invade the interiors of tidal rivers during extended periods of reduced freshwater inflow. The reduction in chaetognath densities after implementation of the MFL is another indication that habitat quality in the LHR was improved by the MFL by reducing the duration of periods of reduced freshwater inflow.

The declining trends evident for prosobranch gastropods (aquatic snails) and *Palemonetes pugio* (daggerblade grass shrimp) may have alternative explanations. Different life stages of *Palaemonetes* have been shown to move downstream as freshwater inflows increase (MacDonald et al. 2005), and thus it is possible that elevated flows associated with MFL implementation shifted the *Palaemonetes* habitat downstream towards the lower tidal river, causing densities in the upper tidal river to decline. Prosobranch gastropods are benthic herbivores that primarily consume attached, benthic algae. Benthic algae, in turn, are dependent on adequate light reaching the bottom for growth. Freshwater inflows introduce colored, dissolved, organic matter (CDOM) consisting of humic acids, fulvic acids, tannins, etc.) which is a naturally occurring light attenuator. CDOM, which tends to be called "color" by freshwater ecologists, eventually becomes diluted as seaward-moving estuarine flows mix with larger volumes of water (i.e., at larger cross-sections of tidal river or at the receiving basin itself), allowing more light to reach the bottom. In most estuarine settings, it can be expected that

[1] Note that the systematics of hydromedusae in southeastern U.S. coastal waters are incompletely resolved, and although the assignment of the genus *Clytia* to this form (see Figure 5.1-9) thus must remain tentative, recognition and enumeration of this organism remained consistent throughout the course of the surveys analyzed here.

increased freshwater inflows associated with MFLs would have increased CDOM loadings and shifted this dilution zone farther seaward, making the upper tidal river less suitable for benthic algae and their gastropod predators. However, in the case of the Hillsborough River, a large portion of the flow for minimum flow supplementation has been obtained from Sulphur Springs, which has very low CDOM (color), and thus may have actually improved the light environment in the upper tidal river. Bottom and average water-column DO, on the other hand, appeared to become reduced during the MFL implementation process (Figure 6.1-3 and 6.1-4), possibly as a result of increased vertical density stratification associated with the increase in freshwater inflows to the estuary. Certain taxa (and possibly gastropods) can be expected to respond negatively to increased hypoxia.

In general, the primary temporal trend in the plankton-net catch during MFL implementation was an increase in the abundance of a number of taxa, with the collective increase in abundance shifting the tidal Hillsborough River's community structure towards that of a spring-dominated estuary. This would be expected, given the increased role of Sulphur Springs in supplying fresh water to the estuary under the MFL. The utility of the present approach toward detecting community-level change may have been enhanced by the fact that spring water was used to achieve the MFL, as the indicators used in this approach were largely identified by Burghart et al. (2013) from samples collected from spring-dominated estuaries.

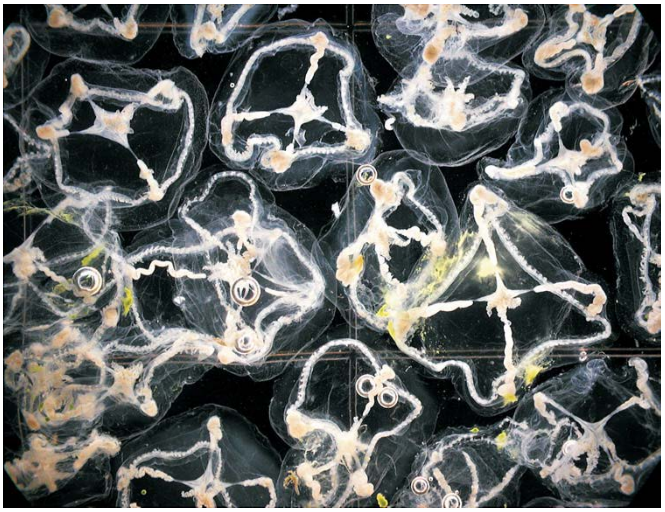


Figure 6.1-9. Photos of lower Hillsborough River plankton-net samples when the hydromedusa *Clytia* sp. was absent (top photo) and blooming (bottom photo; E. Peebles photos from MacDonald et al. 2005)

6.2 Nekton Results

The nekton community was found to be statistically significantly different between MFL periods with a two-way crossed (MFL period and river segment) ANOSIM test (average R test statistic value of 0.122, $p = 0.001$), but this low R value indicates the differences between the communities were not large. In pairwise comparisons, five of the six possible pairs were statistically significantly different (1 vs 2, 1 vs 3, 1 vs 4, 2 vs 3, and 2 vs 4; Appendix 6.2 A). In pairwise comparisons of river segments, two of the comparisons were significantly different (R = 0.107, $p = 0.001$; Appendix 6.2 A). The lower and middle segment pair (R = 0.099, $p = 0.001$) and the lower and upper segment pair (R = 0.172, $p = 0.001$; Appendix 6.2 A). However, the MDS plot does not show a clear pattern among the samples from the different MFL periods, and the high stress value (2D stress = 0.26) indicates “little reliance should be placed on the detail of the plot” (Clarke et al. 2014; Figure 6.2-1).

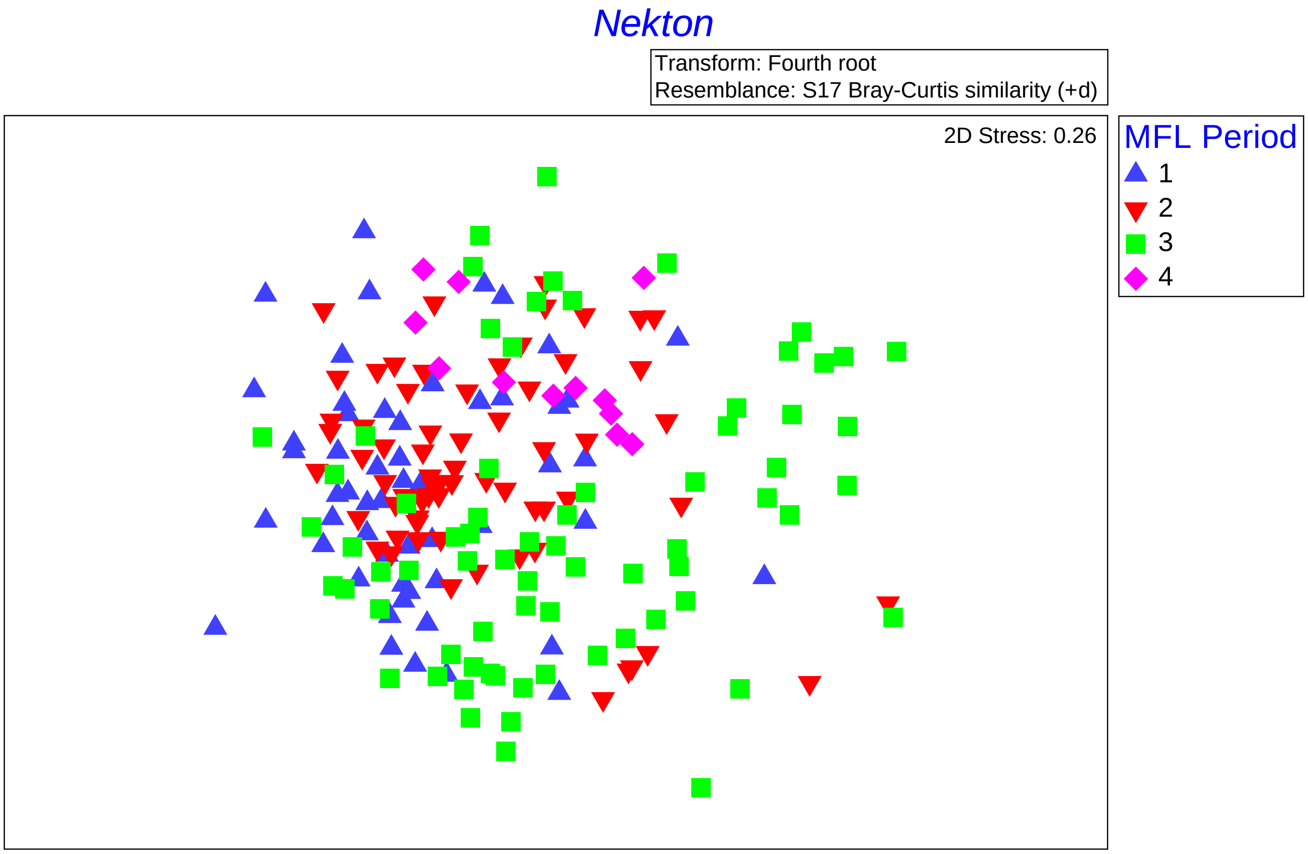


Figure 6.2-1 Non-metric multidimensional scaling (nMDS) plot of seine net sample similarity (zero-adjusted Bray-Curtis similarity matrix of fourth-root transformed abundances of individuals by taxon) with a 2D stress value of 0.26. Each symbol in the plot represents a single sample; samples close together in the plot had similar community composition. Samples were collected during the HBMP program (2000 – 2012) and by Water & Air in 2018. A total of 69 taxa (fish and large mobile crustaceans) contributed to this analysis. Symbol labels represent the MFL period in which the sample was collected.

The density of organisms found in the seine net samples differed between the MFL periods, with larger mean (but highly variable) numbers of organisms found in MFL period 1, before the MFL was implemented (Figure 6.2-2, Appendix 6.2 B). Spearman's rank correlation test found a statistically significant negative correlation between (the categorial variable of) MFL period and the total density of nektonic organisms in the samples (r_S = -0.3897, $p < 0.0001$). However, there was no significant correlation between MFL period and Shannon index (r_S = 0.0649, p = 0.3564) or MFL period and taxon richness (r_S = -0.1040, p = 0.1387; Table 6.2-1; Figures 6.2-3 and 6.3-4). As expected, total catch was positively correlated with taxon richness (r_S = -0.5788, $p < 0.0001$; Table 6.2-1).

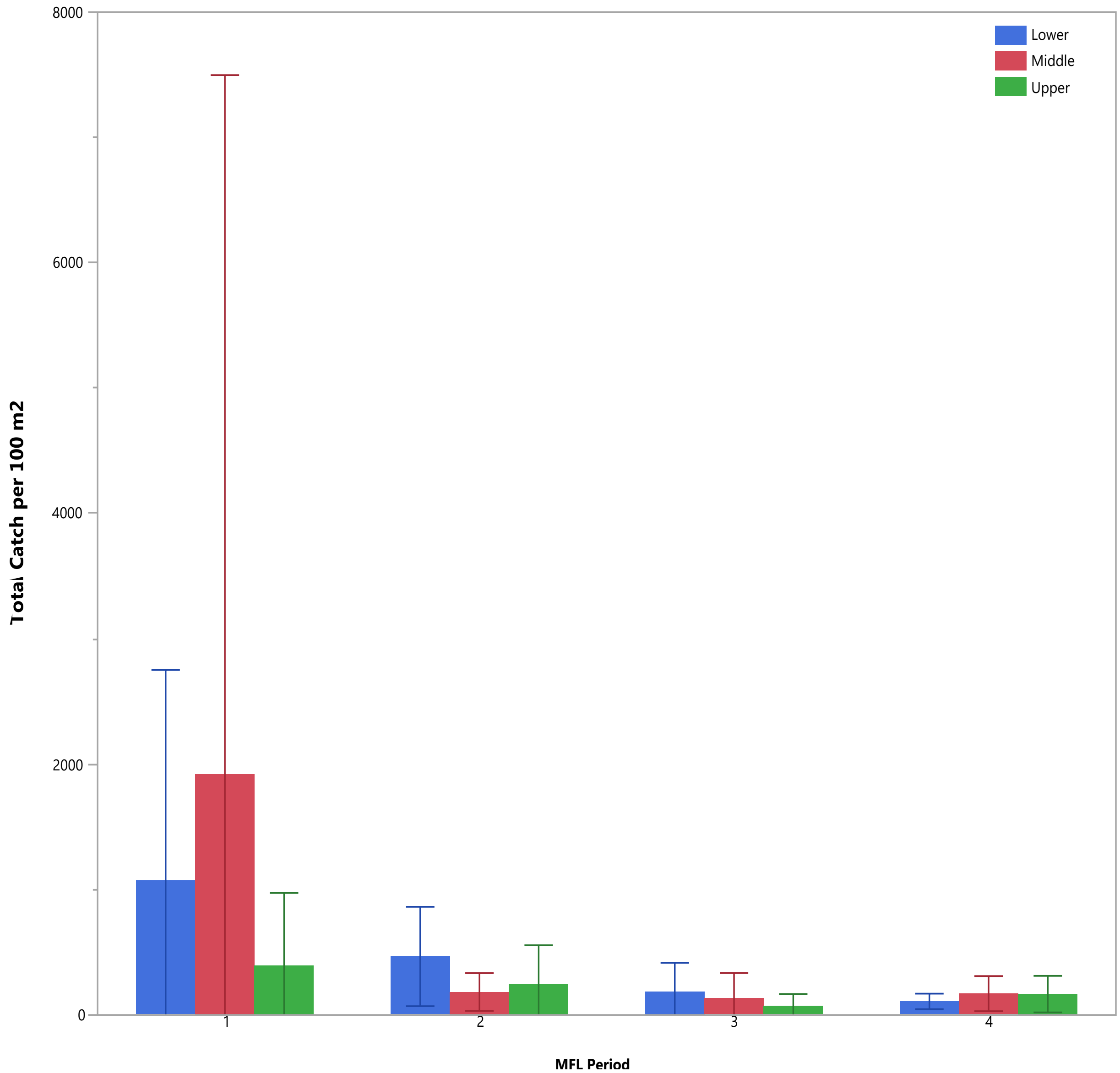


Figure 6.2-2 Mean (error bars represent standard deviation) total catch per 100 m^2 of river bottom per MFL period by river segment.

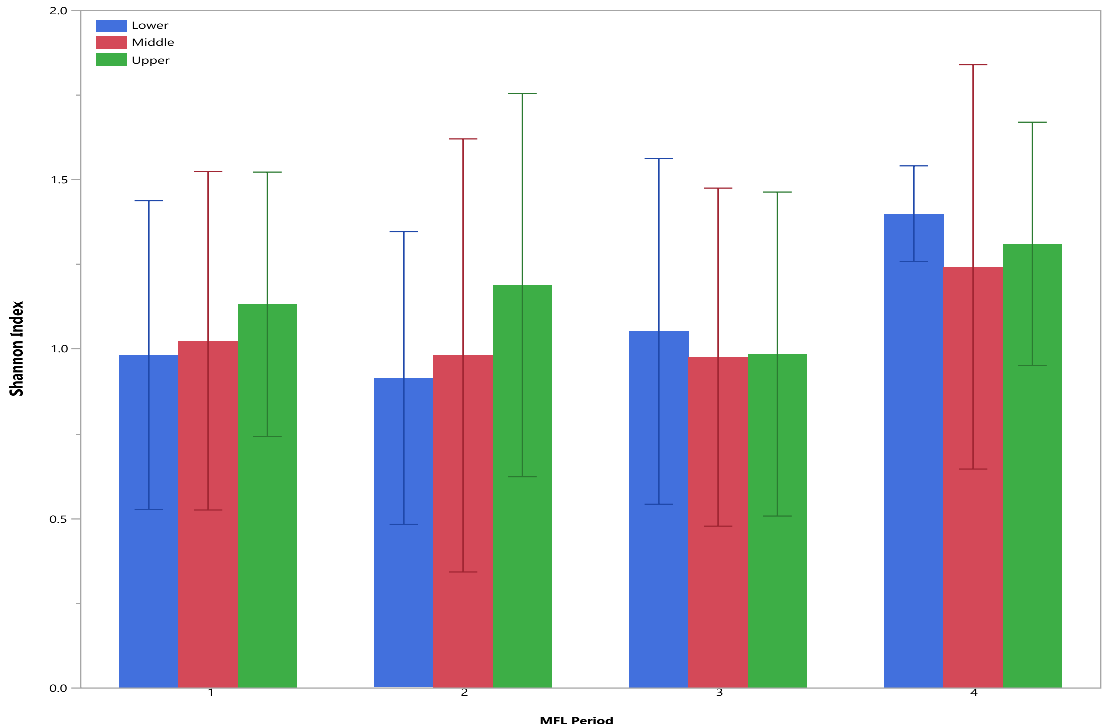


Figure 6.2-3 Mean Shannon index value (error bars represent standard deviation) of nekton samples (in a single seine catch) by MFL period and river segment.

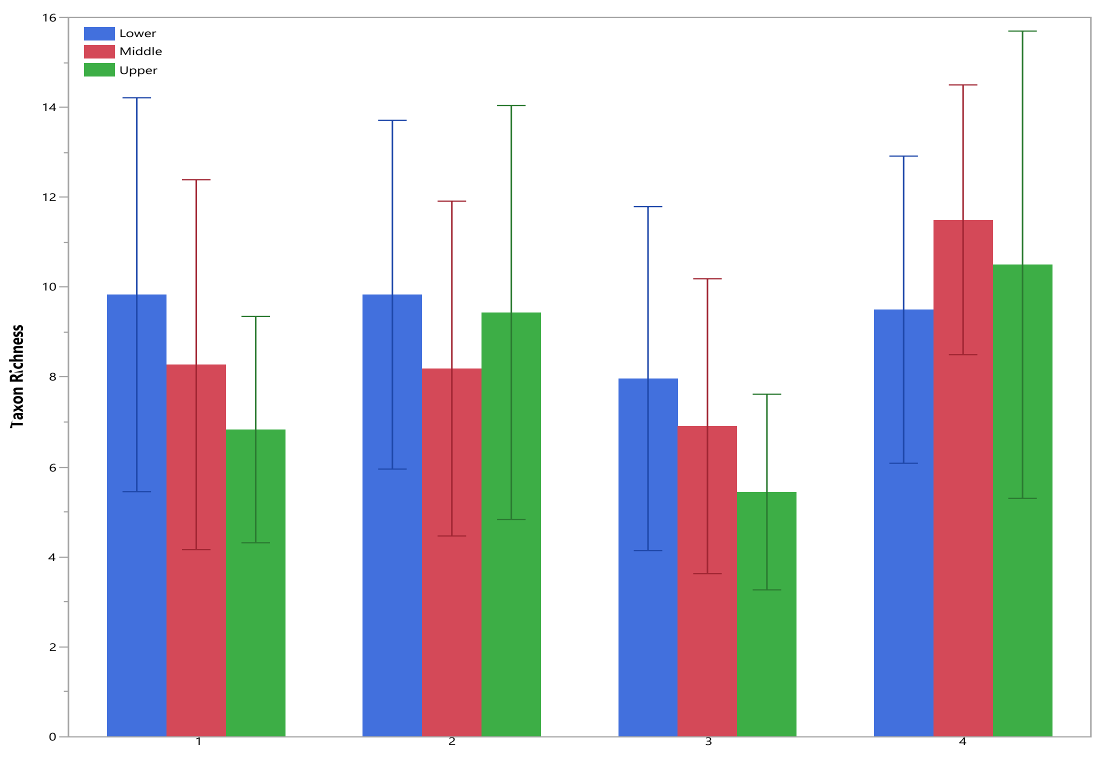


Figure 6.2-4 Mean (error bars represent standard deviation) taxonomic richness of nekton samples (in a single seine catch) by MFL period and river segment.

Spearman's rank correlation test found a significant negative correlation (r_S = -0.4710, p < 0.0001) between MFL period and average salinity (salinity measures from the top, middle, and bottom of the water quality profile were averaged). Statistically significant differences in average salinity were found between MFL periods using a Kruskal-Wallis test [Chi square (χ^2) = 51.7974, p < 0.0001, degrees of freedom (df) = 3]. Specifically, MFL period 1 was significantly statistically different from the other three periods in Wilcoxon pairwise tests (Table 6.2-2). Salinity dropped after implementation of the MFL regulations in all three river segments (Figure 6.2-5 and Appendix 6.2 C Table 1). Average DO concentration (measures from the top, middle, and bottom of the water quality profile were averaged) was not significantly correlated with MFL period (r_S = 0.0044, p = 0.9506; Table 6.2-1; Figure 6.2-5; and Appendix 6.2 C Table 2). Means, medians, standard deviations, and sample sizes for average pH and average temperature from water quality profiles for each river segment by MFL period are presented in Appendix 6.2 C.

Table 6.2-1 Spearman's rank correlation coefficients (associated *p*-value below) for nekton diversity measures and water quality data (averaged of the water quality profile's top, mid, and bottom readings) collected concurrently with seine sample collection (DO = dissolved oxygen concentration in mg/L; salinity was measured in ppt).

	MFL Period	Total Catch	Taxon Richness	Shannon Index	Average Salinity	Average DO
Total Catch	**-0.3897**					
***p*- value**	**< 0.0001**					
Taxon Richness	-0.1040	**0.5788**				
***p*- value**	0.1387	**< 0.0001**				
Shannon Index	0.0649	-0.1110	**0.4964**			
***p*- value**	0.3564	0.1139	**< 0.0001**			
Average Salinity	**-0.4710**	**0.4492**	**0.2241**	-0.0667		
***p*- value**	**< 0.0001**	**< 0.0001**	**0.0013**	0.3434		
Average DO	0.0044	0.0336	-0.0282	-0.0278	**-0.3185**	
***p*- value**	0.9506	0.6333	0.6885	0.6935	**< 0.0001**	
River Kilometer		**-0.2102**	**-0.2040**	0.0819	**-0.4785**	**0.2602**
***p*- value**		**0.0025**	**0.0034**	0.2443	**< 0.0001**	**0.0002**

Average salinity was positively correlated with total catch (r_S = 0.4492, p < 0.0001) as was taxon richness (r_S = 0.2241, p = 0.0013; Table 6.2-1). RKm was negatively correlated with total catch (r_S = -0.2102, p = 0.0025), taxon richness (r_S = -0.2040, p = 0.0034), and average salinity (r_S = -0.4785, p < 0.0001; Table 6.2-1). Average DO was negatively correlated with RKm (r_S = 0.2602, p = 0.0002; Table 6.2-1).

Table 6.2-2 Results of Wilcoxon pairwise comparisons of average salinity the (salinity in ppt averaged from the water quality profile's top, mid, and bottom readings collected concurrently with seine sample collection) between MFL periods. Top value is the test statistic (*Z*), and bottom value is the associated *p*-value. Statistically significant (original α = 0.05, α = 0.0083 with Bonferroni correction for multiple comparisons) results are in bold.

MFL Period	1	2	3	4
2	**-5.2637**			
	< 0.0001			
3	**-6.7401**	-2.0449		
	< 0.0001	0.0409		
4	**-3.4830**	-1.2772	-0.3043	
	0.0005	0.2015	0.7609	

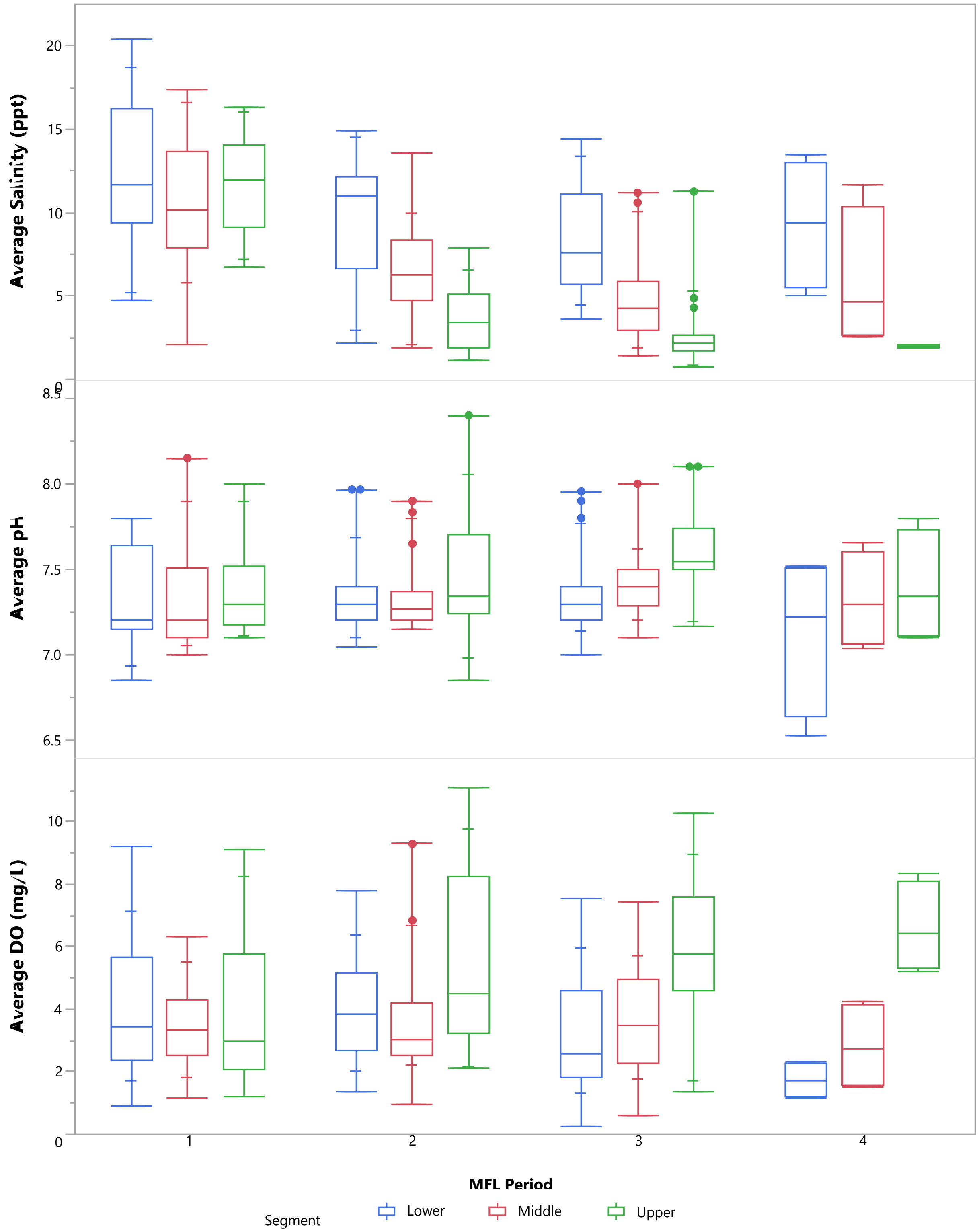


Figure 6.2-5 Boxplots of three water quality measures (averaged from readings at the top, middle, and bottom of the water quality profiles; DO = dissolved oxygen concentration) collected concurrently with seine samples by MFL period and river segment.

SIMPER analysis examined the extent to which different nektonic taxa contributed to the difference and similarity between samples from the four MFL periods and the three river segments (Appendix 6.2 D). Some of the species that were consistently important to the similarity or dissimilarity among sample groups also showed interesting patterns of abundance.

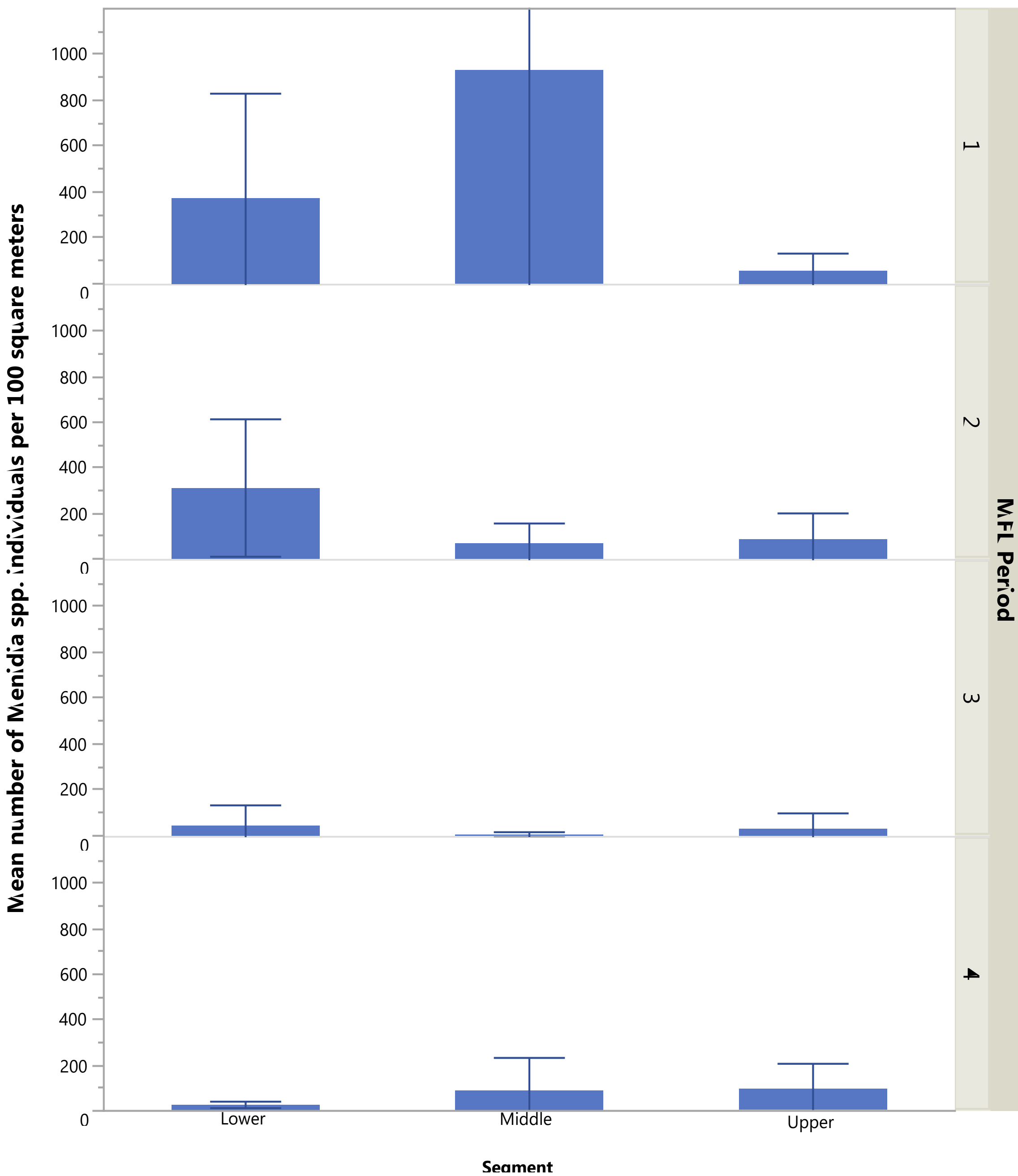


Figure 6.2-6 Mean (error bars represent standard deviation) densities of *Menidia* spp. individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment. Standard deviation for the middle segment in MFL period 1 is 3259.

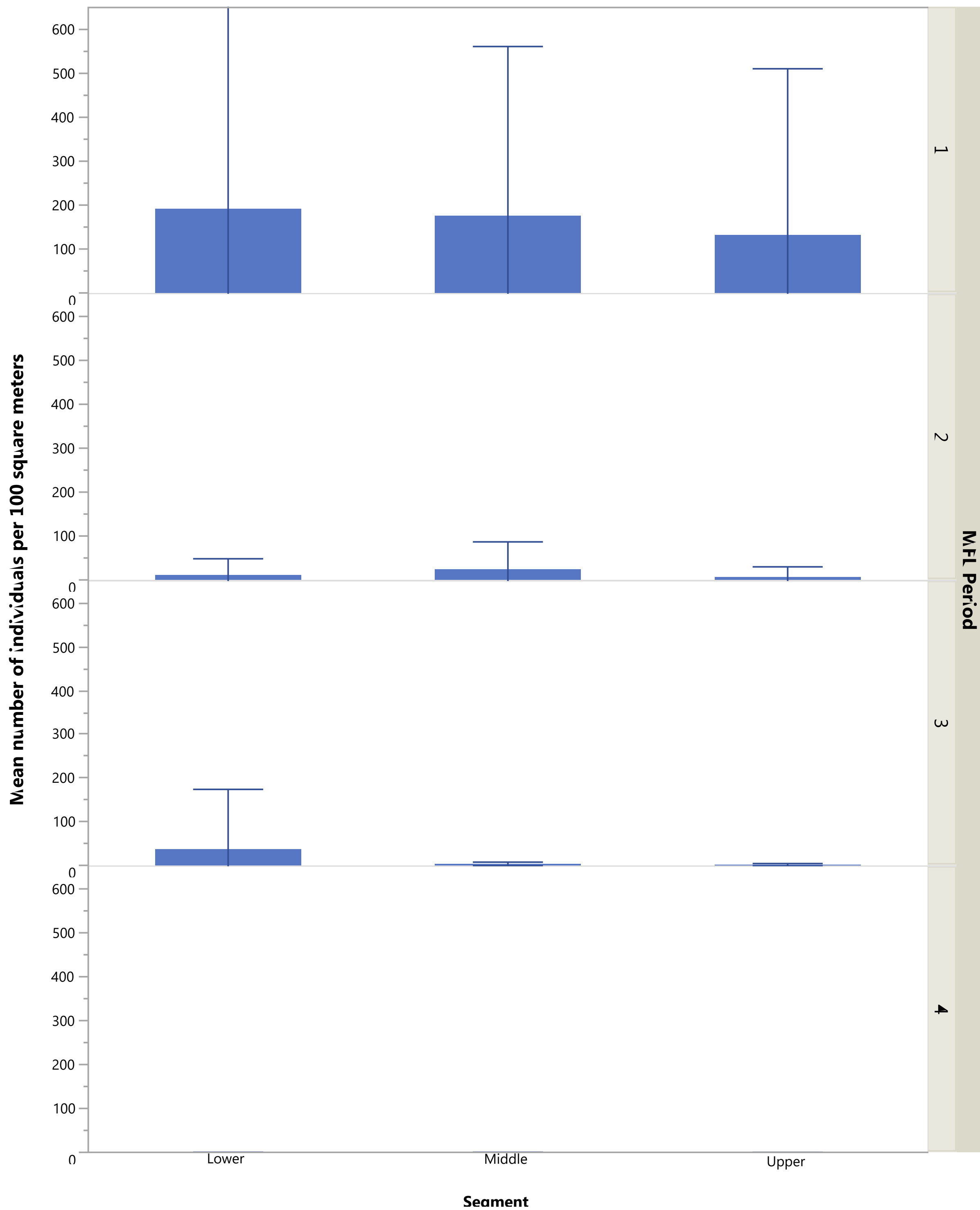


Figure 6.2-7 Mean (error bars represent standard deviation) densities of *Palaemonetes pugio* individuals per 100 m^2 of river bottom found in of nekton samples (seine net catches) by MFL period and river segment. Standard deviation for the lower segment in MFL period 1 is 923.

The most numerically-dominant organisms in the seine samples during MFL periods 1, 2, and 4 and the second-most dominant in MFL period 3 were silversides (*Menidia* spp.). The largest catches of silversides were made during MFL period 1 with the mean number of individuals per seine sample falling after the implementation of a minimum flow (Figure 6.2-6). During MFL period 4, all specimens caught by Water & Air in 2018 were identified in the field as *Menidia beryllina* (inland silverside), specifically, in contrast to the genus level identification used in the HBMP seine sample data. For analysis purposes, *Menidia* spp. was also used for the 2018 specimens. Inland silversides tolerate varying salinities, form large schools, and are found in inland freshwater bodies as well as in estuaries (Kells and Carpenter 2011). The more marine *M. peninsulae* (tidewater silverside), which is similar in appearance, is also likely to be present in the river, especially toward the river mouth and during periods of high salinity.

Another dominant species that appears to have decreased in abundance after MFL period 1 is the daggerblade grass shrimp (a decapod crustacean), *Palaemonetes pugio*. This species was the second-most abundant species in MFL period 1, the fifth-most abundant species in MFL period 2, and the third-most abundant species in MFL period 3 (Figure 6.2-7). Only two (total) *P. pugio* were found during the two sample events in Spring 2018. This shrimp is known to be euryhaline but is most common in mesohaline/estuarine waters (Wood 1967).

In SIMPER analysis (Appendix 6.2 D) species that consistently contribute to the average dissimilarity between factor groups are good discriminators (Clarke et al. 2014). *Menidia* spp. and *P. pugio* are the top two species that contributed most to the differences between MFL periods 1 versus 2 and 1 versus 3. *Menidia* spp. was also important in the dissimilarity between MFL periods 1 and 4, as was *Eucinostomus harengulus*, tidewater mojarra (Appendix 6.2 D).

Mean densities of *Eucinostomus* (mojarra) individuals in the samples increased over the MFL periods (Figure 6.3-8). In 2018 (MFL period 4) all *Eucinostomus* individuals were identified as *E. harengulus,* tidewater mojarra, and this taxon was a large contributor to differences between MFL period 4 and the other three periods (Appendix 6.2 D). In the previous MFL periods (during the HBMP seine net monitoring of nekton), both *E. harengulus* and *Eucinostomus* spp. were recorded. Only during MFL period 1 was another species of *Eucinostomus* identified in the study area; one individual of *E. gula*, silver jenny. Tidewater mojarra are common in estuaries and will enter freshwater, while silver jennies are rare in freshwater (Kells and Carpenter 2011).

Menhaden (*Brevoortia* spp.) were the third-most abundant species in MFL period 1 but became much less common in the subsequent MFL periods after a minimum flow was implemented, ranking as the ninth-most and sixth-most abundant species in MFL periods 2 and 3, respectively. No menhaden were captured in the April and May 2018 seine samples (Figure 6.2-9). Previously, April and May were peak months for capture of menhaden by seine in the Hillsborough River (MacDonald et al. 2005). This may be due to the small number of samples collected in 2018 and the stochasticity of capturing a school. The fish were likely *B. smithi*, yellowfin menhaden, a marine species that spawns offshore but enters brackish and fresh water (Water & Air Research and SDI Environmental Services 1995; Kells and Carpenter 2011; Robins et al. 2018). Possibly fewer catches of this marine/estuarine schooling fish were to be expected after implementation of minimum flows (SWFWMD and Atkins 2015). Gulf menhaden (*B. patronus*), particularly post-larvae and juveniles, are sensitive to low DO concentrations and are frequently victims of fish kills (Lassuy 1983).

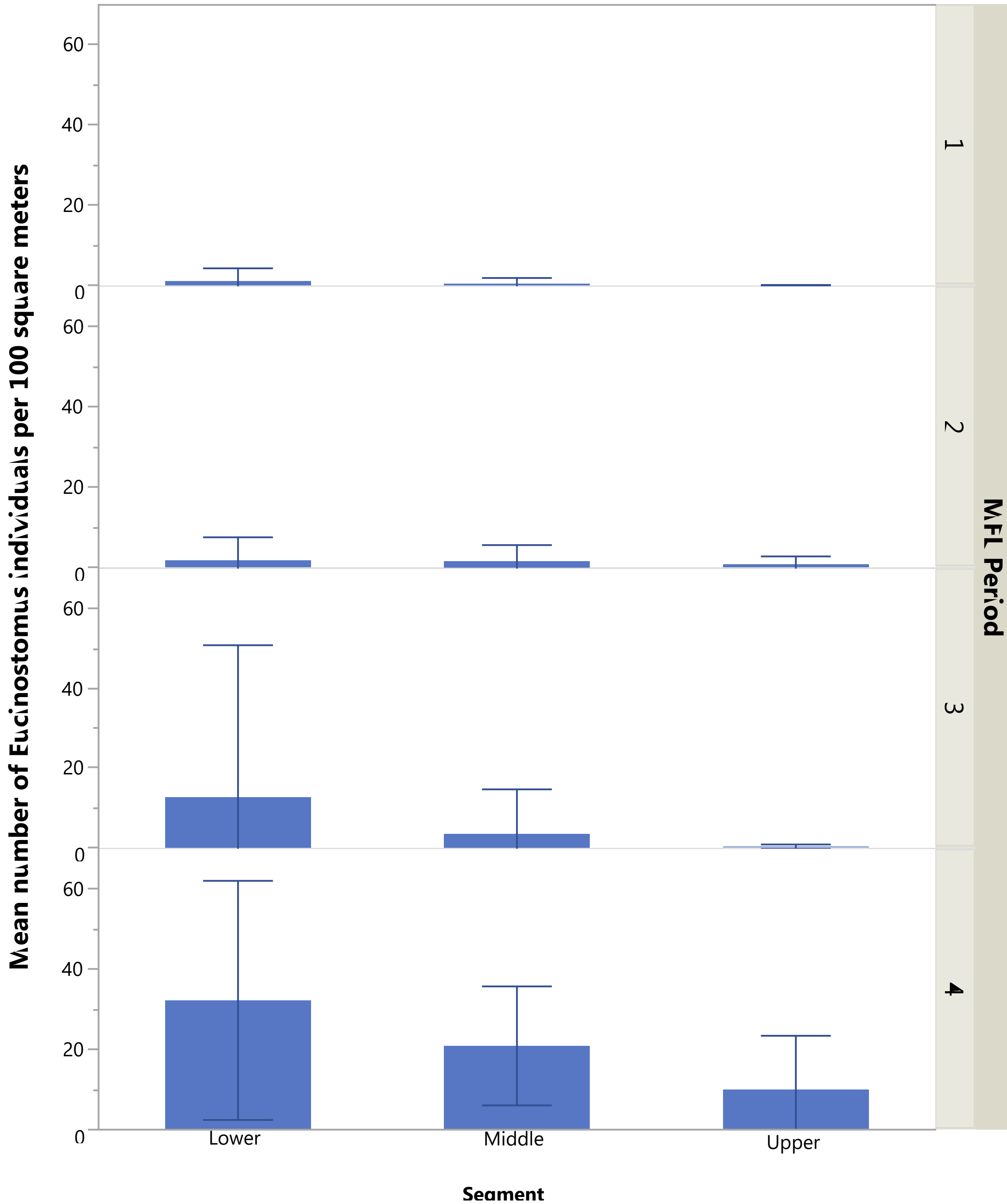


Figure 6.2-8 Mean (error bars represent standard deviation) densities of *Eucinostomus* spp. individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

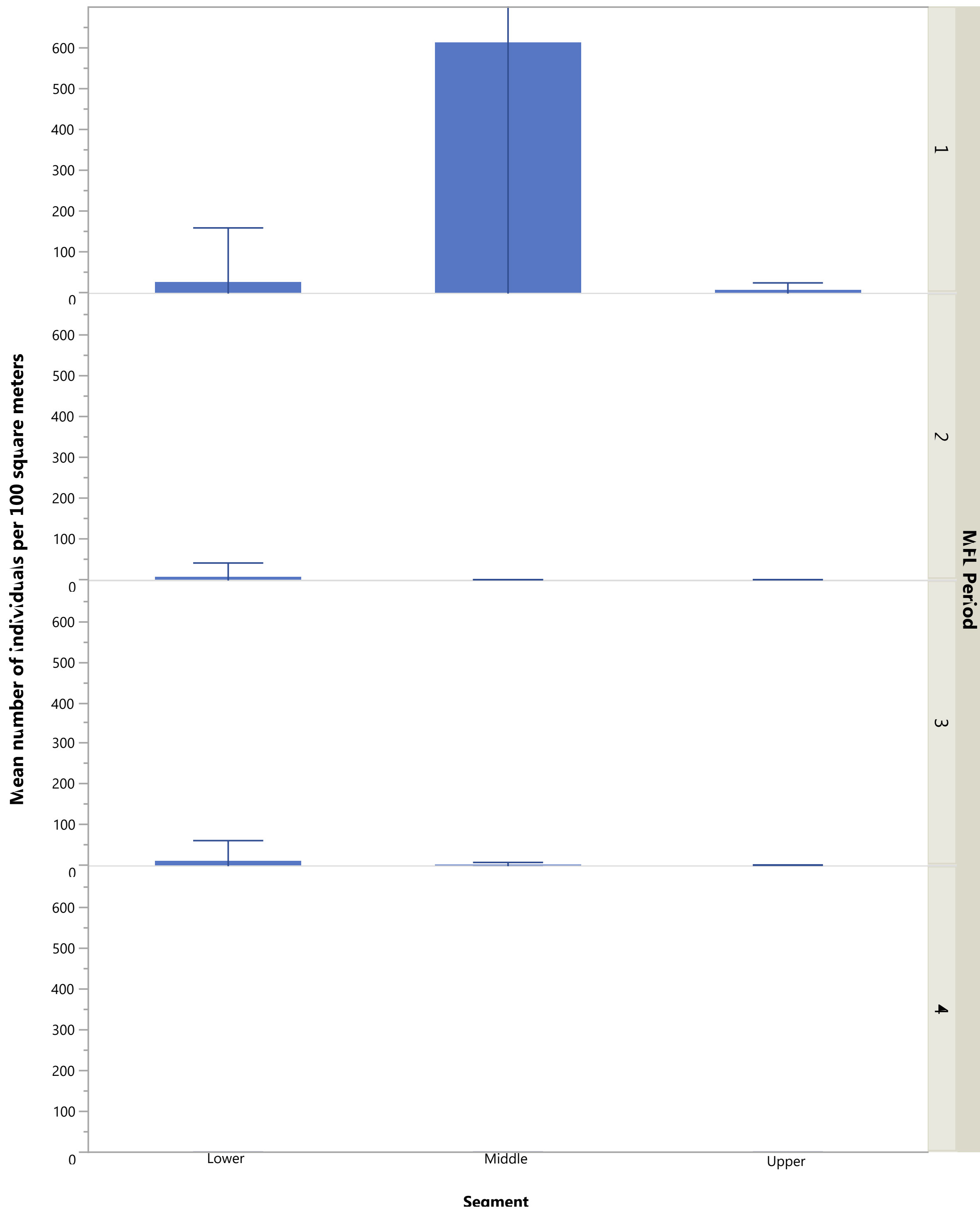


Figure 6.2-9 Mean (error bars represent standard deviation) densities of *Brevoortia* spp. individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment. Standard deviation for the middle segment in MFL period 1 is 2382.

Another dominant taxon in the HBMP program samples not found in Water & Air’s 2018 seine samples is the bay anchovy, *Anchoa mitchilli* (Figure 6.2-10). Interestingly, April and May are months the taxon was previously recorded in the Hillsborough River from seine samples (MacDonald et al. 2005). The bay anchovy is a marine species of schooling fish (estuarine spawner) that enters rivers (MacDonald et al. 2005, Robins et al. 2018). The highest mean abundances of bay anchovy were found in MFL period 1 during which period the species was the fourth-ranked species for overall abundance. Its mean abundance was lower in MFL period 2 (compared with MFL period 1), but it was the third-most abundant species during MFL period 2. *Anchoa mitchilli* was the most abundant species in the samples from MFL period 3. The small number of samples that constitutes the total sampling effort for MFL period 4 and the low probability of capturing a school of anchovy in a single sample may explain the absence of this species from the seine net samples in 2018.

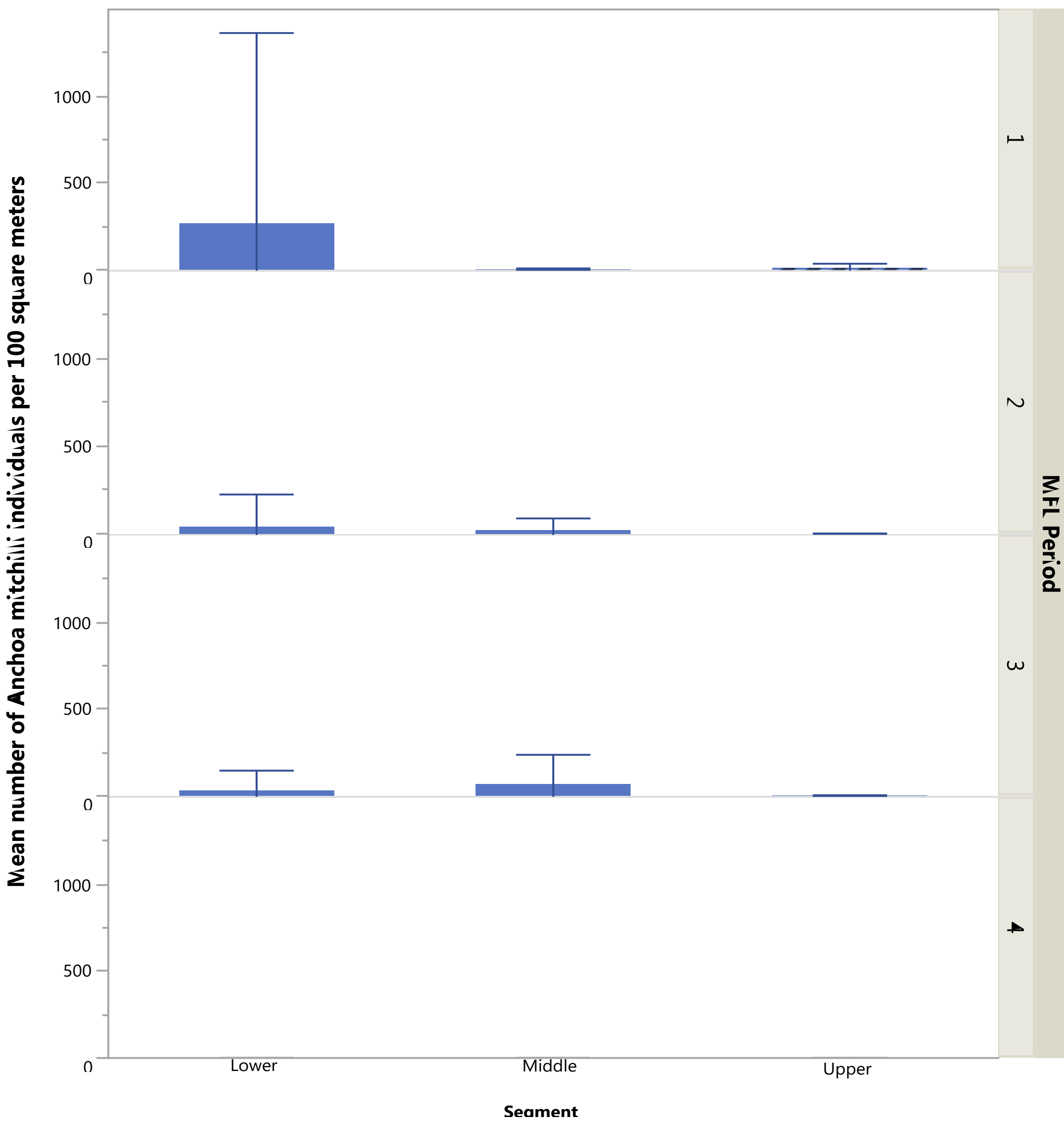


Figure 6.2-10 Mean (error bars represent standard deviation) densities of *Anchoa mitchilli* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Gambusia holbrooki, the eastern mosquitofish, was abundant in all four MFL periods and found in all river segments (Figure 6-2.11). These live-bearing fish are the most common freshwater fish in Florida and are tidal river residents that tolerate brackish water (MacDonald et al. 2005; Robins et al. 2018).

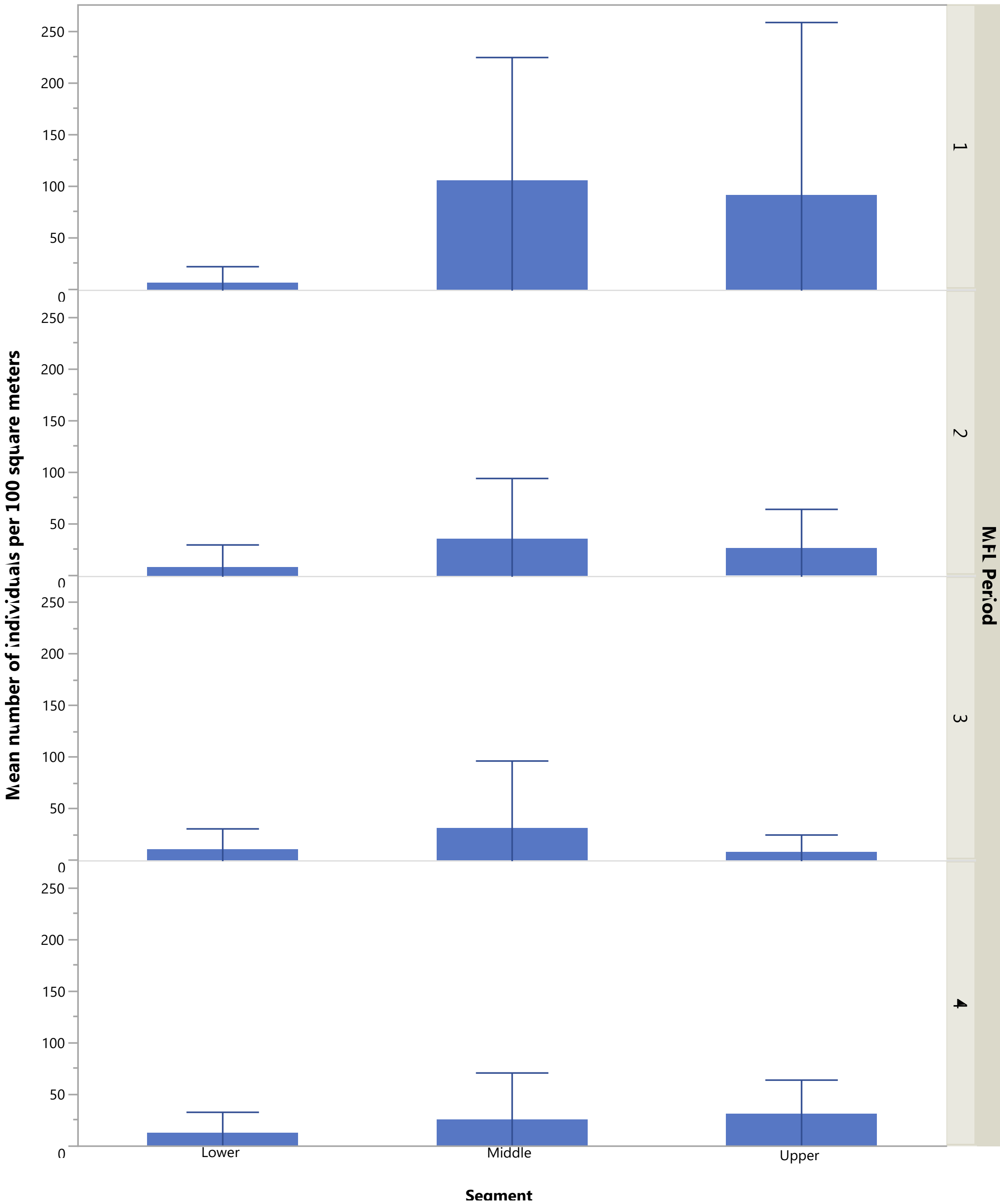


Figure 6.2-11 Mean (error bars represent standard deviation) densities of *Gambusia holbrooki* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Lucania parva, the rainwater killifish, was found during all four MFL periods. During the first three MFL periods, it was found in all three river segments and in the middle and upper segments in 2018 (Figure 6.2-12). It is a tidal river resident that peaks in abundance during the summer (MacDonald et al. 2005) and is known to inhabit brackish water (Kells and Carpenter 2011).

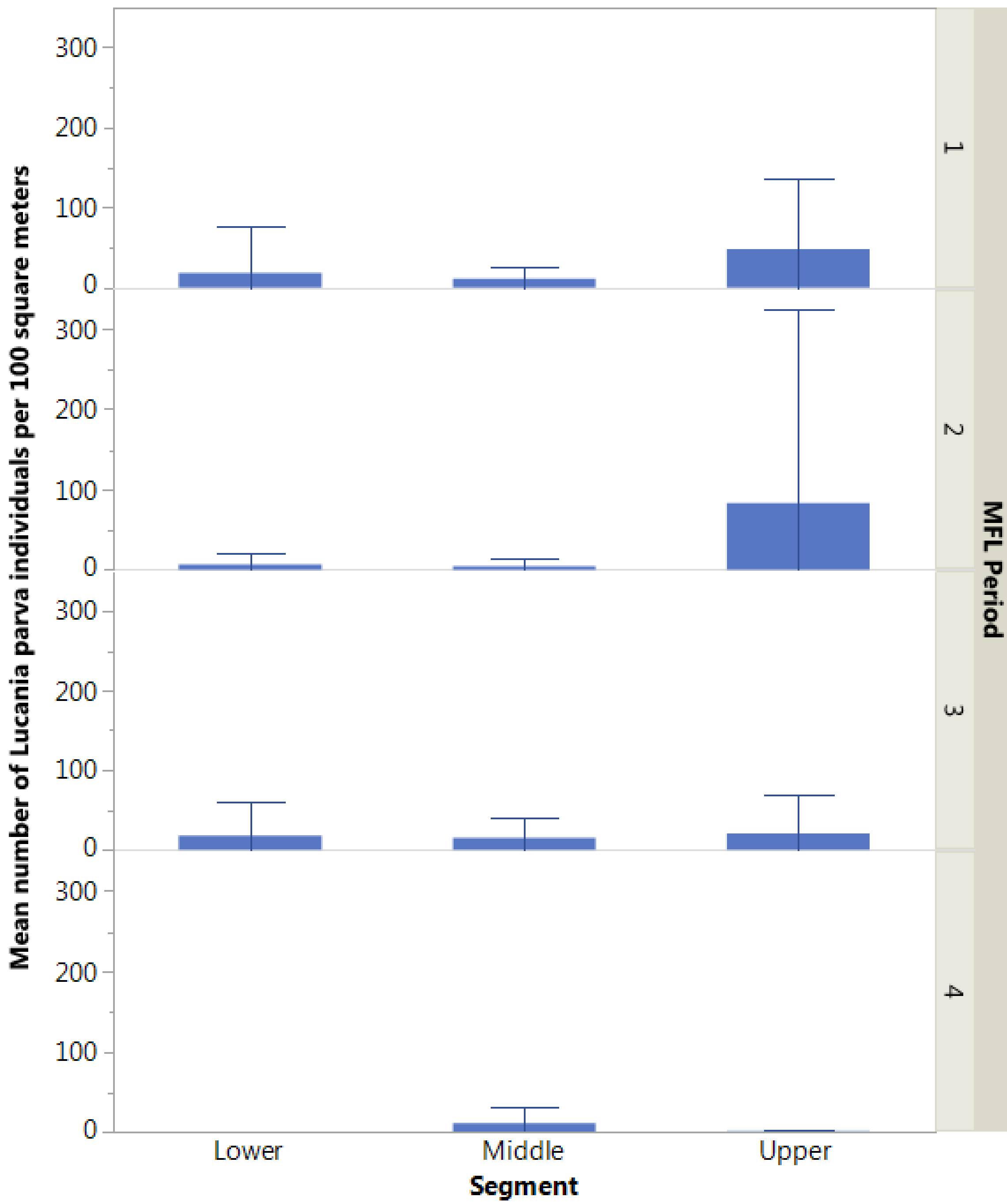


Figure 6.2-12 Mean (error bars represent standard deviation) densities of *Lucania parva* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Poecilia latipinna, the sailfin molly, was most abundant in in the first MFL period and less common in the subsequent MFL periods with only one individual found in the 2018 sampling. In the first three MFL periods, the species was found in all three river segments (Figure 6.2-13). These live-bearing fish are tidal river residents, found in fresh and brackish water (MacDonald et al. 2005; Robins et al. 2018).

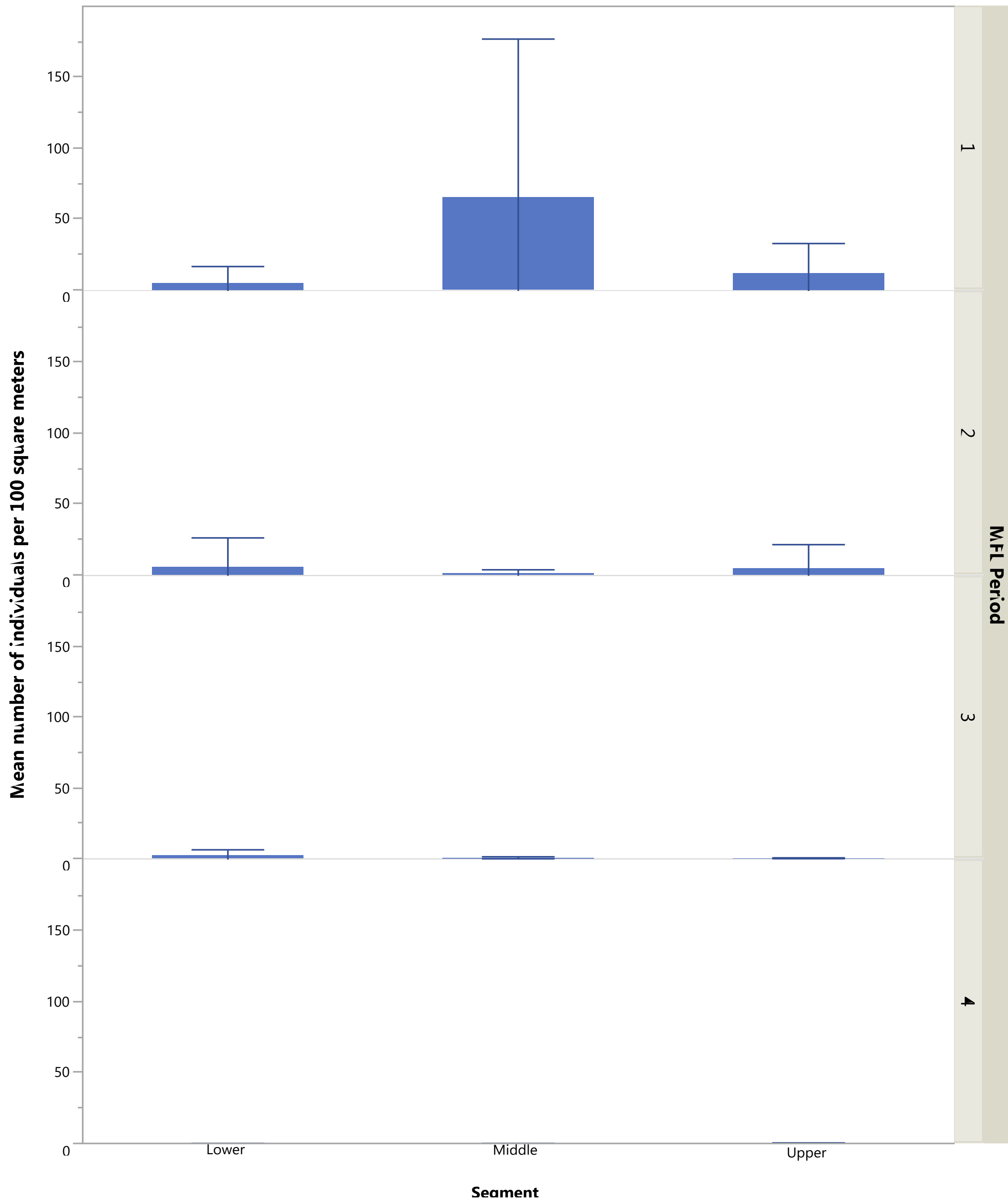


Figure 6.2-13 Mean (error bars represent standard deviation) densities of *Poecilia latipinna* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Cyprinodon variegatus, the sheepshead minnow, was found in the first three MFL periods (in about half the seine samples), but not in 2018 (Figure 6.2-14). The mean abundances appear to have been highest in the second MFL period after a minimum flow was established, but before it was increased. A tidal river resident, this species tolerates a range of salinities, but prefers areas with little to no current (MacDonald et al. 2005; Kells and Carpenter 2011; Robins et al. 2018).

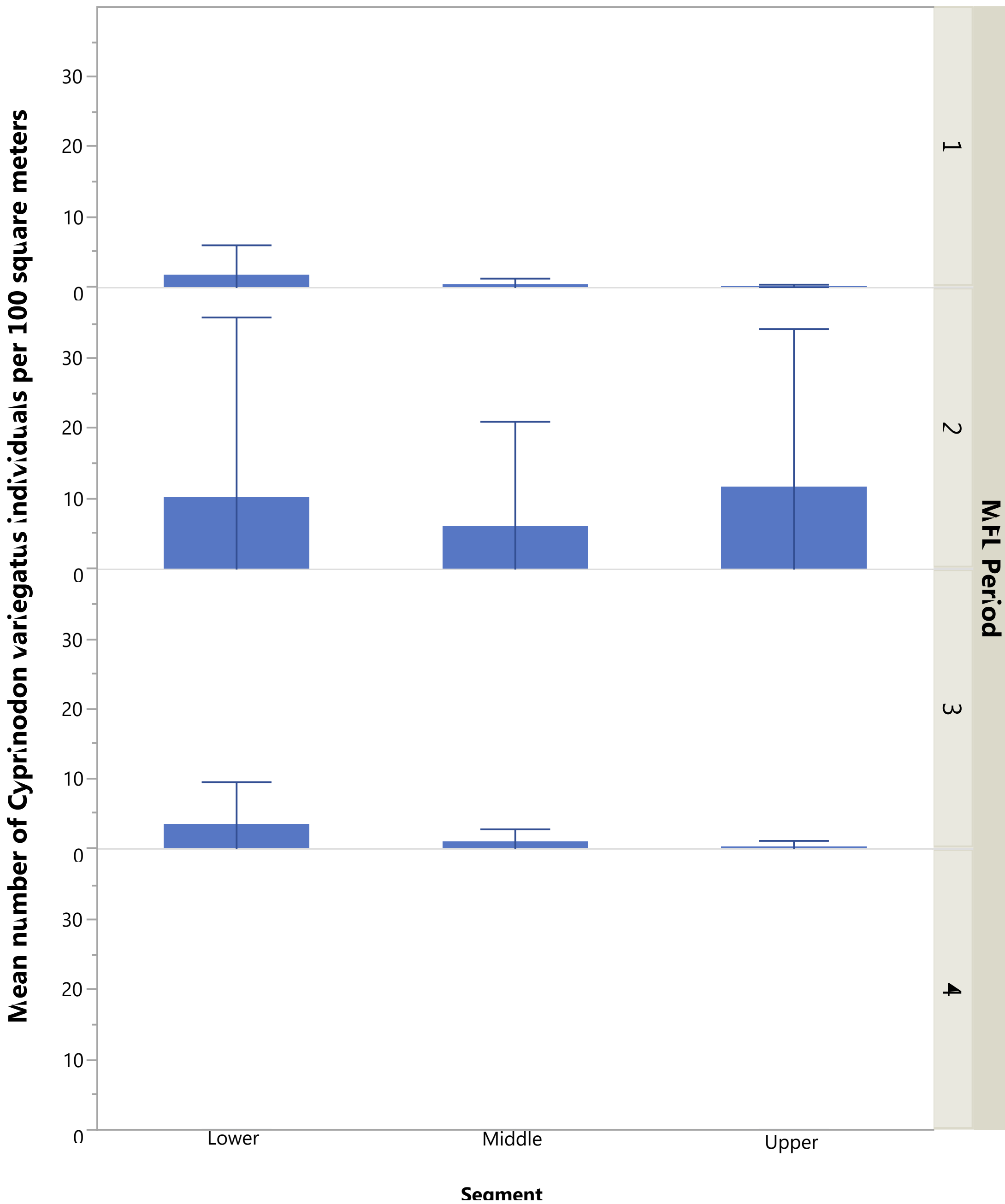


Figure 6.2-14 Mean (error bars represent standard deviation) densities of *Cyprinodon variegatus* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

The striped mullet, *Mugil cephalus*, a schooling fish, was found during all four MFL periods (Figure 6.2-15). These marine fish spawn in the ocean but enter rivers. In all four periods, striped mullet were most abundant in the lower river segment.

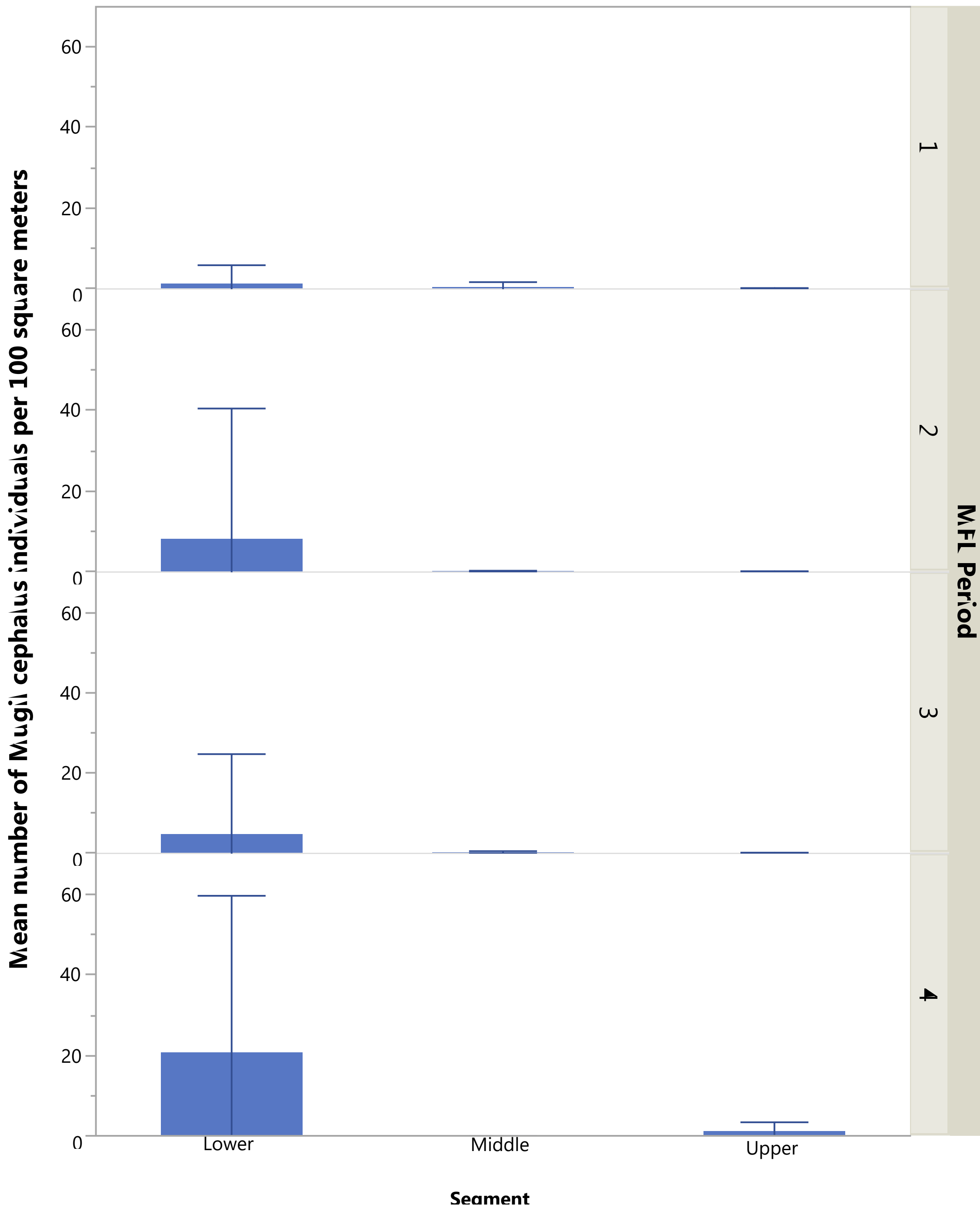


Figure 6.2-15 Mean (error bars represent standard deviation) densities of *Mugil cephalus* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

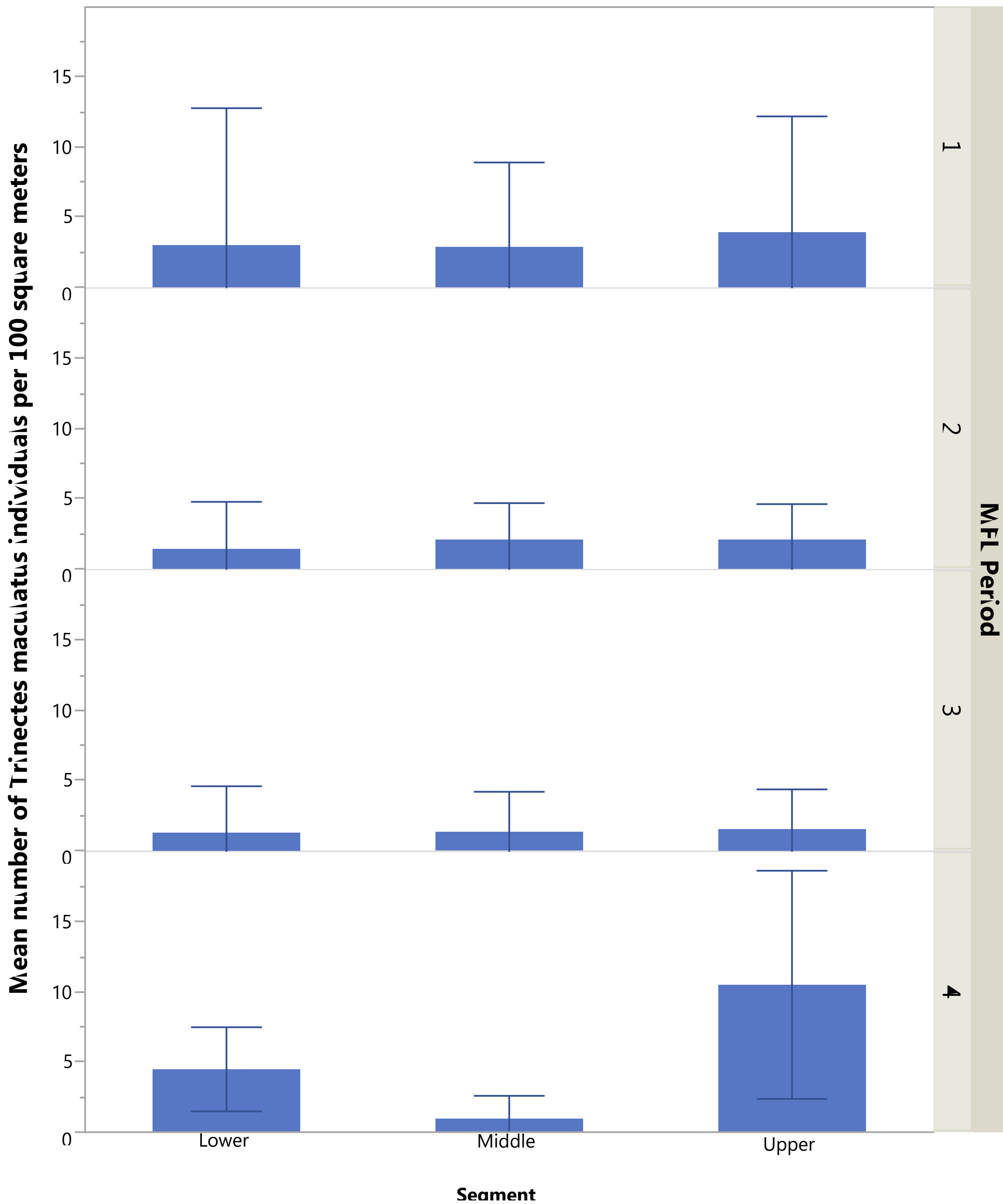


Figure 6.2-16 Mean (error bars represent standard deviation) densities of *Trinectes maculatus* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Trinectes maculatus, hogchoker, was found during all four MFL periods in all river segments (Figure 6.2-16). Considered a marine species, these fish range far inland and are estuarine spawners (MacDonald et al. 2005 and Robins et al. 2018). The presence of flatfishes may indicate adequate benthic basal resources and the absence of severe eutrophic effects (Moreno et al. 2000).

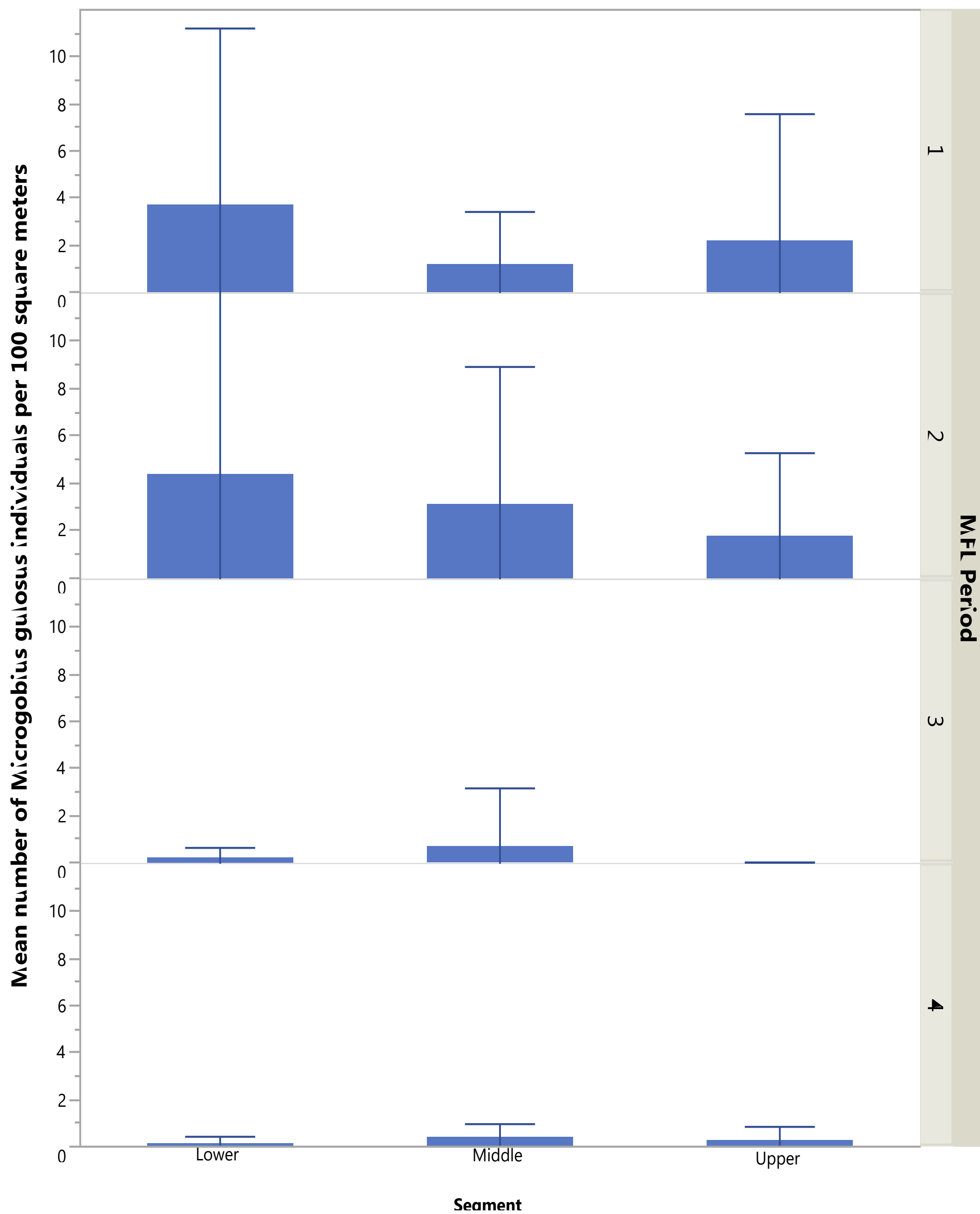


Figure 6.2-17 Mean (error bars represent standard deviation) densities of *Microgobius gulosus* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Microgobius gulosus, the clown goby, appears to have become less abundant after the first two MFL periods when minimum flows were adjusted to the current level. This species can be resident in tidal rivers and tolerates a range of salinities in low-energy habitats (MacDonald et al. 2005; Kells and Carpenter 2011; Robins et al. 2018).

Fundulus seminolis, the Seminole killifish, a species endemic to Florida, increased in abundance after the first MFL period (Figure 6.2-18). It occupies quiet areas of fresh to brackish water (Robins et al. 2018).

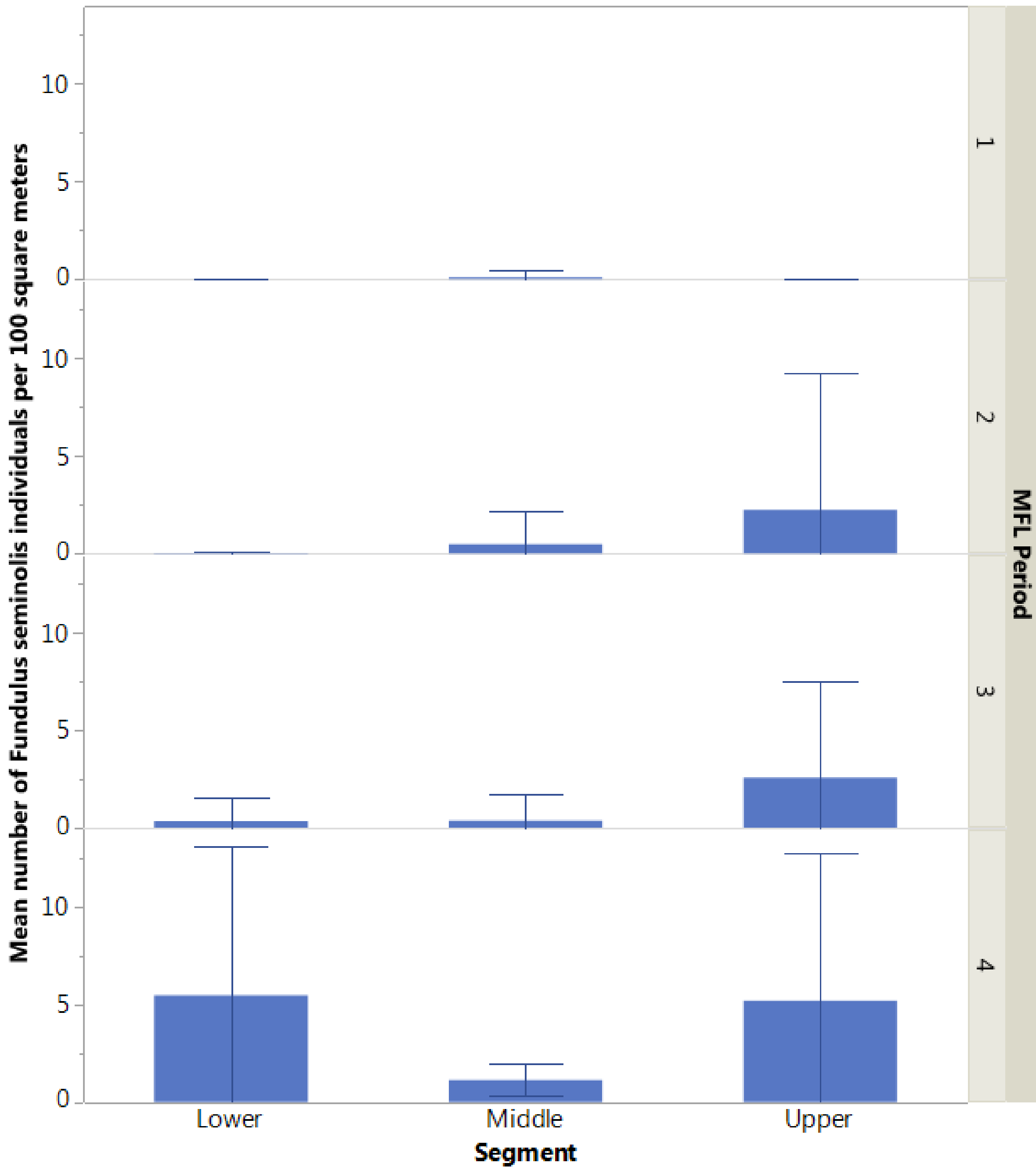


Figure 6.2-18 Mean (error bars represent standard deviation) densities of *Fundulus seminolis* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Micropterus salmoides, largemouth bass, is a freshwater gamefish (found in tidal rivers) that became more abundant after minimum flows were implemented and was more prevalent in the upper and middle river segments (Figure 6.2-19). The specimens caught by Water & Air during the 2018 sampling were usually juveniles.

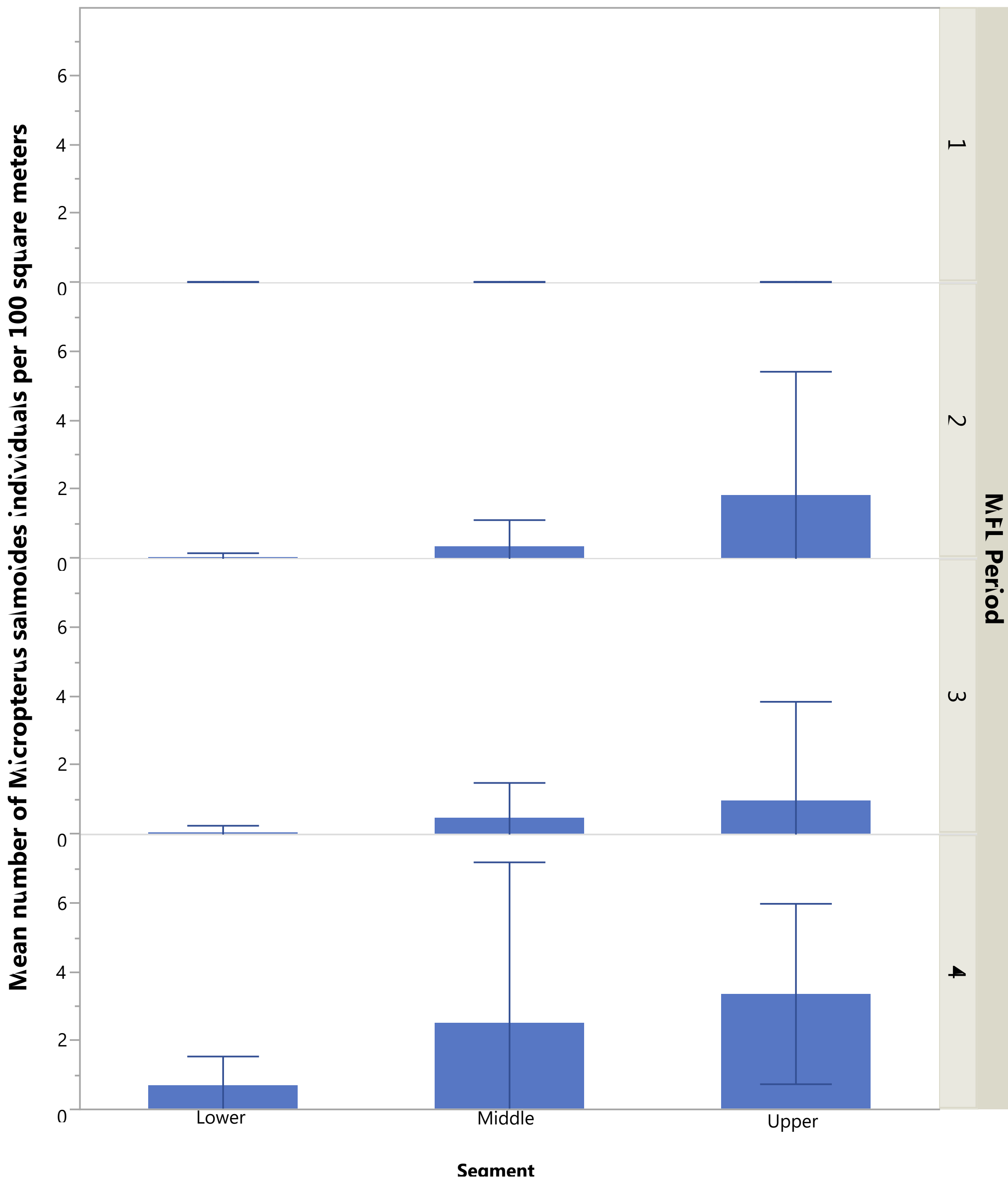


Figure 6.2-19 Mean (error bars represent standard deviation) densities of *Micropterus salmoides* individuals per 100 m^2 of river bottom found in nekton samples (seine net catches) by MFL period and river segment.

Changes in the distribution and abundance of some fish species appear to have occurred following the initial implementation of a minimum flow in 2002 and when the minimum flow was increased in 2008 to the current level. In general, over the three MFL periods, a reduction in the abundance of some marine taxa and increase in some freshwater taxa (e.g. largemouth bass) appear to have occurred. This is likely related to changes in the salinity of the study area. A previous study in this same area of the Hillsborough River reported changes in the distribution of freshwater-oligohaline taxa in fyke net samples (Catalano et al. 2006) and found, consistent with this study, no impact on taxon/species richness with changes in flow. As noted in SWFWMD and Atkins (2015), some of the largest reductions in mean numbers were in estuarine/marine baitfish taxa.

6.3 Benthic Macroinvertebrate Results

The benthic macroinvertebrate community was found to be significantly different between MFL periods with a two-way crossed (MFL period and river segment) ANOSIM test (Average R test statistic value of 0.339, p = 0.001). In pairwise tests between MFL periods only MFL periods 2 and 3 were not significantly different from each other (Appendix 6.3-1). In pairwise comparisons of river segment the only significant difference was between the Lower and Upper segments (R = 0.399, p = 0.002; Appendix 6.3-1; Figure 6.3-1).

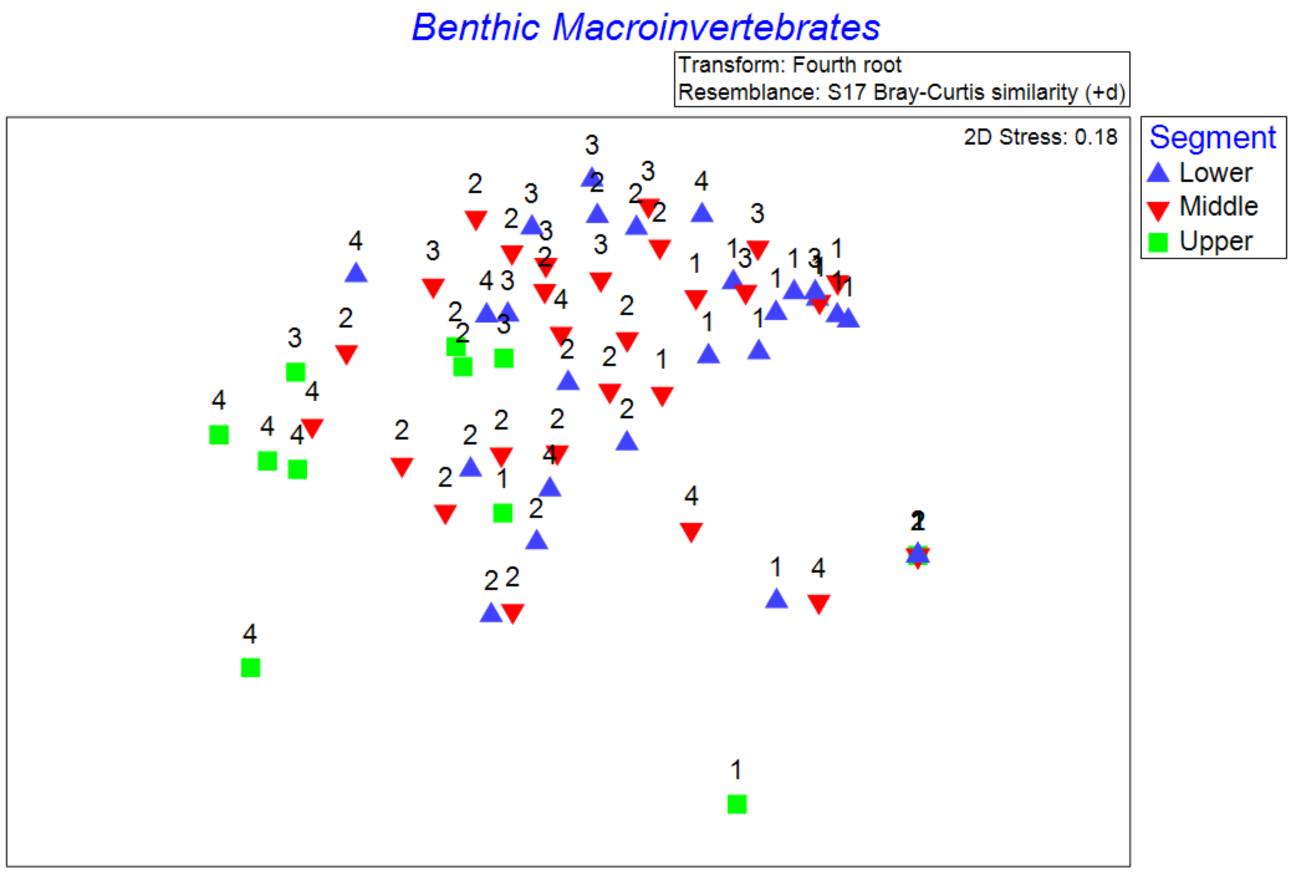


Figure 6.3-1 Non-metric multidimensional scaling (nMDS) plot of benthic invertebrate dredge sample similarity (zero-adjusted Bray-Curtis similarity matrix of fourth-root transformed macroinvertebrate densities by taxon as number of individuals per m^2). Each symbol in the plot represents a single dredge sample; samples close together in the plot had similar community composition. Samples were collected during the HBMP program (2000 – 2009) and by Water & Air in 2018. A total of 112 taxa contributed to this analysis. Number labels represent the MFL

period the sample was collected during, while symbols represent which river segment the sample was collected from.

The density of organisms found in the dredge samples was different between the MFL periods, with fewer organisms found before the MFL was implemented, in MFL Period 1 (Figure 6.3-2, Appendix 6.3-2). Spearman's rank correlation test found a significant correlation between (the categorial variable of) MFL period and the total density of macroinvertebrate organisms in the samples ($r_S = 0.5400$, $p = 0.0001$, Table 6.3-1). Taxon richness ($r_S = 0.6035$, $p < 0.0001$) and Shannon Index ($r_S = 0.5264$, $p < 0.0001$) were also significantly correlated with MFL period (Table 6.3-1, Figures 6.3-2 and 6.3-3).

Table 6.3-1 Spearman's rank correlation coefficients (associated *p*-value below) for macroinvertebrate diversity measures and water quality data collected near the bottom concurrently with dredge sample collection (Bottom DO = dissolved oxygen concentration in mg/L; salinity was measured in ppt).

	MFL Period	**Total # Organisms per m^2**	**Bottom DO**	**Bottom Salinity**	**Taxon Richness**
MFL Period					
***p-* value**					
Total # Organisms/m2	0.5400				
***p-* value**	< 0.0001				
Bottom DO	0.2610	0.4947			
***p-* value**	0.0291	<.0001			
Bottom Salinity	-0.3001	-0.4196	-0.6042		
***p-* value**	0.0116	0.0003	< 0.0001		
Taxon Richness	0.6035	0.8678	0.5086	-0.4456	
***p-* value**	< 0.0001	<.0001	< 0.0001	0.0001	
Shannon Index	0.5264	0.6393	0.4215	-0.4632	0.8651
***p-* value**	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001

Spearman's rank correlation test found a significant correlation between MFL period and dissolved oxygen near the bottom ($r_S = 0.2610$, $p = 0.0291$, Table 6.3-1 and Figure 6.3-5). Salinity near the bottom was also correlated with MFL period ($r_S = 0.3001$, $p = 0.0116$; Table 6.3-1 and Figure 6.3-5).

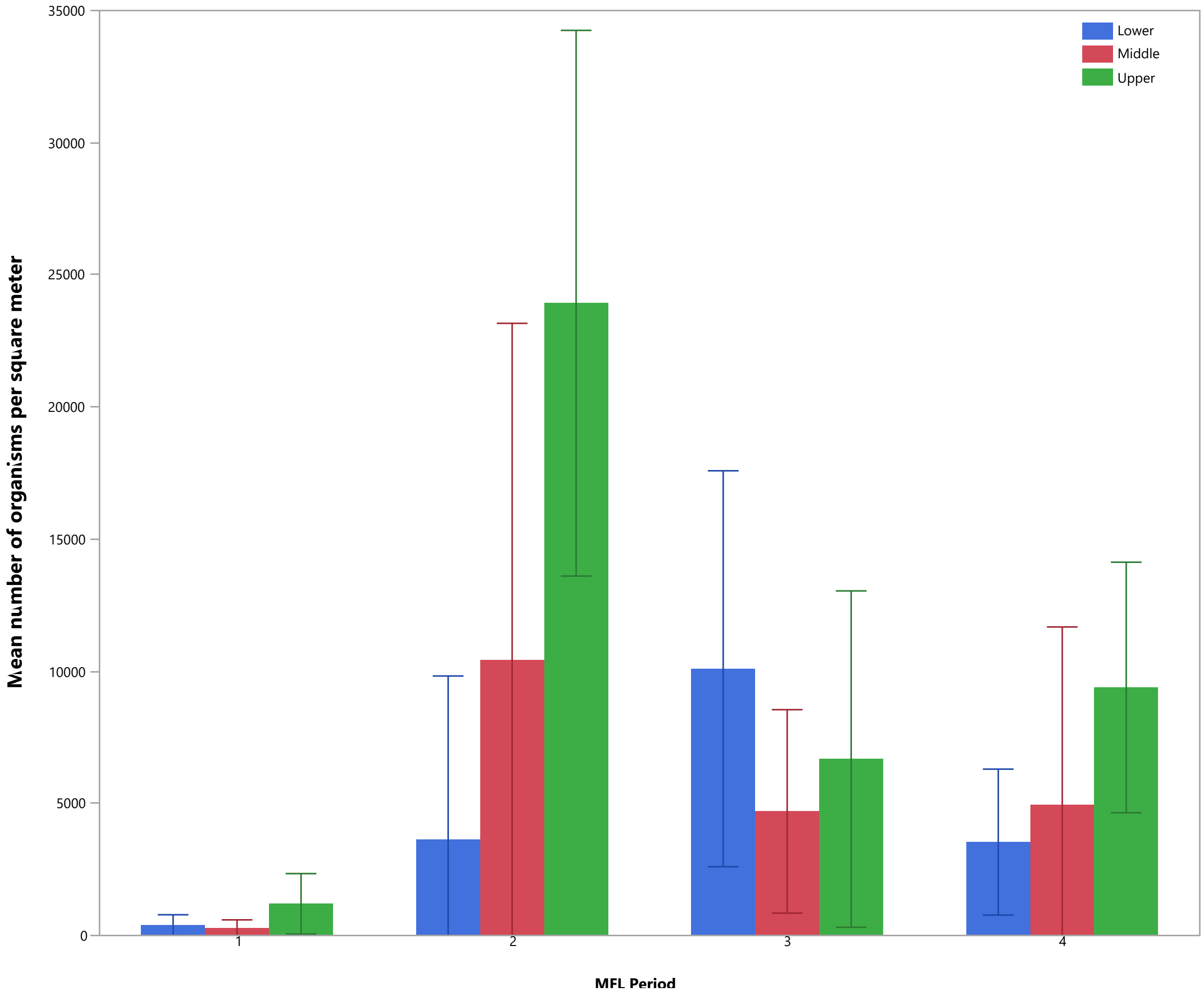


Figure 6.3-2 Mean (error bars represent standard deviation) density of benthic macroinvertebrates per MFL period by river segment.

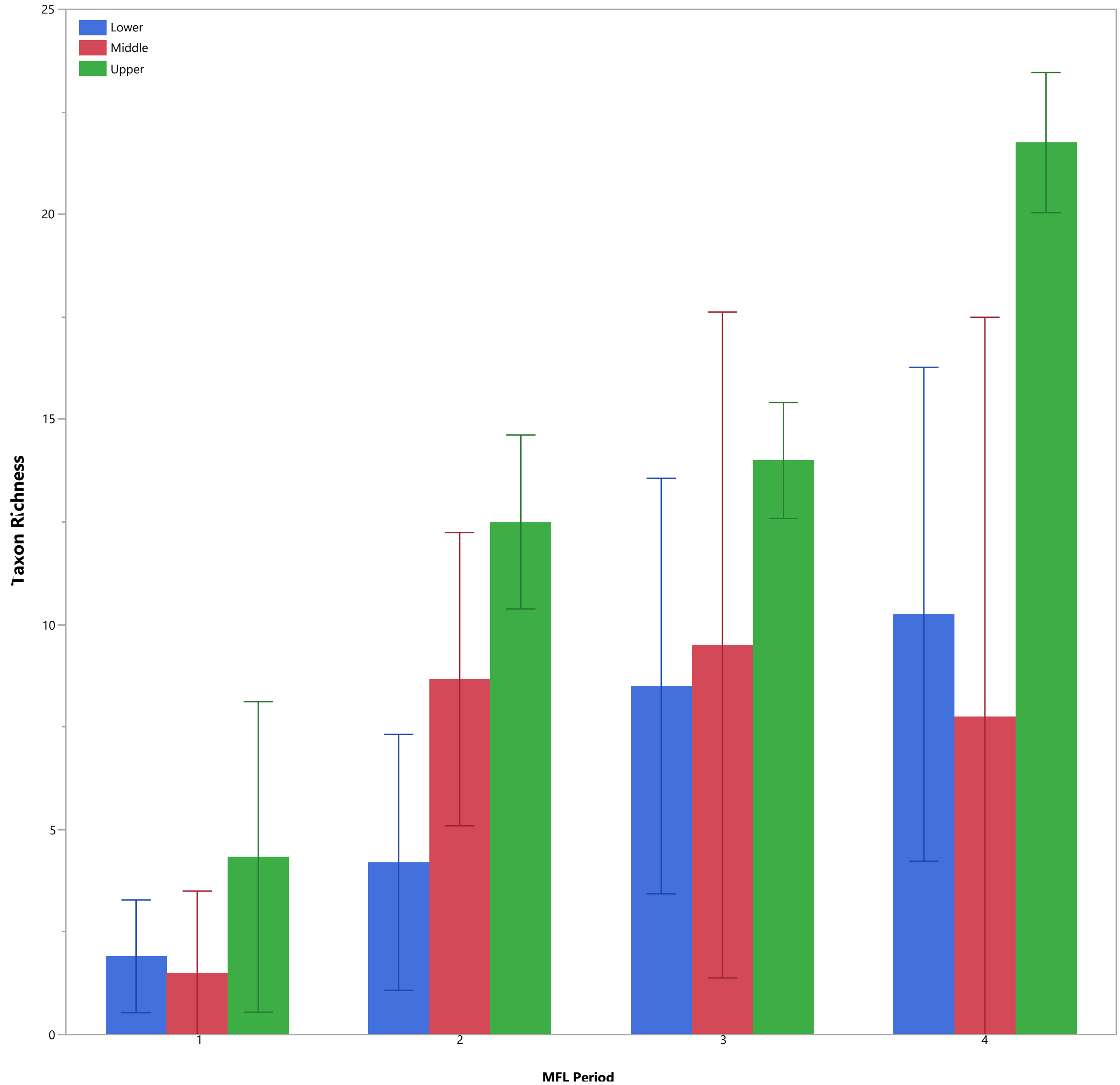


Figure 6.3-3 Mean (error bars represent standard deviation) taxonomic richness of benthic macroinvertebrates in a single dredge sample by MFL period and river segment.

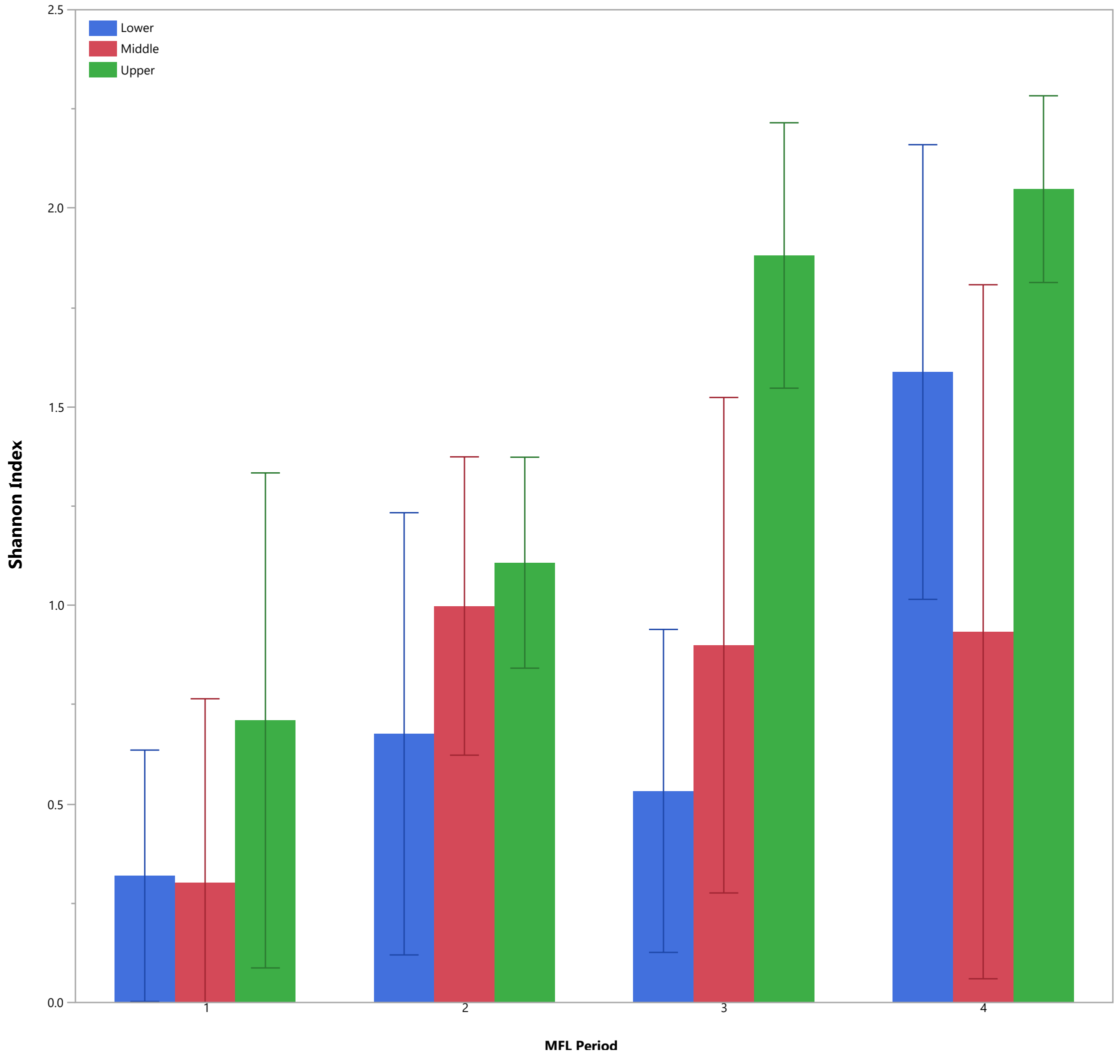


Figure 6.3-4 Mean Shannon index value (error bars represent standard deviation) for benthic macroinvertebrate communities in dredge samples by MFL period and river segment.

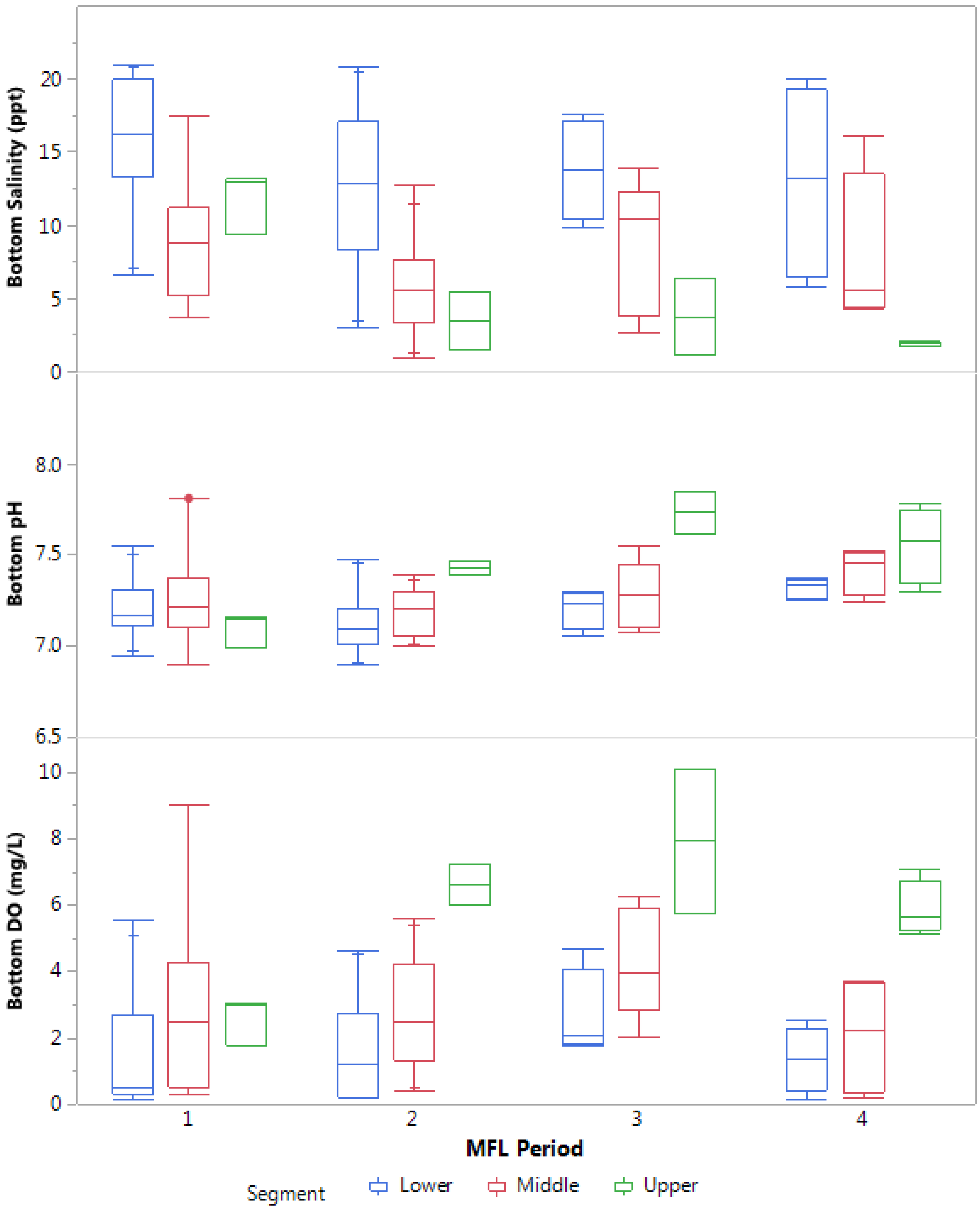


Figure 6.3-5 Boxplots of three water quality measures (DO = dissolved oxygen concentration) collected near the bottom by MFL period and river segment.

SIMPER analysis examined the extent to which different macroinvertebrate taxa contributed to the difference and similar between samples from the four MFL periods and the three river segments (Appendix 6.3 C). Some of the species that consistently were important to the similarity or dissimilarity among sample groups also showed interesting patterns of abundance.

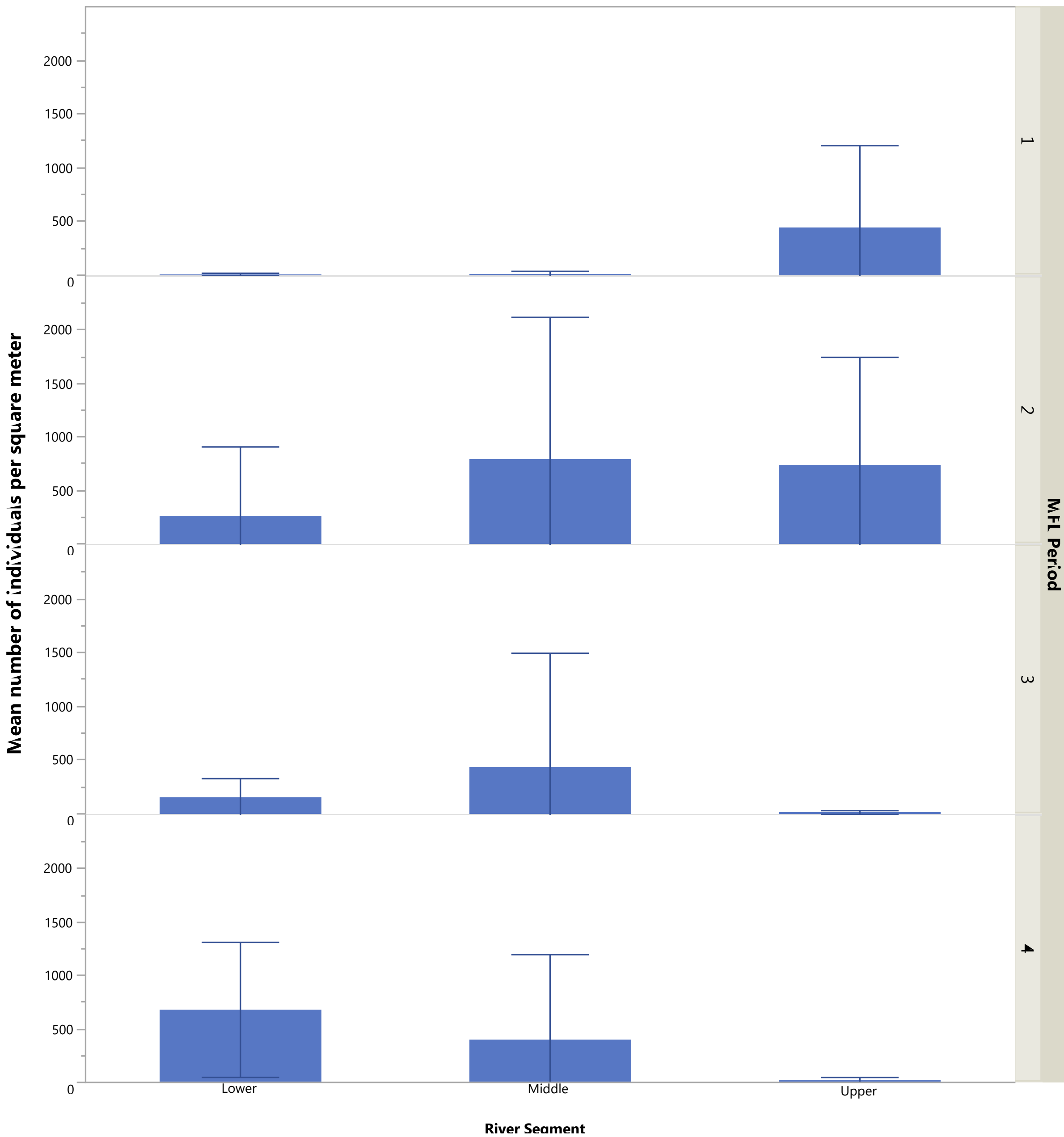


Figure 6.3-6 Mean (error bars represent standard deviation) densities of *Laeonereis culveri* individuals found in benthic dredge samples by MFL period and river segment.

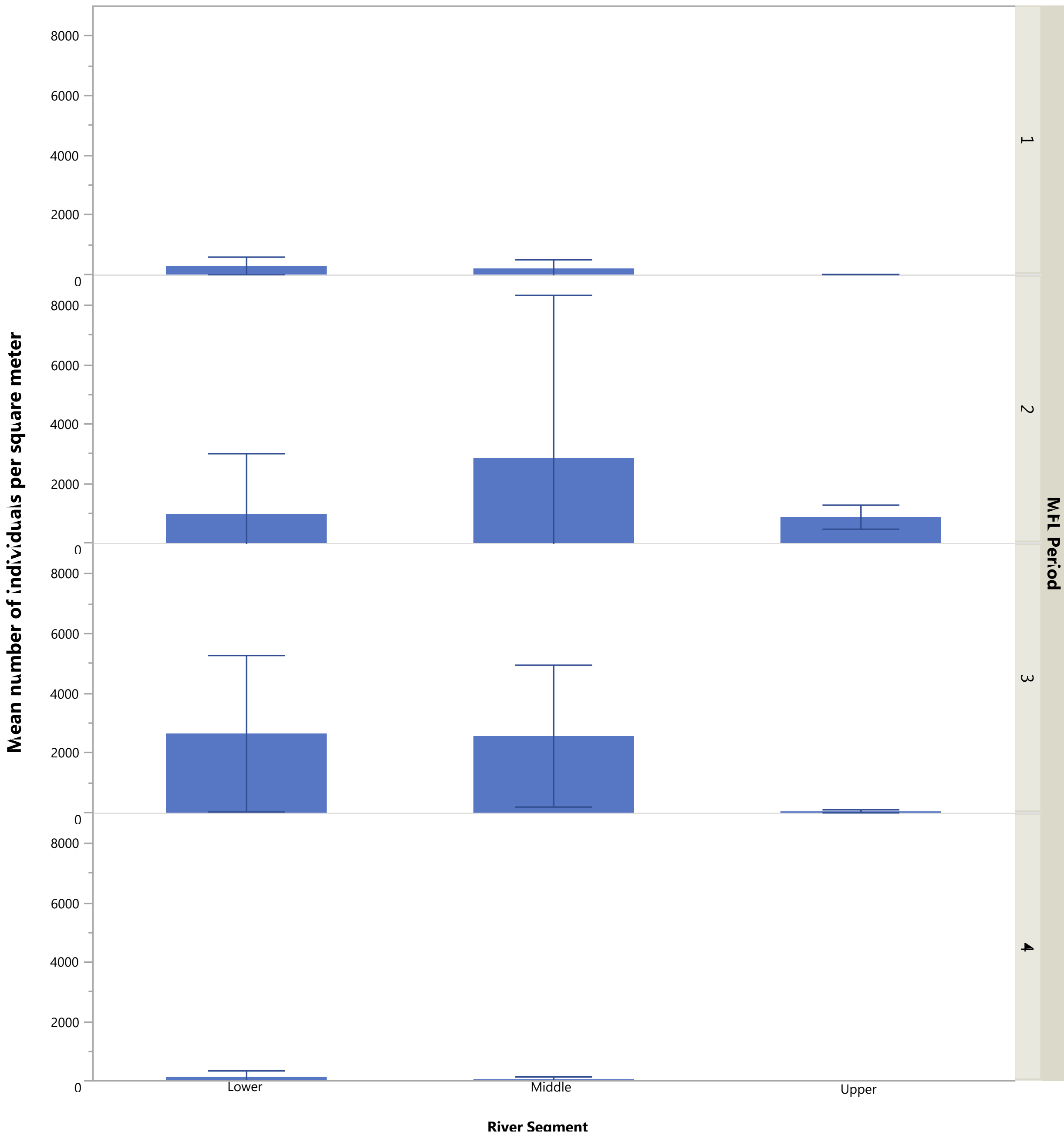


Figure 6.3-7 Mean (error bars represent standard deviation) densities of *Stenoninereis martini* individuals found in benthic dredge samples by MFL period and river segment.

A polychaete, *Laeonereis culveri*, was present before the MFL was implemented mainly in the Upper segment, but after some minimum flow was established, it became prevalent in other parts of the study area. After minimum flows were increased (MFL periods 3 and 4), it appears to have become distributed mainly in the downstream portion of the study area. Polychaetes are generally marine organisms. Possibly consistent low salinity in the area closer to the dam has affected its distribution. *Laeonereis culveri* is known to tolerate a range of salinities and is often associated with sandy substrate with sand grains often found in the guts of these worms (Heard 1979).

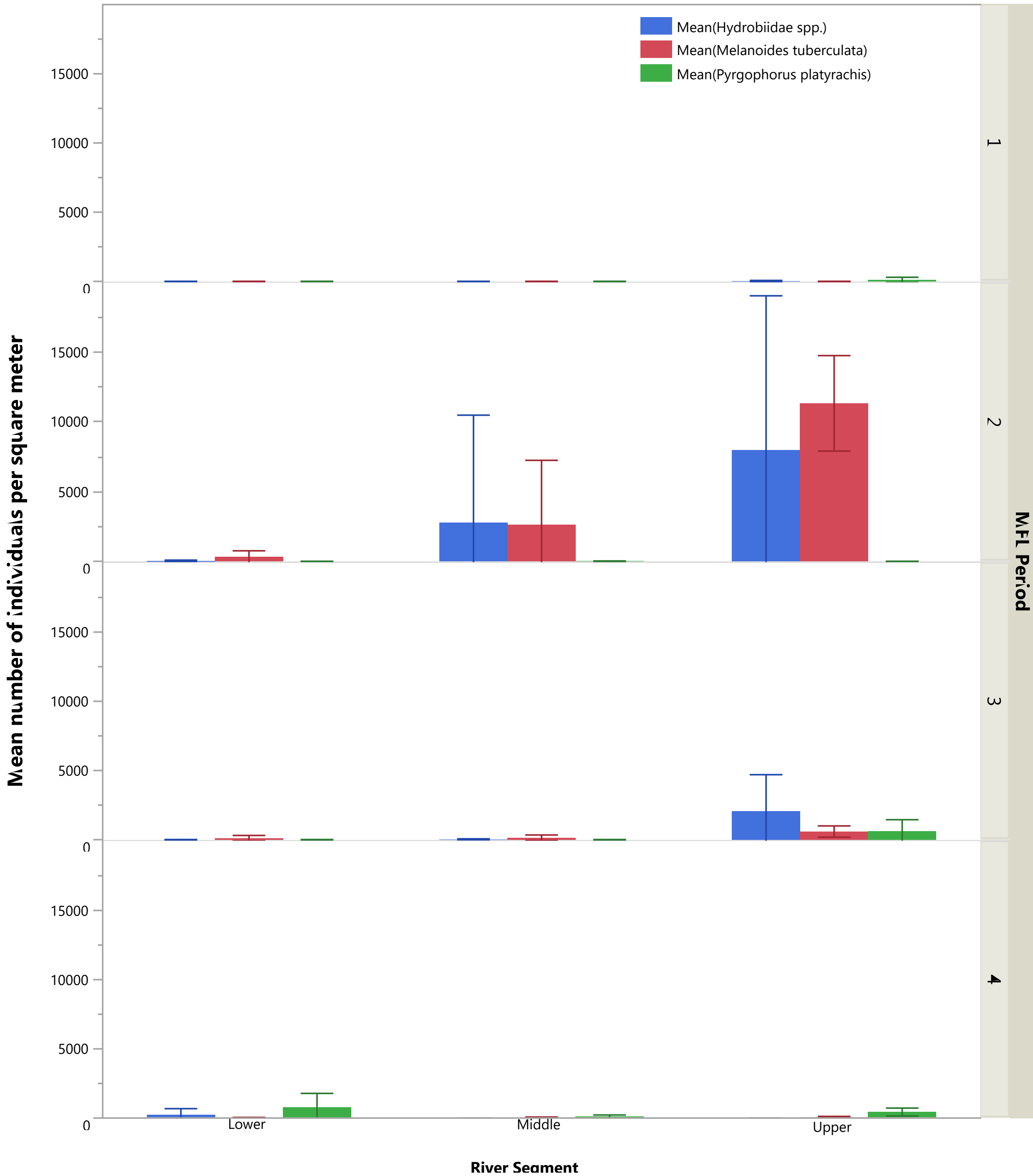


Figure 6.3-8 Mean (error bars represent standard deviation) densities of three snail taxa found in benthic dredge samples by MFL period and river segment.

Another polychaete, *Stenoninereis martini*, also seemed to have drastically reduced densities in the Upper segment after minimum flows were increased (Figure 6.3-7). Generally, this taxon is associated with silt and mud bottoms and is known to tolerate a range of salinities and low DO (Heard 1979).

The snail taxa *Melanoides tuberculata, Pyrgophorus platyrachis*, and hydrobiid snails identified to the family level were at very low densities before a minimum flow was implemented (MFL Period 1). These populations appear to have bloomed in the Middle and Upper segments after the implementation of 10 cfs supplied from Sulphur Springs and then dropped to lower densities following the implementation of higher minimum flows. The non-native gastropod, *Melanoides tuberculata*, tolerates a wide range of salinities (Farani 2015) and thus changes in its abundance in the LHR may relate to the availability of benthic resources or DO concentration. Similarly, *Pyrgophorus platyrachis,* a hydrobiid snail, is known from fresh and brackish environments (Heard 1979). Both freshwater and estuarine species of gastropods from the family Hydrobiidae are present in Florida (Heard et al. 2002), thus any changes in the abundance of these snails over the different MFL periods probably cannot be linked to salinity changes due to a lack of taxonomic resolution.

7.0 Summary and Conclusions

The objective of this report is to evaluate the impacts and effects of minimum flows implemented for the LHR. Specifically, the report assesses the effects of the LHR recovery strategy on water quality and quantity both above and below the Hillsborough River Dam for the current hydrobiological assessment period, defined as October 1, 2012 through May 31, 2018.

Minimum flow and recovery strategy rules were first developed for the LHR in 2000. Both were substantially revised in 2007, and minor formatting changes to the recovery strategy rule were made in 2014. The current minimum flows for the LHR (Rule 40D-8.041(1), F.A.C.) are based on extending a salinity range of less than 5 ppt from the Hillsborough River Dam toward Sulphur Springs. The current recovery strategy for the LHR (Rule 40D-80.073(8), F.A.C.) provides detailed project information, timetables for project implementation and reporting requirements intended to support recovery and maintenance of the minimum flows established for the river.

The recovery strategy requires the District to evaluate the hydrology, DO, salinity, temperature, pH, and biologic results or effects achieved from implementation of the recovery strategy for the prior five years including the duration, frequency, and impacts of the adjusted minimum flow as described in Paragraph 40D-8.041(1)(b), F.A.C. As part of the evaluation, the District will assess the recording systems used to monitor these parameters. The District shall also monitor and evaluate the effect the recovery strategy is having on water levels in the Hillsborough River above the City's dam to at least Fletcher Avenue. The District will evaluate the projects described in this recovery strategy relative to their potential to cause unacceptable adverse impacts prior to their implementation. These requirements are discussed in this report.

The implementation of the LHR recovery strategy identifies several water resource projects, their order of priority for development and use as sources for river recovery, and for most, the quantities of water that the projects/sources can or are expected to provide to recover and maintain the established minimum flows. These projects are listed below.

1) Sulphur Springs, involving lower weir modifications and Sulphur Springs pool upper weir and pump station modifications, to supply water up to 18 cfs (has provided supplemental water to the LHR since the mid-1960's with system modifications in 2012);

2) Blue Sink – analysis shows it can supply up to 3.1 cfs (brought online in March 2018);

3) Tampa Bypass Canal and Hillsborough River Reservoir - diversions to supply up to 11 cfs (has provided supplemental water to the LHR since 2008);

4) Morris Bridge Sink - to supply water up to 6 cfs (permitted – not currently in use);

5) Transmission pipeline evaluation (per Chapter 40D-8.073[8][b][2]) (completed (SWFWMD 2018)); and

6) Investigation of water storage or additional water supply options – TAP up to 50 mgd for minimum flow supplementation with unspecified allocations for minimum flow purposes (feasibility analysis by the City currently underway).

7.1 Hydrology

The current minimum flows rule specifies a flow of 20 cfs of freshwater equivalent at the base of the reservoir dam from July 1 through March 31 and 24 cfs from April 1 through June 30. The total volume of water required to meet minimum flows is to be augmented by a fresh water equivalent factor, originally determined to be 3 cfs but now under further evaluation by the District. These flow requirements are adjusted per the recovery strategy rule based on a proportionate amount that flow in the Hillsborough River at the USGS gage near Zephyrhills is below 58 cfs. Water flow below the dam including supplemental augmentation data is assessed by year in table 7.1-1 below.

Table 7.1-1 Water flow below the dam, including minimum flow supplementation, assessed by year. Based on providing a minimum flow of 20 or 24 cfs (does not include freshwater equivalent factor).

Year	Assessment Period Days	Missing Data Days	Days Supp. Aug. Needed	Percentage Supp. Aug. Needed Days	Percentage of Supp. Aug. Days w/ Deficit	Mean Deficit (cfs) ± S.E.			Deficit Range (cfs)	Days Min. Flow Achieved	Days Min. Flow Not Achieved
2012	92	0	29	31.5	3.4	-0.2	±	0.0	-0.2	91	1
2013	365	1	165	45.3	21.8	-2.2	±	0.4	-14.4 to -0.1	328	36
2014	365	4	48	13.3	47.9	-5.0	±	0.6	-12.2 to -0.4	338	23
2015	365	27	55	16.3	94.5	-6.5	±	0.5	-23.2 to -1.0	286	52
2016	366	15	104	29.6	34.6	-4.2	±	0.5	-10.5 to -0.2	315	36
2017	365	5	197	54.7	31.0	-3.3	±	0.4	-15.0 to -0.1	299	61
2018	151	0	109	72.2	22.9	-1.3	±	0.2	-6.4 to -0.1	126	25

Note that for 2018, minimum flow implementation was generally sufficient to meet minimum flow requirements of 20 and 24 cfs. However, additional flow originally identified in the LHR recovery strategy necessary to meet the freshwater equivalent (3 cfs) was not achieved 60 percent of the time (days) for the period from January 01, 2018 through May 31, 2018. The 2018 pumping data indicates that the mean deficit for these days when the minimum flow was not achieved was by an average of 2.3 cfs. Additional small deficits occurred in early 2018 due to a miscommunication between the City and the District regarding minimum flow supplementation pumping responsibilities and volume determinations. This was during a period when pump ownership at the dam and S-161 was being transferred from the District to the City. A review of missing data periods for 2014 through 2017 indicates that these missing data were due to equipment problems and equipment maintenance when pumps were offline.

Now that minimum flow pumping responsibilities at Structures S-161, S-162, the dam, Sulphur Springs and Blue Sink are aligned with those specified in the recovery strategy, and Blue Sink has been brought online as a minimum flow supplementation resource it is expected that minimum flow targets, including the freshwater equivalent, are more likely to be achieved over the next five year evaluation cycle.

All activities and projects proposed in the recovery strategy are either underway, completed, or have been determined not to be viable (in the case of the transmission pipeline). Acquisition of necessary permits and other unforeseen issues have delayed construction and full implementation of some recovery strategy projects. However, important components of the recovery strategy are currently in operation (Sulphur Springs, Blue Sink, and the TBC) or are potentially available (Morris Bridge Sink) as minimum flow recovery sources.

7.2 Water Quality

7.2.1 Discharge Rate and Water Quality

Investigation of relationships between LHR discharge and various water quality parameters suggested that when flows over the dam were > 1 cfs, concentrations of orthophosphate, total nitrogen, and total phosphorus also increase, possibly due to increased land surface runoff. Increased water color values when flows over the dam were > 1cfs may be related to an increase in turbidity associated with increased land surface runoff, and/or due to an increase in tannic water from increased water flow from the Green Swamp in the portion of the river's watershed. Conversely, salinity in the study area appeared to decrease when flows over the dam were > 1 cfs, likely due to dilution of LHR water by freshwater from above the dam. Dissolved oxygen (concentration and percent saturation), and pH also appeared to decrease when flows over the dam were > 1 cfs, possibly due to increased nutrient levels with the addition of water from behind the dam.

7.2.2 Minimum Flow Periods and Water Quality

Four minimum flow implementation periods (i.e., MFL periods) were used for water quality assessments. The MFL periods and data exclusions were defined as:

- MFL Period 1 - No minimum flow rule in place: October 1, 1979 to February 28, 2002;
- MFL Period 2 – MFLs requiring 10 cfs from Sulphur Springs in place: March 1, 2002 to December 31, 2007;
- MFL Period 3 – MFLs requiring 20 or 24 cfs freshwater equivalents (adjusted for Hillsborough River flow at Zephyrhills) from Sulphur Springs and dam (TBC/reservoir) releases in place: January 1, 2008 to September 30, 2012 (previous hydrobiological assessment period); and
- MFL Period 4 – MFLs requiring 20 or 24 cfs freshwater equivalents (adjusted for Hillsborough River flow at Zephyrhills) from Sulphur Springs, Blue Sink, and dam (TBC/reservoir) release: October 1, 2012 to May 31, 2018 (current 5-year assessment period).

Significant differences in the water quality variables between minimum flow implementation periods (i.e., MFL periods) occurred at a few locations throughout the Hillsborough River. These sites include 1) East Fowler Avenue (above the dam), 2) Rowlett Park Drive and Sligh Avenue (just downstream of the dam and within the biological assessment study area), 3) Sulphur Springs tributary, and 4) West Platt Street (at the mouth of the river). These differences in water quality remained unchanged both with flow and without flow at the dam.

Data were available for the middle locations of Hanna's Whirl and North 12th Street only for January 2009 to May 2018 (representing MFL periods 3 and 4), whereas data for East Fowler Avenue, Rowlett Park Drive, and West Platt Street were available from October 1979 through May 2018 (representing MFL periods 1 through 4), and data for Sligh Avenue were available from August 1999 through May 2018 (representing MFL periods 1 through 4). The water quality variables for MFL period 1 differed significantly from those for MFL periods 2, 3, or 4 in 82 comparisons. The variables for MFL period 2 differed significantly from those for MFL periods 3 or 4 in 31 comparisons, and MFL period 3 was significantly different from MFL periods 4 for 7 comparisons (2 at West Platt Street and 5 at Sulphur Springs). Thus, the water quality variables for MFL period 1 with no minimum flow rule in place were often significantly different compared to MFL periods 2, 3, and 4 with minimum flow rules. The water quality variables response to the MFL period 2 minimum flow rule was not equivalent to their response during MFL periods 3 and 4 minimum flow rule. During MFL periods 3 and 4 the water quality variables were very equivalent in their response, meaning that there does not appear to be a significant difference in water quality between the first and second 5-year assessment periods. Note that these two MFL periods have the same minimum flow rule. Variations in salinity, DO, and nutrients are discussed in more detail below.

7.2.2.1 Salinity

As expected, salinity increased from upstream to downstream (i.e. towards the bay) in the LHR (as measured at the stations included in this report). Due to salinity incursions from the mouth of the river, it is not surprising that salinity was higher during all MFL periods at all of the stations when freshwater discharge was not occurring at the dam. With the implementation of minimum flow requirements and the recovery strategy, the increase in freshwater flows have resulted in lower salinities. More specifically, salinity was significantly lower during MFL periods 2, 3, and 4 as compared to MFL period 1 (Figure 7.2-1).

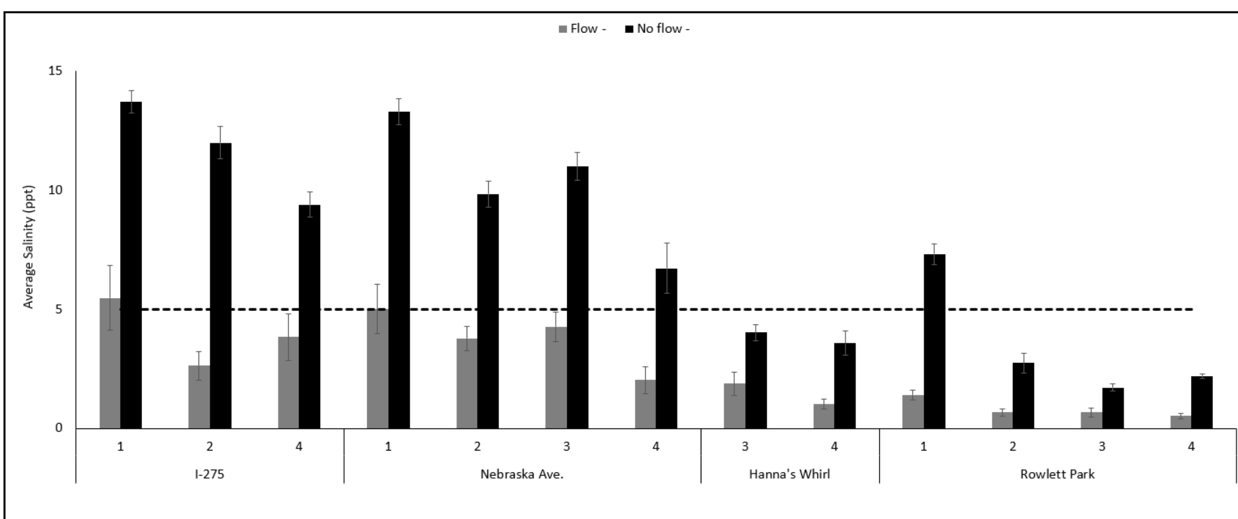


Figure 7.2-1. Salinity at selected stations below the dam for periods 1, 2, 3, and 4 based upon flow over the dam. No flow periods represent operation of LHR Recovery Strategy projects to reduce salinity below the dam.

Salinity results in the LHR below the dam indicate good progress has been made in establishing a salinity range of less than 5 ppt from the dam towards Sulphur Springs based on the current operation of the recovery strategy projects. Additional analysis will be performed by the District over the next five-year assessment period to determine if the requirements of the LHR recovery strategy and rule have been achieved.

7.2.2.2 Dissolved Oxygen Concentration

DO concentration varied with respect to locations within certain reaches of the Hillsborough River and whether or not flow was occurring at the dam. During times that flow over the dam was < 1 cfs, results show that DO concentration at Rowlett (below the dam) was significantly lower in period 1 then periods 3 and 4. At this location, Period 2 was also significantly lower than Period 4. This indicates an increase in DO concentration with recovery strategy implementation over time in the area just below the dam. During the same conditions, the West Platt station (lower river segment) showed that DO concentration during Periods 2 and 3 were significantly lower than Period 4, indicating an increase in DO concentration with recovery strategy implementation over time in the lower river segment.

7.2.2.3 Nutrients (nitrates/nitrites, total nitrogen, orthophosphate, total phosphorus)

During the time that flow over the dam was < 1 cfs, sites located below the dam that were analyzed generally demonstrated nutrients decreased over time. Nitrate-Nitrite results demonstrate significantly higher values during Periods 1 and 2 then Period 4 at Rowlett (just below the dam). Total Nitrogen results show Period 1 had significantly higher values then Periods 2, 3, and 4 at Rowlett (just below the dam) and West Platt Street (lower river segment). Orthophosphate results show significantly higher values during Period 1 then Period 3 at Rowlett (just below the dam) and West Platt Street (lower river segment). Total Phosphorous results show significantly higher values during Period 1 then Periods 2 and 3 at Rowlett (just below the dam) and West Platt Street (lower river segment).

7.3 Biological Communities

7.3.1 Zooplankton

In general, the primary temporal trend in the plankton-net catch during MFL implementation was an increase in the abundance of a number of zooplankton taxa, with the collective increase in abundance shifting the tidal Hillsborough River's community structure towards that of a spring-dominated estuary. On average 16 percent of trophic-state indicators for the zooplankton assemblage suggested declining conditions, but 42 percent suggested improving habitat conditions. Furthermore, 42 percent of the trophic-state indicators did not show detectable change. The weight of evidence from this analysis suggests habitats within the LHR improved after a minimum flow was implemented.

Because the LHR is used as a nursery habitat by young fishes and crustaceans, high densities of *Clytia* and other gelatinous predators are considered detrimental to the quality of nursery habitat (Purcell 1992, Purcell et al. 1994, Rees and Gershwin 2000). It appears likely that after a minimum flow was implemented the water flowing downstream effectively displaced and dispersed *Clytia* from the upper portion of the LHR, improving habitat quality for other species. The reduction in chaetognath densities after implementation of the MFL is another indication that habitat quality in the LHR was improved by increased freshwater flow during periods without discharge over the dam.

7.3.2 Nekton

The nekton community (under no-flow conditions) was statistically different with respect to species composition and abundance in all comparisons between time periods with different minimum flows. Specifically, the two periods with the current (higher) minimum flows (MFL periods 3 and 4) did not significantly differ in ANOSIM analysis, but all the other pairs were different. Samples from the period before a minimum flow was implemented appear the most different with higher abundances of some taxa (menhaden and grass shrimp), higher salinity in the upper LHR segment (closest to the dam), and the absence (or near absence) of other taxa (largemouth bass and the endemic, Seminole killifish). In general, the dominant taxa were somewhat consistent across all four MFL periods, but their rankings within the most abundant 15 species fluctuated. Earlier MFL periods had significantly higher catch per unit effort, but not higher species diversity or species richness. Higher catch per unit effort was significantly correlated with higher salinity, and decreasing catch was correlated with geographic location (RKm) closer to the dam.

The HBMP collections of nekton with a seine net ended in 2012, and Water & Air was not provided with any data from nekton collections in the study area made after this time (and is not aware if such data exists). The collections made in April and May 2018 provide a snapshot of the nekton community in the river after a decade of minimum flows at the current level. Further sampling of the study area could help confirm if what appear to be positive trends (increasing diversity and richness see Figures 5.2-3 and 5.2-4) hold consistently in the LHR or if they are artifacts of sampling only in the spring. Additional sampling could also provide insight into whether or not taxa that were common in the past (e.g. sheepshead minnow, sailfin molly), but not found in 2018 are still present in the study area. In 2018, a species that had never been documented by the HBMP program (a non-native species, the Mayan cichlid, *Mayaheros urophthalmus*) was found in one of the seine samples. Biannual monitoring (spring and fall) during the next 5-year assessment period would allow a better understanding of the current status of the nekton community in LHR and how it has changed over time.

7.3.3 Benthic Macroinvertebrates

Like the nekton samples, the benthic macroinvertebrate samples showed significant differences between the MFL periods, though in this case, the only two periods that were not significantly different were the second and third periods, which had different mandated minimum flows. However, use of different laboratories for processing the samples may have contributed in part to this effect. Samples from the lower and upper LHR study area segments had significantly different benthic macroinvertebrate communities, likely reflecting different salinity regimes. In contrast to the nekton (or possibly because of being prey for nekton), the density of macroinvertebrates increased after the implementation of minimum flows. Both macroinvertebrate richness and diversity were positively correlated with increasing MFL period (Table 5.3-1).

A polychaete, *Laeonereis culveri,* was present mainly in the upper LHR segment before the MFL was implemented, but after implementation of a minimum flow, it became prevalent in other parts of the study area. After minimum flows were increased (MFL periods 3 and 4), it appears to have become distributed mainly in the downstream portion of the study area. Polychaetes are generally marine organisms, tied to higher salinity conditions; thus, it would be expected that lower salinity in the area closer to the dam has potentially shifted its distribution downstream. Another polychaete, *Stenoninereis martini*, also seemed to have drastically reduced densities in the upper segment after minimum flows were increased.

The snail taxa *Melanoides tuberculata*, *Pyrgophorus platyrachis*, and hydrobiid snails identified to the family level appeared at very low densities before a minimum flow was implemented (during MFL Period 1) but appear to have bloomed in the middle and upper study area segments of the LHR after the implementation of 10 cfs minimum flow, then dropped to lower densities following the implementation of higher minimum flows.

As was suggested for the nekton community, additional sampling (probably biannually in winter and summer, as these were the samples that were processed during the HBMP and were used for this analysis) of the benthic invertebrate community could augment our understanding of the current state of this community, allowing confirmation of potential trends such as the increasing richness and diversity captured during the two spring samplings in 2018. The presence of freshwater taxa from the dam toward Sulphur Springs could also be monitored.

7.3.4 Overall Biological Community Conclusions

The results from all three types of sampling indicate there have been changes in the aquatic animal communities that inhabit the LHR. The benthic macroinvertebrate and fish communities seem to exhibit some evidence of a shift toward a community more reflective of purely freshwater habitats. Many of the taxa present in the study area are, however, known to be tolerant of a large range of salinities and thus changes in their numbers are difficult to attribute to the observed lower salinity with increasing MFL period (when more water was discharged to the river during periods with no dam discharge). The addition of supplemental water seems to have lowered the mean salinity (particularly in areas closer to the dam) on biological sampling days that occurred after 30 days of no dam discharge. Patterns of abundance for organisms like benthic snails may depend more on the presence of food resources like large mats of algae or aquatic vegetation which are likely dependent on a combination of flow conditions, available light (affected by depth, season, and canopy cover).

Dissolved oxygen levels in the upper study segment appear to have increased after the implementation of minimum flows, possibly contributing to increased species diversity and richness. Some taxa are more sensitive than others to brief periods of low DO, thus longer periods without hypoxic conditions may allow a more diverse community to persist.

The zooplankton community appears to show a positive trend with respect to the presence of oligotrophic indicator taxa. This sampling took place only toward the downstream portion of the study area and thus does not include the area that experienced the largest changes in salinity with increased minimum flow supplementation.

8.0 Considerations

Several factors to be considered in relation to the current recovery strategy were identified during the completion of this five-year assessment report. Identification of these factors led to the development of several key issues or actions for consideration to potentially improve the ability of the District and City to assess and/or consistently meet minimum flow criteria established for the LHR.

- Discuss and seek agreement on any issues related to City and District responsibilities for monitoring, operation and reporting for projects and other activities associated with minimum flows implementation for the LHR.

- Further evaluate the additional flow quantities, based upon measured salinity values below the dam, needed to address the freshwater equivalent noted in the MFL rule (40D-8.041(1)(b).

- As discussed, and currently being evaluated by the District, implement a strategy to supplement Sulphur Springs and Blue Sink as the primary sources for minimum flow supplementation. Sulfur Springs is subject to water quality and quantity fluctuations. The primary sources under consideration are the TAP and the TBC. Sulphur Springs and Blue Sink could remain as back-up sources.

- Complete biannual (i.e., twice yearly) biological sampling events during the next 5 years to better characterize the response of biological communities to minimum flows implementation. Biannual monitoring (spring and fall) during the next 5-year assessment period would allow a better understanding of the status of the biological community in the LHR and how it has changed over time.

- In light of the results that 10 to 15 percent of the water pumped from the TBC into the reservoir is re-circulated to the TBC and that at most (a few tens of thousands to a few hundred thousand gallons per day) is lost to evaporation/transpiration (Motz et al. 2008, SWFWMD 2008), there is a need to discuss and seek agreement on some LHR recovery strategy rule issues. Specifically, the rule-specified delivery to the base of the Hillsborough River Dam of only 75 percent (8.3 cfs) of the 11 cfs diverted from the TBC to the reservoir for LHR recovery, and the requirement that the City provide an additional 1.9 mgd from some permittable source to address the 25 percent difference between the quantities pumped from the TBC and released to the LHR. The 1.9 mgd quantity, which approximates the hypothesized 25 percent loss associated transfer of water from the DTBC through the reservoir to the LHF, is expected to help address any minimum flow deficits. According to the recovery strategy, the 1.9 mgd from a permittable source is to be used in preference to all other recovery flow sources except Sulphur Springs and Blue Sink.

9.0 References

ADA Engineering and Earth Resources Consulting Scientists. 2016. Morris Bridge Sink Project H404 2016 Annual Report. Prepared for the Southwest Florida Water Management District.

ADA Engineering and Earth Resources Consulting Scientists. 2017. Morris Bridge Sink Project H404 2017 Annual Report. Prepared for the Southwest Florida Water Management District.

ADA Engineering and Earth Resources Consulting Scientists. 2018. Morris Bridge Sink Project H404 2018 Annual Report. Prepared for the Southwest Florida Water Management District.

Burghart, S.E., Jones, D.L., and Peebles, E.B. 2013. "Variation in estuarine consumer communities along an assembled eutrophication gradient: Implications for trophic instability". *Estuaries and Coasts* vol. 36, no. 5, pp. 951-965.

Cardno. 2017. Lower Hillsborough River Dissolved Oxygen Study. Riverview, Florida. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Carpenter, Kent E., Kells, Valerie A. March 2011. A Field Guide to Coastal Fishes from Maine to Texas (First Edition). The John Hopkins University Press. ISBN-13:978-0-8018-9838-9 (paperback). 448 p.

Catalano, Matthew J., Allen, Michael S., and Murie, Debra J. American Fisheries Society. 2006. "Effects of Variable Flows on Water Chemistry Gradients and Fish Communities at the Hillsborough River, Florida". *North American Journal of Fisheries Management*. vol. 26, pp. 108-118.

Clarke, K.R. and Gorley, R.N. 2015. PRIMER v7: User Manual/Tutorial. PRIMER-E, Plymouth, England.

Clarke, K.R. and Gorley, R.N., Summerfield, P.J., and Warwick, R.M. 2014 Change in Marine Communities: An Approach to Statistical Analysis and Interpretation, 3rd Edition. PRIMER-E, Plymouth, England.

de Leiva Moreno, J.I., Agostini, V.N., Caddy, J.F., and Carocci, F. March 2000. "Food and Agriculture Organization of The United Nations, Viale delle Terme di Caracalla, 00100 Rome Italy". *ICES Journal of Marine Science v*ol. 57, no. 4, pp. 1091-1102.

Farani, G.L.; Nogueira, M.M.; Johnsson, R.; Neves, E.; 2015. "The salt tolerance of the freshwater snail *Melanoides tuberculata* (Mollusca, Gastropoda), a bioinvader gastropod, Brazil". *Pan-American Journal of Aquatic Sciences.* vol. 10, no. 3, pp. 212-221

Florida Marine Research Institute. 2017. Fisheries-Independent Monitoring Program Procedure Manual. (version updated February 15, 2017)

Geraghty and Miller, Inc. 1982. Evaluation of the Water-Supply Potential of the Tampa Bypass Canal: Report to the West Coast Regional Water Supply Authority, Clearwater, Florida.

Heard, R.W. 1979. Guide to Common Tidal Marsh Invertebrates of the Northeastern Gulf of Mexico. MASGP-79-004, Mississippi-Alabama Sea Grant Consortium.

Heard, R.W., Overstreet, R.M., and Foster, J.M. 2002. "Hydrobiid Snails (Mollusca: Gastropoda: Rissooidea) from St. Andrew Bay, Florida". *Gulf and Caribbean Research* vol. 14, no. 1, pp. 13-34.

Janicki Environmental, Inc. 2015. Hillsborough River LAMFE post-processing project (H4000) SWFWMD task v, Work Assignment No 14T200000, Task 4.3 Final Report: Analytical Results and Recommendations. St. Petersburg, Florida. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Knutilla, R. L. and Corral, M.A. 1984. Impacts of the Tampa Bypass Canal System on the Areal Hydrology, Hillsborough County, Florida. Water-Resources Investigation Report 84-4222. Report of the United States Geological Survey, Tallahassee, Florida.

Lassuy, D.R. 1983. Species profiles: Life Histories and Environmental Requirements (Gulf of Mexico) – Gulf menhaden. U.S. Fish and Wildlife Service, Division of Biological Services, FWS/OBS-82/11.2 U.S. Army Corps of Engineers, TR EL-82-4. 13 pp.

MacDonald, T.C., Peebles, E.B., Greenwood, M.F.D., Matheson, Jr., R.E., McMichael, Jr., R.H. May 2005. Freshwater Inflow Effects on Fishes and Invertebrates in the Hillsborough River Estuary. Technical report prepared for Southwest Florida Water Management District, Brooksville, Florida.

Motz, L. H. 1975. Hydrologic Effects of the Tampa Bypass Canal System. Florida Bureau of Geology Report of Investigations 82. Tallahassee, Florida.

Motz, Louis H., Ross, M.A., and Davis, P.R. 2008. Peer Review Panel Report, Tampa Pipeline Project. Draft, Prepared for Southwest Florida Water Management District and City of Tampa.

MWH. 2009. Blue Sink Feasibility Study Augmentation Potential for the Lower Hillsborough River. Prepared for City of Tampa.

Purcell, J.E. 1992. Effects of predation by the scyphomedusan, *Chrysaora quinquecirrha* on zooplankton populations in Chesapeake Bay, USA. Marine Ecology Progress Series vol. 87, pp. 65-76.

Purcell, J.E., Nemazie, D.A., Dorsey, S.E., Houde, E.D., and Gamble, J.C. 1994. Predation mortality of bay anchovy *Anchoa mitchilli* eggs and larvae due to scyphomedusae and ctenophores in Chesapeake Bay. Marine Ecology Progress Series vol. 114 pp. 47-58.

Rees, J.T., and Gershwin, L.A. 2000. Non-indigenous hydromedusae in California's upper San Francisco Estuary: life cycles, distribution, and potential environmental impacts. *Scientia Marina* vol. 64, pp. 73-86.

Robins, Robert H., Page, Lawrence M., Williams, James D., Randall, Zachary S., and Sheehy, Griffin E. April 2018. Fishes in the Fresh Waters of Florida: An Identification Guide and Atlas. University of Florida Press, Gainesville, Florida. ISBN 13:978-1-6834-0033-2

Southwest Florida Water Management District, Hydrologic Evaluation Section, Final Report. 2009. Results of Blue Sink Pumping Test No. 2. Hillsborough County, Florida. Brooksville, Florida.

Southwest Florida Water Management District and Atkins, North America, Inc. 2015. A Hydrobiological Assessment of the Phased Implementation of Minimum Flows for the Lower Hillsborough River. Brooksville, Florida.

Southwest Florida Water Management District, 2016. Lower Hillsborough River Recovery Strategy Implementation - Annual Update. Brooksville, Florida.

Southwest Florida Water Management District, 2017. Lower Hillsborough River Recovery Strategy Implementation - Annual Update. Brooksville, Florida.

Southwest Florida Water Management District, 2018. Lower Hillsborough River Recovery Strategy Implementation – Annual Update. Brooksville, Florida.

Scharping, R.J., Garman, K.M., Henry, R.P., Prahathees, J.E., and Garey, J.R. 2018. The fate of urban springs: Pumping-induced seawater intrusion in a phreatic cave.

Vanasse Hangen Brustlin, Inc. 2016. Letter Report submitted to Stacey B. Day, Southwest Florida Water Management District, dated December 8, 2016; Regarding: Algal Abundance in Sulphur Springs Letter Report, Tampa, Florida. University Park, Florida.

Vanasse Hangen Brustlin, Inc. 2018. Technical Memorandum, submitted to Southwest Florida Water Management District Brooksville, Florida, dated August 30, 2018; regarding: Sulphur Springs Pilot Algal Maintenance Program.

Water and Air Research, Inc. and SDI Environmental Services, Inc. March 1995. Second Interpretive Report Tampa Bypass Canal and Hillsborough River Hydro-Biological Monitoring Program. Volumes I, II, and III.

Water & Air Research, Inc. December 2018. Biological Assessment of the Lower Hillsborough River. Prepared for Southwest Florida Water Management District.

Wood, C.E. 1967. "Physioecology of the grass shrimp, *Palaemonetes pugio*, in the Galveston Bay estuarine system". *Contributions in Marine Science: University of Texas Marine Science Institute* vol. 12, pp. 54-79.

APPENDIX 4.3.1-1

2018 SAMPLING STATIONS FOR BIOLOGICAL SAMPLES

Appendix 4.3.1-1 Water & Air's 2018 sampling locations in the Lower Hillsborough River between Sligh Avenue and the dam by sample type and river segment. River kilometer denotes the distance from the river mouth on Hillsborough Bay. These locations were sampled in both April and May of 2018.

Sample Type	River Segment	Station	River Kilometer	Latitude	Longitude
zooplankton	Lower	Lower A	11.34	28.01756	-82.46471
zooplankton	Lower	Lower B	11.37	28.01792	-82.46468
zooplankton	Middle	Middle A	12.73	28.02038	-82.45329
zooplankton	Middle	Middle B	12.97	28.01986	-82.45102
nekton	Lower	Lower B	10.80	28.01306	-82.46463
nekton	Lower	Lower A	11.50	28.01925	-82.46445
nekton	Middle	Middle A	13.20	28.01929	-82.44875
nekton	Middle	Middle B	14.25	28.01454	-82.44194
nekton	Upper	Upper A	15.35	28.02154	-82.43561
nekton	Upper	Upper B	15.65	28.02259	-82.43298
benthic macroinvertebrate	Lower	Lower A	11.40	28.01818	-82.46469
benthic macroinvertebrate	Lower	Lower B	12.16	28.02079	-82.45901
benthic macroinvertebrate	Middle	Middle A	13.60	28.01859	-82.44574
benthic macroinvertebrate	Middle	Middle B	13.85	28.01731	-82.44452
benthic macroinvertebrate	Upper	Upper B	15.35	28.02155	-82.43576
benthic macroinvertebrate	Upper	Upper A	15.75	28.02279	-82.43210

APPENDIX 4.3.2-1

ZOOPLANKTON SAMPLING DATES BY MFL PERIOD

Appendix 4.3.2-1 Sample dates from the HBMP program 2000 to 2012 that met the 30 day no-flow criteria by MFL period along with Water & Air's sample dates in 2018. On each sample date, a single plankton tow was collected at each of the four stations (RKm 11.34, 11.37, 12.73, and 12.97).

MFL Period			
1	**2**	**3**	**4**
2000-04-12	2002-03-27	2008-01-10	2018-04-10
2000-05-15	2002-04-24	2008-06-12	2018-05-08
2000-06-12	2002-05-23	2008-11-06	
2000-07-11	2002-06-06	2008-12-09	
2000-08-09	2006-04-11	2009-01-08	
2000-11-07	2006-05-24	2009-02-03	
2000-12-06	2006-06-22	2009-03-08	
2001-01-09	2006-07-06	2009-04-21	
2001-02-06	2006-11-07	2009-05-06	
2001-03-07	2006-12-06	2009-11-23	
2001-04-18	2007-01-31	2010-11-16	
2001-05-03	2007-02-15	2010-12-01	
2001-06-04	2007-03-29	2011-01-04	
2001-07-18	2007-04-26	2011-06-27	
2001-12-12	2007-05-10	2012-03-06	
2002-01-10	2007-06-27	2012-04-03	
2002-02-21	2007-07-25	2012-05-02	
		2012-06-13	

APPENDIX 4.3.3-1

NEKTON SAMPLING DATES AND STATION BY MFL PERIOD

Appendix 4.3.3-1a. Sample dates from the HBMP program 2000 to 2012 that met the 30 day no-flow criteria by MFL period along with Water & Air's sample dates in 2018. On each sample date, one 21.3 m shoreline seine net sample was collected at each station.

MFL Period 1		MFL Period 2		MFL Period 3		MFL Period 4	
Date	**RKm**	**Date**	**RKm**	**Date**	**RKm**	**Date**	**RKm**
2000-05-23	10.742	2002-03-18	10.593	2008-01-22	11.453	2018-04-09	13.2
	11.155		11.509		12.422		14.25
	13.106		12.972		13.206		15.35
	15.72		14.773		13.409	2018-04-11	10.8
2000-06-16	12.03	2002-04-17	12.407	2008-06-18	11.414		11.5
	12.549		12.64		11.815		15.65
	12.966		13.281		14.074	2018-05-07	14.25
	15.441		13.644		15.945		15.35
2000-07-11	10.646	2002-05-21	11.912	2008-07-07	12.541		15.65
	11.523		11.98		12.649	2018-05-08	10.8
	14.123		14.042		14.272		11.5
	14.88		15.967		14.397		13.2
2000-11-27	10.909	2002-06-05	10.79	2008-10-27	10.606		
	11.19		11.096		11.933		
	14.126		14.77		14.362		
	14.231		14.907		14.523		
2000-12-12	11.243	2006-04-27	10.769	2008-11-13	13.374		
	15.055		13.646		15.034		
	15.568		14.993	2008-12-16	11.473		
2001-01-09	11.486	2006-05-08	10.575		12.698		
	12.589		12.436		12.951		
	13.475		13.456		14.592		
	13.668		14.541	2009-01-06	11.574		
					12.16		
					13.162		
					14.696		

MFL Period 1 cont'd		MFL Period 2 cont'd		MFL Period 3 cont'd		MFL Period 4	
Date	RKm	Date	RKm	Date	RKm	Date	RKm
2001-02-13	11.034	2006-06-20	11.224	2009-02-04	10.608		
	11.102		12.609		14.713		
	14.573		14.888		15.786		
	14.992		15.843	2009-03-04	11.324		
2001-03-05	11.372	2006-07-17	12.012		12.022		
	12.41		12.133		13.632		
	13.054		13.59		15.215		
	14.399		13.875	2009-04-20	10.833		
2001-04-18	11.215	2006-11-13	11.609		11.37		
	12.832		11.871		13.717		
	13.766		14.402		15.588		
2001-05-15	11.517		14.981	2009-05-18	10.605		
	12.518	2006-12-13	10.807		11.925		
	13.914		11.97		13.496		
	15.566		13.419		14.692		
2001-06-21	10.798		13.943	2009-12-07	11.062		
	15.496	2007-01-18	11.87		11.792		
	15.851		11.921		15.316		
2001-07-25	11.749		13.081		15.637		
	12.802		13.109	2010-11-08	12.004		
	14.473	2007-02-22	10.609		12.804		
2001-12-11	12.529		12.119		12.974		
	13.038		12.977	2010-12-06	10.757		
	15.069		14.263		11.867		
					14.124		
					14.228		
				2011-06-20	12.244		
					12.537		
					13.389		
					13.998		

MFL Period 1 cont'd		MFL Period 2 cont'd		MFL Period 3 cont'd		MFL Period 4	
Date	RKm	Date	RKm	Date	RKm	Date	RKm
2002-01-03	11.446	2007-03-21	11.197	2012-03-12	10.862		
	13.647		11.436		15.336		
	14.051		14.24		15.386		
2002-02-04	12.046		15.318	2012-04-10	10.802		
	12.426	2007-04-09	10.568		11.392		
	13.538		11.147		14.492		
	14.584		13.107		16.044		
			15.162	2012-05-14	10.711		
		2007-05-16	11.675		10.849		
			12.593		12.749		
			14.792		15.223		
			15.136	2012-06-11	11.149		
		2007-06-04	11.422		12.002		
			11.622		14.557		
			13.615		16.034		
			15.209				
		2007-07-11	11.719				
			12.708				
			14.985				
			15.965				

Appendix 4.3.3-1b. Number of seine net nekton samples from the HBMP program (2000 to 2012) collected on days that met the 30 day no-flow criteria and from Water & Air's sample collection in 2018 by MFL period, month, and year (N = 204). Numbers on grey background are totals.

Period	Year	n	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1	2000	19	0	0	0	0	4	4	4	0	0	0	4	3
	2001	28	4	4	4	3	4	3	3	0	0	0	3	0
	2002	7	3	4	0	0	0	0	0	0	0	0	0	0
Total		**54**	**7**	**8**	**4**	**3**	**8**	**7**	**7**	**0**	**0**	**0**	**7**	**3**
2	2002	16	0	0	4	4	4	4	0	0	0	0	0	0
	2006	23	0	0	0	3	4	4	4	0	0	0	4	4
	2007	28	4	4	4	4	4	4	4	0	0	0	0	0
Total		**67**	**4**	**4**	**8**	**11**	**12**	**12**	**8**	**0**	**0**	**0**	**4**	**4**
3	2008	22	4	0	0	0	0	4	4	0	0	4	2	4
	2009	23	4	3	4	4	4	0	0	0	0	0	0	4
	2010	7	0	0	0	0	0	0	0	0	0	0	3	4
	2011	4	0	0	0	0	0	4	0	0	0	0	0	0
	2012	15	0	0	3	4	4	4	0	0	0	0	0	0
Total		**71**	**8**	**3**	**7**	**8**	**8**	**12**	**4**	**0**	**0**	**4**	**5**	**12**
4	2018	12	0	0	0	6	6	0	0	0	0	0	0	0

APPENDIX 4.3.4-1

BENTHIC MACROINVERTEBRATE SAMPLING DATES AND STATION BY MFL PERIOD

Appendix 4.3.4-1 Sample dates from the HBMP program 2000 to 2012 that met the 30 day no-flow criteria by MFL period along with Water & Air's sample dates in 2018. On each sample date, a single dredge sample was collected at each station.

MFL Period 1		MFL Period 2		MFL Period 3		MFL Period 4	
Date	RKm	Date	RKm	Date	RKm	Date	RKm
2000-07-30	11.523	2002-03-28	12.06	2008-01-10	11.354	2018-04-10	11.4
	11.589		12.833		13.002		12.155
	14.435		13.252		13.322		13.6
	14.88	2006-07-28	11.67	2009-01-14	11.857		13.85
2001-01-15	10.898		11.921		13.205		15.35
	12.589		13.359		13.719		15.75
	13.475		14.172	2009-02-10	12.325	2018-05-09	11.4
	13.668	2006-08-04	10.863		12.788		12.155
2001-02-23	11.034		11.693		14.528		13.6
	12.313		13.412	2009-03-16	11.41		13.85
	14.573		13.433		13.358		15.35
	14.992	2007-01-05	10.854		15.336		15.75
2001-03-07	11.372		13.247				
	12.512		13.402				
	13.461	2007-02-13	10.748				
	14.399		11.734				
2001-07-26	11.173		13.632				
	12.944		13.712				
2002-02-25	11.54	2007-03-14	10.646				
	12.345		14.193				
	13.35		14.597				
	13.385	2007-07-23	10.583				
			12.984				
			15.745				

APPENDIX 5.1-1

WATER QUALITY SECTION TABLES

List of Tables included in Appendix 5-1.1

Table 5.1-1 Mean, standard deviation (SD), and sample number (n) for the water quality variables collected from the middle water column at the EPCHC and USGS stations (without water flow over the dam) and separated by MFL period and Lower Hillsborough River segment from October 1979 to May 2018.

Table 5.1-2 Mean, standard deviation (SD), and sample number (n) for the water quality variables collected from the middle water column at the EPCHC and USGS stations (with water flow over the dam) and separated by MFL period and Lower Hillsborough River segment from October 1979 to May 2018.

Table 5.2.1-1 Spearman Rho correlation analysis between mean monthly discharge (cfs) at USGS station 02304500 at the Hillsborough River dam and discrete monthly water quality variables at Rowlett Park Drive (EPCHC 105) below the dam from October 1979 to May 2018. Alpha = 0.0041667 after a Bonferroni correction for multiple comparisons. Bold values are significant.

Table 5.2.2.1-1 Kruskal-Wallis with multiple comparison Dunn's Test analysis of nitrates/nitrites by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Table 5.2.2.1-2 Kruskal-Wallis analysis with multiple comparison Dunn's Test of orthophosphate by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Table 5.2.2.1-3 Kruskal-Wallis analysis with multiple comparison Dunn's Test of total phosphorus by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Table 5.2.2.1-4 Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Table 5.2.2.1-5 Kruskal-Wallis analysis with multiple comparison Dunn's Test of conductivity by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Table 5.2.2.1-6 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Table 5.2.2.1-7 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen percent saturation by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-8 Kruskal-Wallis with multiple comparison Dunn's Test analysis of pH by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-9 Kruskal-Wallis with multiple comparison Dunn's Test analysis of total nitrogen by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-10 Kruskal-Wallis analysis with multiple comparison Dunn's Test of water color by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-11 Kruskal-Wallis analysis with multiple comparison Dunn's Test of conductivity by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-12 Kruskal-Wallis analysis with multiple comparison Dunn's Test of total nitrogen by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-13 Kruskal-Wallis analysis with multiple comparison Dunn's Test of orthophosphate by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-14 Kruskal-Wallis analysis with multiple comparison Dunn's Test of total phosphorus by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-15 Kruskal-Wallis analysis with multiple comparison Dunn's Test of chlorophyll *a* uncorrected by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-16 Kruskal-Wallis analysis with multiple comparison Dunn's Test of nitrates/nitrites by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-17 Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-18 Kruskal-Wallis analysis with multiple comparison Dunn's Test of pH by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.1-19 Kruskal-Wallis analysis with multiple comparison Dunn's Test of water color by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-1 Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity at EPCHC and USGS stations for MFL period 1 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-2 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 1 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-3 Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 2 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-4 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 2 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-5 Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 3 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-6 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 3 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-7 Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 4 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-8 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 4 without water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-9 Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 1 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-10 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 1 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-11 Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity at EPCHC and USGS stations for MFL period 2 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-12 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 2 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-13 Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 3 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-14 Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 3 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-15 Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 4 with water flow over the dam from October 1979 to May 2018.

Table 5.2.2.2-16 Kruskal-Wallis with multiple comparison Dunn's Test analysis of dissolved oxygen at EPCHC and USGS stations for MFL period 4 with water flow over the dam from October 1979 to May 2018.

Table 5.2.3-1 Number of monthly sampling days that dissolved oxygen percent saturation was under the Florida state water quality standard (38%), or salinity was above the 5.0 (ppt) MFL goal at the EPCHC and USGS stations by MFL period and Lower Hillsborough River segment from October 1979 to May 2018 when water was flowing over the dam.

Table 5.2.3-2 Number of monthly sampling days that dissolved oxygen percent saturation was under the Florida state water quality standard (38%), or salinity was over the 5.0 (ppt) MFL goal at the EPCHC and USGS stations by MFL period and Lower Hillsborough River segment from October 1979 to May 2018 when water was not flowing over the dam.

Table 5.1-1. Mean, standard deviation (SD), and sample number (n) for the water quality variables collected from the middle water column at the EPCHC and USGS stations (without water flow over the dam) and separated by MFL period and Lower Hillsborough River segment from October 1979 to May 2018.

Location (EPCHC/USGS station)-MFL period	Average Salinity (ppt)		SD	n	Average Specific Conductance (umho/cm)		SD	n	Average Dissolved Oxygen (mg/L)		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	0.49	±	1.18	42	583.65	±	1492.88	71	7.09	±	2.18	70
E Fowler Ave (106)-02	0.18	±	0.03	19	381.53	±	41.60	19	6.33	±	2.33	19
E Fowler Ave (106)-03	0.18	±	0.01	19	377.47	±	19.66	19	7.20	±	2.13	19
E Fowler Ave (106)-04	0.19	±	0.01	13	390.62	±	25.43	13	8.07	±	1.66	13
Temple Terrace Hwy (266)-04	0.19	±	0.01	7	395.14	±	19.01	7	7.87	±	2.16	7
N 56th St (265)-04	0.20	±	0.01	7	419.00	±	30.32	7	7.15	±	1.97	7
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	7.31	±	3.63	70	12822.66	±	5751.42	70	3.50	±	1.58	69
Rowlett Park Dr (105)-02	2.74	±	1.85	19	5054.74	±	3167.49	19	4.35	±	1.29	19
Rowlett Park Dr (105)-03	1.70	±	0.64	18	3246.67	±	1153.69	18	5.41	±	0.55	18
Rowlett Park Dr (105)-04	2.19	±	0.30	13	4132.31	±	529.62	13	5.80	±	0.61	13
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	4.03	±	1.02	9	7316.67	±	1712.13	9	2.89	±	1.92	9
Hanna's Whirl (1515)-04	3.58	±	1.82	13	6516.92	±	3082.50	13	4.65	±	1.35	13
N 12th St (1514)-03	7.10	±	2.47	10	12357.00	±	3994.22	10	2.29	±	2.09	10
N 12th St (1514)-04	5.25	±	2.07	13	9342.31	±	3438.20	13	3.34	±	1.07	13
Nebraska Ave (2304520)-01	13.30	±	2.70	25	ns				ns			
Nebraska Ave (2304520)-02	9.84	±	2.42	19	ns				ns			
Nebraska Ave (2304520)-03	11.01	±	2.59	19	ns				ns			
Nebraska Ave (2304520)-04	6.71	±	2.11	4	ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	13.70	±	2.16	21	ns				ns			
Hwy I-275 (23060013)-02	12.00	±	1.36	4	ns				ns			
Hwy I-275 (23060013)-04	9.39	±	1.38	7	ns				ns			
N River Shore Dr (1512)-03	11.60	±	3.00	10	19443.00	±	4654.61	10	1.72	±	2.16	10
N River Shore Dr (1512)-04	9.31	±	3.81	13	15858.46	±	5989.33	13	2.50	±	1.63	13
Sligh Ave (152)-01	16.91	±	3.56	21	27538.10	±	5246.57	21	2.07	±	1.69	20
Sligh Ave (152)-02	11.37	±	4.80	19	19020.53	±	7472.29	19	1.74	±	1.56	19
Sligh Ave (152)-03	14.07	±	3.04	19	23265.26	±	4640.00	19	1.76	±	1.58	19
Sligh Ave (152)-04	11.77	±	3.29	13	19753.08	±	5135.01	13	2.50	±	1.02	13
Lower river segment at river mouth												
W Platt St (2)-01	28.56	±	3.94	67	44063.24	±	5369.06	68	5.58	±	1.34	66
W Platt St (2)-02	25.43	±	3.14	19	39836.84	±	4411.75	19	4.86	±	1.86	19
W Platt St (2)-03	27.78	±	2.36	19	43257.89	±	3436.46	19	4.86	±	1.36	19
W Platt St (2)-04	26.19	±	1.25	13	41069.23	±	1734.64	13	6.44	±	0.82	13
Tributaries												
Sulphur Springs (174)-02	3.01	±	2.10	8	5502.50	±	3575.00	8	8.25	±	0.45	8
Sulphur Springs (174)-03	2.10	±	0.49	19	3963.68	±	879.96	19	8.20	±	0.74	19
Sulphur Springs (174)-04	2.85	±	0.20	13	5290.77	±	355.05	13	8.00	±	1.00	13
Twin Lake Outfall (616) -04	0.20		n-a	1	414.00		n-a	1	6.02		n-a	1

Table 5.1-1. Continued.

Location (EPCHC/USGS station)-MFL period	Average Dissolved Oxygen Saturation %		SD	n	Average pH		SD	n	Average Nitrates/ Nitrites (mg/L)		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	73.30		n-a	1	7.74	±	0.37	71	0.58	±	0.26	67
E Fowler Ave (106)-02	74.69	±	27.31	19	7.73	±	0.39	19	0.38	±	0.25	19
E Fowler Ave (106)-03	80.85	±	22.39	19	7.80	±	0.28	19	0.64	±	0.22	19
E Fowler Ave (106)-04	92.51	±	24.19	13	7.73	±	0.66	13	0.59	±	0.24	13
Temple Terrace Hwy (266)-04	90.31	±	26.16	7	7.90	±	0.28	7	0.33	±	0.18	7
N 56th St (265)-04	82.07	±	22.93	7	7.92	±	0.27	7	0.04	±	0.06	7
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	61.00	±	n-a	1	7.25	±	0.24	70	0.12	±	0.11	68
Rowlett Park Dr (105)-02	52.98	±	15.58	19	7.36	±	0.11	19	0.13	±	0.06	19
Rowlett Park Dr (105)-03	64.16	±	5.42	18	7.49	±	0.15	18	0.11	±	0.07	18
Rowlett Park Dr (105)-04	68.94	±	5.73	13	7.48	±	0.13	13	0.05	±	0.03	13
Middle river segment (12.6 to < 14.5 river kilometers from mouth)									ns			
Hanna's Whirl (1515)-03	35.11	±	21.01	9	7.27	±	0.19	9	ns			
Hanna's Whirl (1515)-04	55.47	±	13.66	13	7.43	±	0.18	13	ns			
N 12th St (1514)-03	27.94	±	23.82	10	7.21	±	0.16	10	ns			
N 12th St (1514)-04	40.47	±	12.49	13	7.32	±	0.10	13	ns			
Nebraska Ave (2304520)-01	ns				ns				ns			
Nebraska Ave (2304520)-02	ns				ns				ns			
Nebraska Ave (2304520)-03	ns				ns				ns			
Nebraska Ave (2304520)-04	ns				ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	ns				ns				ns			
Hwy I-275 (23060013)-02	ns				ns				ns			
Hwy I-275 (23060013)-04	ns				ns				ns			
N River Shore Dr (1512)-03	21.45	±	24.94	10	7.19	±	0.17	10	ns			
N River Shore Dr (1512)-04	30.98	±	19.85	13	7.26	±	0.09	13	ns			
Sligh Ave (152)-01	89.70	±	n-a	1	7.17	±	0.15	21	0.08	±	0.08	21
Sligh Ave (152)-02	22.26	±	19.49	19	7.17	±	0.14	19	0.12	±	0.07	19
Sligh Ave (152)-03	22.24	±	19.36	19	7.27	±	0.19	19	0.10	±	0.06	19
Sligh Ave (152)-04	31.80	±	12.99	13	7.29	±	0.14	13	0.06	±	0.04	13
Lower river segment at river mouth												
W Platt St (2)-01	69.35	±	0.49	2	7.77	±	0.24	68	0.02	±	0.02	68
W Platt St (2)-02	66.88	±	23.04	19	7.74	±	0.15	19	0.02	±	0.02	19
W Platt St (2)-03	66.84	±	14.80	19	7.86	±	0.17	19	0.03	±	0.02	19
W Platt St (2)-04	87.39	±	12.36	13	7.93	±	0.10	13	0.02	±	0.02	13
Tributaries												
Sulphur Springs (174)-02	101.30	±	4.67	8	7.51	±	0.08	8	0.09	±	0.08	8
Sulphur Springs (174)-03	100.48	±	9.44	19	7.52	±	0.14	19	0.15	±	0.11	19
Sulphur Springs (174)-04	98.08	±	11.31	13	7.48	±	0.13	13	0.05	±	0.05	13
Twin Lake Outfall (616) -04	72.20		n-a	1	7.57		n-a	1	0.03		n-a	1

Table 5.1-1. Continued.

Location (EPCHC/USGS station)-MFL period	Average Total Nitrogen (mg/L)		SD	n	Average Ortho Phosphate (mg/L)		SD	n	Average Total Phosphorus (mg/L)		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	1.06	±	0.61	70	0.11	±	0.07	52	0.18	±	0.16	71
E Fowler Ave (106)-02	1.10	±	0.47	18	0.09	±	0.05	19	0.20	±	0.23	19
E Fowler Ave (106)-03	1.04	±	0.24	19	0.06	±	0.02	19	0.08	±	0.02	19
E Fowler Ave (106)-04	1.02	±	0.24	13	0.06	±	0.04	13	0.09	±	0.03	13
Temple Terrace Hwy (266)-04	0.88	±	0.19	7	0.06	±	0.05	7	0.10	±	0.05	7
N 56th St (265)-04	0.51	±	0.20	7	0.03	±	0.03	7	0.08	±	0.04	7
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	1.16	±	0.42	70	0.17	±	0.08	52	0.25	±	0.15	70
Rowlett Park Dr (105)-02	0.50	±	0.22	18	0.10	±	0.03	19	0.13	±	0.04	19
Rowlett Park Dr (105)-03	0.46	±	0.17	18	0.10	±	0.04	18	0.12	±	0.04	18
Rowlett Park Dr (105)-04	0.33	±	0.21	13	0.09	±	0.01	13	0.11	±	0.02	13
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	ns				ns				ns			
Hanna's Whirl (1515)-04	ns				ns				ns			
N 12th St (1514)-03	ns				ns				ns			
N 12th St (1514)-04	ns				ns				ns			
Nebraska Ave (2304520)-01	ns				ns				ns			
Nebraska Ave (2304520)-02	ns				ns				ns			
Nebraska Ave (2304520)-03	ns				ns				ns			
Nebraska Ave (2304520)-04	ns				ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	ns				ns				ns			
Hwy I-275 (23060013)-02	ns				ns				ns			
Hwy I-275 (23060013)-04	ns				ns				ns			
N River Shore Dr (1512)-03	ns				ns				ns			
N River Shore Dr (1512)-04	ns				ns				ns			
Sligh Ave (152)-01	1.00	±	0.36	21	0.14	±	0.05	21	0.21	±	0.07	21
Sligh Ave (152)-02	0.73	±	0.21	18	0.13	±	0.03	19	0.18	±	0.05	19
Sligh Ave (152)-03	0.56	±	0.19	19	0.12	±	0.04	19	0.17	±	0.05	19
Sligh Ave (152)-04	0.44	±	0.18	13	0.12	±	0.02	13	0.16	±	0.04	13
Lower river segment at river mouth												
W Platt St (2)-01	0.77	±	0.22	68	0.18	±	0.09	51	0.32	±	0.19	68
W Platt St (2)-02	0.60	±	0.22	18	0.12	±	0.04	19	0.19	±	0.05	19
W Platt St (2)-03	0.44	±	0.16	19	0.10	±	0.03	19	0.18	±	0.07	19
W Platt St (2)-04	0.44	±	0.23	13	0.12	±	0.02	13	0.18	±	0.03	13
Tributaries												
Sulphur Springs (174)-02	0.26	±	0.09	8	0.09	±	0.01	8	0.10	±	0.02	8
Sulphur Springs (174)-03	0.31	±	0.20	19	0.09	±	0.01	19	0.11	±	0.02	19
Sulphur Springs (174)-04	0.22	±	0.11	13	0.10	±	0.01	13	0.11	±	0.02	13
Twin Lake Outfall (616) -04	0.73		n-a	1	0.02		n-a	1	0.06		n-a	1

Table 5.1-1. Continued.

Location (EPCHC/USGS station)-MFL period	Average Chlorophyll *a* uncorrected (µg/L)		SD	n	Average Water Color (pcu)		SD	n	Average Water Temperature °C		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	11.43	±	17.26	19	22.15	±	18.07	71	22.69	±	4.76	69
E Fowler Ave (106)-02	29.59	±	63.49	10	28.78	±	22.44	19	24.28	±	4.35	19
E Fowler Ave (106)-03	11.87	±	19.30	19	15.95	±	12.18	19	21.70	±	4.86	19
E Fowler Ave (106)-04	15.85	±	14.29	13	13.30	±	6.49	13	21.87	±	4.33	13
Temple Terrace Hwy (266)-04	17.40	±	12.60	7	10.84	±	3.93	7	22.42	±	3.13	7
N 56th St (265)-04	20.59	±	7.39	7	11.16	±	3.40	7	22.45	±	3.20	7
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	24.90	±	38.21	70	22.53	±	10.61	70	23.33	±	4.08	68
Rowlett Park Dr (105)-02	13.21	±	26.07	19	10.59	±	3.98	19	24.73	±	2.17	19
Rowlett Park Dr (105)-03	5.71	±	4.65	18	17.11	±	11.82	18	23.59	±	2.32	18
Rowlett Park Dr (105)-04	4.48	±	1.75	13	9.95	±	3.12	13	23.45	±	1.90	13
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	ns				ns				25.00	±	2.40	9
Hanna's Whirl (1515)-04	ns				ns				23.38	±	2.59	13
N 12th St (1514)-03	ns				ns				24.90	±	2.84	10
N 12th St (1514)-04	ns				ns				23.75	±	2.24	13
Nebraska Ave (2304520)-01	ns				ns				ns			
Nebraska Ave (2304520)-02	ns				ns				ns			
Nebraska Ave (2304520)-03	ns				ns				ns			
Nebraska Ave (2304520)-04	ns				ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	ns				ns				ns			
Hwy I-275 (23060013)-02	ns				ns				ns			
Hwy I-275 (23060013)-04	ns				ns				ns			
N River Shore Dr (1512)-03	ns				ns				25.60	±	3.15	10
N River Shore Dr (1512)-04	ns				ns				23.84	±	2.57	13
Sligh Ave (152)-01	29.97	±	24.28	21	15.62	±	5.62	21	24.04	±	3.47	21
Sligh Ave (152)-02	13.34	±	8.64	19	13.77	±	3.68	19	25.52	±	2.90	19
Sligh Ave (152)-03	36.55	±	65.47	19	16.58	±	10.80	19	24.75	±	3.18	19
Sligh Ave (152)-04	16.71	±	16.62	13	9.87	±	2.12	13	23.60	±	2.80	13
Lower river segment at river mouth												
W Platt St (2)-01	10.83	±	6.11	68	8.00	±	3.00	68	23.34	±	4.38	68
W Platt St (2)-02	8.51	±	4.76	14	8.72	±	1.45	19	24.80	±	4.29	19
W Platt St (2)-03	7.75	±	4.56	19	7.59	±	2.53	19	23.80	±	4.40	19
W Platt St (2)-04	8.38	±	4.31	13	5.41	±	1.38	13	22.87	±	3.58	13
Tributaries												
Sulphur Springs (174)-02	3.23	±	4.39	6	7.25	±	3.60	8	25.09	±	1.07	8
Sulphur Springs (174)-03	1.56	±	1.15	19	8.09	±	3.56	19	25.15	±	0.68	19
Sulphur Springs (174)-04	4.58	±	9.13	13	6.28	±	1.10	13	25.39	±	0.54	13
Twin Lake Outfall (616) -04	11.30		n-a	1	47.80		n-a	1	24.45		n-a	1

Table 5.1-2. Mean, standard deviation (SD), and sample number (n) for the water quality variables collected from the middle water column at the EPCHC and USGS stations (with water flow over the dam) and separated by MFL period and Lower Hillsborough River segment from October 1979 to May 2018.

Location (EPCHC/USGS station)-MFL period	Average Salinity (ppt)		SD	n	Average Specific Conductance (umho/cm)		SD	n	Average Dissolved Oxygen (mg/L)		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	0.30	±	0.35	151	311.00	±	96.90	197	3.57	±	2.18	196
E Fowler Ave (106)-02	0.13	±	0.04	50	272.63	±	76.53	51	3.33	±	1.96	51
E Fowler Ave (106)-03	0.15	±	0.04	37	300.74	±	76.91	38	3.15	±	2.10	38
E Fowler Ave (106)-04	0.14	±	0.03	55	291.11	±	72.61	55	3.39	±	1.68	53
Temple Terrace Hwy (266)-04	0.14	±	0.04	17	286.53	±	95.93	17	2.72	±	1.79	16
N 56th St (265)-04	0.13	±	0.04	17	279.18	±	90.10	17	2.78	±	2.07	16
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	1.40	±	2.63	181	2031.95	±	4277.83	198	5.84	±	2.33	197
Rowlett Park Dr (105)-02	0.67	±	1.07	51	1275.02	±	1984.30	51	6.27	±	1.63	51
Rowlett Park Dr (105)-03	0.67	±	1.11	35	1276.89	±	2020.27	35	6.04	±	1.59	35
Rowlett Park Dr (105)-04	0.52	±	0.85	54	1010.11	±	1594.08	54	6.24	±	1.44	54
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	1.87	±	2.74	32	3350.78	±	4776.41	32	4.80	±	2.03	32
Hanna's Whirl (1515)-04	1.01	±	1.58	54	1887.96	±	2854.99	54	5.42	±	1.80	54
N 12th St (1514)-03	3.12	±	4.25	35	5432.89	±	7149.81	35	4.43	±	1.88	35
N 12th St (1514)-04	2.02	±	3.18	55	3595.11	±	5421.72	55	4.95	±	2.00	55
Nebraska Ave (2304520)-01	5.01	±	3.88	14	ns				ns			
Nebraska Ave (2304520)-02	3.78	±	3.49	47	ns				ns			
Nebraska Ave (2304520)-03	4.26	±	3.75	38	ns				ns			
Nebraska Ave (2304520)-04	2.02	±	2.39	17	ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)					ns				ns			
Hwy I-275 (23060013)-01	5.47	±	3.83	8	ns				ns			
Hwy I-275 (23060013)-02	2.62	±	3.09	26	ns				ns			
Hwy I-275 (23060013)-04	3.83	±	4.07	17	ns				ns			
N River Shore Dr (1512)-03	5.68	±	6.11	35	9619.89	±	10040.40	35	3.84	±	2.11	35
N River Shore Dr (1512)-04	4.02	±	5.14	55	6900.95	±	8537.50	55	4.16	±	2.22	55
Sligh Ave (152)-01	4.87	±	5.69	10	8428.90	±	9251.43	10	2.56	±	2.03	10
Sligh Ave (152)-02	4.15	±	5.29	51	7145.94	±	8669.72	51	4.01	±	2.15	51
Sligh Ave (152)-03	5.42	±	6.60	38	9141.00	±	10738.65	38	3.68	±	2.08	38
Sligh Ave (152)-04	4.79	±	5.88	55	8132.05	±	9712.80	55	3.98	±	2.23	55
Lower river segment at river mouth												
W Platt St (2)-01	20.71	±	7.04	191	32527.42	±	10603.74	197	4.66	±	1.93	191
W Platt St (2)-02	17.53	±	7.91	51	28088.98	±	12152.72	51	4.39	±	1.73	51
W Platt St (2)-03	23.82	±	3.75	38	37550.00	±	5511.01	38	4.38	±	2.15	38
W Platt St (2)-04	22.57	±	3.25	54	35779.63	±	4786.51	54	4.17	±	2.22	54
Tributaries												
Sulphur Springs (174)-02	2.15	±	0.24	4	4060.00	±	421.98	4	6.17	±	1.66	4
Sulphur Springs (174)-03	2.43	±	0.57	38	4556.05	±	988.39	38	6.11	±	2.09	38
Sulphur Springs (174)-04	2.62	±	0.28	55	4896.55	±	491.74	55	5.78	±	1.22	55
Twin Lake Outfall (616) -04	0.14	±	0.02	5	281.00	±	39.96	5	6.42	±	0.83	5

Table 5.1-2. Continued.

Location (EPCHC/USGS station)-MFL period	Average Dissolved Oxygen Saturation %		SD	n	Average pH		SD	n	Average Nitrates/ Nitrites (mg/L)		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01		±			7.18	±	0.47	195	0.20	±	0.27	160
E Fowler Ave (106)-02	36.90	±	19.61	50	7.01	±	0.34	51	0.17	±	0.17	51
E Fowler Ave (106)-03	34.89	±	21.17	37	7.16	±	0.33	38	0.16	±	0.18	38
E Fowler Ave (106)-04	38.55	±	17.28	55	7.16	±	0.24	55	0.15	±	0.15	55
Temple Terrace Hwy (266)-04	33.11	±	19.42	17	7.05	±	0.32	17	0.14	±	0.16	17
N 56th St (265)-04	34.45	±	23.38	17	7.14	±	0.37	17	0.06	±	0.08	17
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01		±			7.38	±	0.40	196	0.12	±	0.08	160
Rowlett Park Dr (105)-02	72.47	±	15.42	50	7.38	±	0.36	51	0.12	±	0.11	51
Rowlett Park Dr (105)-03	71.86	±	15.06	35	7.46	±	0.29	35	0.06	±	0.06	35
Rowlett Park Dr (105)-04	74.21	±	15.01	54	7.41	±	0.32	54	0.07	±	0.06	55
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	57.33	±	22.89	32	7.43	±	0.26	32	ns			
Hanna's Whirl (1515)-04	64.32	±	20.05	54	7.41	±	0.34	54	ns			
N 12th St (1514)-03	52.69	±	20.82	35	7.40	±	0.22	35	ns			
N 12th St (1514)-04	59.39	±	22.49	55	7.32	±	0.28	55	ns			
Nebraska Ave (2304520)-01	ns				ns				ns			
Nebraska Ave (2304520)-02	ns				ns				ns			
Nebraska Ave (2304520)-03	ns				ns				ns			
Nebraska Ave (2304520)-04	ns				ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	ns				ns				ns			
Hwy I-275 (23060013)-02	ns				ns				ns			
Hwy I-275 (23060013)-04	ns				ns				ns			
N River Shore Dr (1512)-03	46.32	±	24.09	35	7.33	±	0.19	35	ns			
N River Shore Dr (1512)-04	50.59	±	26.20	55	7.28	±	0.28	55	ns			
Sligh Ave (152)-01	ns				7.02	±	0.15	10	0.14	±	0.10	10
Sligh Ave (152)-02	47.35	±	24.12	50	7.22	±	0.19	51	0.20	±	0.10	51
Sligh Ave (152)-03	44.54	±	23.46	38	7.34	±	0.18	38	0.11	±	0.08	38
Sligh Ave (152)-04	48.79	±	26.25	55	7.27	±	0.28	55	0.10	±	0.08	55
Lower river segment at river mouth												
W Platt St (2)-01	ns				7.67	±	0.36	195	0.05	±	0.05	160
W Platt St (2)-02	56.46	±	18.69	47	7.62	±	0.27	51	0.08	±	0.07	51
W Platt St (2)-03	59.62	±	25.79	38	7.83	±	0.25	38	0.04	±	0.04	38
W Platt St (2)-04	56.30	±	27.55	54	7.67	±	0.25	54	0.05	±	0.04	55
Tributaries												
Sulphur Springs (174)-02	76.68	±	20.88	4	7.20	±	0.28	4	0.20	±	0.10	4
Sulphur Springs (174)-03	75.14	±	25.65	38	7.33	±	0.29	38	0.23	±	0.20	38
Sulphur Springs (174)-04	71.48	±	15.06	55	7.21	±	0.22	55	0.22	±	0.20	55
Twin Lake Outfall (616) -04	79.12	±	7.32	5	7.40	±	0.08	5	0.25	±	0.08	5

Table 5.1-2. Continued.

Location (EPCHC/USGS station)-MFL period	Average Total Nitrogen (mg/L)		SD	n	Average Ortho Phosphate (mg/L)		SD	n	Average Total Phosphorus (mg/L)		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	1.03	±	0.36	182	0.24	±	0.12	86	0.32	±	0.23	196
E Fowler Ave (106)-02	1.02	±	0.26	44	0.17	±	0.08	51	0.22	±	0.09	51
E Fowler Ave (106)-03	1.05	±	0.17	38	0.18	±	0.09	38	0.20	±	0.09	38
E Fowler Ave (106)-04	0.92	±	0.23	54	0.17	±	0.08	55	0.19	±	0.08	55
Temple Terrace Hwy (266)-04	1.00	±	0.26	16	0.21	±	0.12	17	0.23	±	0.09	17
N 56th St (265)-04	0.91	±	0.23	16	0.18	±	0.10	17	0.22	±	0.10	17
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	1.15	±	0.40	183	0.23	±	0.12	84	0.30	±	0.14	198
Rowlett Park Dr (105)-02	1.01	±	0.33	46	0.15	±	0.07	51	0.21	±	0.08	51
Rowlett Park Dr (105)-03	0.92	±	0.31	35	0.15	±	0.09	35	0.18	±	0.09	35
Rowlett Park Dr (105)-04	0.82	±	0.24	55	0.15	±	0.07	55	0.18	±	0.07	55
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	ns				ns				ns			
Hanna's Whirl (1515)-04	ns				ns				ns			
N 12th St (1514)-03	ns				ns				ns			
N 12th St (1514)-04	ns				ns				ns			
Nebraska Ave (2304520)-01	ns				ns				ns			
Nebraska Ave (2304520)-02	ns				ns				ns			
Nebraska Ave (2304520)-03	ns				ns				ns			
Nebraska Ave (2304520)-04	ns				ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	ns				ns				ns			
Hwy I-275 (23060013)-02	ns				ns				ns			
Hwy I-275 (23060013)-04	ns				ns				ns			
N River Shore Dr (1512)-03	ns				ns				ns			
N River Shore Dr (1512)-04	ns				ns				ns			
Sligh Ave (152)-01	1.28	±	0.44	10	0.19	±	0.08	10	0.27	±	0.11	10
Sligh Ave (152)-02	0.97	±	0.23	45	0.16	±	0.06	51	0.21	±	0.07	51
Sligh Ave (152)-03	0.83	±	0.28	38	0.15	±	0.07	38	0.18	±	0.07	38
Sligh Ave (152)-04	0.74	±	0.24	55	0.15	±	0.06	55	0.19	±	0.06	55
Lower river segment at river mouth												
W Platt St (2)-01	0.99	±	0.35	185	0.31	±	0.17	111	0.43	±	0.17	199
W Platt St (2)-02	0.78	±	0.35	44	0.16	±	0.06	51	0.21	±	0.07	51
W Platt St (2)-03	0.66	±	0.28	38	0.14	±	0.06	38	0.21	±	0.06	38
W Platt St (2)-04	0.56	±	0.22	55	0.15	±	0.06	55	0.20	±	0.05	55
Tributaries												
Sulphur Springs (174)-02	0.46	±	0.19	4	0.10	±	0.01	4	0.11	±	0.01	4
Sulphur Springs (174)-03	0.45	±	0.24	38	0.10	±	0.02	38	0.11	±	0.02	38
Sulphur Springs (174)-04	0.36	±	0.19	55	0.10	±	0.01	55	0.11	±	0.02	55
Twin Lake Outfall (616) -04	0.97	±	0.10	5	0.07	±	0.04	5	0.16	±	0.13	5

Table 5.1-2. Continued.

Location (EPCHC/USGS station)-MFL period	Average Chlorophyll *a* uncorrected (µg/L)		SD	n	Average Water Color (pcu)		SD	n	Average Water Temperature °C		SD	n
Upper river segment (≥ 14.5 river kilometers from mouth) above dam												
E Fowler Ave (106)-01	3.43	±	4.93	45	82.95	±	52.08	197	22.66	±	4.65	197
E Fowler Ave (106)-02	2.74	±	2.48	26	83.70	±	42.51	51	21.97	±	4.77	51
E Fowler Ave (106)-03	6.69	±	11.63	38	86.51	±	46.28	38	22.91	±	4.74	38
E Fowler Ave (106)-04	5.99	±	9.97	55	64.71	±	32.44	55	22.51	±	4.16	55
Temple Terrace Hwy (266)-04	4.31	±	6.07	17	76.08	±	43.43	17	23.77	±	4.11	17
N 56th St (265)-04	9.94	±	8.73	17	69.19	±	36.48	17	24.23	±	4.32	17
Upper river segment (≥ 14.5 river kilometers from mouth) below dam												
Rowlett Park Dr (105)-01	10.70	±	16.59	194	75.54	±	43.82	198	23.69	±	4.55	198
Rowlett Park Dr (105)-02	11.30	±	15.01	51	74.61	±	43.66	51	23.39	±	4.57	51
Rowlett Park Dr (105)-03	11.51	±	10.61	35	67.23	±	39.92	35	24.69	±	4.47	35
Rowlett Park Dr (105)-04	11.65	±	11.54	55	60.14	±	32.26	55	24.45	±	3.62	54
Middle river segment (12.6 to < 14.5 river kilometers from mouth)												
Hanna's Whirl (1515)-03	ns				ns				24.61	±	4.45	32
Hanna's Whirl (1515)-04	ns				ns				24.43	±	3.62	54
N 12th St (1514)-03	ns				ns				24.24	±	4.43	35
N 12th St (1514)-04	ns				ns				24.71	±	3.36	55
Nebraska Ave (2304520)-01	ns				ns				ns			
Nebraska Ave (2304520)-02	ns				ns				ns			
Nebraska Ave (2304520)-03	ns				ns				ns			
Nebraska Ave (2304520)-04	ns				ns				ns			
Lower river segment (< 12.6 river kilometers from mouth)												
Hwy I-275 (23060013)-01	ns				ns				ns			
Hwy I-275 (23060013)-02	ns				ns				ns			
Hwy I-275 (23060013)-04	ns				ns				ns			
N River Shore Dr (1512)-03	ns				ns				24.61	±	3.93	35
N River Shore Dr (1512)-04	ns				ns				25.02	±	3.22	55
Sligh Ave (152)-01	18.81	±	12.92	10	74.40	±	74.34	10	26.67	±	1.09	10
Sligh Ave (152)-02	19.04	±	72.65	51	58.65	±	40.64	51	24.09	±	3.80	51
Sligh Ave (152)-03	10.29	±	9.38	38	54.91	±	39.17	38	24.89	±	3.87	38
Sligh Ave (152)-04	16.69	±	21.21	55	49.65	±	32.48	55	25.02	±	3.27	55
Lower river segment at river mouth												
W Platt St (2)-01	13.49	±	9.16	198	25.83	±	26.36	199	24.66	±	5.00	197
W Platt St (2)-02	7.17	±	10.85	47	33.75	±	31.59	51	24.26	±	5.01	51
W Platt St (2)-03	10.64	±	8.57	38	31.78	±	30.84	38	25.39	±	5.63	38
W Platt St (2)-04	14.19	±	19.53	55	33.69	±	31.26	55	25.22	±	4.67	54
Tributaries												
Sulphur Springs (174)-02	1.18	±	0.38	4	11.60	±	2.95	4	25.84	±	0.33	4
Sulphur Springs (174)-03	1.83	±	1.16	38	8.81	±	2.61	38	25.25	±	0.62	38
Sulphur Springs (174)-04	2.34	±	0.98	55	6.61	±	1.86	55	25.45	±	0.55	55
Twin Lake Outfall (616) -04	5.24	±	2.37	5	63.20	±	63.16	5	26.49	±	2.69	5

Table 5.2.1-1. Spearman Rho correlation analysis between mean monthly discharge (cfs) at USGS station 02304500 at the Hillsborough River dam and Rowlett Park Drive (EPCHC 105) below the dam from October 1979 to May 2018. Alpha = 0.0041667 after a Bonferroni correction for multiple comparisons. Bold values are significant.

		With Flow (> 1 cfs)	Without Flow (≤ 1 cfs)
		Mean Monthly Discharge	Mean Monthly Discharge
Water Temperature	Spearman rho	0.132	-0.002
	P-Value	0.016	0.986
Dissolved Oxygen	Spearman rho	0.232	-0.436
	P-Value	**0.000**	**0.000**
Dissolved Oxygen % Saturation	Spearman rho	0.172	-0.009
	P-Value	0.044	0.950
Conductivity	Spearman rho	-0.802	0.496
	P-Value	**0.000**	**0.000**
pH	Spearman rho	-0.382	-0.401
	P-Value	**0.000**	**0.000**
Salinity	Spearman rho	-0.636	0.483
	P-Value	**0.000**	**0.000**
Nitrates/Nitrites	Spearman rho	-0.120	0.093
	P-Value	0.038	0.316
OrthoPhosphate	Spearman rho	0.406	0.352
	P-Value	**0.000**	**0.000**
Total Nitrogen	Spearman rho	0.147	0.680
	P-Value	**0.009**	**0.000**
Total Phosphorus	Spearman rho	0.340	0.444
	P-Value	**0.000**	**0.000**
Chlorophyll *a* uncorrected	Spearman rho	-0.334	0.296
	P-Value	0.000	0.001
Water Color	Spearman rho	0.717	0.492
	P-Value	**0.000**	**0.000**

Table 5.2.2.1-1. Kruskal-Wallis with multiple comparison Dunn's Test analysis of nitrates/nitrites by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 2	East Fowler Avenue (EPCHC 106)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	2.8360			
	P-value	0.0046			
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value		2.8241		
	P-value		0.0047		
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value			2.9850	
	P-value			0.0028	
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value			3.1284	
	P-value			0.0018	
Sulphur Springs (EPCHC 174)-MFL 3	Z-value				3.3033
	P-value				0.0010

Table 5.2.2.1-2. Kruskal-Wallis analysis with multiple comparison Dunn's Test of orthophosphate by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 3	Sulphur Springs (EPCHC 174)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	2.8691					
	P-value	0.0041					
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value		3.1983	3.9791	3.4964		
	P-value		0.0014	0.0001	0.0005		
West Platt Street (EPCHC 2)-MFL 1	Z-value					3.5822	
	P-value					0.0003	
Sulphur Springs (EPCHC 174)-MFL 2	Z-value						2.3974
	P-value						0.0165

Table 5.2.2.1-3. Kruskal-Wallis analysis with multiple comparison Dunn's Test of total phosphorus by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 3	East Fowler Avenue (EPCHC 106)-MFL 4	Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	4.2268	2.6620					
	P-value	0.0000	0.0078					
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value	2.8015						
	P-value	0.0051						
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value			3.8421	4.6574	4.7073		
	P-value			0.0001	0.0000	0.0000		
West Platt Street (EPCHC 2)-MFL 1	Z-value						2.6722	3.3749
	P-value						0.0075	0.0007

Table 5.2.2.1-4. Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	Nebraska Ave (USGS 2304520)-MFL 2	Nebraska Ave (USGS 2304520)-MFL 4	Hwy I-275 (USGS 23060013)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 2	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	4.6208	6.3498	3.9329									
	P-value	0.0000	0.0000	0.0001									
Nebraska Ave (USGS 2304520)-MFL 1	Z-value				3.6093	3.8569							
	P-value				0.0003	0.0001							
Hwy I-275 (USGS 23060013)-MFL 1	Z-value						3.9662						
	P-value						0.0001						
Sligh Avenue (EPCHC 152)-MFL 1	Z-value							3.8401	3.4048				
	P-value							0.0001	0.0007				
West Platt Street (EPCHC 2)-MFL 1	Z-value									3.4534		2.6706	
	P-value									0.0006		0.0076	
West Platt Street (EPCHC 2)-MFL 2	Z-value										2.7672		
	P-value										0.0057		
Sulphur Springs (EPCHC 174)-MFL 3	Z-value												3.6485
	P-value												0.0003

Table 5.2.2.1-5. Kruskal-Wallis analysis with multiple comparison Dunn's Test of conductivity by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 2	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	Sulphur Springs (EPCHC 174)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	4.8387	6.5698	4.1462					
	P-value	0.0000	0.0000	0.0000					
Sligh Avenue (EPCHC 152)-MFL 1	Z-value				3.8475	3.4166			
	P-value				0.0001	0.0006			
West Platt Street (EPCHC 2)-MFL 1	Z-value						3.2457		
	P-value						0.0012		
West Platt Street (EPCHC 2)-MFL 2	Z-value							2.7795	
	P-value							0.0054	
Sulphur Springs (EPCHC 174)-MFL 3	Z-value								3.6485
	P-value								0.0003

Table 5.2.2.1-6. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	4.3036	4.9078	
	P-value	0.0000	0.0000	
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value		2.7472	
	P-value		0.0060	
West Platt Street (EPCHC 2)-MFL 2	Z-value			2.7925
	P-value			0.0052
West Platt Street (EPCHC 2)-MFL 3	Z-value			3.1485
	P-value			0.0016

Table 5.2.2.1-7. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen percent saturation by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value	3.6506	
	P-value	0.0003	
West Platt Street (EPCHC 2)-MFL 2	Z-value		3.1311
	P-value		0.0017
West Platt Street (EPCHC 2)-MFL 3	Z-value		3.3205
	P-value		0.0009

Table 5.2.2.1-8. Kruskal-Wallis with multiple comparison Dunn's Test analysis of pH by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	4.3604	3.6721	
	P-value	0.0000	0.0002	
West Platt Street (EPCHC 2)-MFL 1	Z-value			3.5850
	P-value			0.0003
West Platt Street (EPCHC 2)-MFL 2	Z-value			2.9287
	P-value			0.0034

Table 5.2.2.1-9. Kruskal-Wallis with multiple comparison Dunn's Test analysis of total nitrogen by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 2	Sligh Avenue (EPCHC 152)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	5.4750	5.9564	6.1584						
	P-value	0.0000	0.0000	0.0000						
Sligh Avenue (EPCHC 152)-MFL 1	Z-value				5.5651	4.3430				
	P-value				0.0000	0.0000				
Sligh Avenue (EPCHC 152)-MFL 2	Z-value						3.6294			
	P-value						0.0003			
West Platt Street (EPCHC 2)-MFL 1	Z-value							2.6936	5.3697	4.8900
	P-value							0.0071	0.0000	0.0000

Table 5.2.2.1-10. Kruskal-Wallis analysis with multiple comparison Dunn's Test of water color by MFL period for each EPCHC or USGS station without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 4
Sligh Avenue (EPCHC 152)-MFL 1	Z-value	3.4917	
	P-value	0.0005	
Sligh Avenue (EPCHC 152)-MFL 2	Z-value	2.6789	
	P-value	0.0074	
West Platt Street (EPCHC 2)-MFL 1	Z-value		3.2298
	P-value		0.0012
West Platt Street (EPCHC 2)-MFL 2	Z-value		4.2305
	P-value		0.0000

Table 5.2.2.1-11. Kruskal-Wallis analysis with multiple comparison Dunn's Test of conductivity by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 2	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	2.6769			
	P-value	0.0074			
West Platt Street (EPCHC 2)-MFL 1	Z-value		2.6453	2.9309	
	P-value		0.0082	0.0034	
West Platt Street (EPCHC 2)-MFL 2	Z-value			4.3626	3.2781
	P-value			0.0000	0.0010

Table 5.2.2.1-12. Kruskal-Wallis analysis with multiple comparison Dunn's Test of total nitrogen by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 4	Rowlett Park Drive (EPCHC 105)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	3.4844						
	P-value	0.0005						
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value		5.5499					
	P-value		0.0000					
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value		2.8439					
	P-value		0.0045					
Sligh Avenue (EPCHC 152)-MFL 1	Z-value			2.6772	3.8032			
	P-value			0.0074	0.0001			
Sligh Avenue (EPCHC 152)-MFL 2	Z-value				4.0234			
	P-value				0.0001			
West Platt Street (EPCHC 2)-MFL 1	Z-value					3.9572	5.5926	8.5127
	P-value					0.0001	0.0000	0.0000
West Platt Street (EPCHC 2)-MFL 2	Z-value							3.1824
	P-value							0.0015

Table 5.2.2.1-13. Kruskal-Wallis analysis with multiple comparison Dunn's Test of orthophosphate by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 2	East Fowler Avenue (EPCHC 106)-MFL 3	East Fowler Avenue (EPCHC 106)-MFL 4	Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	3.8363	3.0081	4.1968						
	P-value	0.0001	0.0026	0.0000						
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value				3.9954	3.5962	4.4057			
	P-value				0.0001	0.0003	0.0000			
West Platt Street (EPCHC 2)-MFL 1	Z-value							6.6494	7.3425	7.6103
	P-value							0.0000	0.0000	0.0000

Table 5.2.2.1-14. Kruskal-Wallis analysis with multiple comparison Dunn's Test of total phosphorus by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 2	East Fowler Avenue (EPCHC 106)-MFL 3	East Fowler Avenue (EPCHC 106)-MFL 4	Rowlett Park Drive (EPCHC 105)-MFL 2	Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	3.9839	4.1873	5.5508						
	P-value	0.0001	0.0000	0.0000						
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value				3.9300	4.8009	5.9298			
	P-value				0.0001	0.0000	0.0000			
West Platt Street (EPCHC 2)-MFL 1	Z-value							8.8356	8.1767	9.6189
	P-value							0.0000	0.0000	0.0000

Table 5.2.2.1-15. Kruskal-Wallis analysis with multiple comparison Dunn's Test of chlorophyll *a* uncorrected by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		East Fowler Avenue (EPCHC 106)-MFL 3	East Fowler Avenue (EPCHC 106)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	2.6905	3.1329				
	P-value	0.0071	0.0017				
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value		2.6647				
	P-value		0.0077				
Sligh Avenue (EPCHC 152)-MFL 2	Z-value			3.0284			
	P-value			0.0025			
West Platt Street (EPCHC 2)-MFL 1	Z-value				6.1242		
	P-value				0.0000		
West Platt Street (EPCHC 2)-MFL 2	Z-value					2.7877	3.3360
	P-value					0.0053	0.0009

Table 5.2.2.1-16. Kruskal-Wallis analysis with multiple comparison Dunn's Test of nitrates/nitrites by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 3	Rowlett Park Drive (EPCHC 105)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	4.5479	4.6265				
	P-value	0.0000	0.0000				
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value	3.2432	3.0149				
	P-value	0.0012	0.0026				
Sligh Avenue (EPCHC 152)-MFL 2	Z-value			4.4297	5.7636		
	P-value			0.0000	0.0000		
West Platt Street (EPCHC 2)-MFL 1	Z-value					3.9028	
	P-value					0.0001	
West Platt Street (EPCHC 2)-MF 2	Z-value						2.9804
	P-value						0.0029

Table 5.2.2.1-17. Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 4	West Platt Street (EPCHC 2)-MFL 2	West Platt Street (EPCHC 2)-MFL 3	West Platt Street (EPCHC 2)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value	2.6965				
	P-value	0.0070				
West Platt Street (EPCHC 2)-MFL 1	Z-value		2.8725	2.7378		
	P-value		0.0041	0.0062		
West Platt Street (EPCHC 2)-MFL 2	Z-value			4.3821	3.2086	
	P-value			0.0000	0.0013	
Sulphur Springs (EPCHC 174)-MFL 2	Z-value					2.9889
	P-value					0.0028
Sulphur Springs (EPCHC 174)-MFL 3	Z-value					3.4456
	P-value					0.0006

Table 5.2.2.18. Kruskal-Wallis analysis with multiple comparison Dunn's Test of pH by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		West Platt Street (EPCHC 2)-MFL 3
West Platt Street (EPCHC 2)-MFL 1	Z-value	3.2994
	P-value	0.0010
West Platt Street (EPCHC 2)-MFL 2	Z-value	3.2461
	P-value	0.0012

Table 5.2.2.1-19. Kruskal-Wallis analysis with multiple comparison Dunn's Test of water color by MFL period for each EPCHC or USGS station with water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Sulphur Springs (EPCHC 174)-MFL 4
Sulphur Springs (EPCHC 174)-MFL 2	Z-value	2.9410
	P-value	0.0033
Sulphur Springs (EPCHC 174)-MFL 3	Z-value	3.9081
	P-value	0.0001

Table 5.2.2.2-1. Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity at EPCHC and USGS stations for MFL period 1 without water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 1	Nebraska Ave (USGS 2304520)-MFL 1	Hwy I-275 (USGS 23060013)-MFL 1	Sligh Avenue (EPCHC 152)-MFL 1	West Platt Street (EPCHC 2)-MFL 1
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	4.0797	6.0651	5.9410	6.9808	13.5104
	P-value	0.0000	0.0000	0.0000	0.0000	0.0000
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value		3.1581	3.1813	4.2983	10.8987
	P-value		0.0016	0.0015	0.0000	0.0000
Nebraska Ave (USGS 2304520)-MFL 1	Z-value					4.8085
	P-value					0.0000
Hwy I-275 (USGS 23060013)-MFL 1	Z-value					4.2833
	P-value					0.0000
Sligh Avenue (EPCHC 152)-MFL 1	Z-value					3.1720
	P-value					0.0015

Table 5.2.2.2-2. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 1 without water flow over the dam from October 1979 to May 2018. Alpha = 0.008 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 1	Sligh Avenue (EPCHC 152)-MFL 1	West Platt Street (EPCHC 2)-MFL 1
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	8.9680	8.0038	3.3735
	P-value	0.0000	0.0000	0.0007
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value			5.4743
	P-value			0.0000
Sligh Avenue (EPCHC 152)-MFL 1	Z-value			5.6828
	P-value			0.0000

Table 5.2.2.2-3. Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 2 without water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Nebraska Ave (USGS 2304520)-MFL 2	Hwy I-275 (USGS 23060013)-MLF 2	Sligh Avenue (EPCHC 152)-MFL 2	West Platt Street (EPCHC 2)-MFL 2	Sulphur Springs (EPCHC 174)-MFL 2
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value	5.3535	3.7493	5.7822	8.7307	
	P-value	0.0000	0.0002	0.0000	0.0000	
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value			3.4400	6.3886	
	P-value			0.0006	0.0000	
Nebraska Ave (USGS 2304520)-MFL 2	Z-value				3.3773	
	P-value				0.0007	
West Platt Street (EPCHC 2)-MFL 2	Z-value					4.7711
	P-value					0.0000

Table 5.2.2.2-4. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 2 without water flow over the dam from October 1979 to May 2018. Alpha = 0.005 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Sligh Avenue (EPCHC 152)-MFL 2	West Platt Street (EPCHC 2)-MFL 2	Sulphur Springs (EPCHC 174)-MFL 2
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value	5.3836		
	P-value	0.0000		
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value	3.0393		3.4839
	P-value	0.0024		0.0005
Sligh Avenue (EPCHC 152)-MFL 2	Z-value		3.6811	5.8235
	P-value		0.0002	0.0000
West Platt Street (EPCHC 2)-MFL 2	Z-value			2.9898
	P-value			0.0028

Table 5.2.2.2-5. Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 3 without water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		North 12th Street (EPCHC 1514)-MFL 3	Nebraska Ave (USGS 2304520)-MFL 3	North River Shore Dr (EPCHC 1512)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 3	West Platt Street (EPCHC 2)-MFL 3	Sulphur Springs (EPCHC 174)-MFL 3
East Fowler Avenue (EPCHC 106)-MFL 3	Z-value	3.9829	6.1212	5.3272	7.2691	9.2135	
	P-value	0.0001	0.0000	0.0000	0.0000	0.0000	
Rowlett Park Drive (EPCHC 105)-MFL 3	Z-value		4.2845	3.8145	5.4166	7.3346	
	P-value		0.0000	0.0001	0.0000	0.0000	
Hanna's Whirl (EPCHC 1515)-MFL 3	Z-value					4.2829	
	P-value					0.0000	
North 12th Street (EPCHC 1514)-MFL 3	Z-value					3.6685	
	P-value					0.0002	
Nebraska Ave (USGS 2304520)-MFL 3	Z-value						3.6996
	P-value						0.0002
North River Shore Dr (EPCHC 1512)-MFL 3	Z-value						3.3161
	P-value						0.0009
Sligh Avenue (EPCHC 152)-MFL 3	Z-value						4.8474
	P-value						0.0000
West Platt Street (EPCHC 2)-MFL 3	Z-value						6.7918
	P-value						0.0000

Table 5.2.2.2-6. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 3 without water flow over the dam from October 1979 to May 2018. Alpha = 0.002 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Hanna's Whirl (EPCHC 1515)-MFL 3	North 12th Street (EPCHC 1514)-MFL 3	North River Shore Dr (EPCHC 1512)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 3	West Platt Street (EPCHC 2)-MFL 3	Sulphur Springs (EPCHC 174)-MFL 3
East Fowler Avenue (EPCHC 106)-MFL 3	Z-value	3.6997	4.3306	4.6860	5.8223		
	P-value	0.0002	0.0000	0.0000	0.0000		
Rowlett Park Drive (EPCHC 105)-MFL 3	Z-value			3.1119	3.9090		3.1473
	P-value			0.0018	0.0001		0.0016
Hanna's Whirl (EPCHC 1515)-MFL 3	Z-value						4.7668
	P-value						0.0000
North 12th Street (EPCHC 1514)-MFL 3	Z-value						5.4359
	P-value						0.0000
North River Shore Dr (EPCHC 1512)-MFL 3	Z-value						5.7913
	P-value						0.0000
Sligh Avenue (EPCHC 152)-MFL 3	Z-value					3.2876	7.1531
	P-value					0.0010	0.0000
West Platt Street (EPCHC 2)-MFL 3	Z-value						3.8655
	P-value						0.0001

Table 5.2.2.2-7. Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 4 without water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		North 12th Street (EPCHC 1514)-MFL 4	Nebraska Ave (USGS 2304520)-MFL 4	Hwy I-275 (USGS 23060013)-MFL 4	North River Shore Dr (EPCHC 1512)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 4	Z-value	4.1618	3.3310	4.8924	5.5131	6.2321	7.6019	
	P-value	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	
Temple Terrace Hwy (EPCHC 266)-MFL 4	Z-value			4.1696	4.4743	5.0759	6.2219	
	P-value			0.0000	0.0000	0.0000	0.0000	
North 56th Street (EPCHC 265)-MFL 4	Z-value			3.9443	4.2175	4.8190	5.9650	
	P-value			0.0001	0.0000	0.0000	0.0000	
Rowlett Park Drive (EPCHC 105)-MFL 4	Z-value			3.4193	3.7524	4.4714	5.8412	
	P-value			0.0006	0.0002	0.0000	0.0000	
Hanna's Whirl (EPCHC 1515)-MFL 4	Z-value						4.6262	
	P-value						0.0000	
North 12th Street (EPCHC 1514)-MFL 4	Z-value						3.4401	
	P-value						0.0006	
West Platt Street (EPCHC 2)-MFL 4	Z-value							4.6656
	P-value							0.0000

Table 5.2.2.2-8. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 4 without water flow over the dam from October 1979 to May 2018. Alpha = 0.001 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Hanna's Whirl (EPCHC 1515)-MFL 4	North 12th Street (EPCHC 1514)-MFL 4	North River Shore Dr (EPCHC 1512)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 4	Z-value	3.7266	5.1168	5.6988	5.7882		
	P-value	0.0002	0.0000	0.0000	0.0000		
Temple Terrace Hwy (EPCHC 266)-MFL 4	Z-value		3.9463	4.4332	4.5027		
	P-value		0.0001	0.0000	0.0000		
North 56th Street (EPCHC 265)-MFL 4	Z-value		3.4653	3.9521	4.0217		
	P-value		0.0005	0.0001	0.0001		
Rowlett Park Drive (EPCHC 105)-MFL 4	Z-value			3.4026	3.4858		
	P-value			0.0007	0.0005		
Hanna's Whirl (EPCHC 1515)-MFL 4	Z-value						3.8727
	P-value						0.0001
North 12th Street (EPCHC 1514)-MFL 4	Z-value					3.5345	5.2630
	P-value					0.0004	0.0000
North River Shore Dr (EPCHC 1512)-MFL 4	Z-value					4.1164	5.8450
	P-value					0.0000	0.0000
Sligh Avenue (EPCHC 152)-MFL 4	Z-value					4.1995	5.9281
	P-value					0.0000	0.0000

Table 5.2.2.2-9. Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 1 with water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 1	Nebraska Ave (USGS 2304520)-MFL 1	Hwy I-275 (USGS 23060013)-MFL 1	Sligh Avenue (EPCHC 152)-MFL 1	West Platt Street (EPCHC 2)-MFL 1
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	3.4450	4.2300	3.5161	3.2374	18.3530
	P-value	0.0006	0.0000	0.0004	0.0012	0.0000
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value					15.6061
	P-value					0.0000
Nebraska Ave (USGS 2304520)-MFL 1	Z-value					2.9500
	P-value					0.0032

Table 5.2.2.2-10. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 1 with water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 1	Sligh Avenue (EPCHC 152)-MFL 1	West Platt Street (EPCHC 2)-MFL 1
East Fowler Avenue (EPCHC 106)-MFL 1	Z-value	9.6507		4.7051
	P-value	0.0000		0.0000
Rowlett Park Drive (EPCHC 105)-MFL 1	Z-value		4.2002	4.8769
	P-value		0.0000	0.0000
Sligh Avenue (EPCHC 152)-MFL 1	Z-value			2.6704
	P-value			0.0076

Table 5.2.2.2-11. Kruskal-Wallis with multiple comparison Dunn's Test analysis of salinity at EPCHC and USGS stations for MFL period 2 with water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Nebraska Ave (USGS 2304520)-MFL 2	Hwy I-275 (USGS 23060013)-MFL 2	Sligh Avenue (EPCHC 152)-MFL 2	West Platt Street (EPCHC 2)-MFL 2
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value	6.8387	5.2178	6.5937	11.7738
	P-value	0.0000	0.0000	0.0000	0.0000
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value	5.5119	4.0946	5.2384	10.4444
	P-value	0.0000	0.0000	0.0000	0.0000
Nebraska Ave (USGS 2304520)-MFL 2	Z-value				4.7171
	P-value				0.0000
Hwy I-275 (USGS 23060013)-MFL 2	Z-value				4.4884
	P-value				0.0000
Sligh Avenue (EPCHC 152)-MF 2	Z-value				5.2060
	P-value				0.0000

Table 5.2.2.2-12. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 2 with water flow over the dam from October 1979 to May 2018. Alpha = 0.005 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 2	Sligh Avenue (EPCHC 152)-MFL 2	West Platt Street (EPCHC 2)-MFL 2
East Fowler Avenue (EPCHC 106)-MFL 2	Z-value	7.0130		
	P-value	0.0000		
Rowlett Park Drive (EPCHC 105)-MFL 2	Z-value		5.2873	4.6630
	P-value		0.0000	0.0000

Table 5.2.2.2-13. Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 3 with water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		North 12th Street (EPCHC 1514)-MFL 3	Nebraska Ave (USGS 2304520)-MFL 3	North River Shore Dr (EPCHC 1512)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 3	West Platt Street (EPCHC 2)-MFL 3	Sulphur Springs (EPCHC 174)-MFL 3
East Fowler Avenue (EPCHC 106)-MFL 3	Z-value	3.4626	6.3270	6.0129	5.9195	11.4993	6.1166
	P-value	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
Rowlett Park Drive (EPCHC 105)-MFL 3	Z-value		4.8261	4.5481	4.4244	9.9251	4.6187
	P-value		0.0000	0.0000	0.0000	0.0000	0.0000
Hanna's Whirl (EPCHC 1515)-MFL 3	Z-value		3.7091	3.4608	3.3169	8.6881	3.5066
	P-value		0.0002	0.0005	0.0009	0.0000	0.0005
North 12th Street (EPCHC 1514)-MFL 3	Z-value					7.8514	
	P-value					0.0000	
Nebraska Ave (USGS 2304520)-MFL 3	Z-value					5.2071	
	P-value					0.0000	
North River Shore Dr (EPCHC 1512)-MFL 3	Z-value					5.2846	
	P-value					0.0000	
Sligh Avenue (EPCHC 152)-MFL 3	Z-value					5.6173	
	P-value					0.0000	
West Platt Street (EPCHC 2)-MFL 3	Z-value						5.4189
	P-value						0.0000

Table 5.2.2.2-14. Kruskal-Wallis analysis with multiple comparison Dunn's Test of dissolved oxygen at EPCHC and USGS stations for MFL period 3 with water flow over the dam from October 1979 to May 2018. Alpha = 0.002 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 3	Hanna's Whirl (EPCHC 1515)-MFL 3	North River Shore Dr (EPCHC 1512)-MFL 3	Sligh Avenue (EPCHC 152)-MFL 3	Sulphur Springs (EPCHC 174)-MFL 3
East Fowler Avenue (EPCHC 106)-MFL 3	Z-value	5.5394				5.5151
	P-value	0.0000				0.0000
Rowlett Park Drive (EPCHC 105)-MFL 3	Z-value		3.2384	4.1433	4.6691	
	P-value		0.0012	0.0000	0.0000	
North River Shore Dr (EPCHC 1512)-MFL 3	Z-value					4.0888
	P-value					0.0000
Sligh Avenue (EPCHC 152)-MFL 3	Z-value					4.6263
	P-value					0.0000

Table 5.2.2.2-15. Kruskal-Wallis analysis with multiple comparison Dunn's Test of salinity at EPCHC and USGS stations for MFL period 4 with water flow over the dam from October 1979 to May 2018. Alpha = 0.003 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Nebraska Ave (USGS 2304520)-MFL 4	Hwy I-275 (USGS 23060013)-MFL 4	North River Shore Dr (EPCHC 1512)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4	Twin Lake Outfall (EPCHC 616)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 4	Z-value	4.0450	5.1327	6.7426	6.9590	12.7553	8.0427	
	P-value	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	
Temple Terrace Hwy (EPCHC 266)-MFL 4	Z-value		4.2770	4.7509	4.8997	8.9038	5.6444	
	P-value		0.0000	0.0000	0.0000	0.0000	0.0000	
North 56th Street (EPCHC 265)-MFL 4	Z-value	3.4963	4.3763	4.9099	5.0587	9.0625	5.8033	
	P-value	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	
Rowlett Park Drive (EPCHC 105)-MFL 4	Z-value	3.4805	4.5659	5.9049	6.1204	11.8943	7.1991	
	P-value	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	
Hanna's Whirl (EPCHC 1515)-MFL 4	Z-value		3.8158	4.8161	5.0316	10.8104	6.1103	
	P-value		0.0001	0.0000	0.0000	0.0000	0.0000	
North 12th Street (EPCHC 1514)-MFL 4	Z-value			3.8953	4.1118	9.9212	5.1955	
	P-value			0.0001	0.0000	0.0000	0.0000	
Nebraska Ave (USGS 2304520)-MFL 4	Z-value					4.7504		
	P-value					0.0000		
Hwy I-275 (USGS 23060013)-MFL 4	Z-value					3.6650		
	P-value					0.0002		
North River Shore Dr (EPCHC 1512)-MFL 4	Z-value					6.0438		
	P-value					0.0000		
Sligh Avenue (EPCHC 152)-MFL 4	Z-value					5.8283		
	P-value					0.0000		
West Platt Street (EPCHC 2)-MFL 4	Z-value						4.7496	5.2776
	P-value						0.0000	0.0000

Table 5.2.2.2-16. Kruskal-Wallis with multiple comparison Dunn's Test analysis of dissolved oxygen at EPCHC and USGS stations for MFL period 4 with water flow over the dam from October 1979 to May 2018. Alpha = 0.001 after a Bonferroni correction for multiple comparisons. Only significant values are shown.

Location (EPCHC station)-MFL period		Rowlett Park Drive (EPCHC 105)-MFL 4	Hanna's Whirl (EPCHC 1515)-MFL 4	North 12th Street (EPCHC 1514)-MFL 4	North River Shore Dr (EPCHC 1512)-MFL 4	Sligh Avenue (EPCHC 152)-MFL 4	West Platt Street (EPCHC 2)-MFL 4	Sulphur Springs (EPCHC 174)-MFL 4	Twin Lake Outfall (EPCHC 616)-MFL 4
East Fowler Avenue (EPCHC 106)-MFL 4	Z-value	7.3321	5.1792	3.8131				5.6262	3.3482
	P-value	0.0000	0.0000	0.0001				0.0000	0.0008
Temple Terrace Hwy (EPCHC 266)-MFL 4	Z-value	5.7914	4.3290	3.3964				4.6250	3.5077
	P-value	0.0000	0.0000	0.0007				0.0000	0.0005
North 56th Street (EPCHC 265)-MFL 4	Z-value	5.6007	4.1382					4.4338	3.4018
	P-value	0.0000	0.0000					0.0000	0.0007
Rowlett Park Drive (EPCHC 105)-MFL 4	Z-value			3.5691	5.3476	5.7003	5.1616		
	P-value			0.0004	0.0000	0.0000	0.0000		
Hanna's Whirl (EPCHC 1515)-MFL 4	Z-value					3.5275			
	P-value					0.0004			
North River Shore Dr (EPCHC 1512)-MFL 4	Z-value							3.6168	
	P-value							0.0003	
Sligh Avenue (EPCHC 152)-MFL 4	Z-value							3.9712	
	P-value							0.0001	
West Platt Street (EPCHC 2)-MFL 4	Z-value							3.4378	
	P-value							0.0006	

Table 5.2.3-1. Number of monthly sampling days that dissolved oxygen percent saturation was under the Florida state water quality standard (38%), or salinity was above the 5.0 (ppt) MFL goal at the EPCHC and USGS stations by MFL period and Lower Hillsborough River segment from October 1979 to May 2018 when water was flowing over the dam.

Location (EPCHC station)-MFL period	Dissolved Oxygen Percent Saturation (<38%) Top Water Samples	Dissolved Oxygen Percent Saturation (<38%) Middle Water Samples	Dissolved Oxygen Percent Saturation (<38%) Bottom Water Samples	Salinity (≥5 ppt) Top Water Samples	Salinity (≥5 ppt) Middle Water Samples	Salinity (≥5 ppt) Bottom Water Samples
Upper segment (≥14.5 river kilometers from mouth) above dam						
East Fowler Avenue (EPCHC 106)-MFL 1	0	0	0	0	0	0
East Fowler Avenue (EPCHC 106)-MFL 2	26	26	25	0	0	0
East Fowler Avenue (EPCHC 106)-MFL 3	21	21	20	0	0	0
East Fowler Avenue (EPCHC 106)-MFL 4	31	32	26	0	0	0
Temple Terrace Hwy (EPCHC 266)-MFL 4	12	12	12	0	0	0
North 56th Street (EPCHC 265)-MFL 4	10	12	13	0	0	0
Upper river segment (≥ 14.5 river kilometers from mouth) below dam						
Rowlett Park Drive (EPCHC 105)-MFL 1	0	0	0	8	18	11
Rowlett Park Drive (EPCHC 105)-MFL 2	0	3	3	0	0	0
Rowlett Park Drive (EPCHC 105)-MFL 3	0	1	3	0	1	1
Rowlett Park Drive (EPCHC 105)-MFL 4	1	3	4	0	0	0
Middle segment (12.6 to < 14.5 river kilometers from mouth)						
Hanna's Whirl (EPCHC 1515)-MFL 3	2	6	8	0	4	9
Hanna's Whirl (EPCHC 1515)-MFL 4	1	8	12	0	2	7
North 12th Street (EPCHC 1514)-MFL 3	3	8	11	5	11	13
North 12th Street (EPCHC 1514)-MFL 4	4	11	19	2	8	16
Nebraska Ave (USGS 2304520)-MFL 01					7	
Nebraska Ave (USGS 2304520)-MFL 02					18	
Nebraska Ave (USGS 2304520)-MFL 03					15	
Nebraska Ave (USGS 2304520)-MFL 04					2	
Tributaries						
Sulphur Springs (EPCHC 174)-MFL 2	0	0	0	0	0	0
Sulphur Springs (EPCHC 174)-MFL 3	0	2	0	0	0	0
Sulphur Springs (EPCHC 174)-MFL 4	0	0	0	0	0	0
Twin Lake (EPCHC 616)-MFL 4	0	0	0	0	0	0

Table 5.2.3-2. Number of monthly sampling days that dissolved oxygen percent saturation was under the Florida state water quality standard (38%), or salinity was over the 5.0 (ppt) MFL goal at the EPCHC and USGS stations by MFL period and Lower Hillsborough River segment from October 1979 to May 2018 when water was not flowing over the dam.

Location (EPCHC station)-MFL period	Dissolved Oxygen Percent Saturation (<38%) Top Water Samples	Dissolved Oxygen Percent Saturation (<38%) Middle Water Samples	Dissolved Oxygen Percent Saturation (<38%) Bottom Water Samples	Salinity (≥5 ppt) Top Water Samples	Salinity (≥5 ppt) Middle Water Samples	Salinity (≥5 ppt) Bottom Water Samples
Upper segment (≥14.5 river kilometers from mouth) above dam						
East Fowler Avenue (EPCHC 106)-MFL 1	0	0	0	0	1	0
East Fowler Avenue (EPCHC 106)-MFL 2	1	1	1	0	0	0
East Fowler Avenue (EPCHC 106)-MFL 3	1	1	1	0	0	0
East Fowler Avenue (EPCHC 106)-MFL 4	0	0	0	0	0	0
Temple Terrace Hwy (EPCHC 266)-MFL 4	0	0	0	0	0	0
North 56th Street (EPCHC 265)-MFL 4	0	0	1	0	0	0
Upper river segment (≥ 14.5 river kilometers from mouth) below dam						
Rowlett Park Drive (EPCHC 105)-MFL 1	0	0	0	39	51	41
Rowlett Park Drive (EPCHC 105)-MFL 2	1	4	7	1	2	4
Rowlett Park Drive (EPCHC 105)-MFL 3	0	0	0	0	0	1
Rowlett Park Drive (EPCHC 105)-MFL 4	0	0	0	0	0	0
Middle segment (12.6 to < 14.5 river kilometers from mouth)						
Hanna's Whirl (EPCHC 1515)-MFL 3	3	5	7	0	1	7
Hanna's Whirl (EPCHC 1515)-MFL 4	0	0	6	0	2	6
North 12th Street (EPCHC 1514)-MFL 3	4	8	6	5	7	10
North 12th Street (EPCHC 1514)-MFL 4	2	5	6	4	7	9
Nebraska Ave (USGS 2304520)-MFL 01					25	
Nebraska Ave (USGS 2304520)-MFL 02					18	
Nebraska Ave (USGS 2304520)-MFL 03					19	
Nebraska Ave (USGS 2304520)-MFL 04					3	
Tributaries						
Sulphur Springs (EPCHC 174)-MFL 2	0	0	0	0	2	1
Sulphur Springs (EPCHC 174)-MFL 3	0	0	0	0	0	0
Sulphur Springs (EPCHC 174)-MFL 4	0	0	0	0	0	0
Twin Lake (EPCHC 616)-MFL 4	0	0	0	0	0	0

APPENDIX 5.1-2

WATER QUALITY DESCRIPTIVE STATISTICS FIGURES

List of Figures included in Appendix 5.1-2

Figure 5.1-1 Average of monthly salinity (ppt) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-2 Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 2304520 Nebraska Avenue in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-3 Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 23060013 Hwy I-275 in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-4 Average of monthly salinity (ppt) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-5 Average of monthly salinity (ppt) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-6 Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 2304520 Nebraska Avenue in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-7 Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 23060013 Hwy I-275 the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-8 Average of monthly salinity (ppt) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-9 Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-10 Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-11 Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-12 Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-13 Average of monthly specific conductance (μmho/cm) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-14 Average of monthly specific conductance (μmho/cm) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-15 Average of monthly specific conductance (μmho/cm) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-16 Average of monthly specific conductance (μmho/cm) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-17 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points

Figure 5.1-18 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-19 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-20 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-21 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-22 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-23 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-24 Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-25 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-26 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-27 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-28 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-29 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-30 Average monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-31 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-32 Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-33 Average of monthly pH data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-34 Average of monthly pH data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-35 Average of monthly pH data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-36 Average of monthly pH data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-37 Average of monthly pH data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-38 Average of monthly pH data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-39 Average of monthly pH data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-40 Average of monthly pH data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-41 Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-42 Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-43 Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-44 Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean,

horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-45 Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-46 Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-47 Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-48 Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-49 Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-50 Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-51 Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-52 Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-53 Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-54 Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-55 Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-56 Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-57 Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-58 Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-59 Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines =

the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-60 Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-61 Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-62 Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-63 Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-64 Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-65 Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-66 Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-67 Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-68 Average of uncorrected monthly chlorophyll *a* (µg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-69 Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-70 Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-71 Average of monthly water color (pcu) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-72 Average of monthly water color (pcu) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-73 Average of monthly water color (pcu) data recorded at EPCHC stations located in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-74 Average of monthly water color (pcu) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-75 Average of monthly water color (pcu) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-76 Average of monthly water color (pcu) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-77 Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-78 Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-79 Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-80 Average of monthly water temperature (°C) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-81 Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-82 Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-83 Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-84 Average of monthly water temperature (°C) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points).

Figure 5.1-85 Average of daily salinity (ppt) data as calculated from specific conductance data at USGS gage 02304517 (Hannah's Whirl near Sulphur Springs) from both surface and bottom continuous data recorders for the available period of record within the scope of the second five-year assessment.

Figure 5.1-86 Average of daily specific conductance (uS/cm) data at USGS gage 02304517 (Hannah's Whirl near Sulphur Springs) from both surface and bottom continuous data recorders for the available period of record within the scope of the second five-year assessment.

Figure 5.1-87 Average of daily dissolved oxygen (mg/L) data at USGS gage 02304517 (Hannah's Whirl near Sulphur Springs) from both surface and bottom continuous data recorders for the available period of record within the scope of the second five-year assessment.

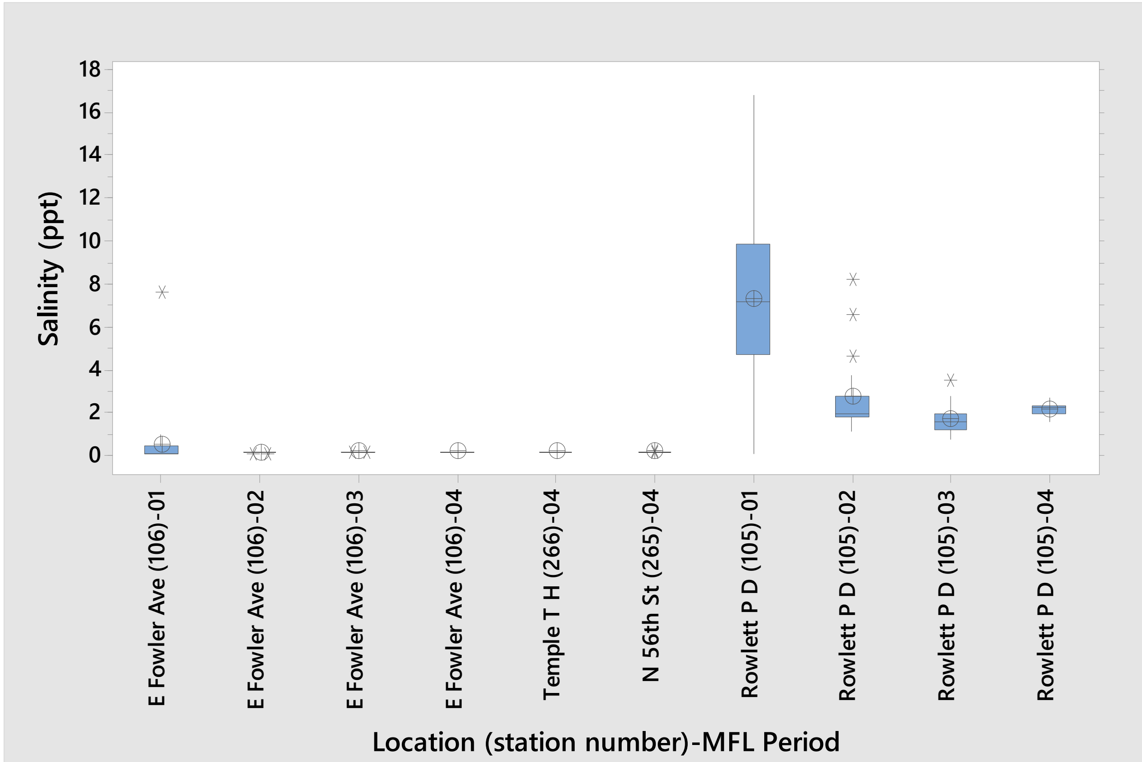


Figure 5.1-1. Average of monthly salinity (ppt) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

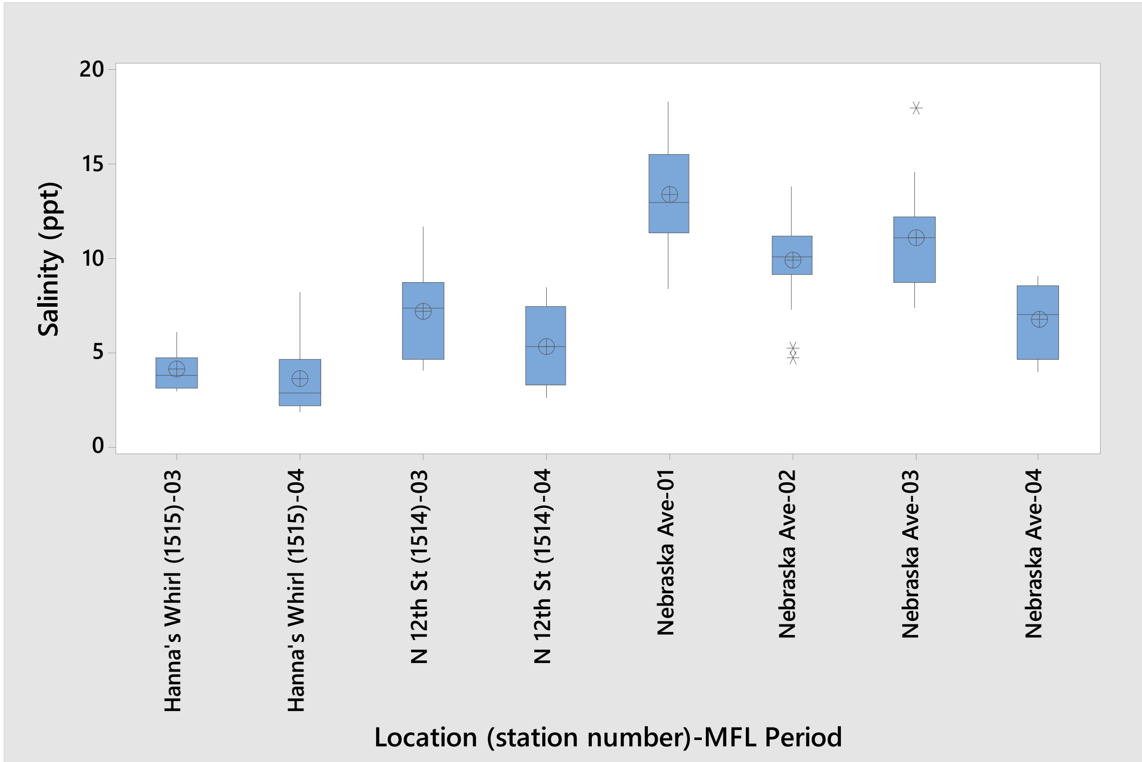


Figure 5.1-2. Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 2304520 Nebraska Avenue in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

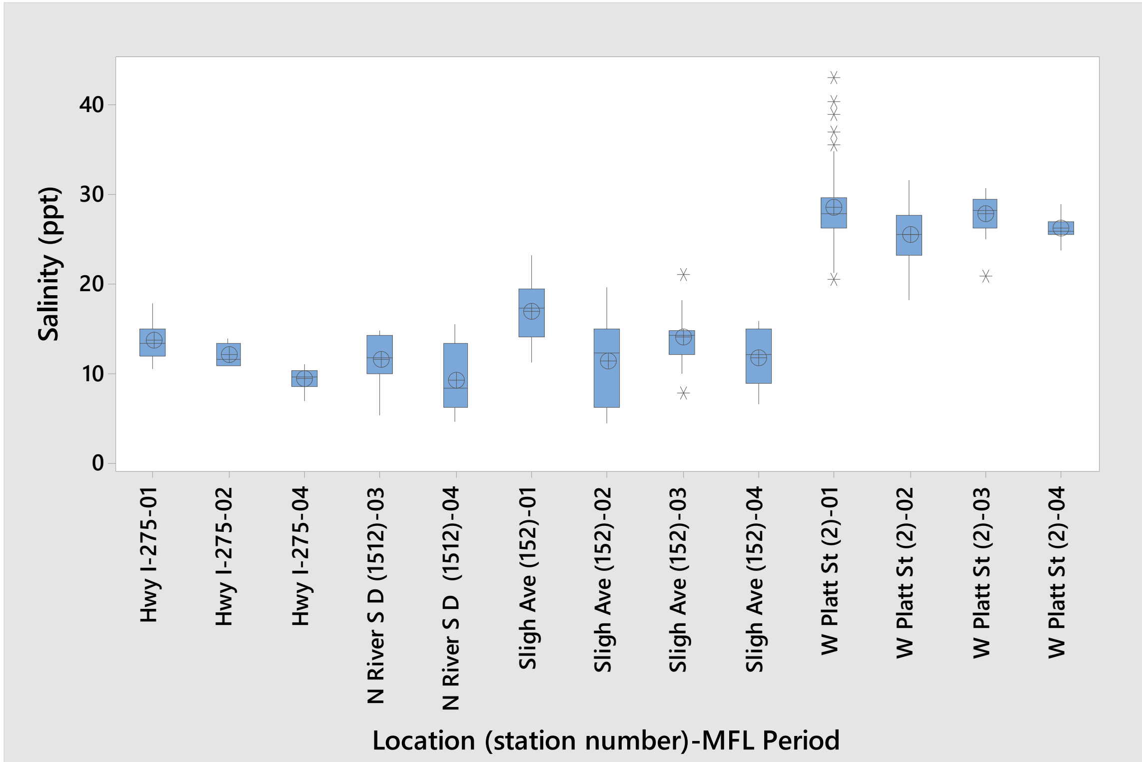


Figure 5.1-3. Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 23060013 Hwy I-275 in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

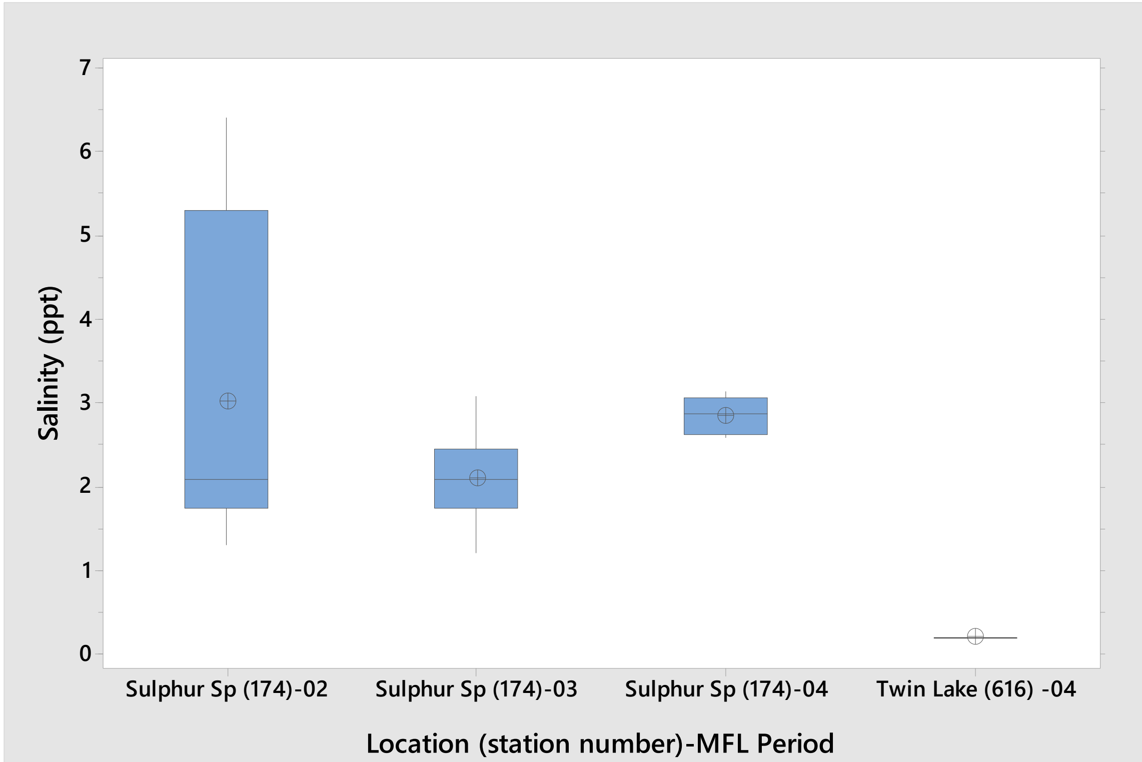


Figure 5.1-4. Average of monthly salinity (ppt) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

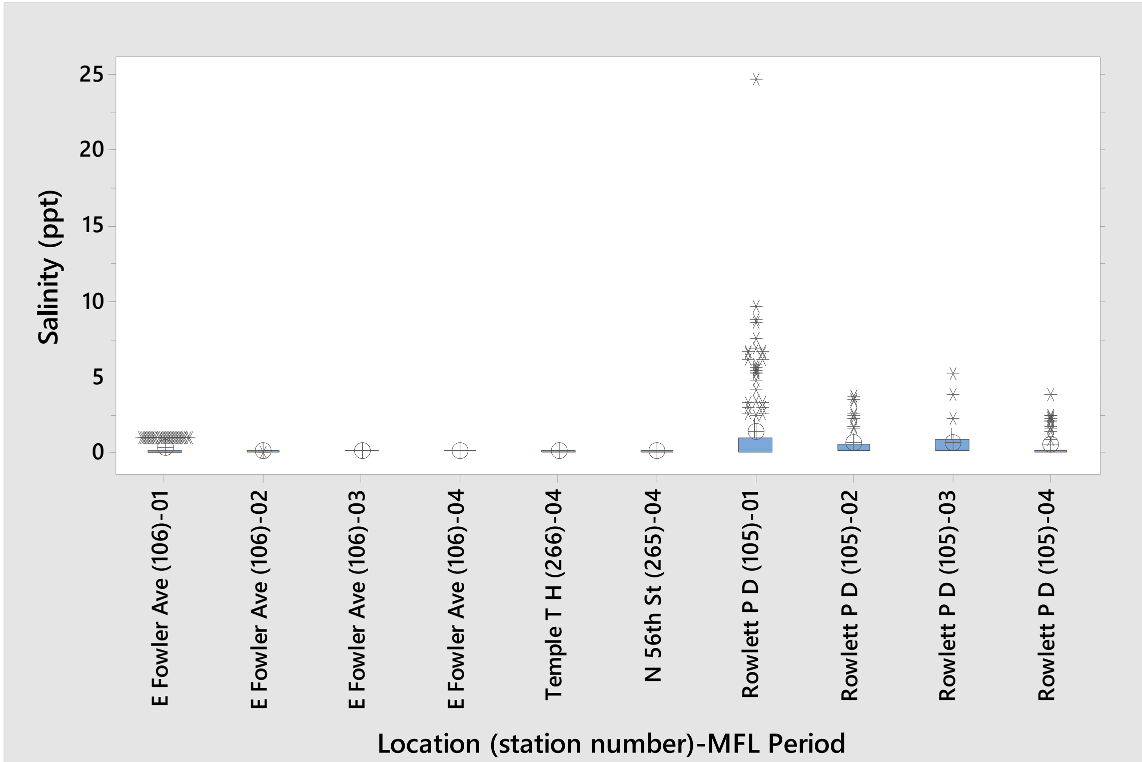


Figure 5.1-5. Average of monthly salinity (ppt) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

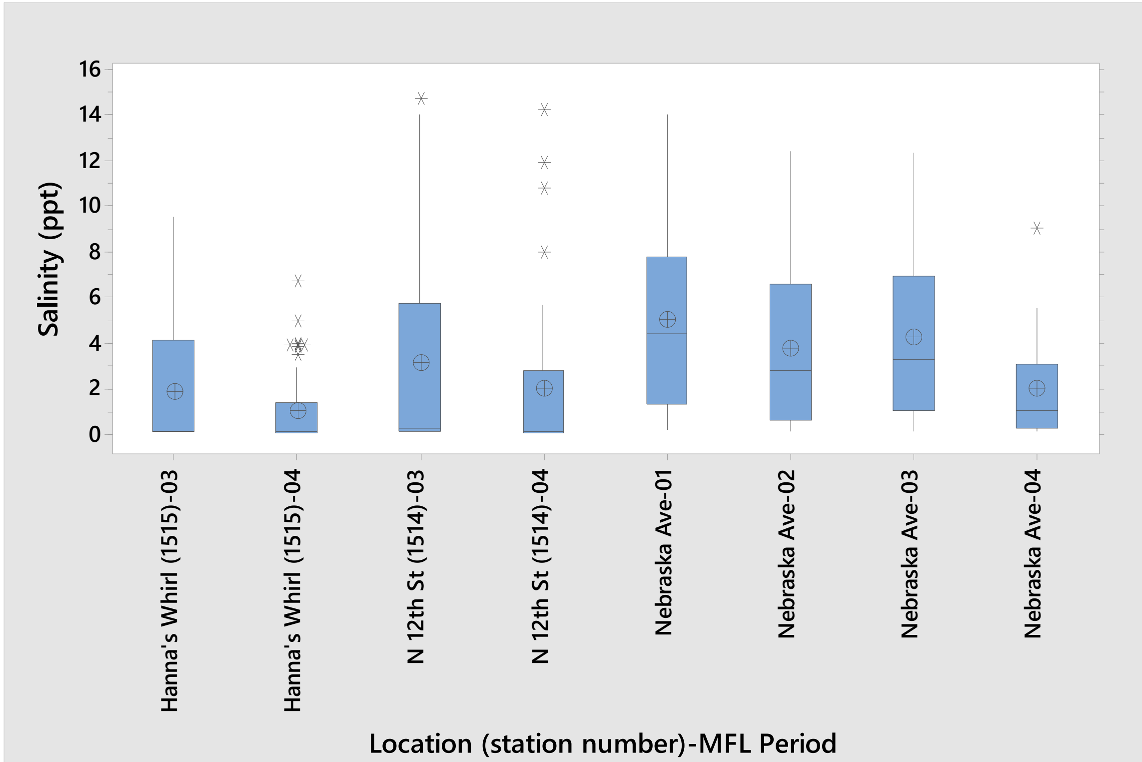


Figure 5.1-6. Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 2304520 Nebraska Avenue in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

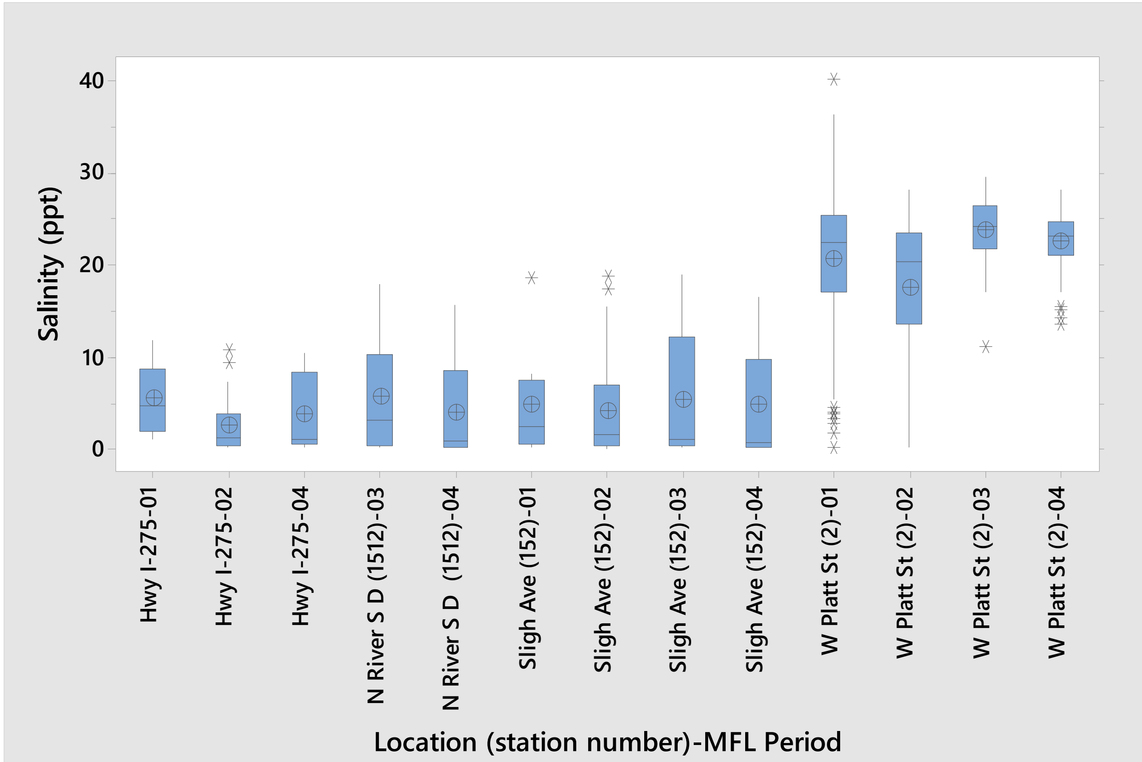


Figure 5.1-7. Average of monthly salinity (ppt) data recorded at EPCHC stations and USGS station 23060013 Hwy I-275 the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

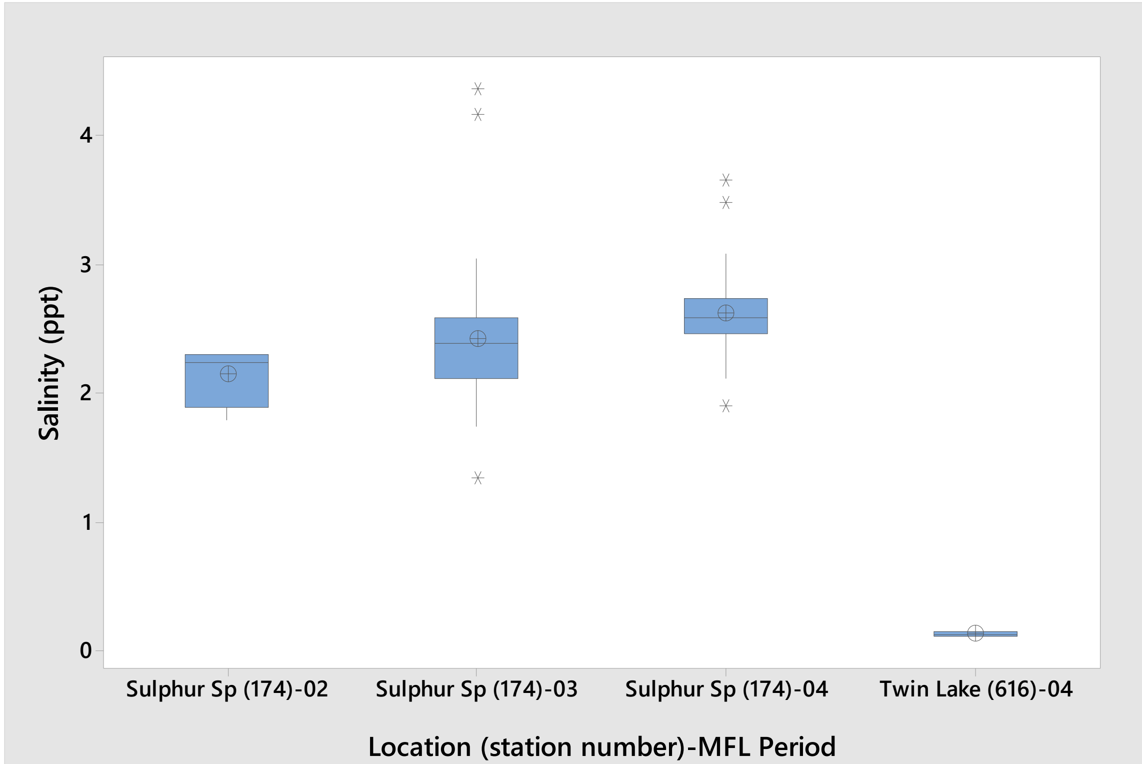


Figure 5.1-8. Average of monthly salinity (ppt) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

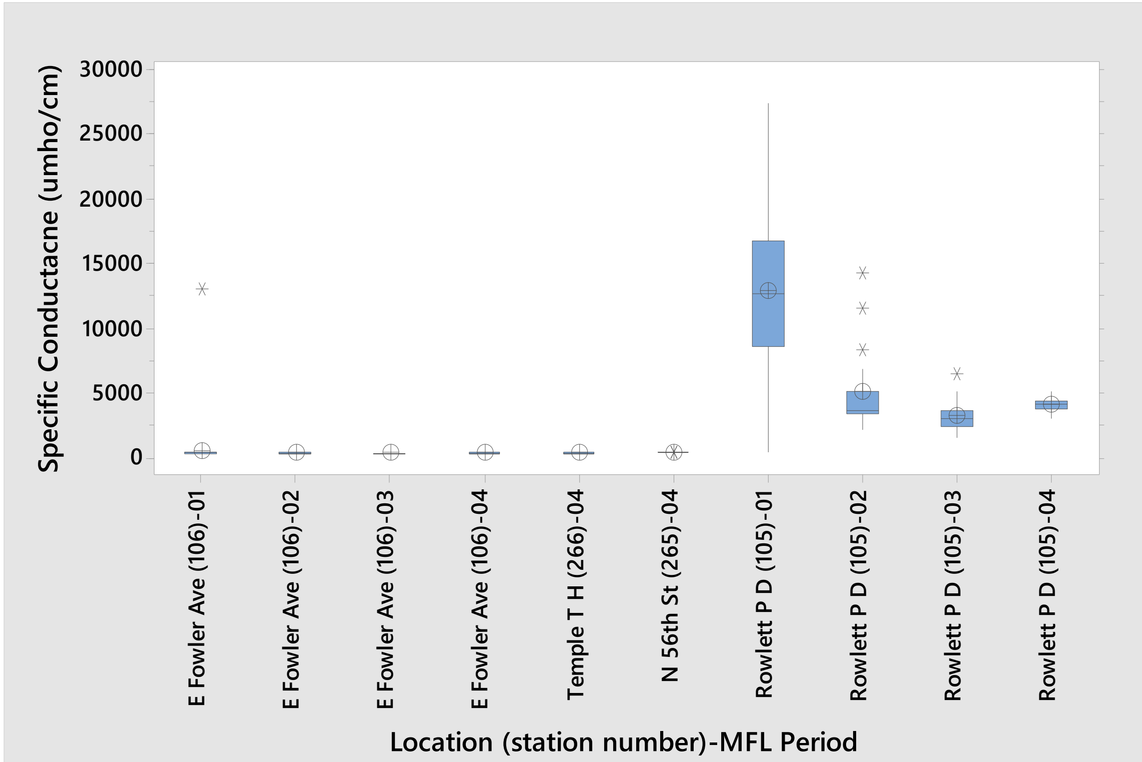


Figure 5.1-9. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

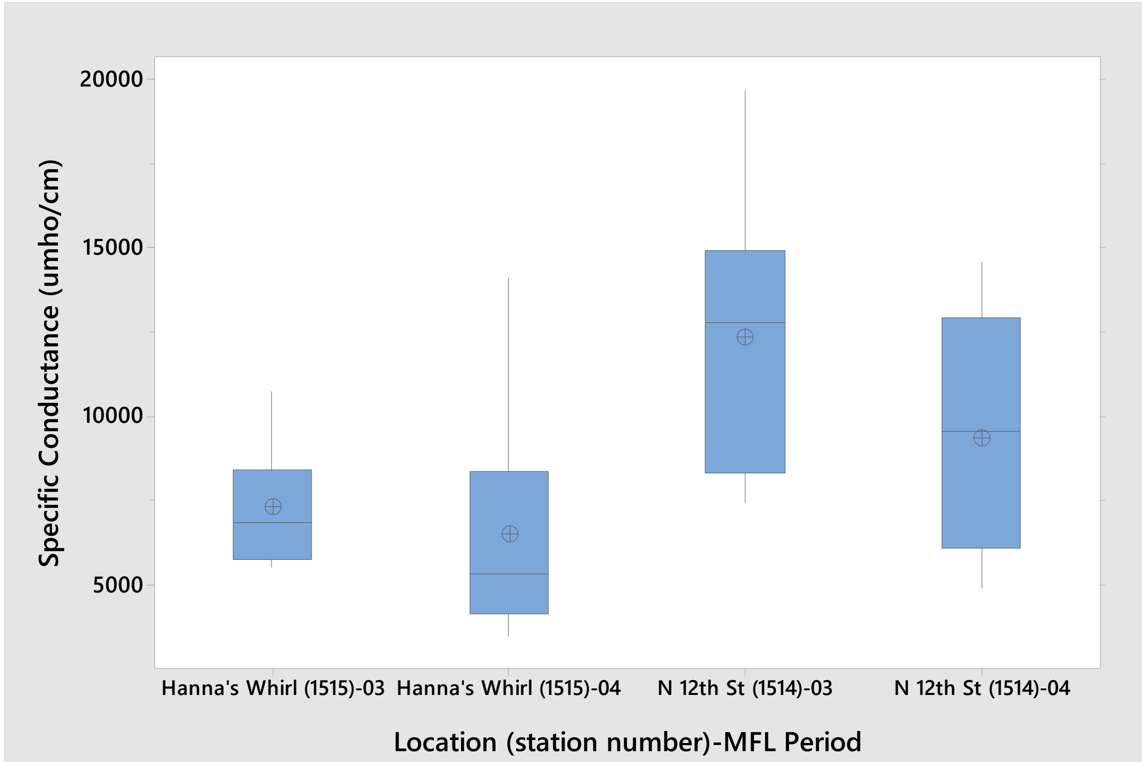


Figure 5.1-10. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

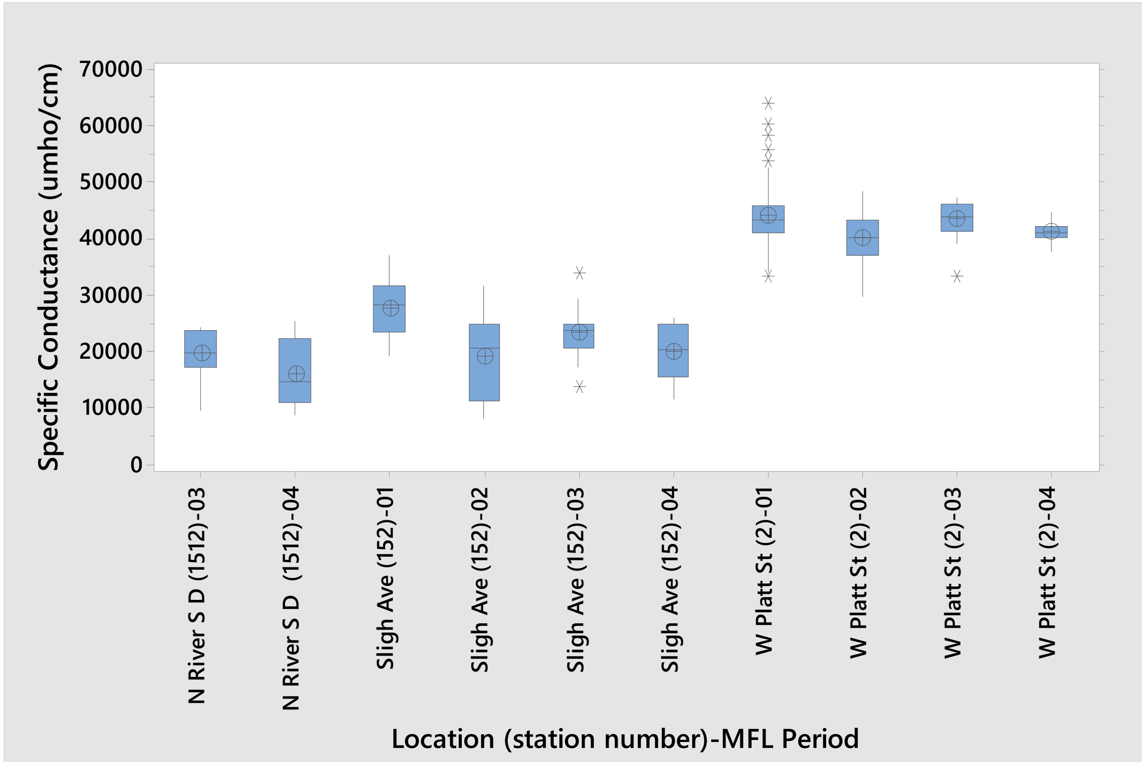


Figure 5.1-11. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

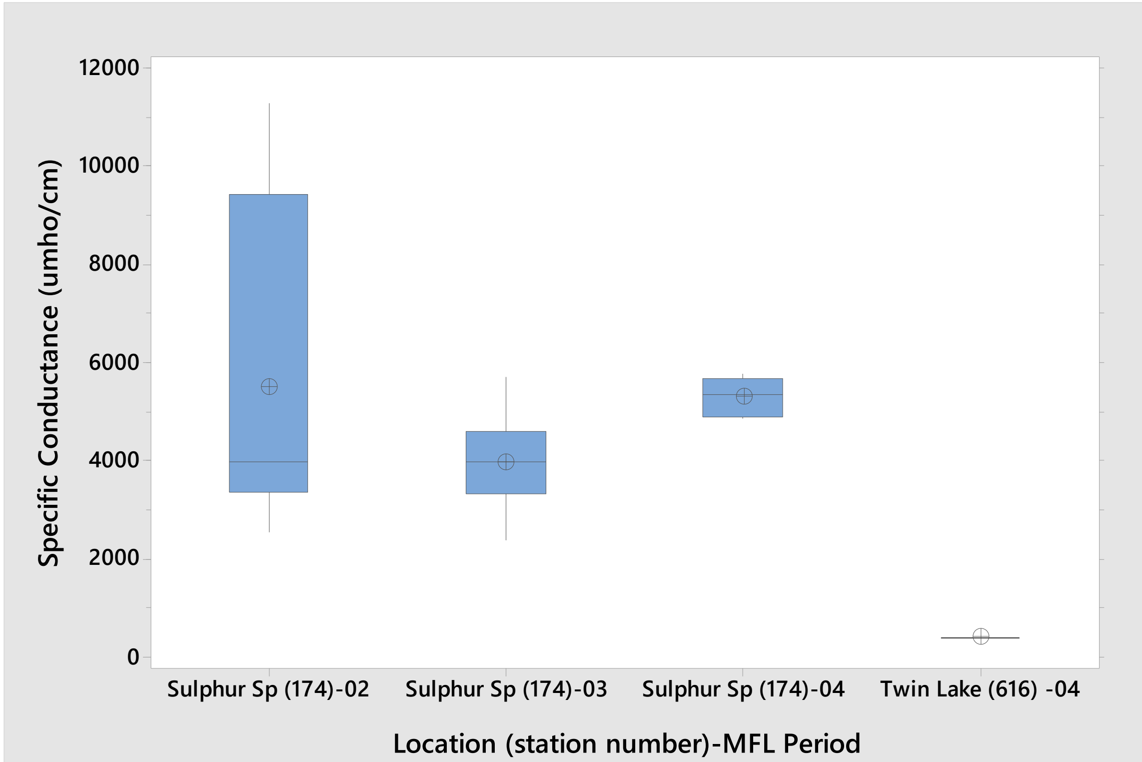


Figure 5.1-12. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

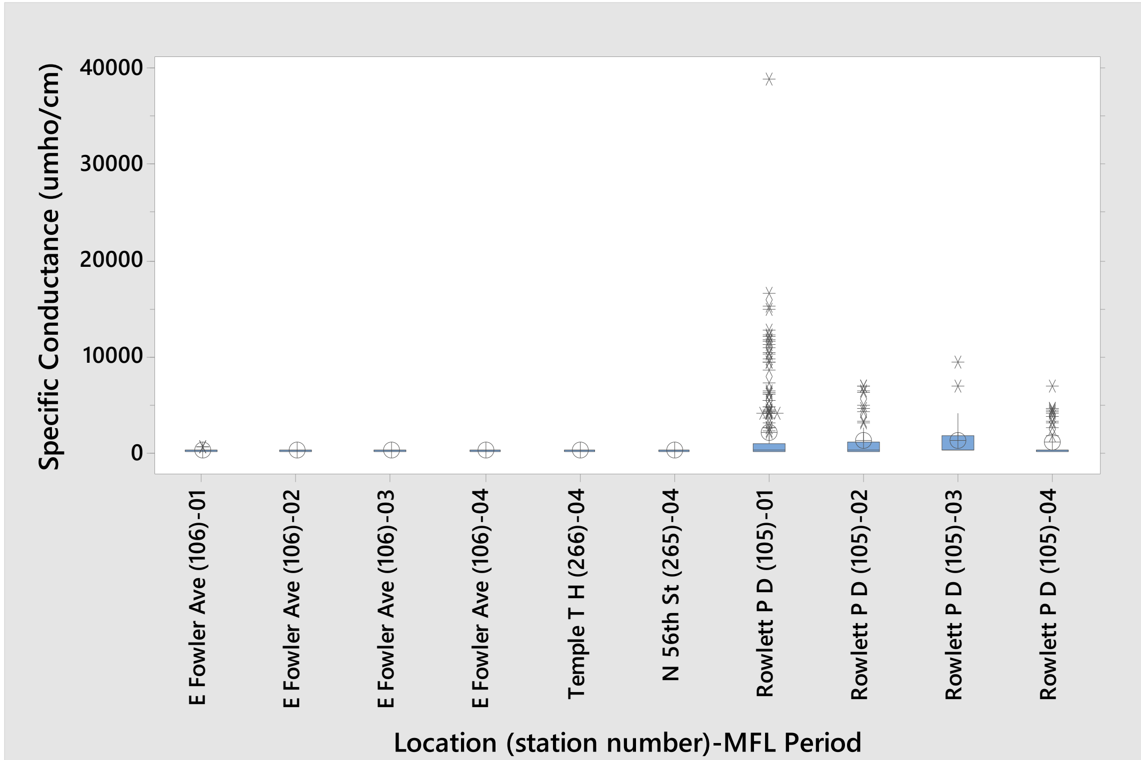


Figure 5.1-13. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

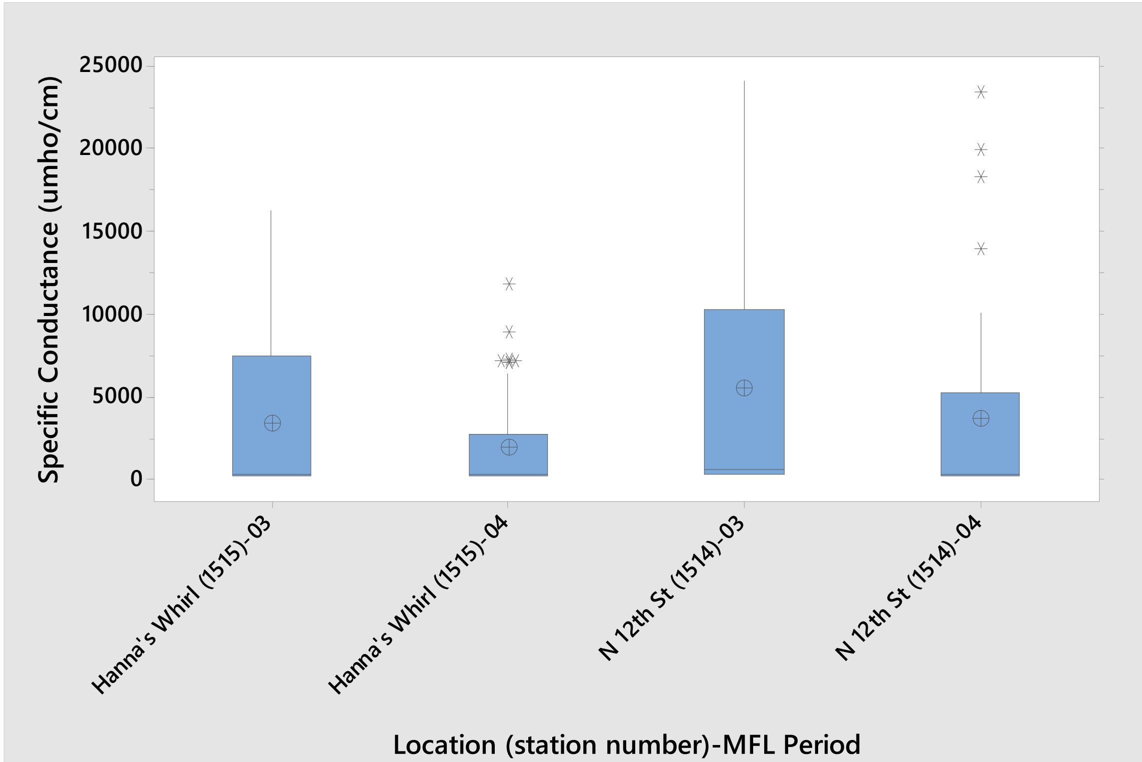


Figure 5.1-14. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

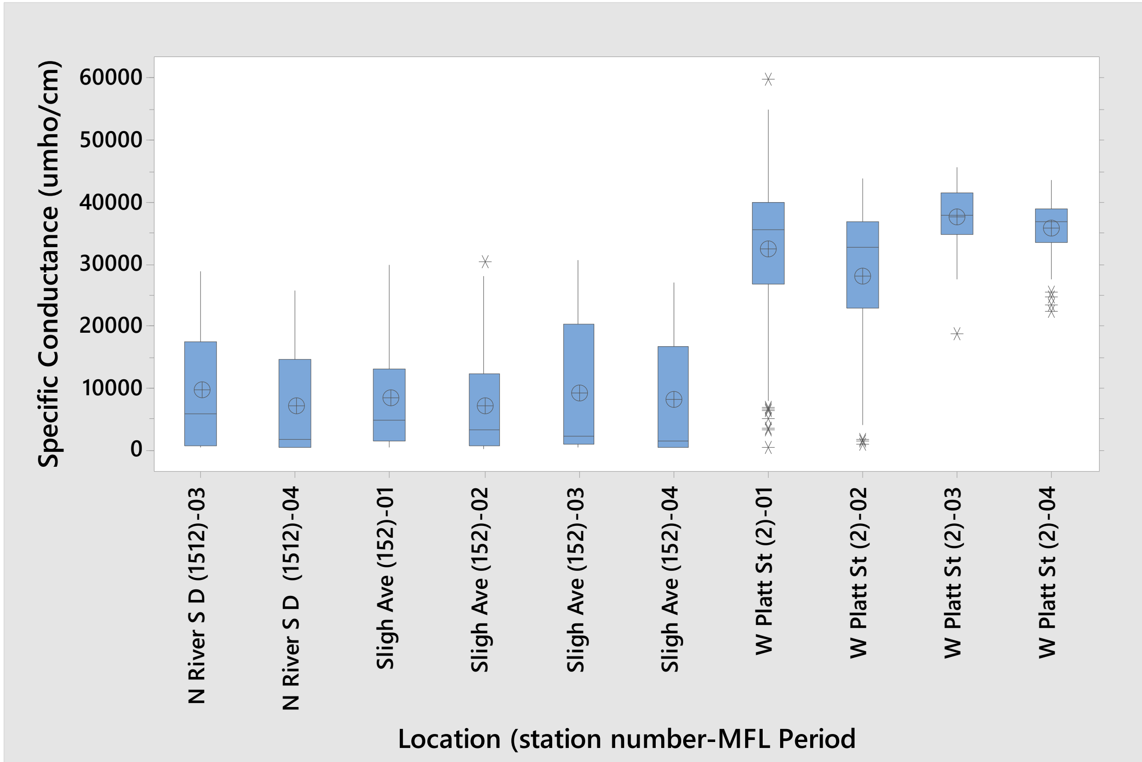


Figure 5.1-15. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

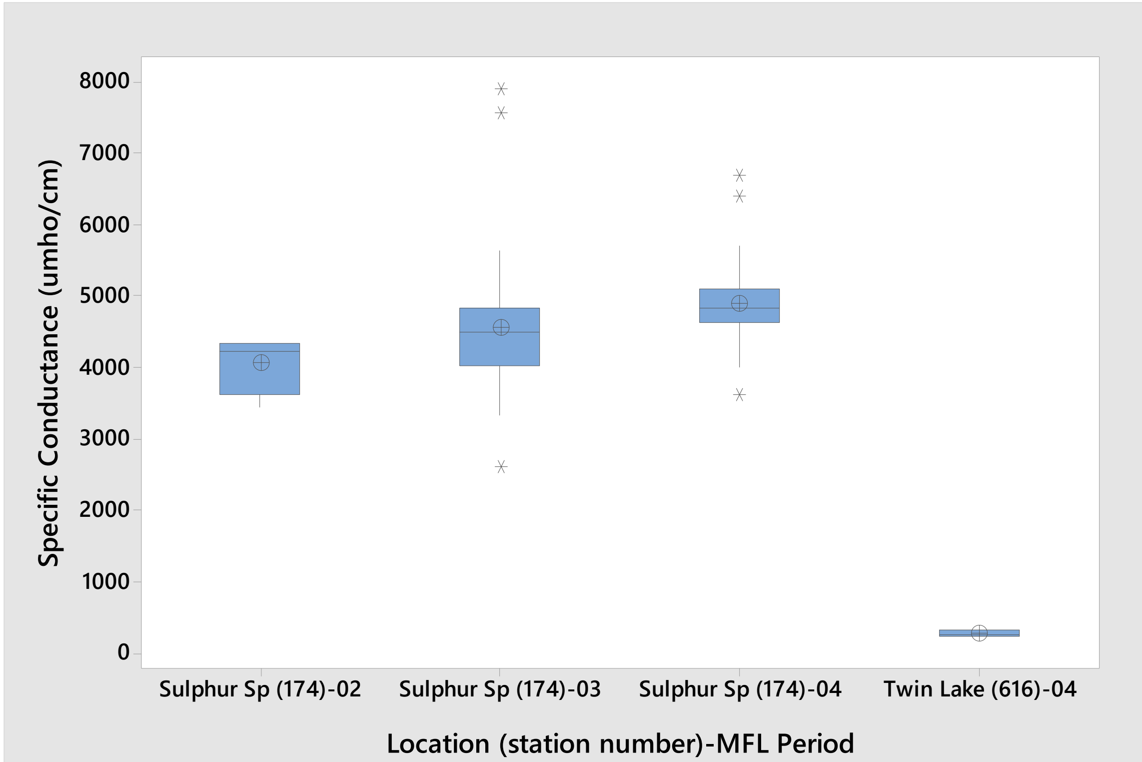


Figure 5.1-16. Average of monthly specific conductance (umho/cm) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

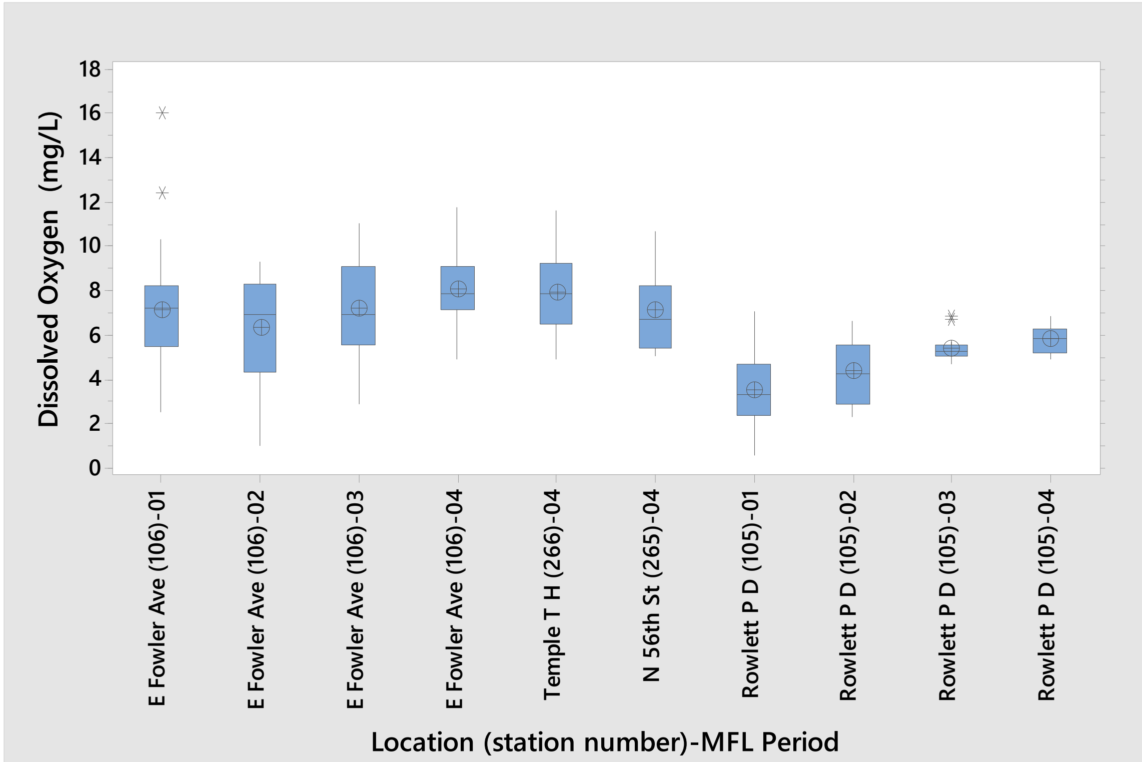


Figure 5.1-17. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

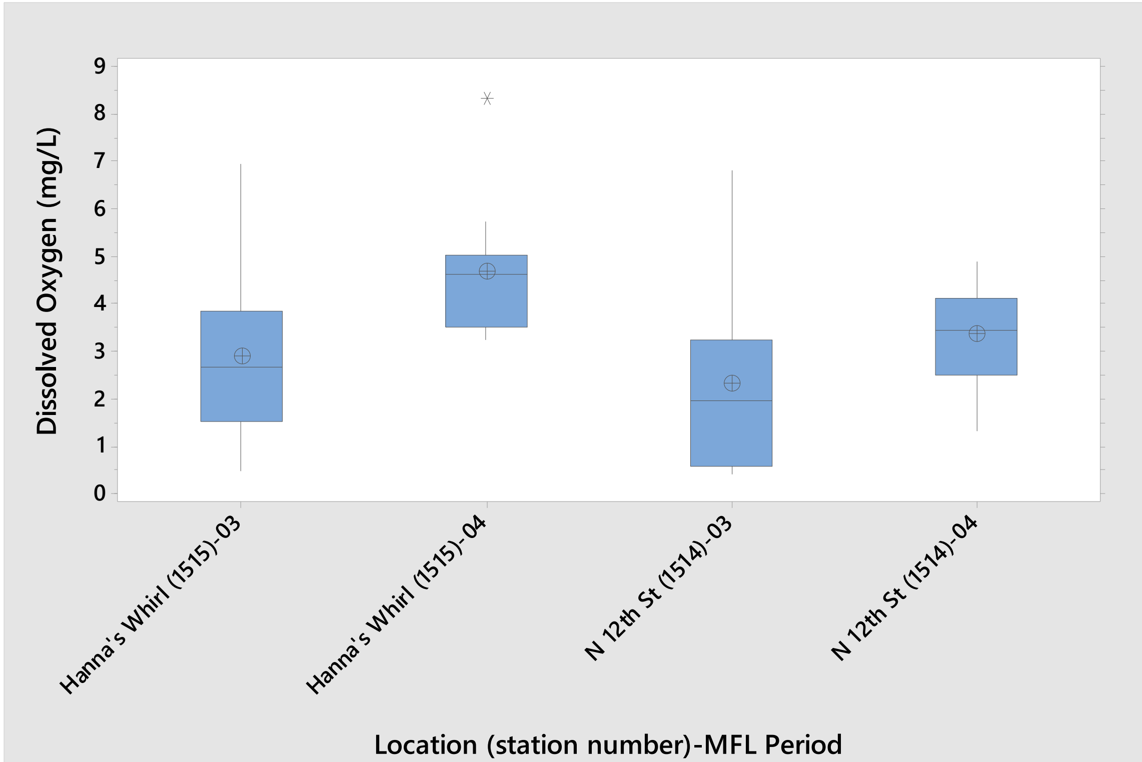


Figure 5.1-18. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

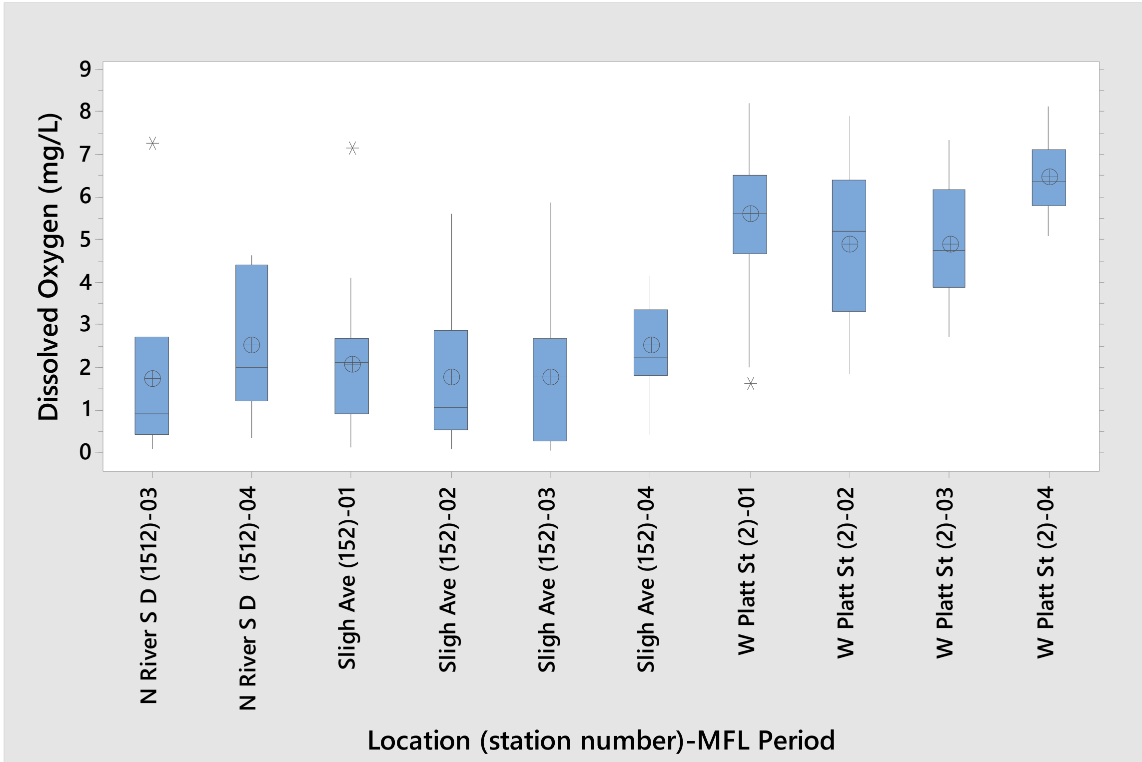


Figure 5.1-19. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

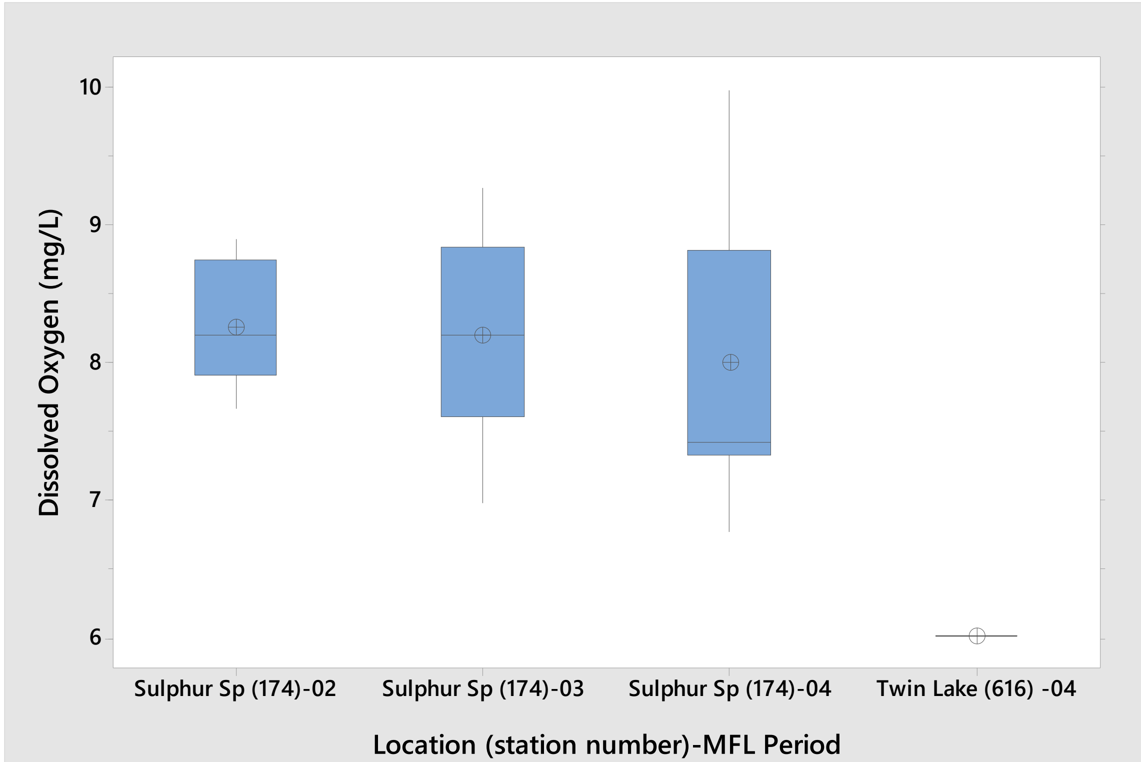


Figure 5.1-20. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

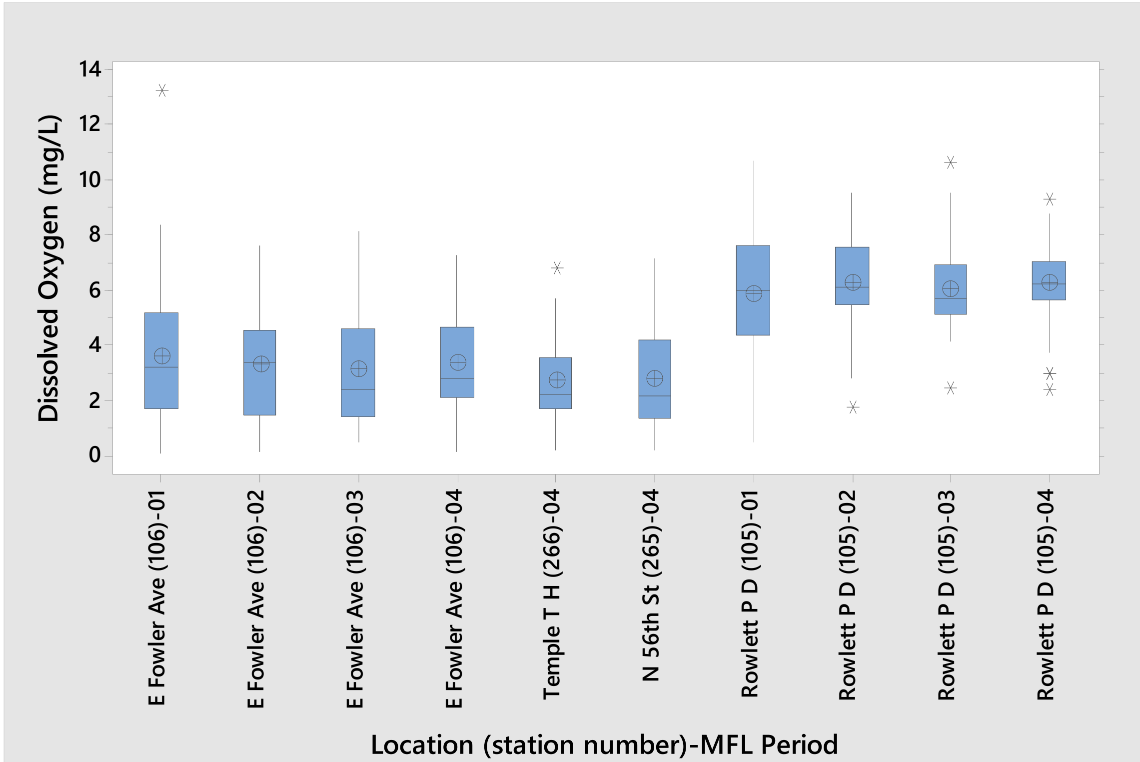


Figure 5.1-21. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

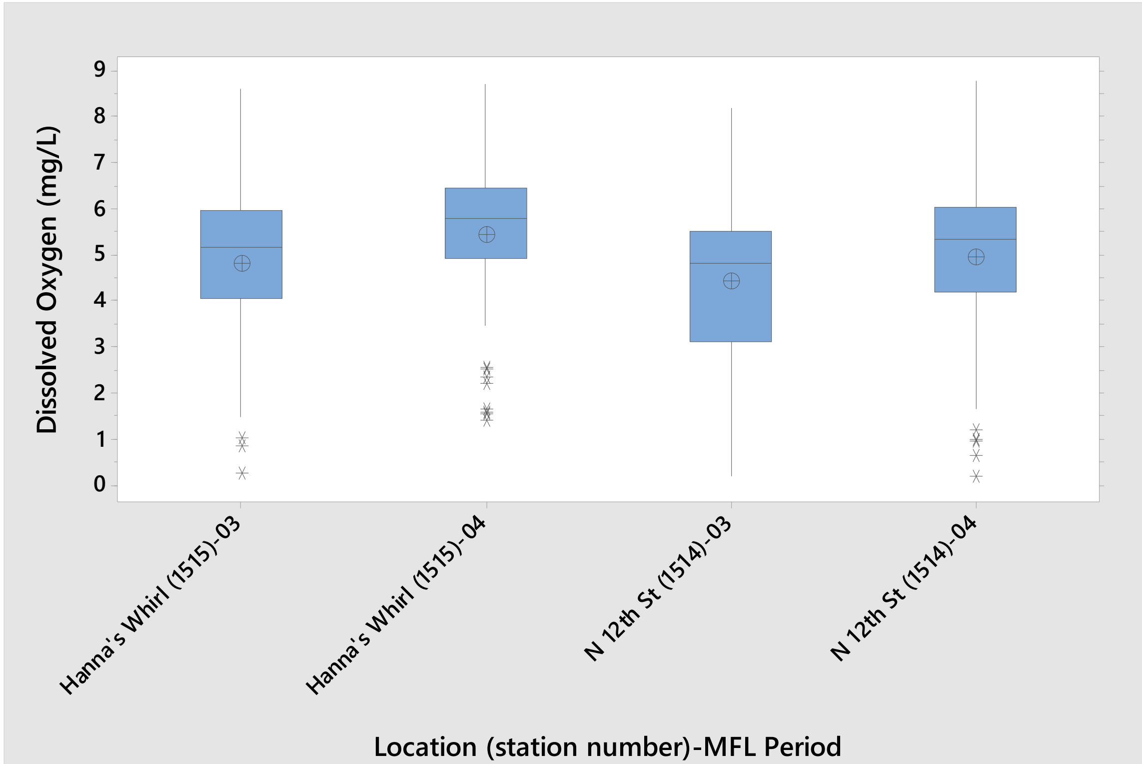


Figure 5.1-22. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

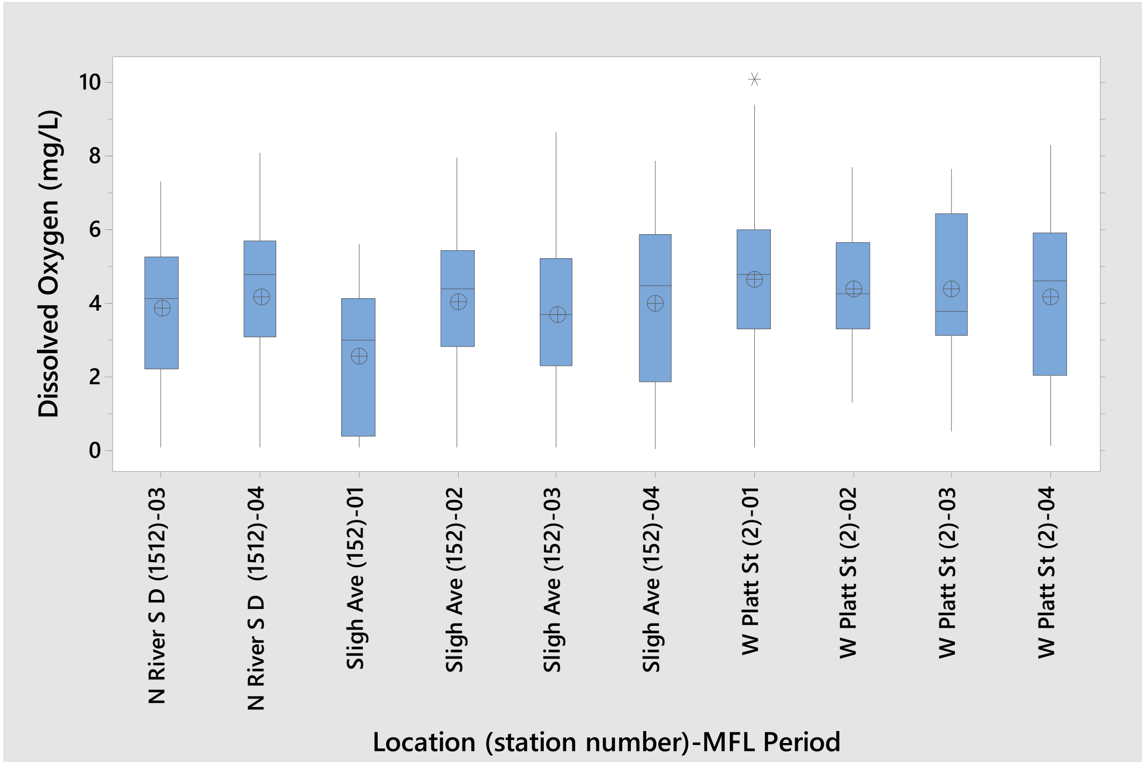


Figure 5.1-23. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

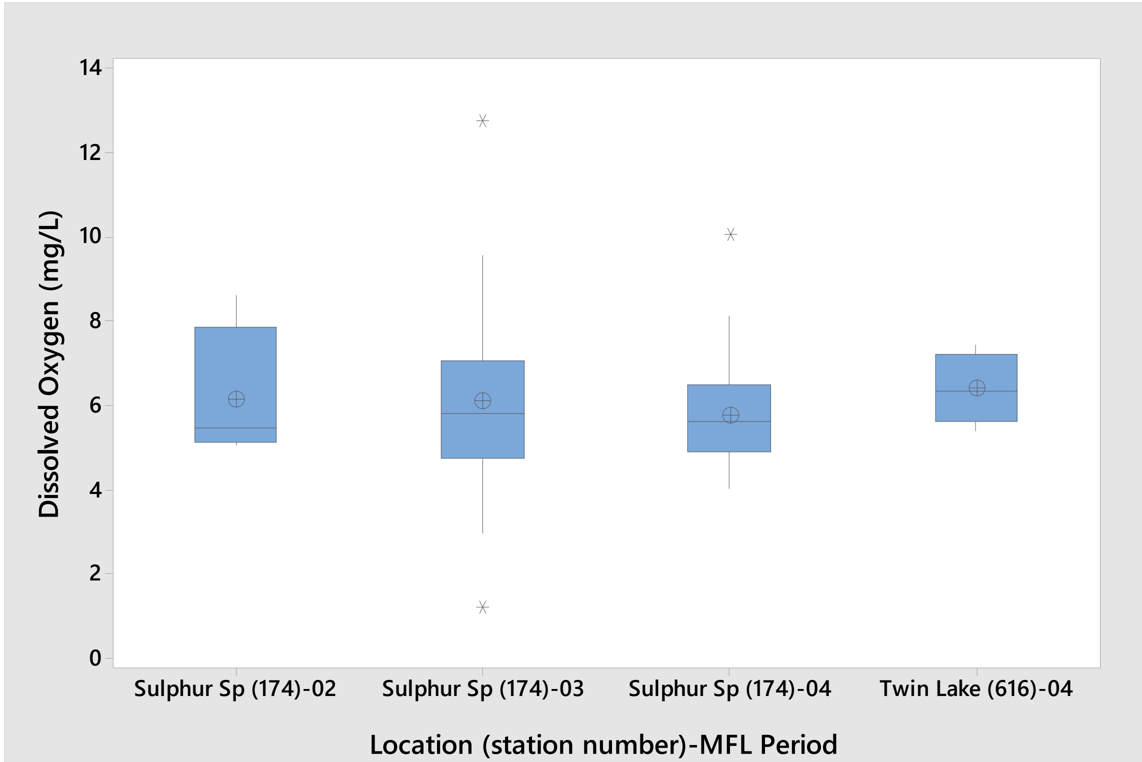


Figure 5.1-24. Average of monthly dissolved oxygen (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

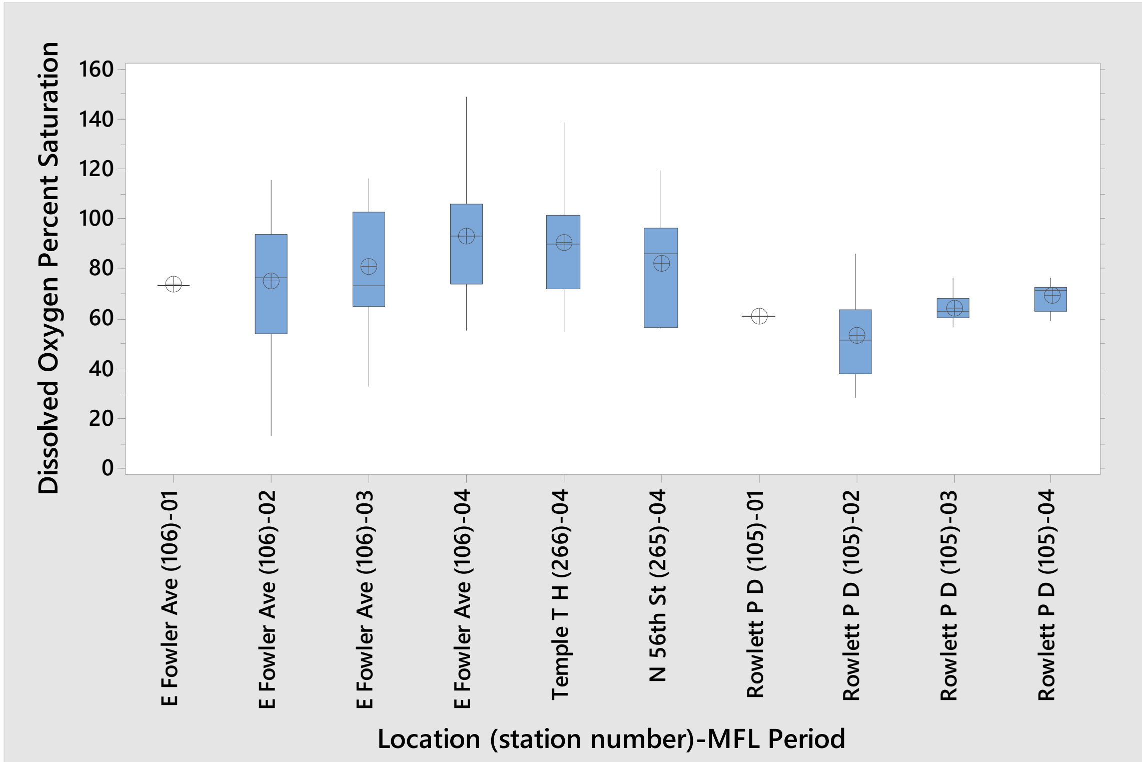


Figure 5.1-25. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

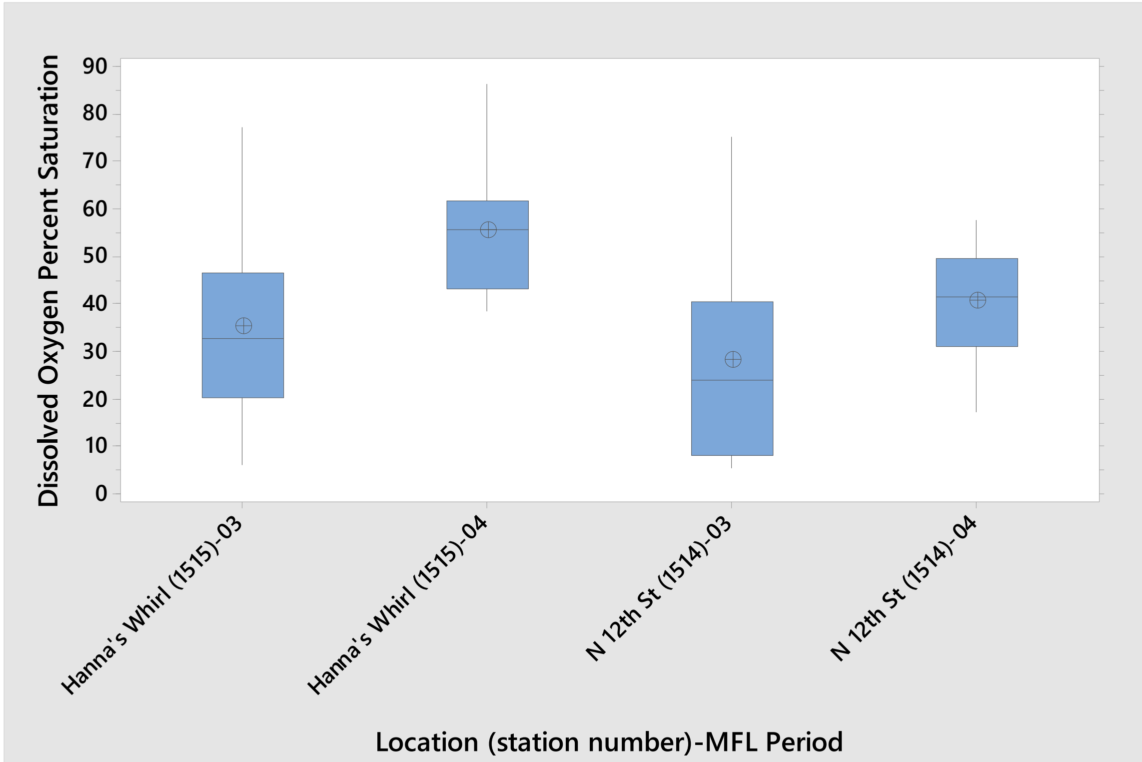


Figure 5.1-26. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

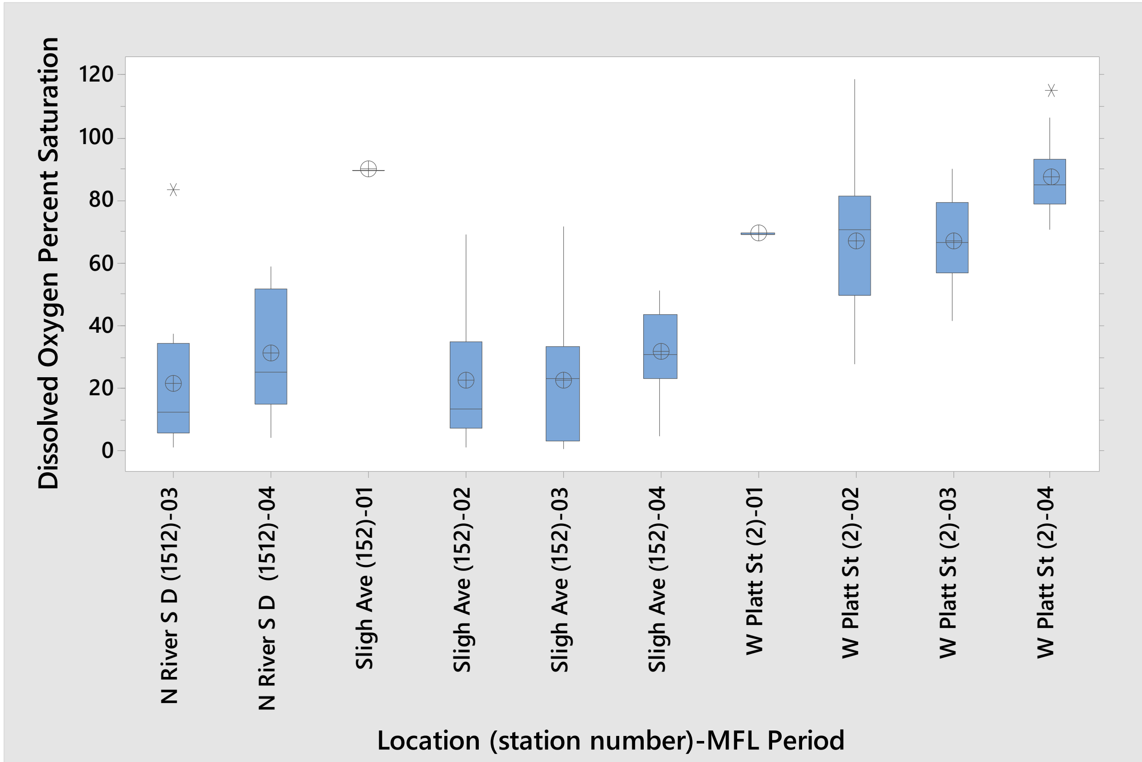


Figure 5.1-27. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

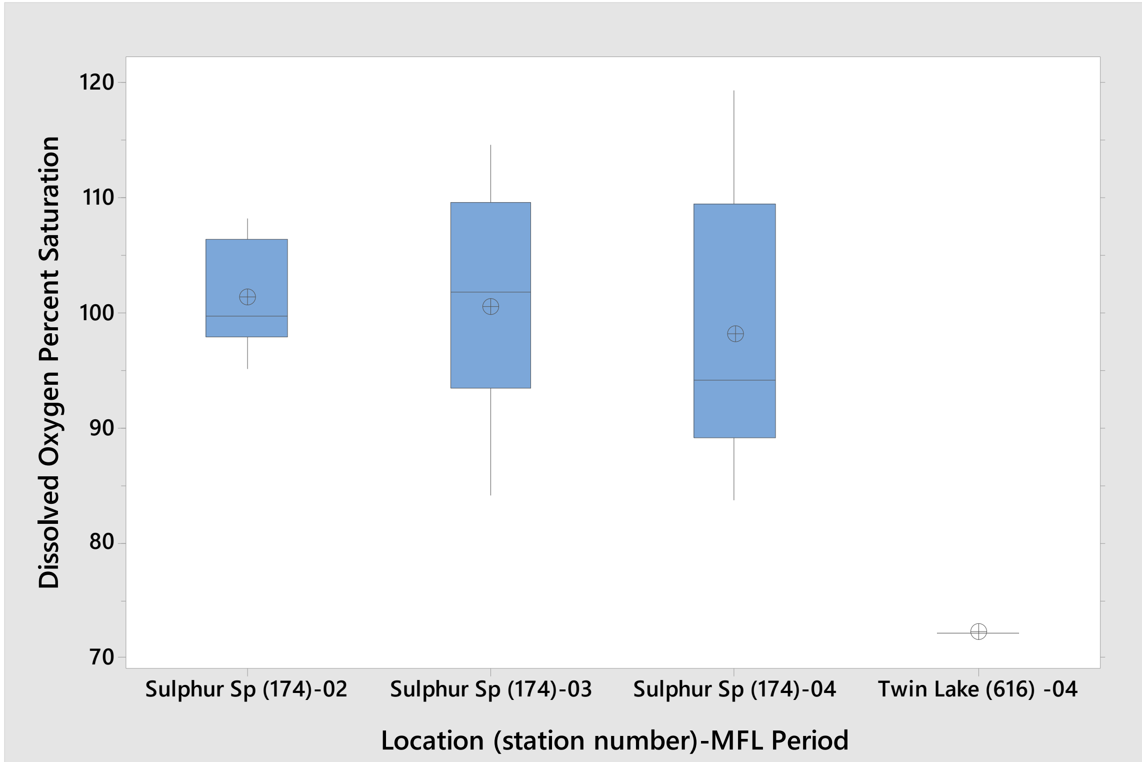


Figure 5.1-28. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

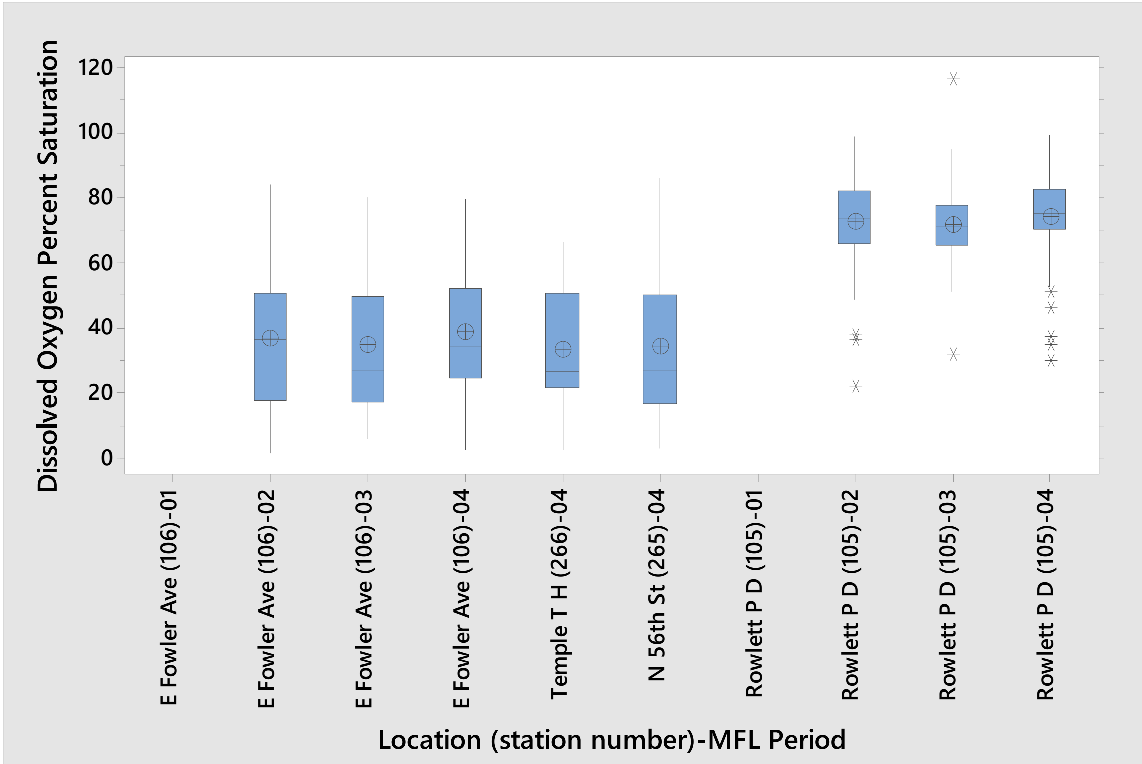


Figure 5.1-29. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

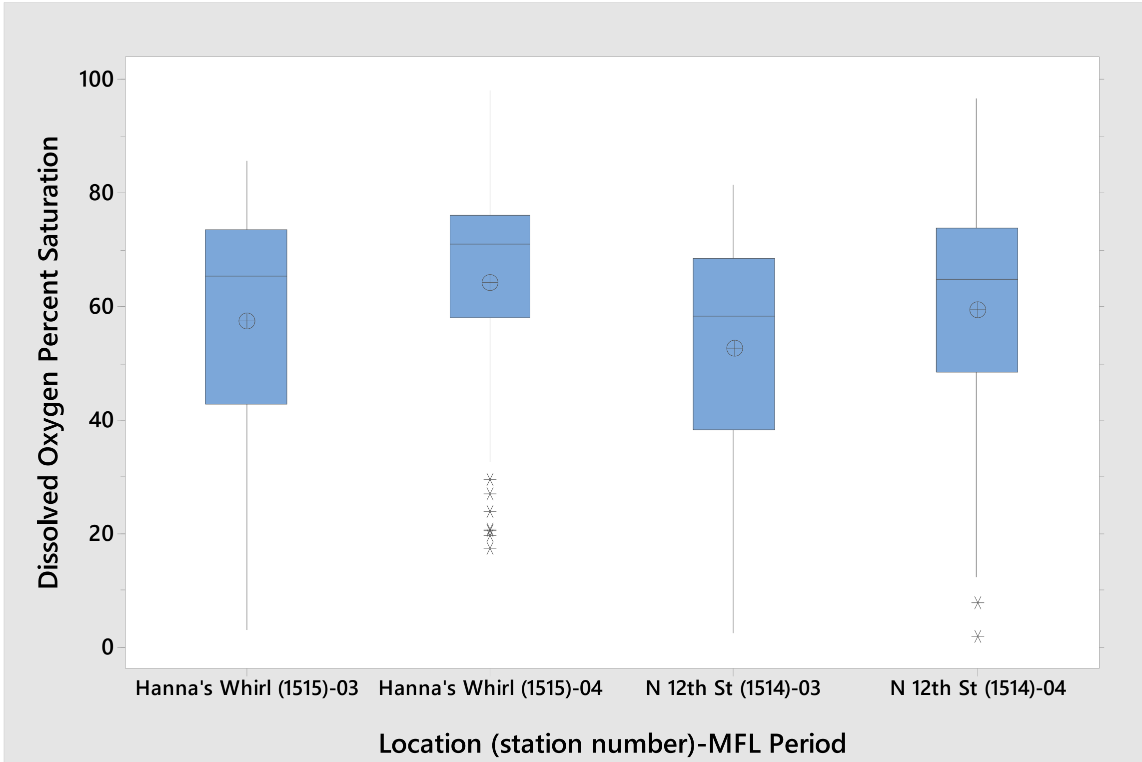


Figure 5.1-30. Average monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

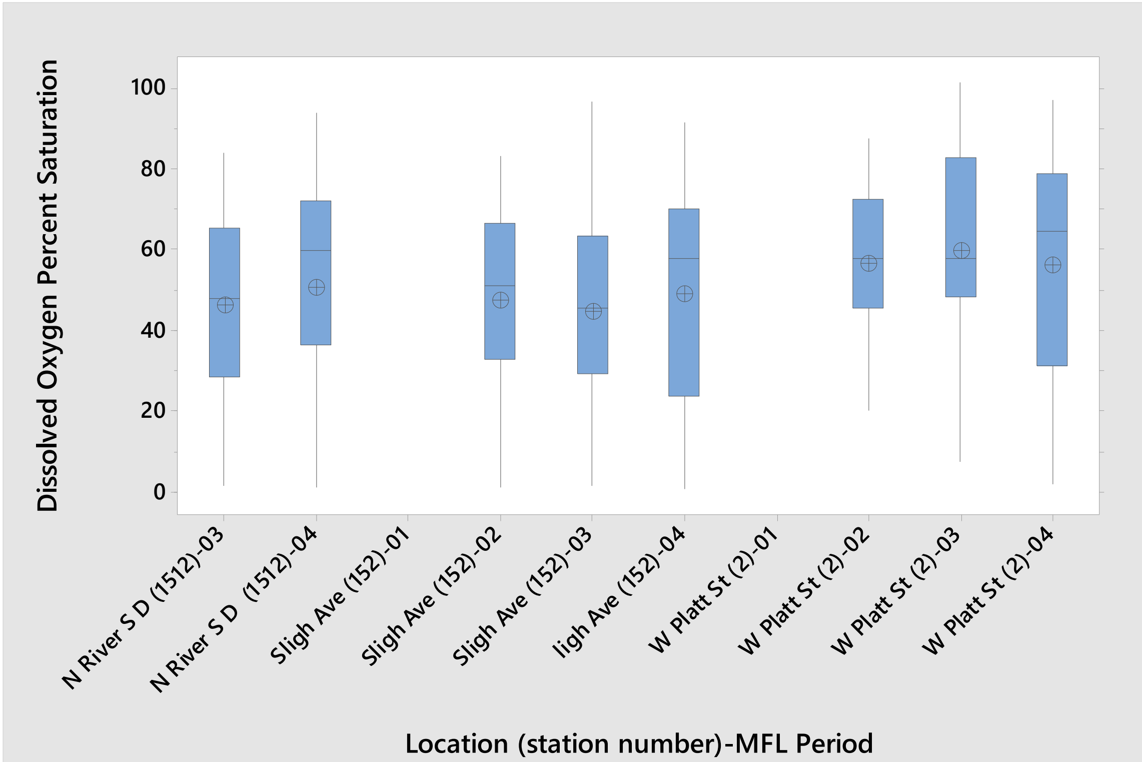


Figure 5.1-31. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

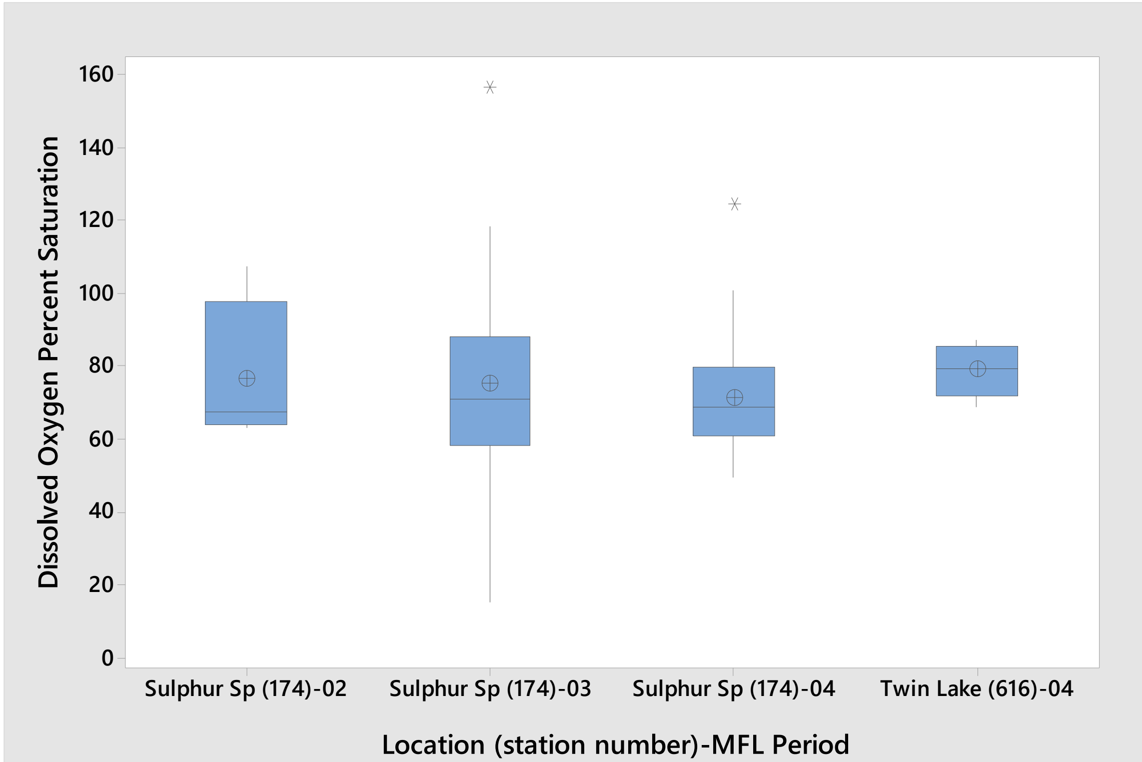


Figure 5.1-32. Average of monthly dissolved oxygen saturation (%) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

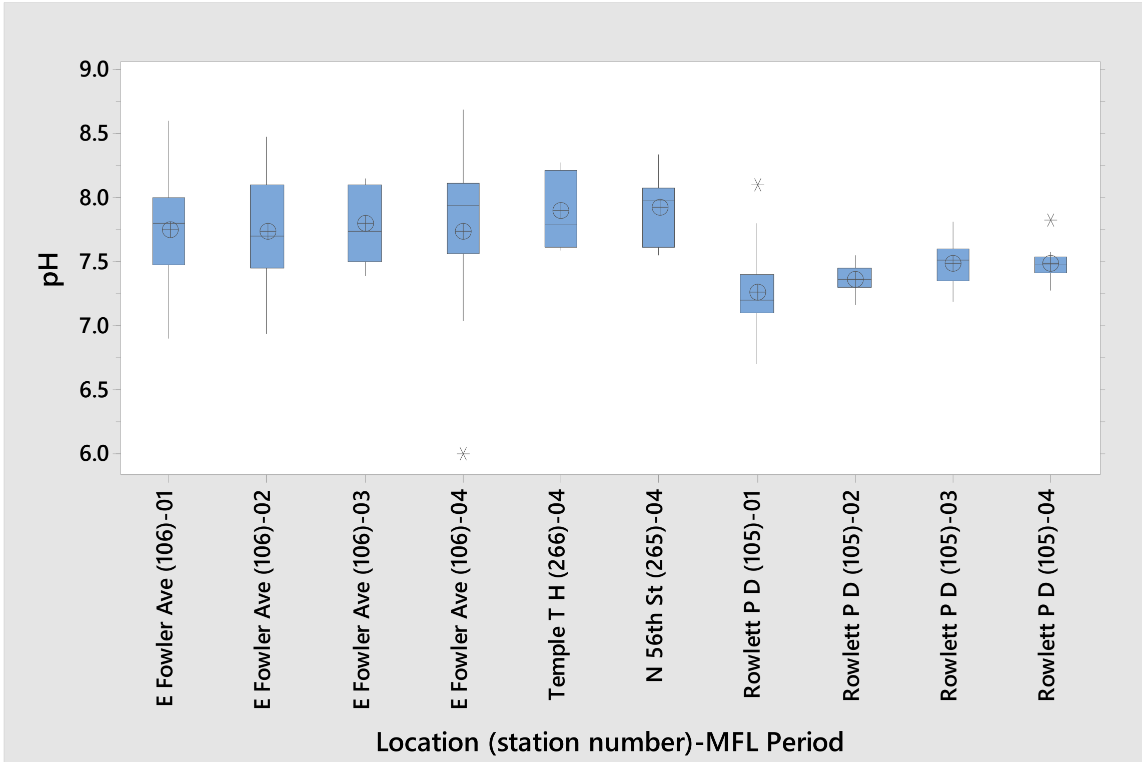


Figure 5.1-33. Average of monthly pH data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

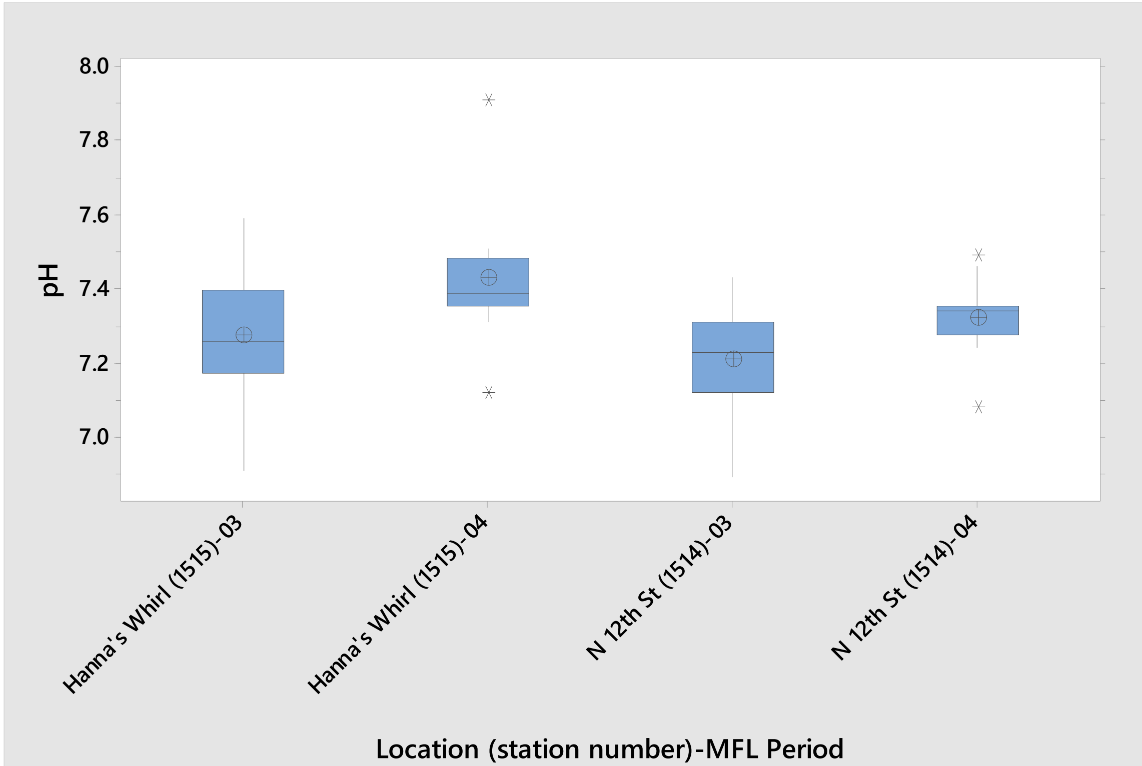


Figure 5.1-34. Average of monthly pH data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

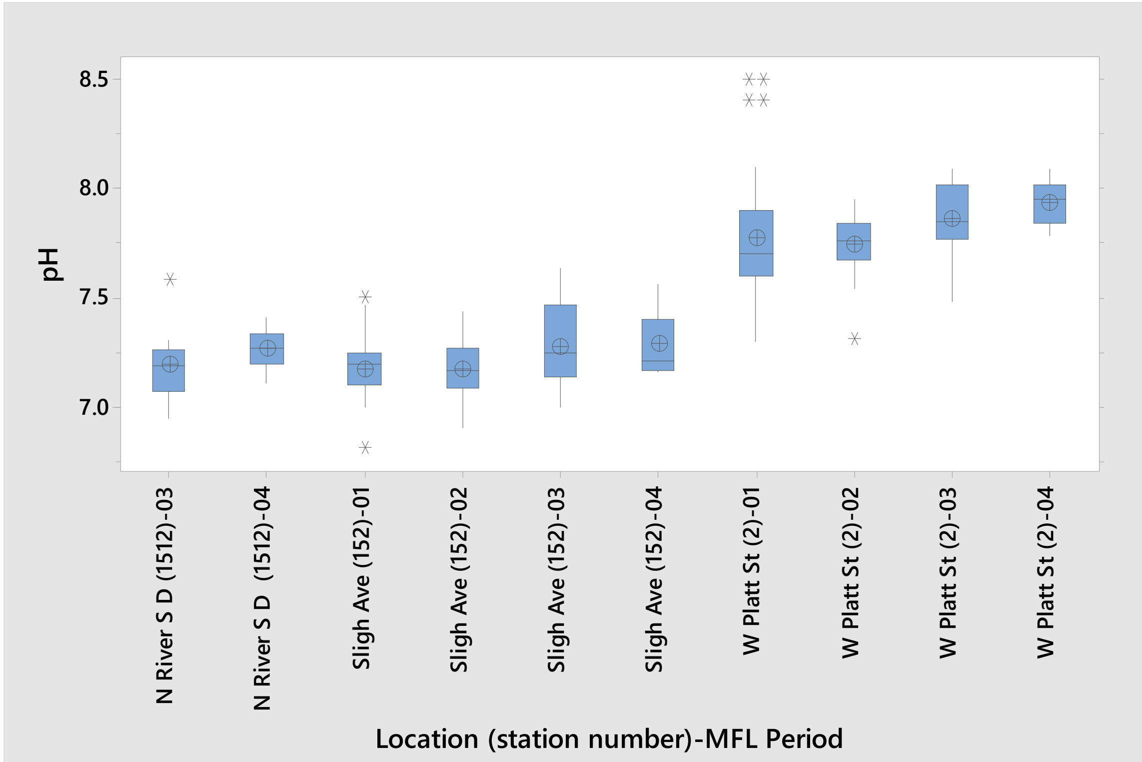


Figure 5.1-35. Average of monthly pH data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

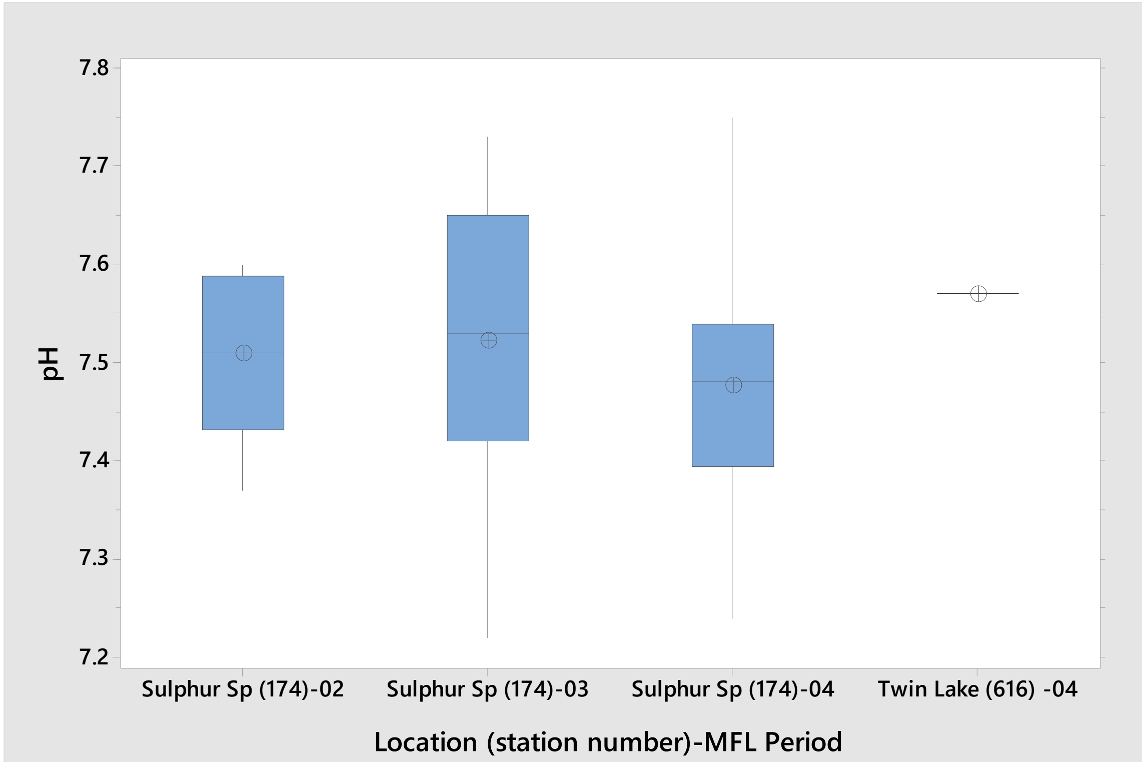


Figure 5.1-36. Average of monthly pH data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

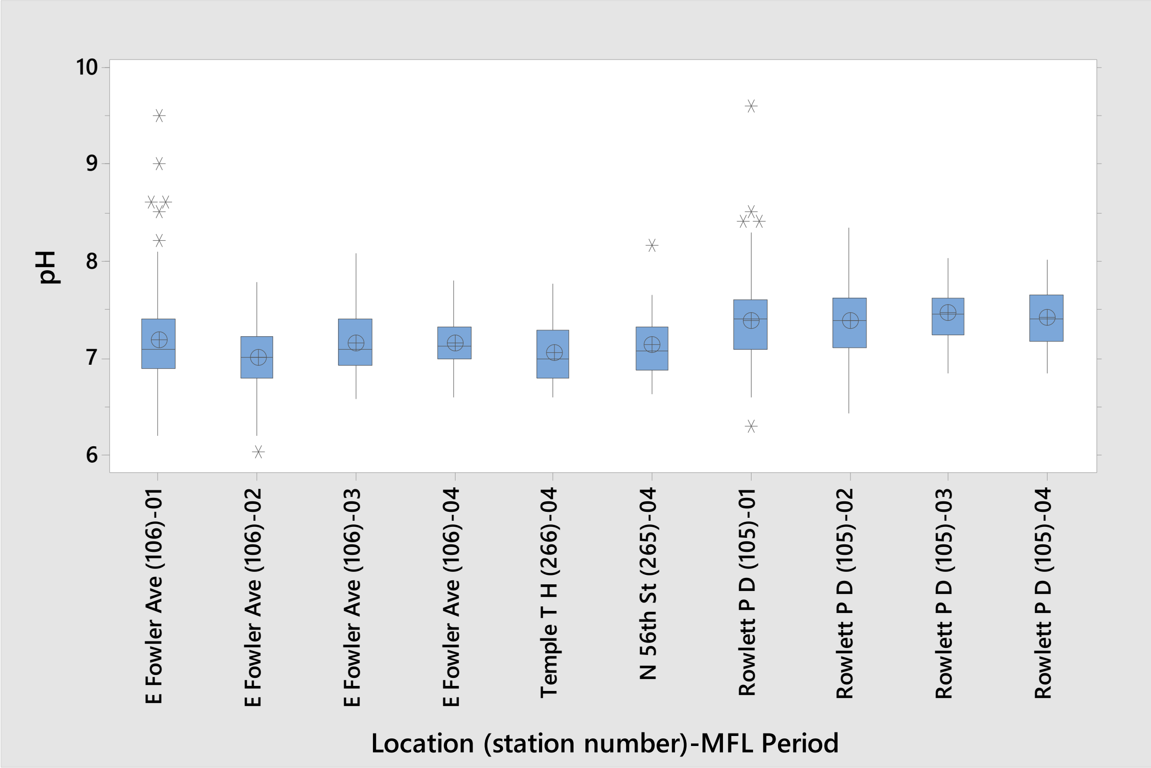


Figure 5.1-37. Average of monthly pH data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

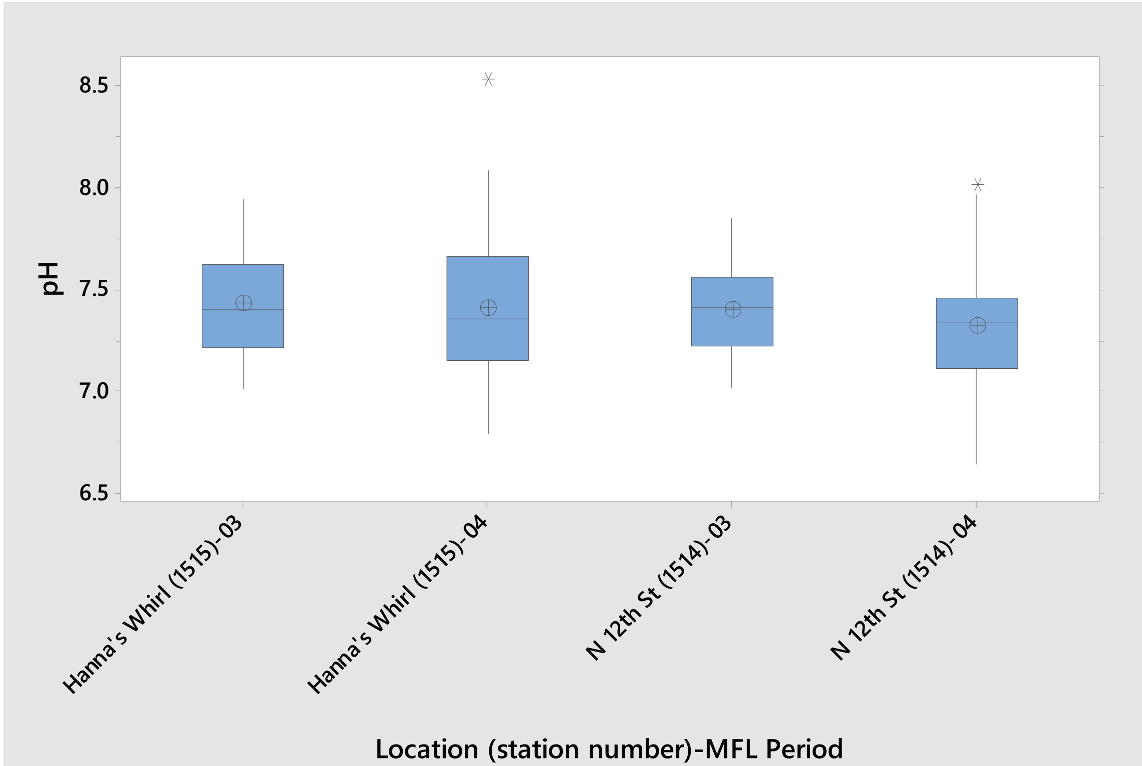


Figure 5.1-38. Average of monthly pH data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

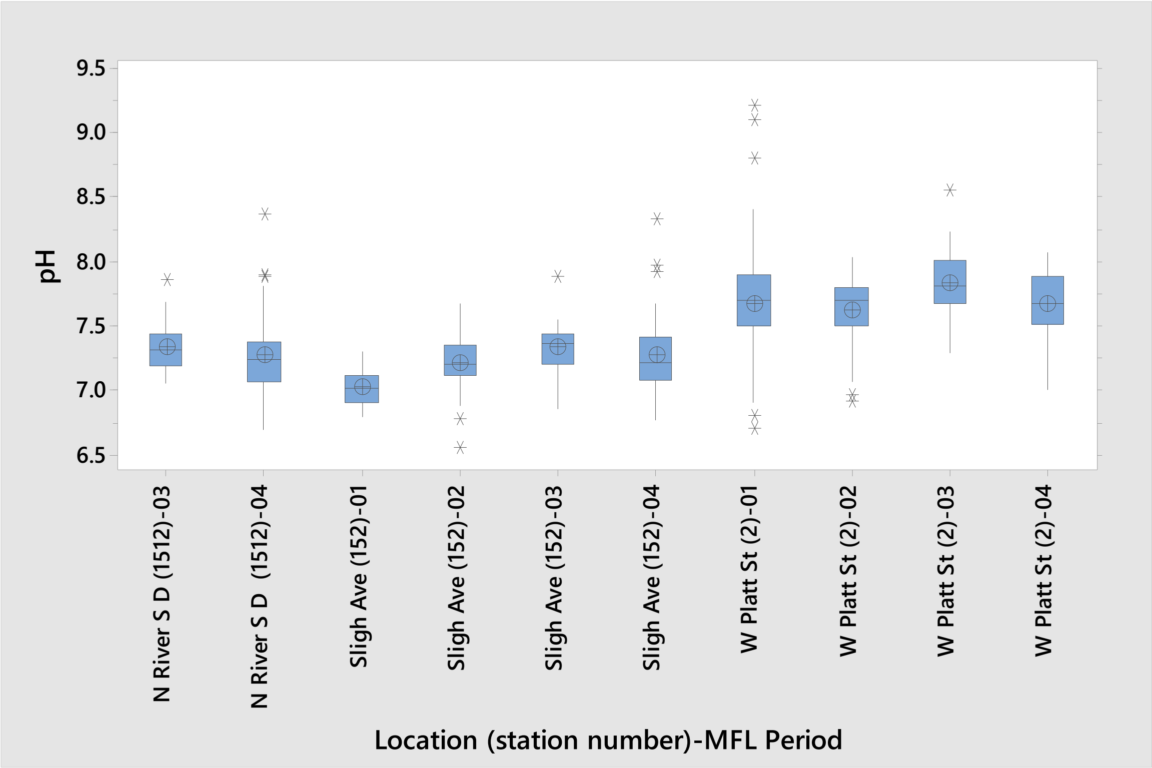


Figure 5.1-39. Average of monthly pH data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

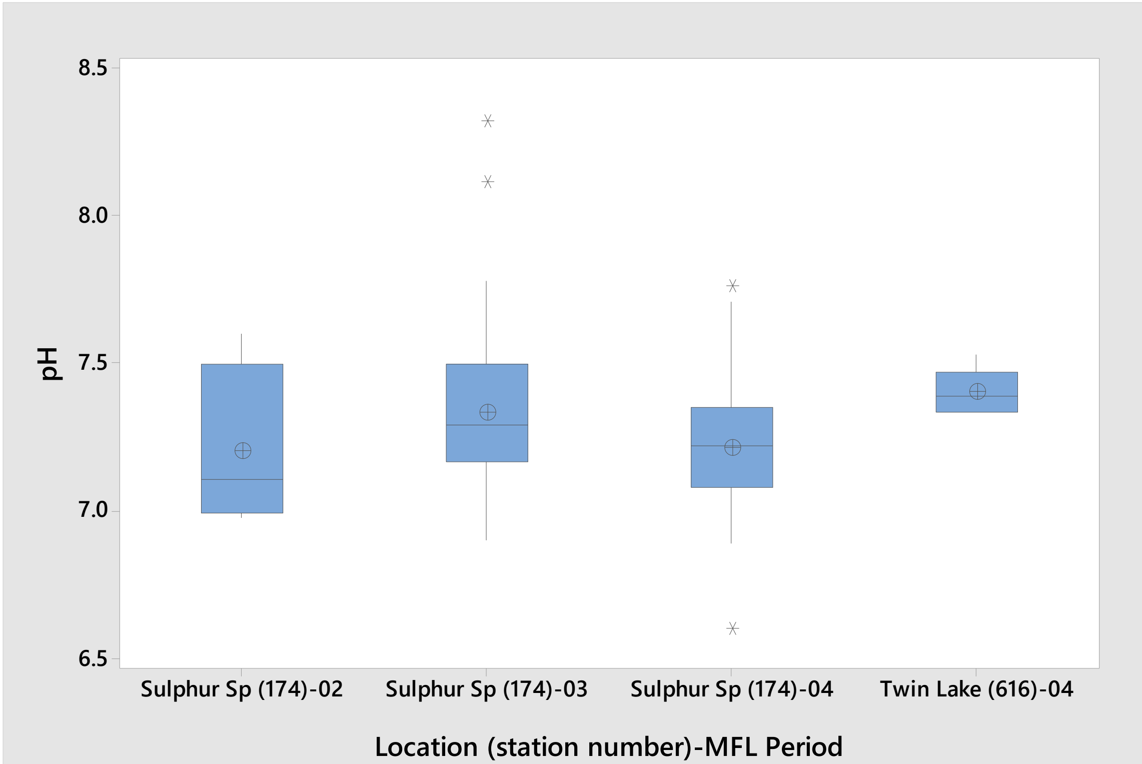


Figure 5.1-40. Average of monthly pH data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

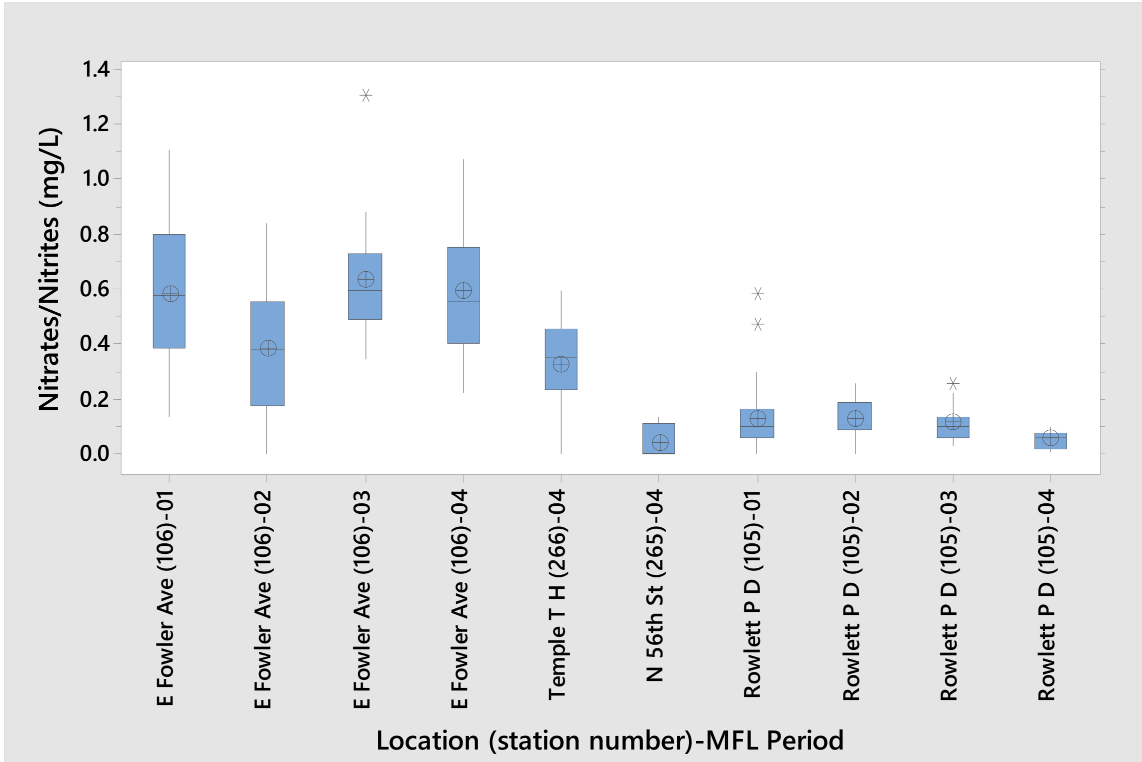


Figure 5.1-41. Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

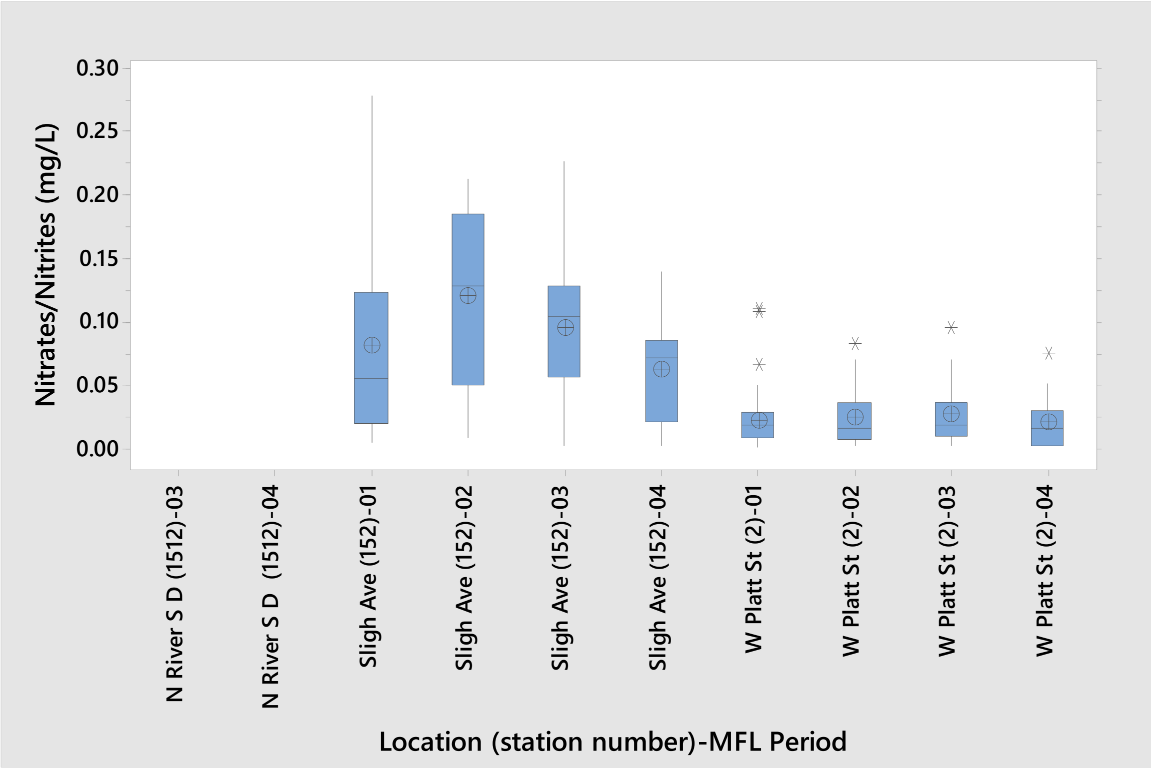


Figure 5.1-42. Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

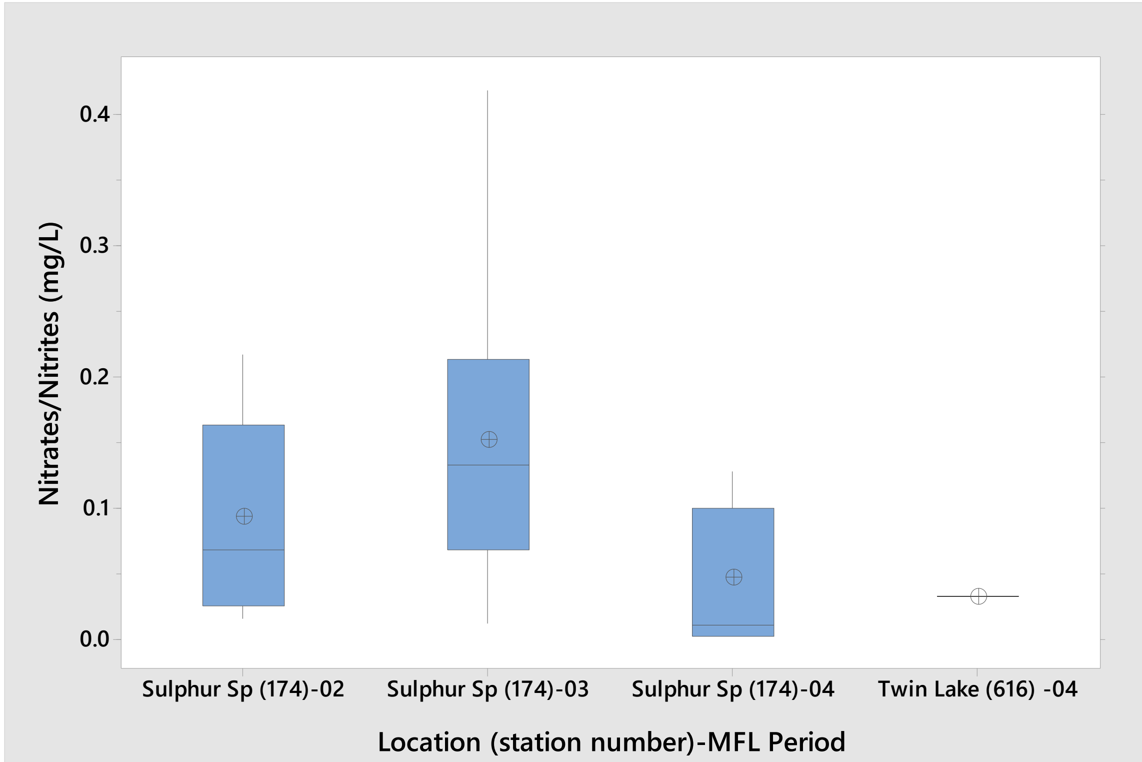


Figure 5.1-43. Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

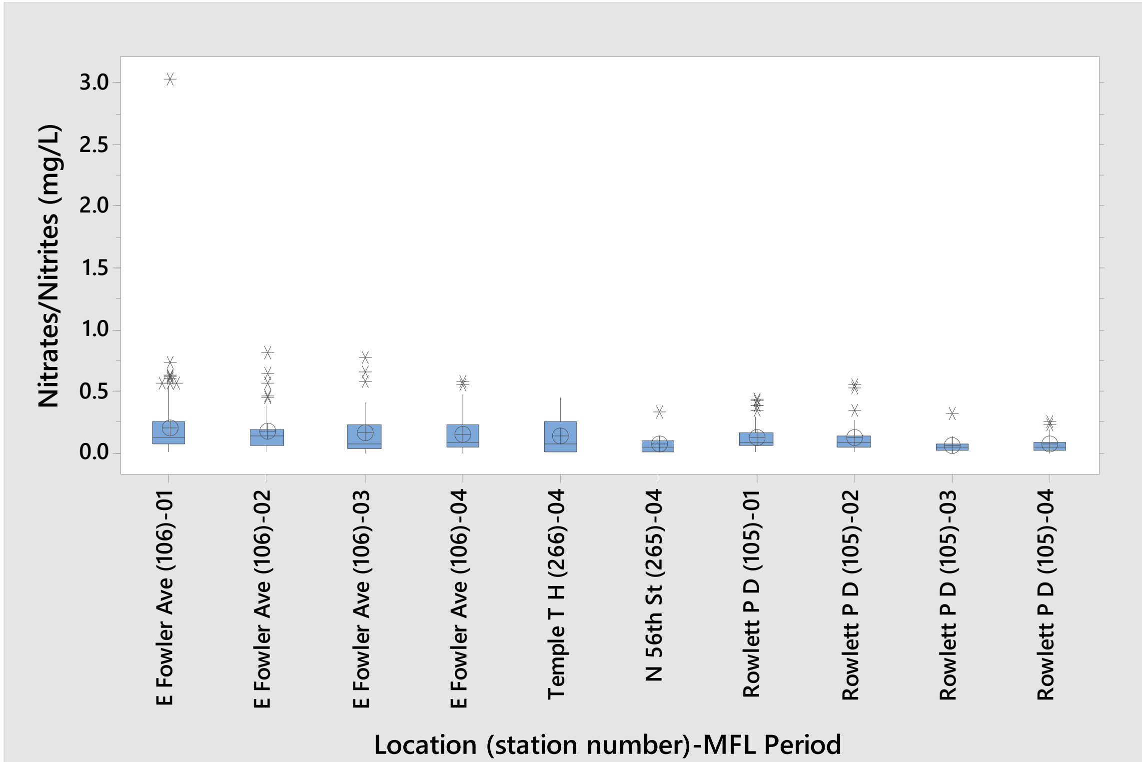


Figure 5.1-44. Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

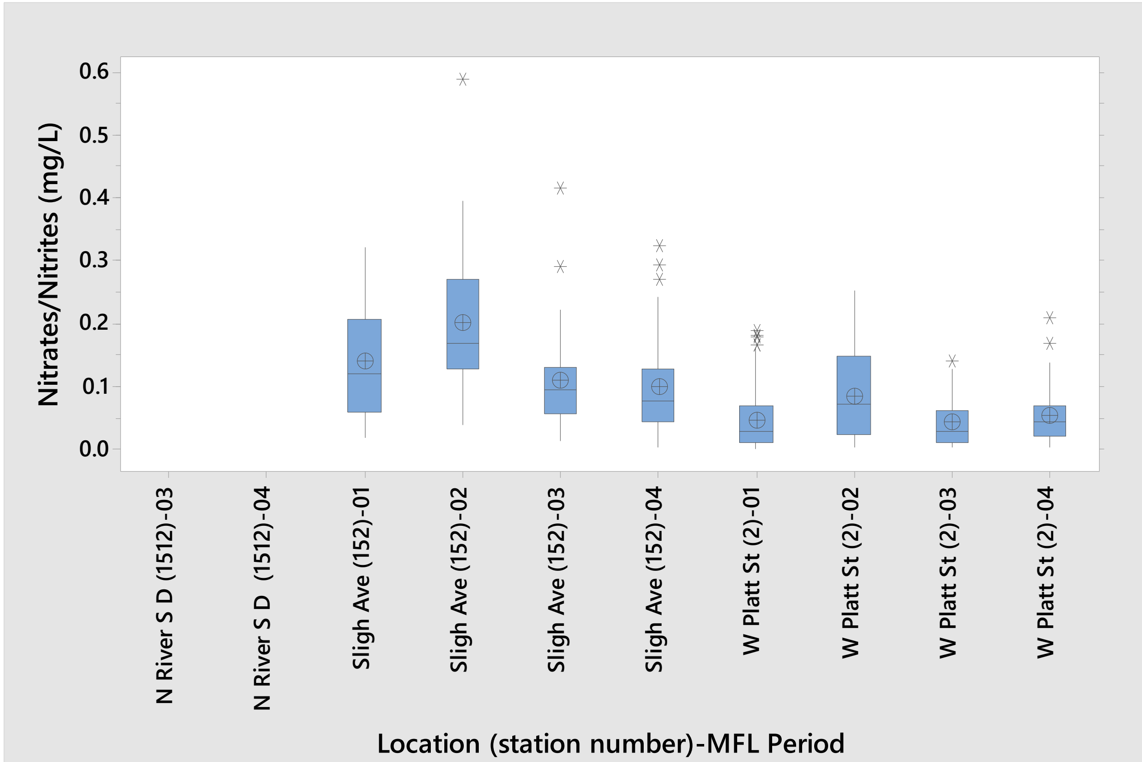


Figure 5.1-45. Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

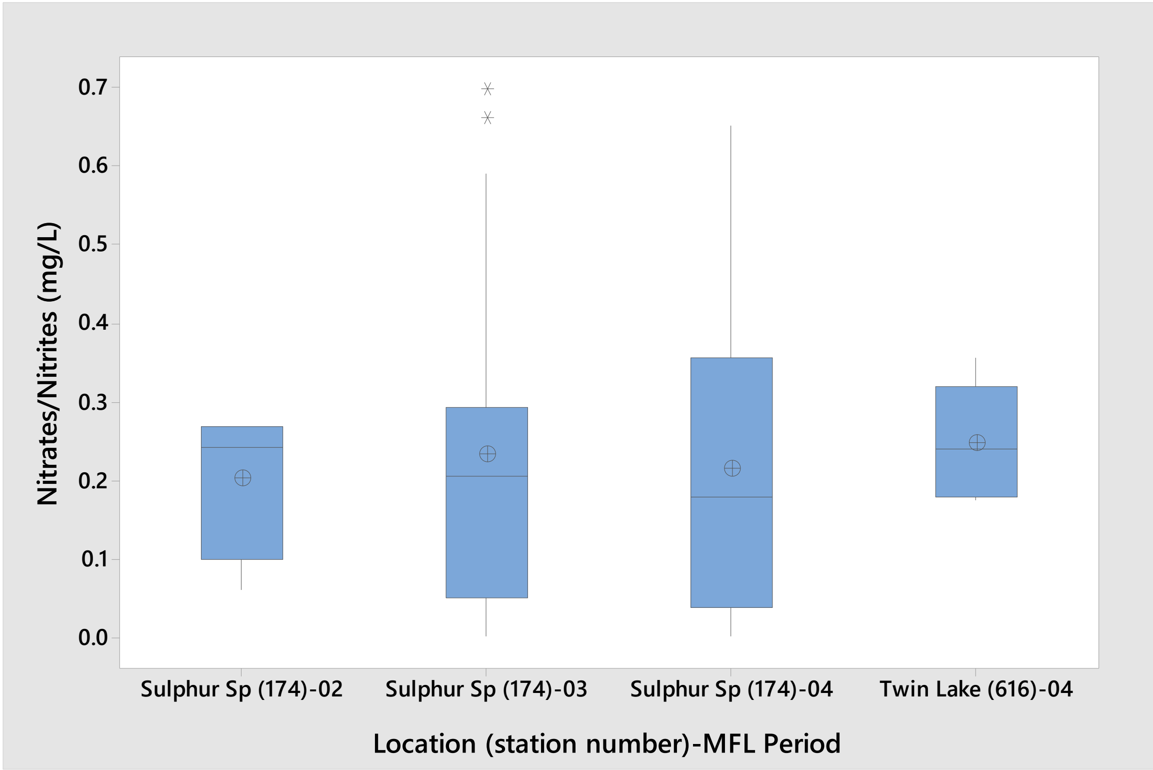


Figure 5.1-46. Average of monthly nitrates/nitrites (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

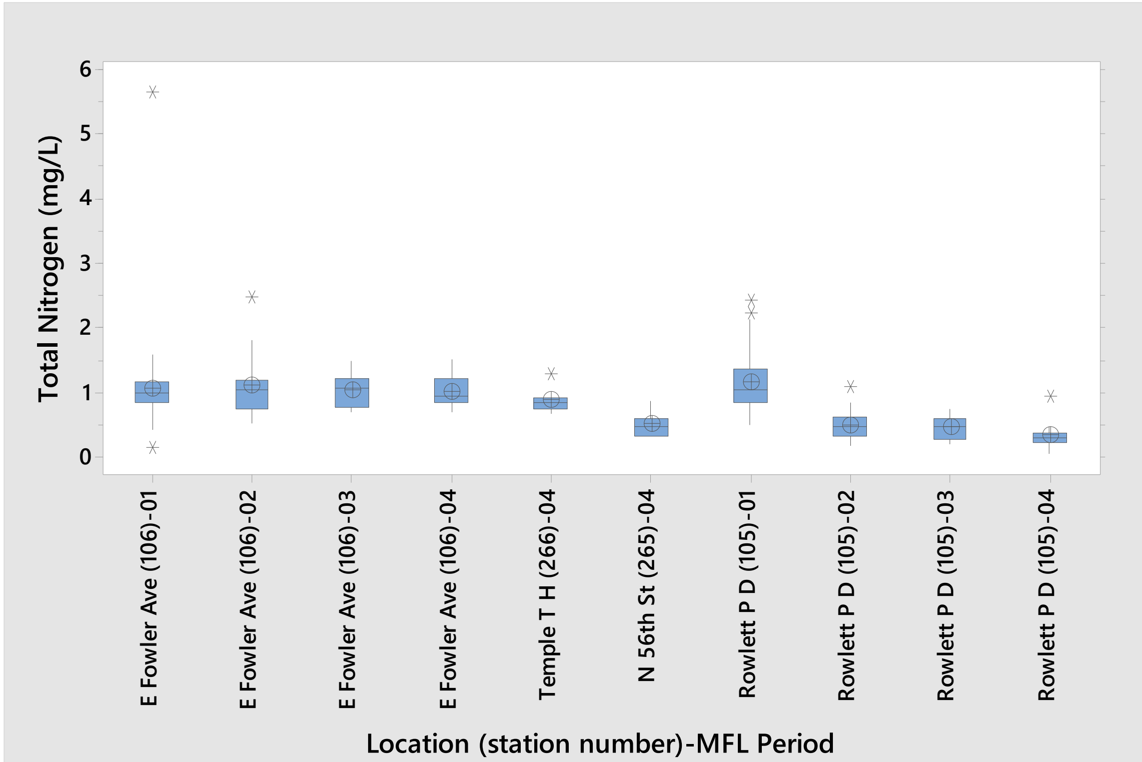


Figure 5.1-47. Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

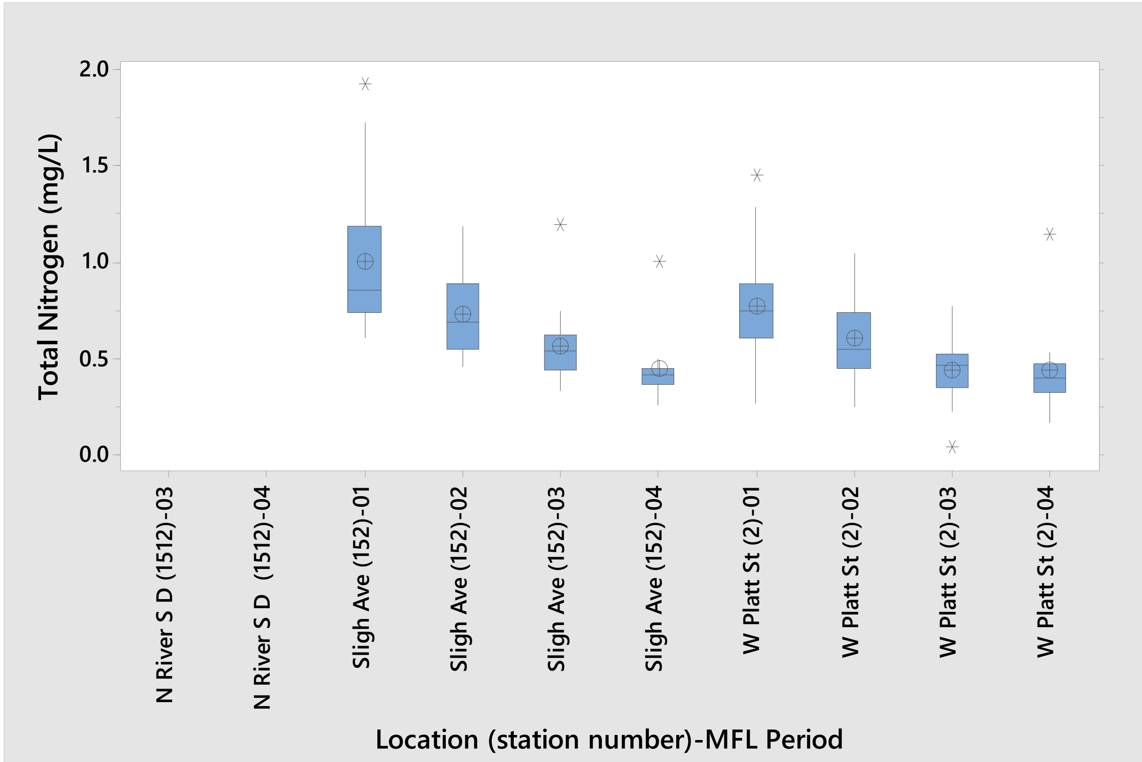


Figure 5.1-48. Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

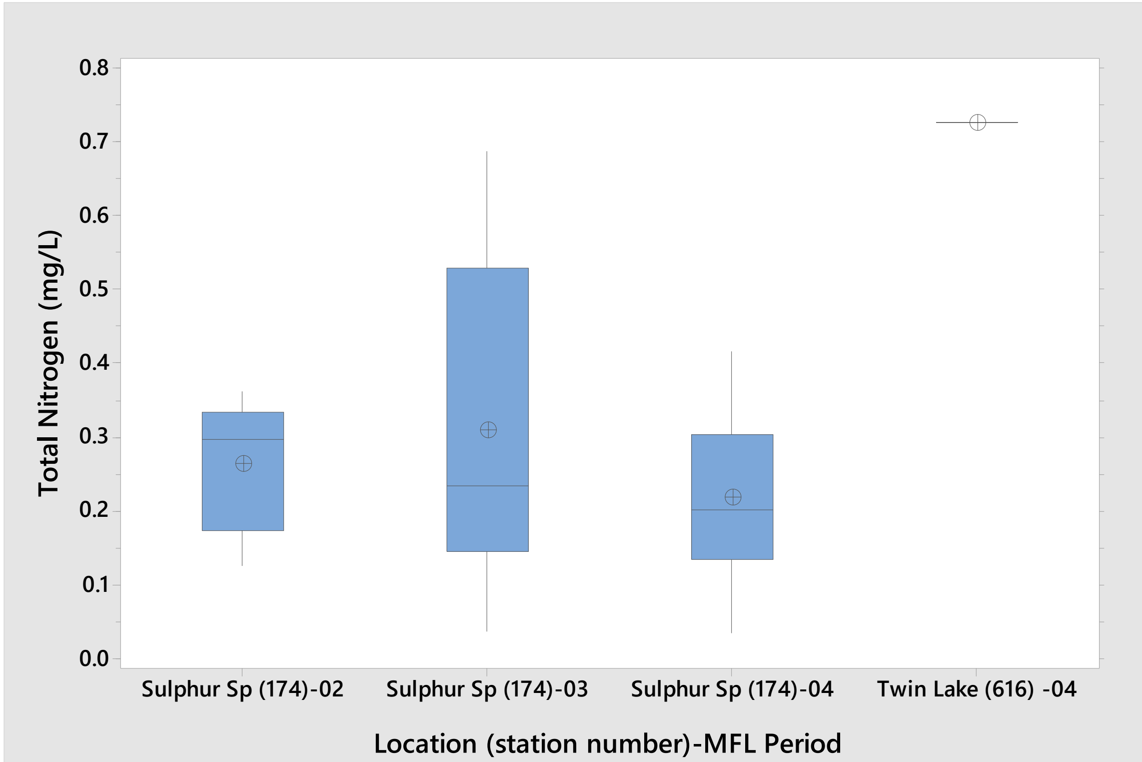


Figure 5.1-49. Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

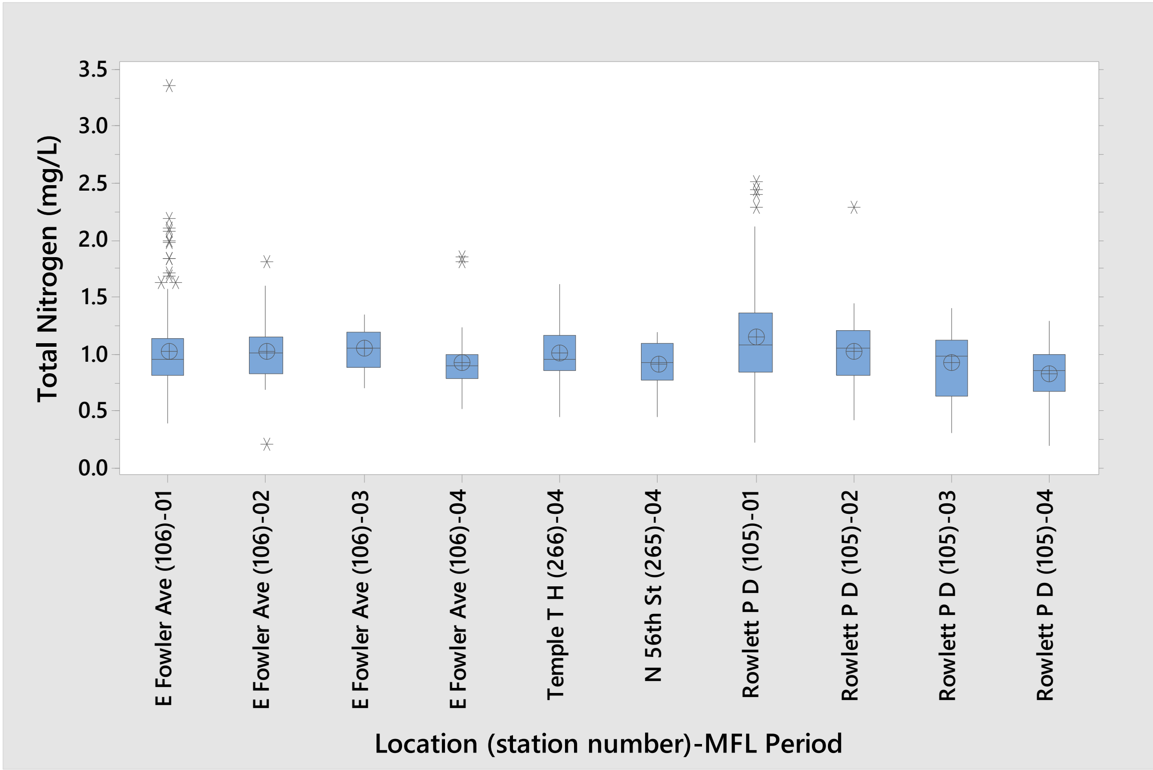


Figure 5.1-50. Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

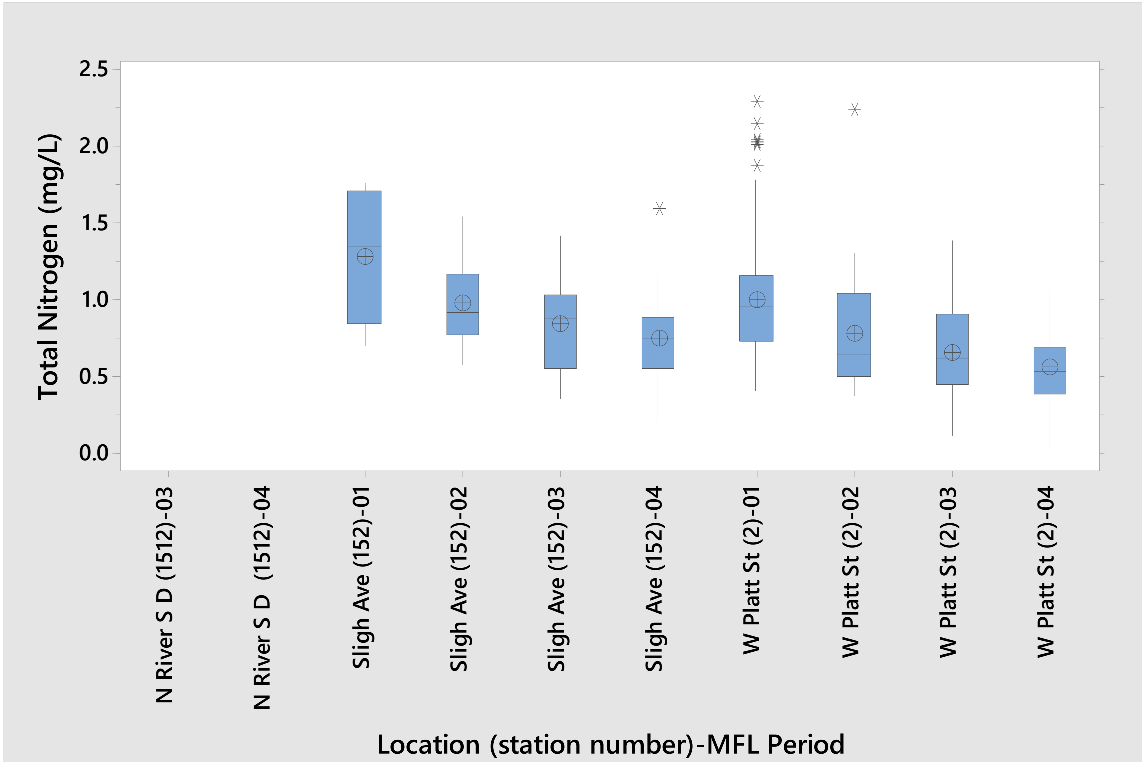


Figure 5.1-51. Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

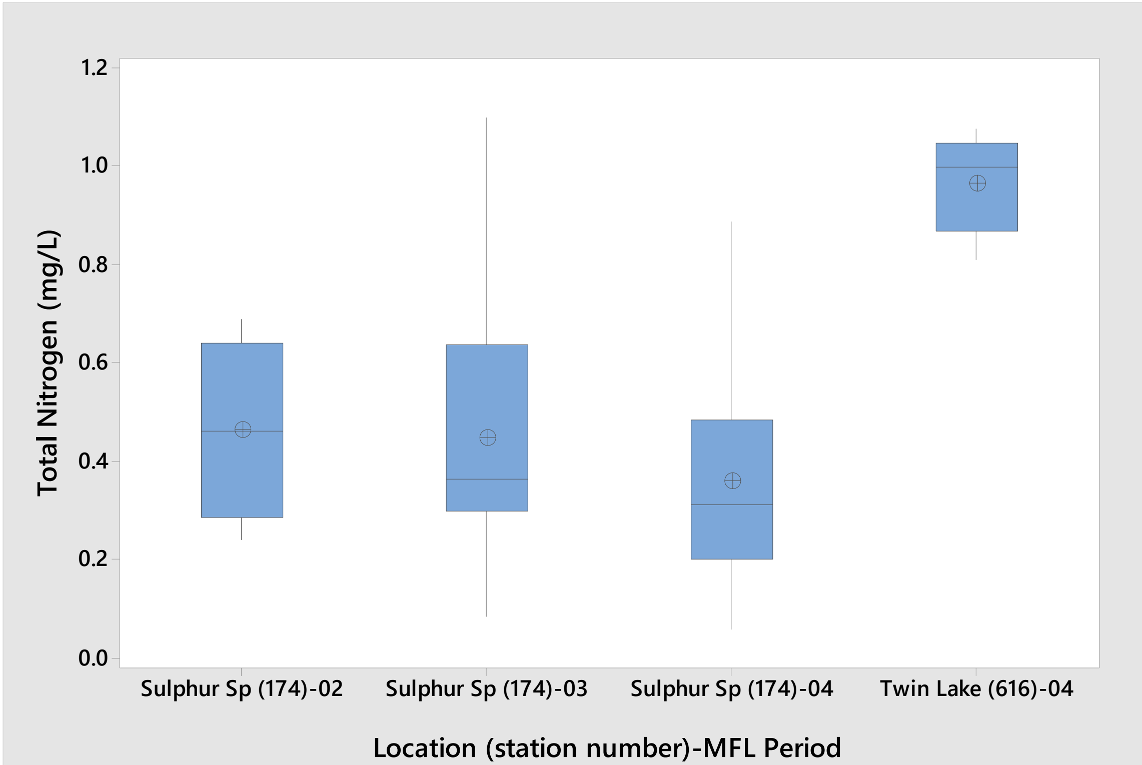


Figure 5.1-52. Average of monthly total nitrogen (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

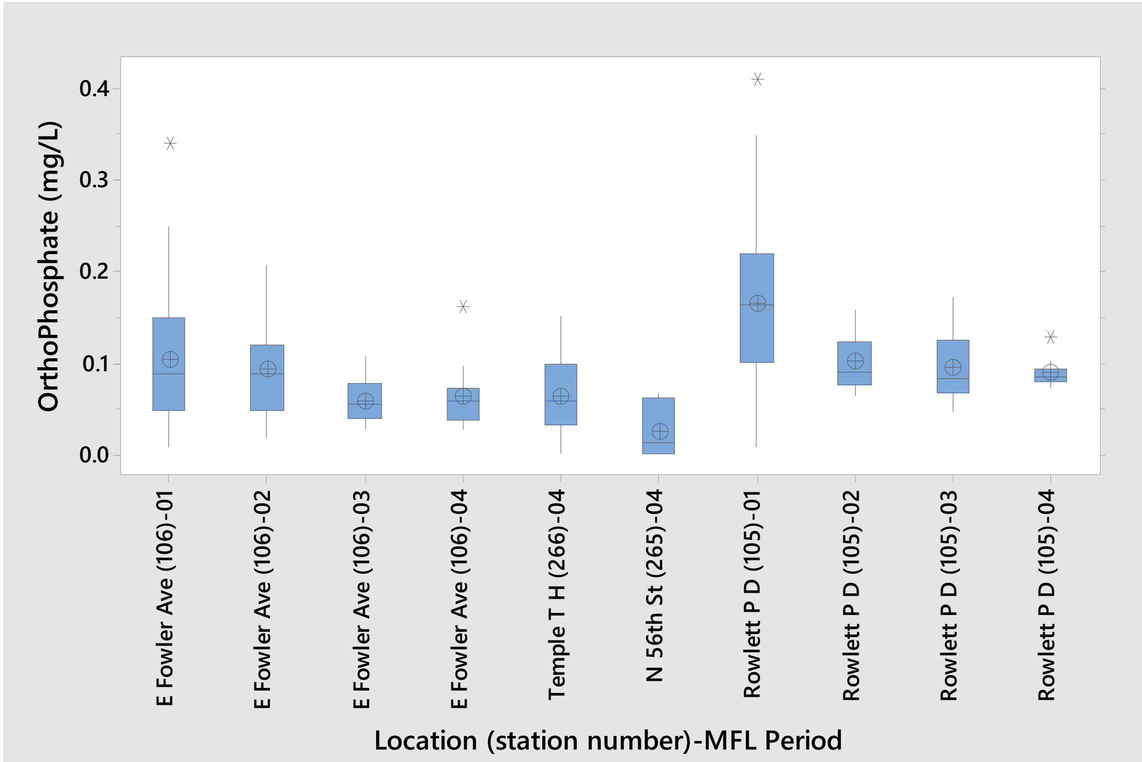


Figure 5.1-53. Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

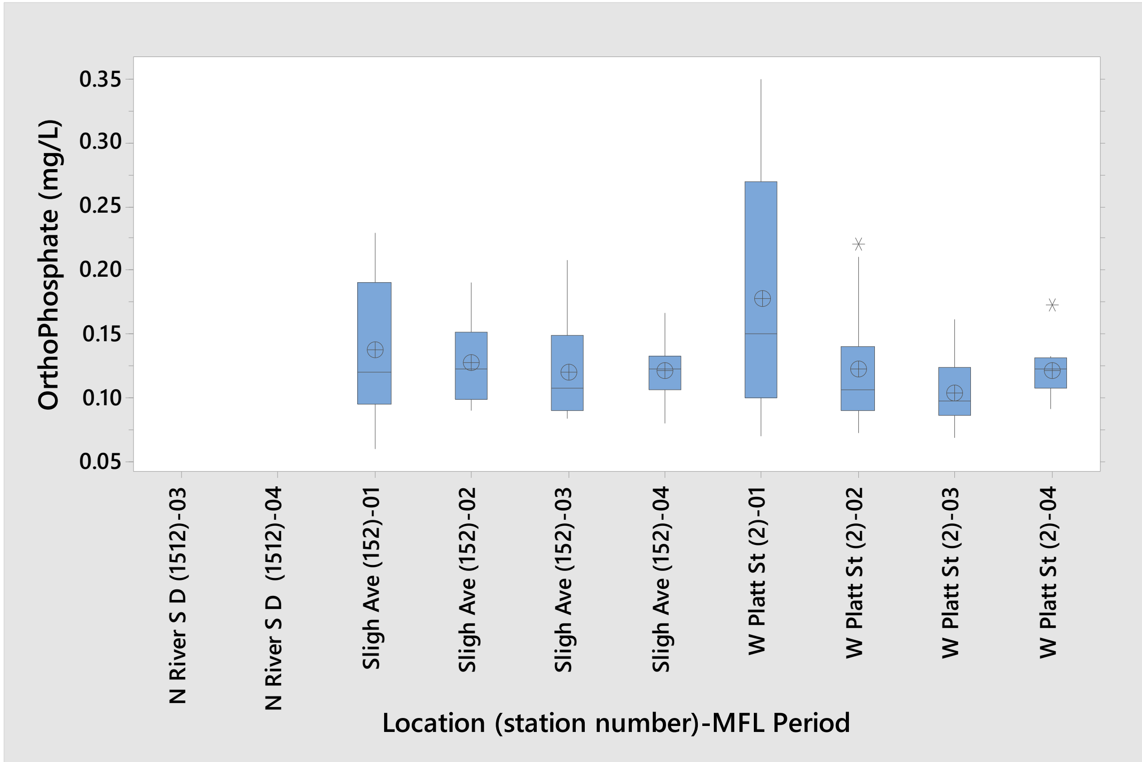


Figure 5.1-54. Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

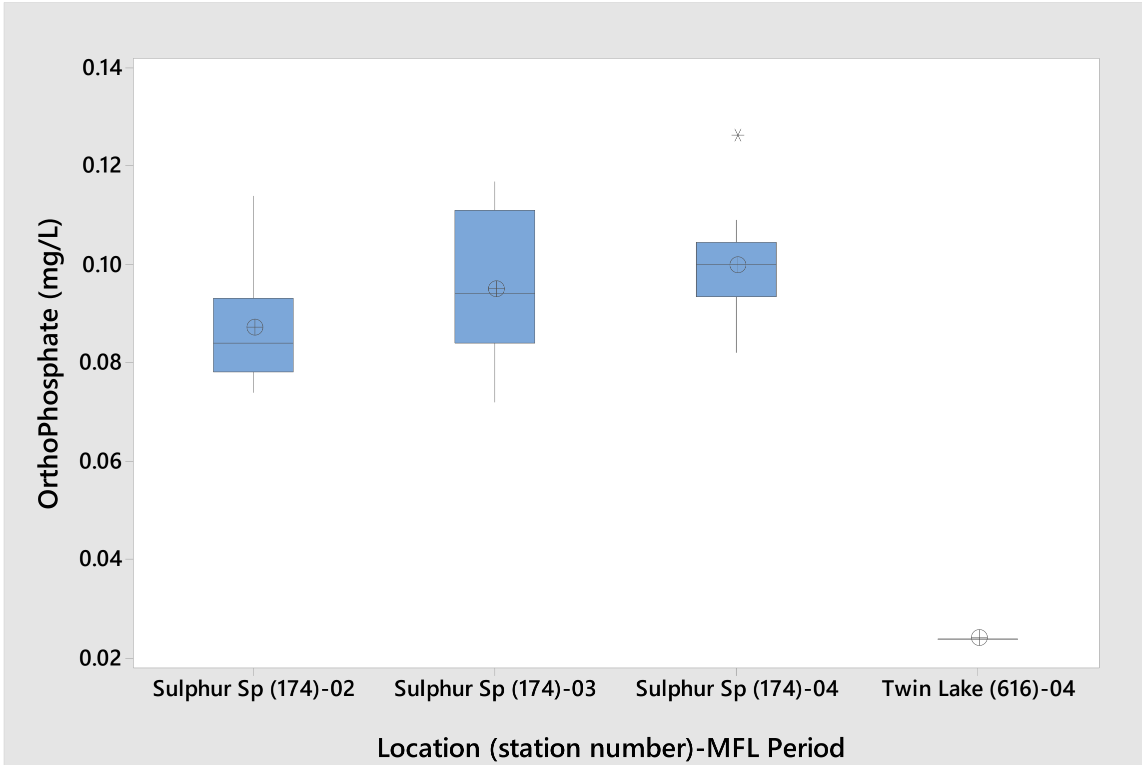


Figure 5.1-55. Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

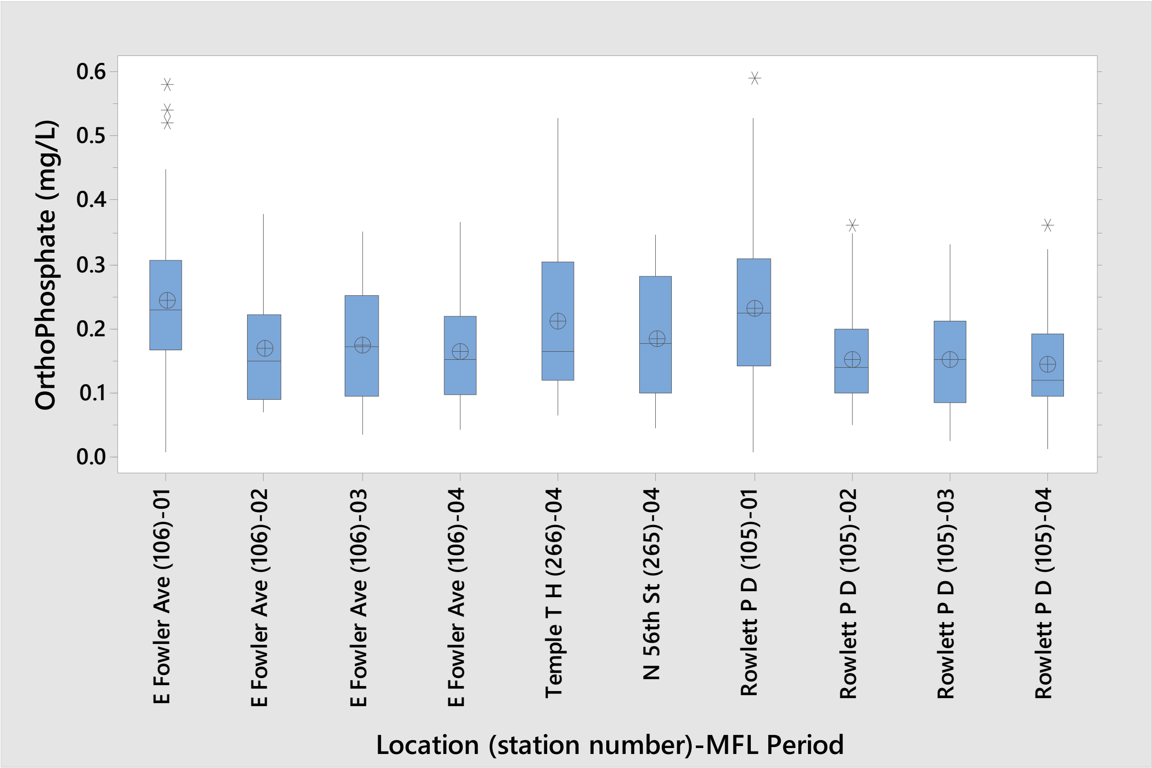


Figure 5.1-56. Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

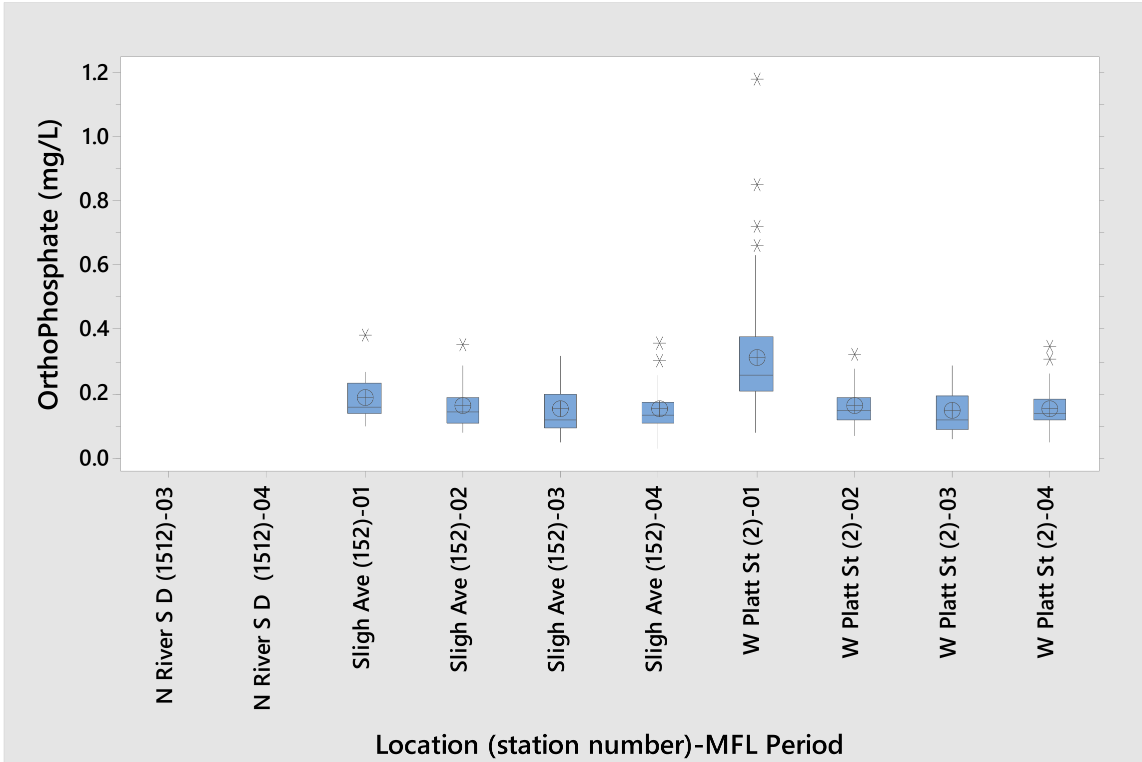


Figure 5.1-57. Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

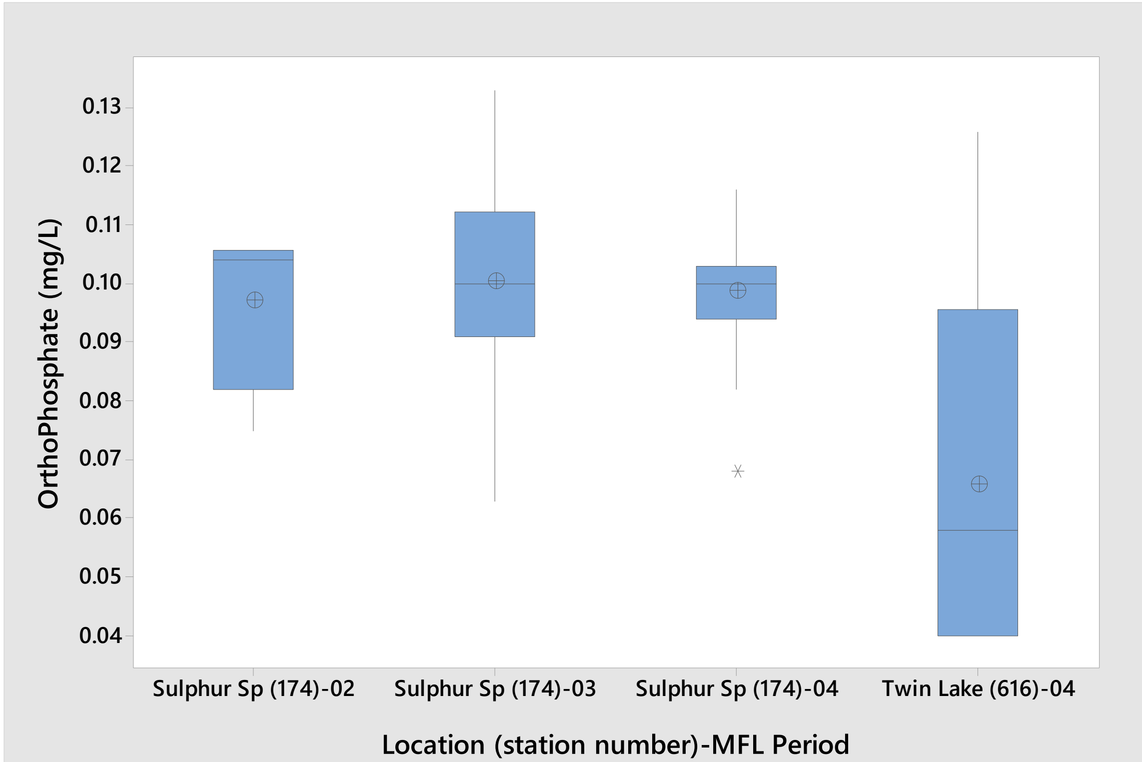


Figure 5.1-58. Average of monthly orthophosphate data (mg/L) recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

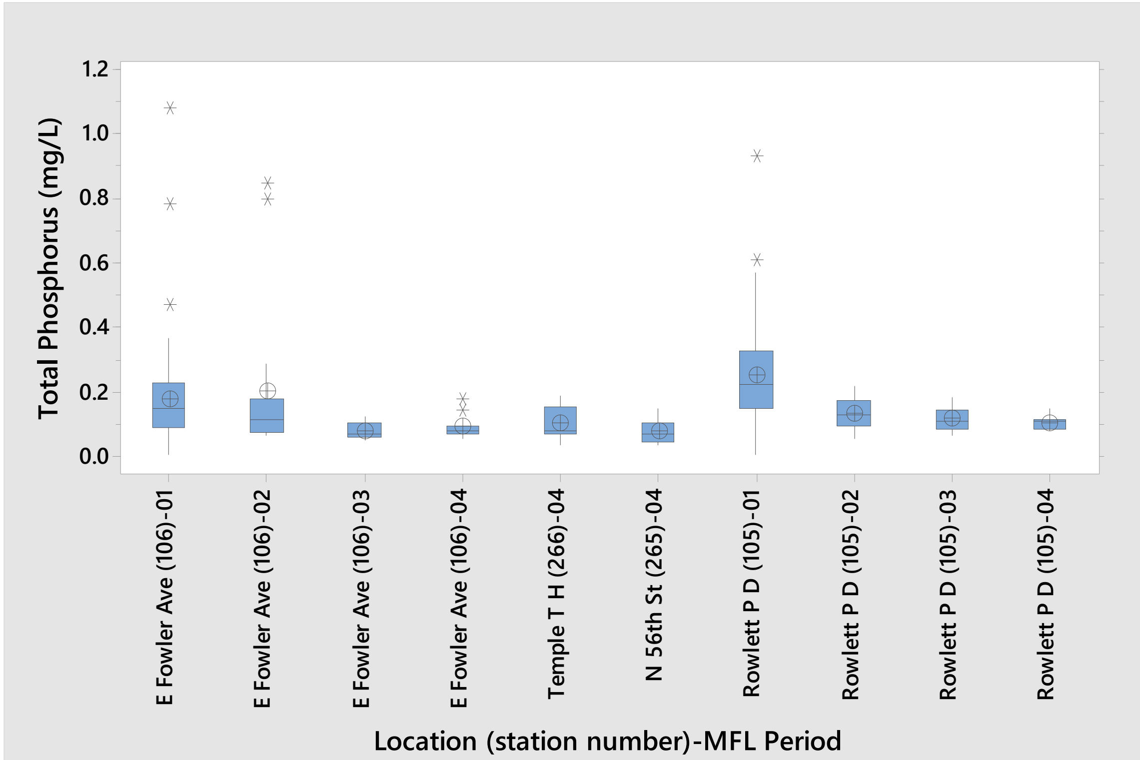


Figure 5.1-59. Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

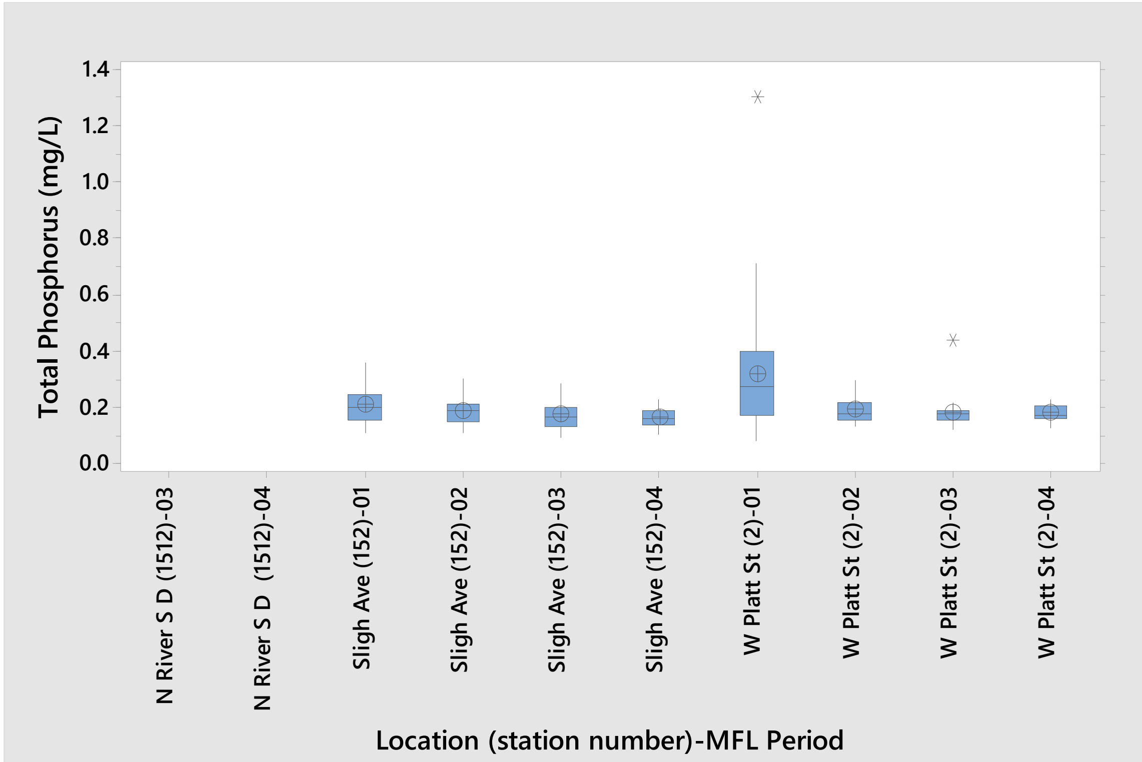


Figure 5.1-60. Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

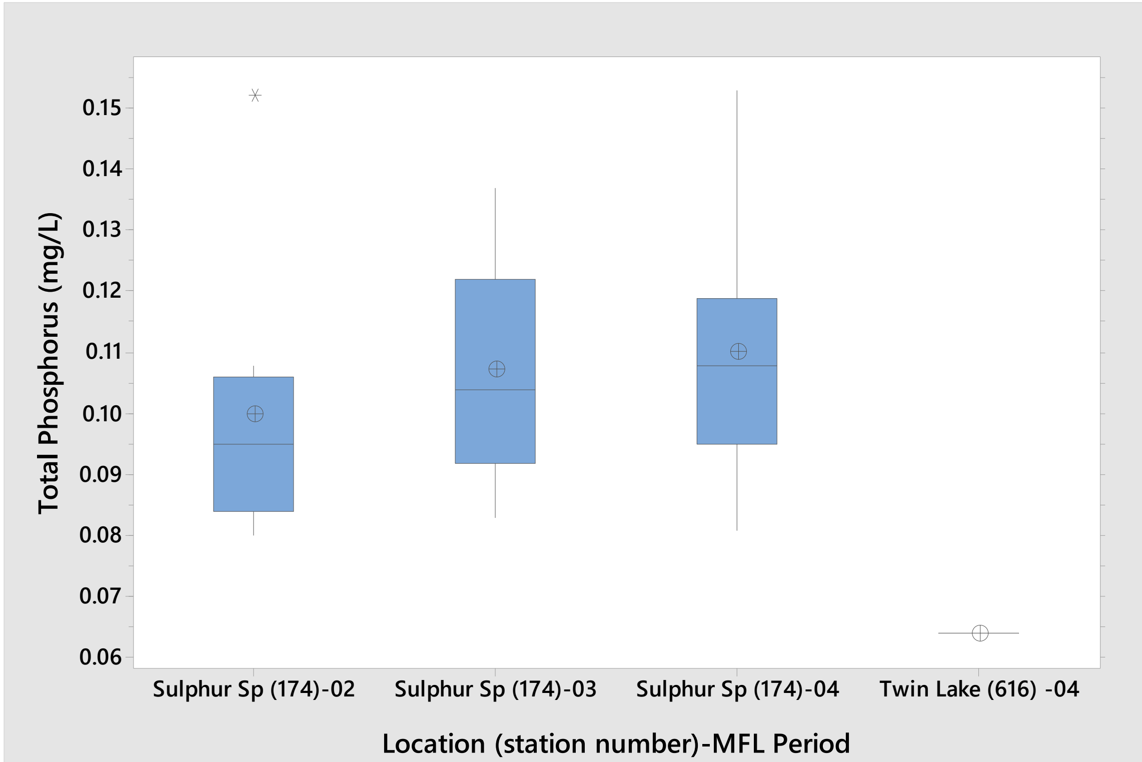


Figure 5.1-61. Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

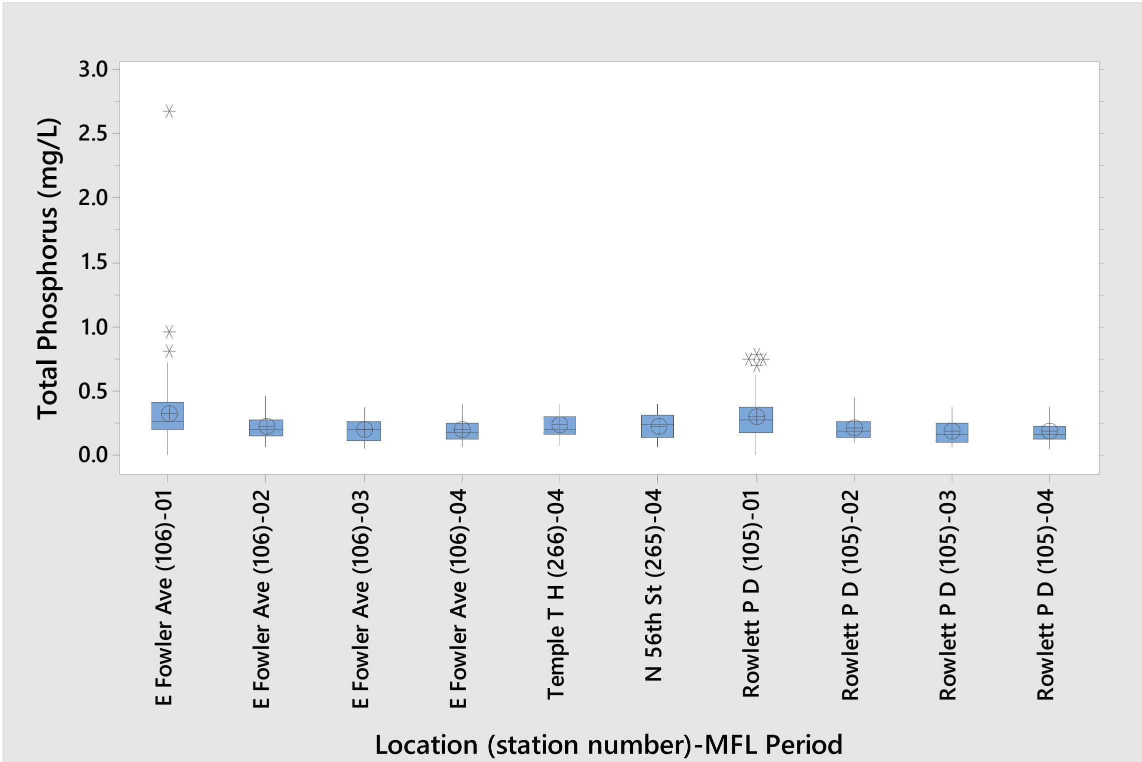


Figure 5.1-62. Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

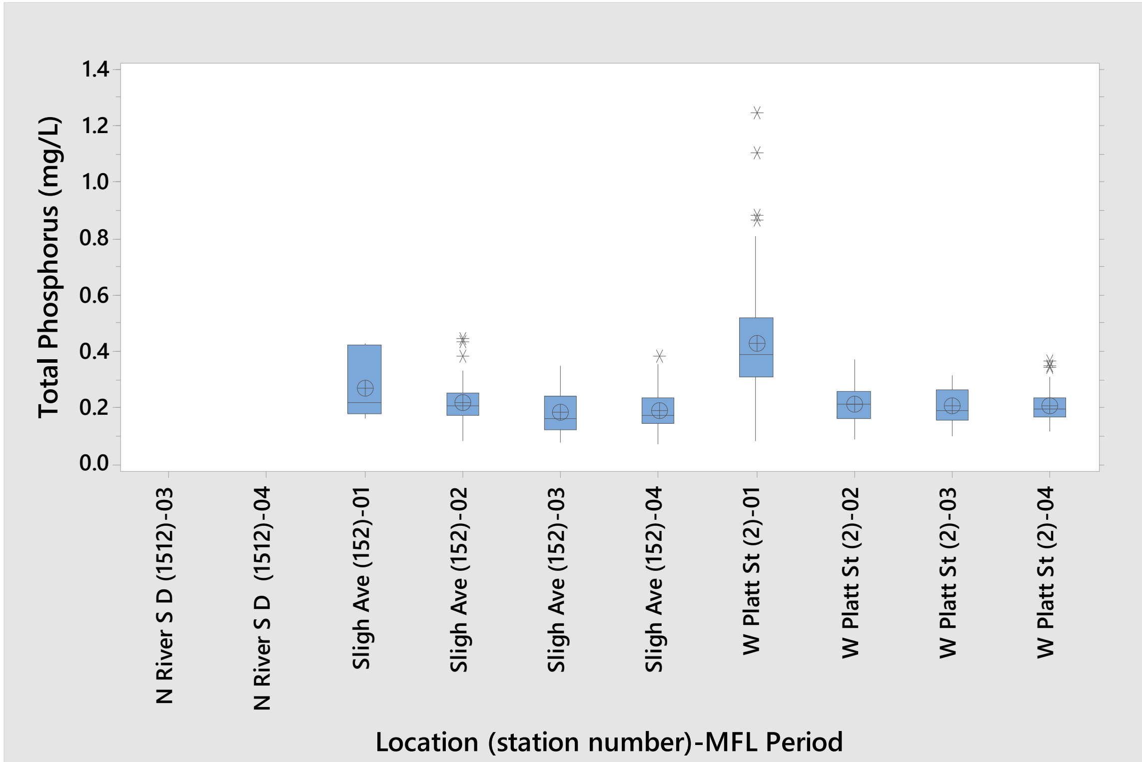


Figure 5.1-63. Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

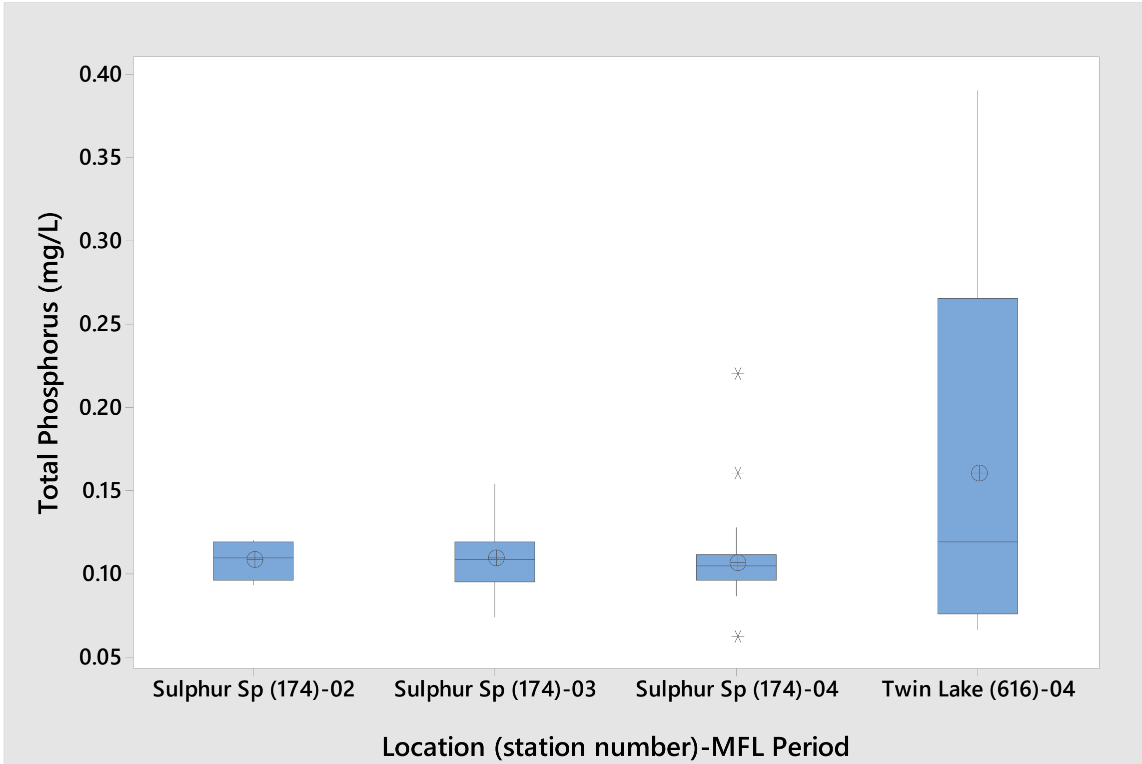


Figure 5.1-64. Average of monthly total phosphorous (mg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

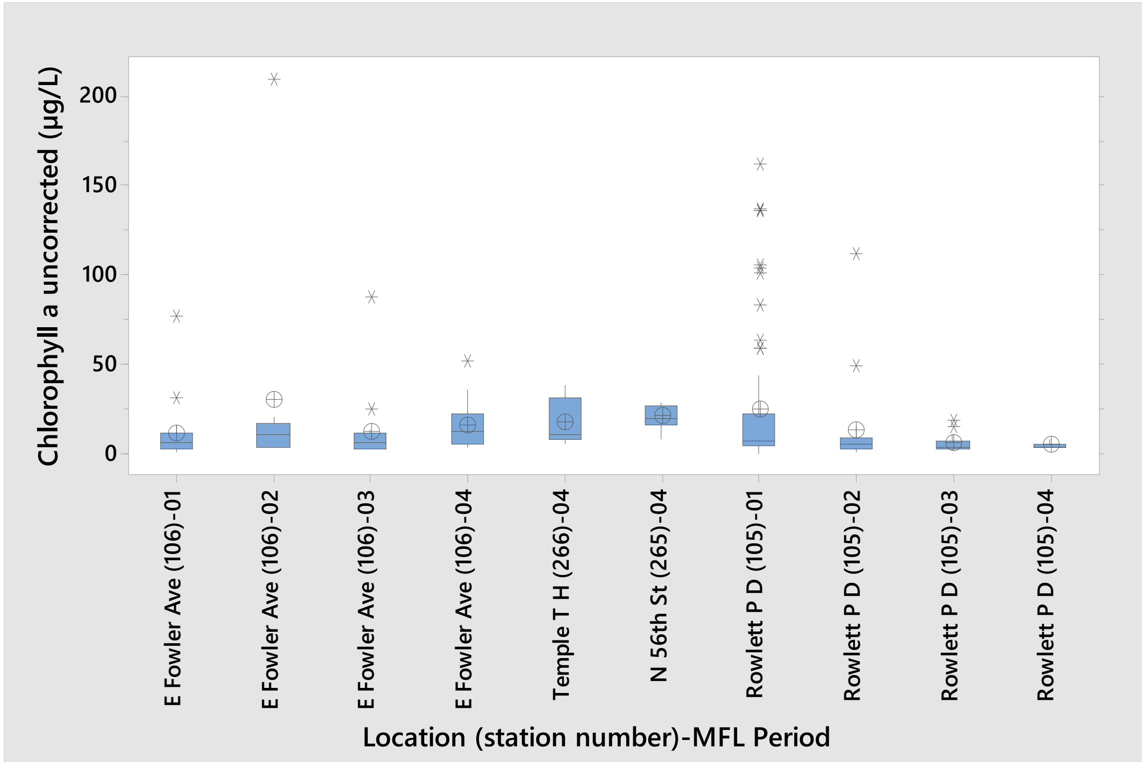


Figure 5.1-65. Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

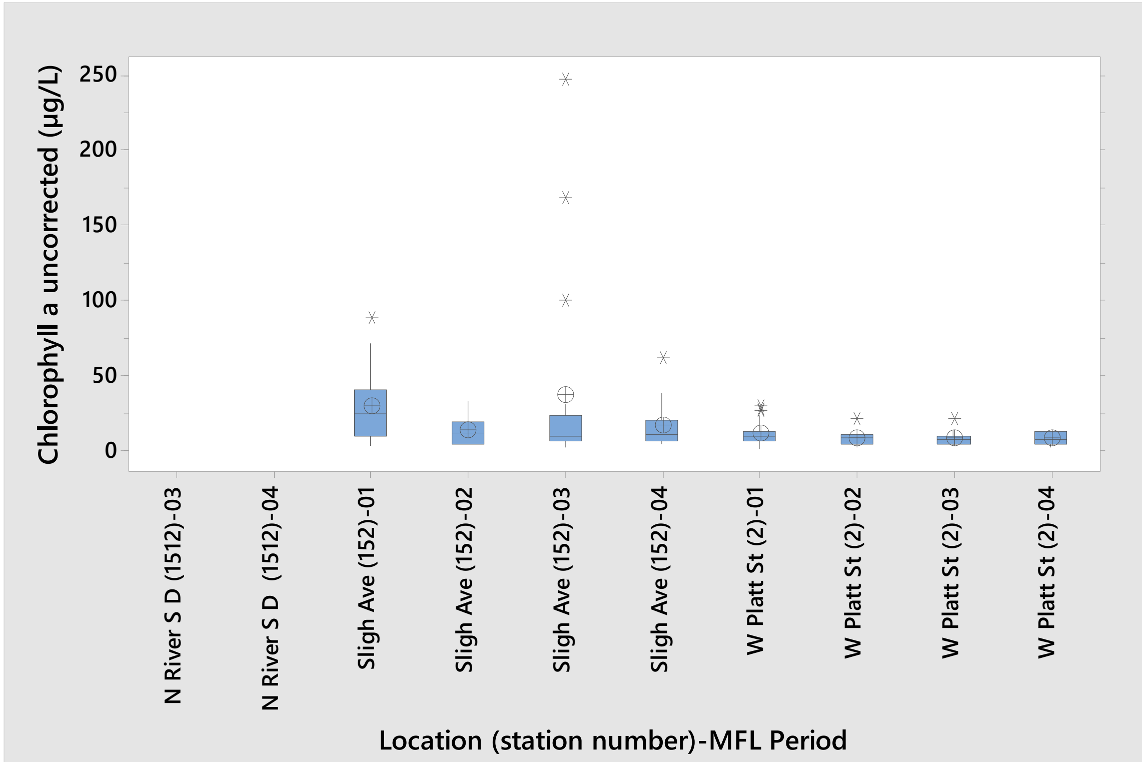


Figure 5.1-66. Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

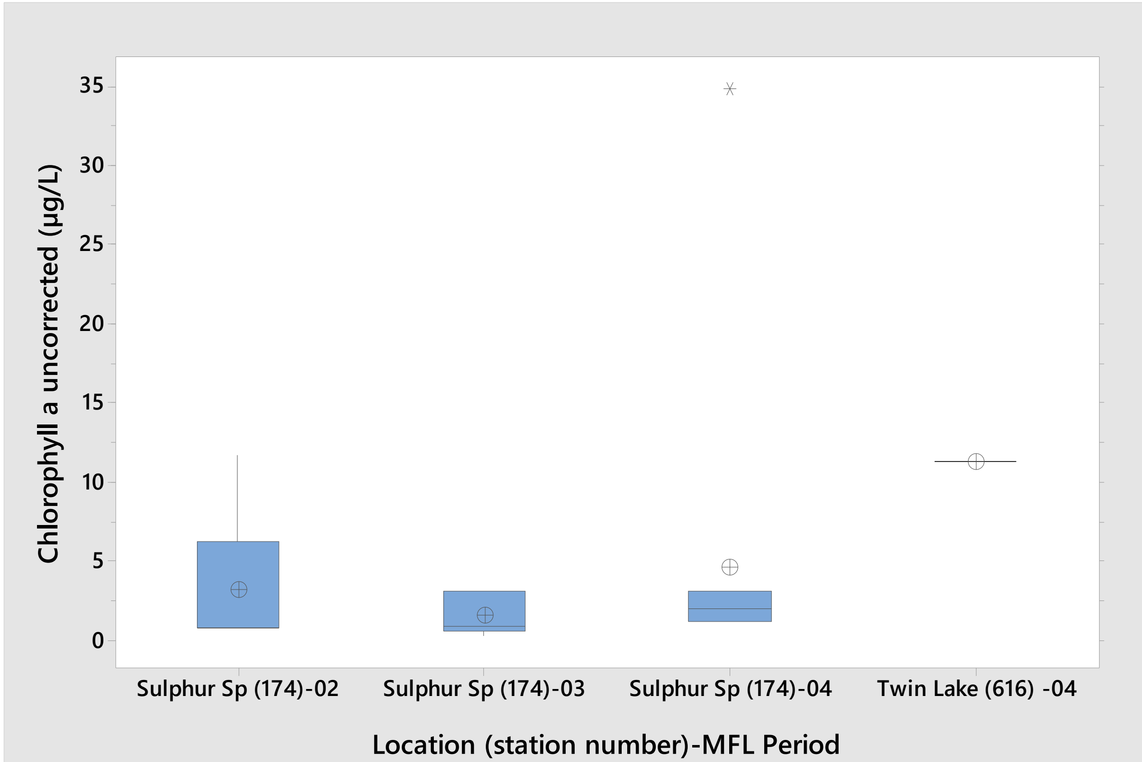


Figure 5.1-67. Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

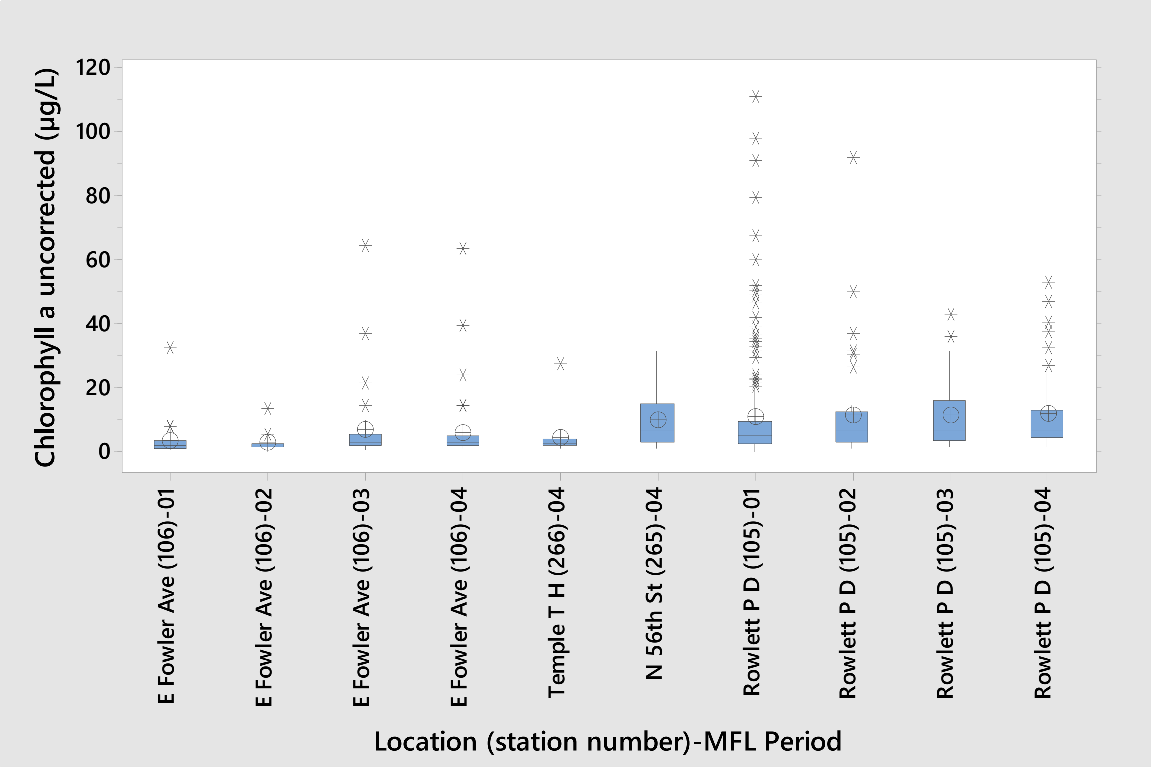


Figure 5.1-68. Average of uncorrected monthly chlorophyll *a* (µg/L) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

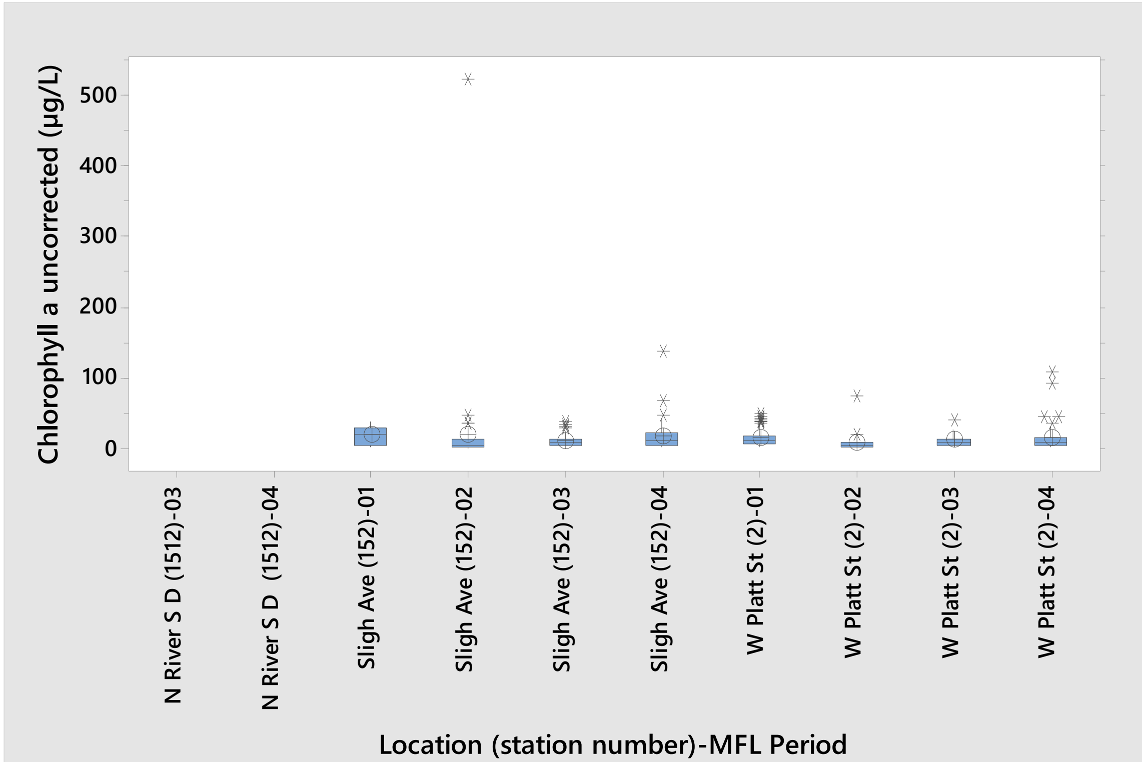


Figure 5.1-69. Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

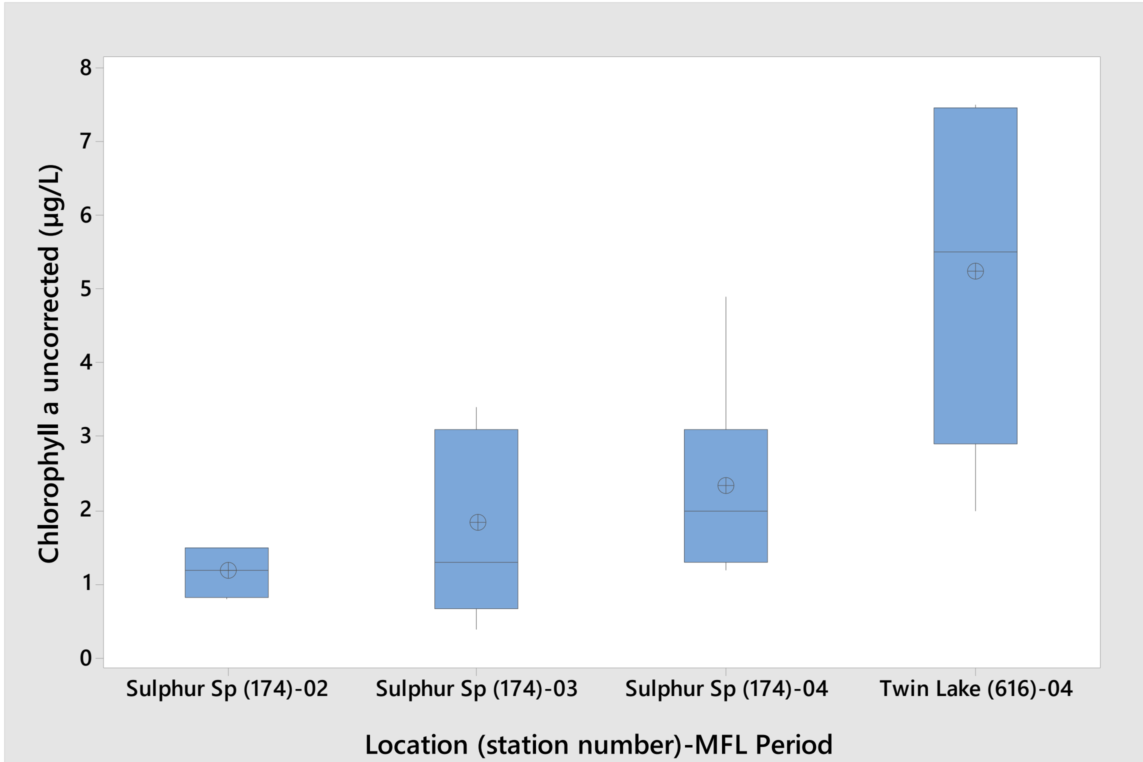


Figure 5.1-70. Average of monthly chlorophyll *a* uncorrected (µg/L) data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

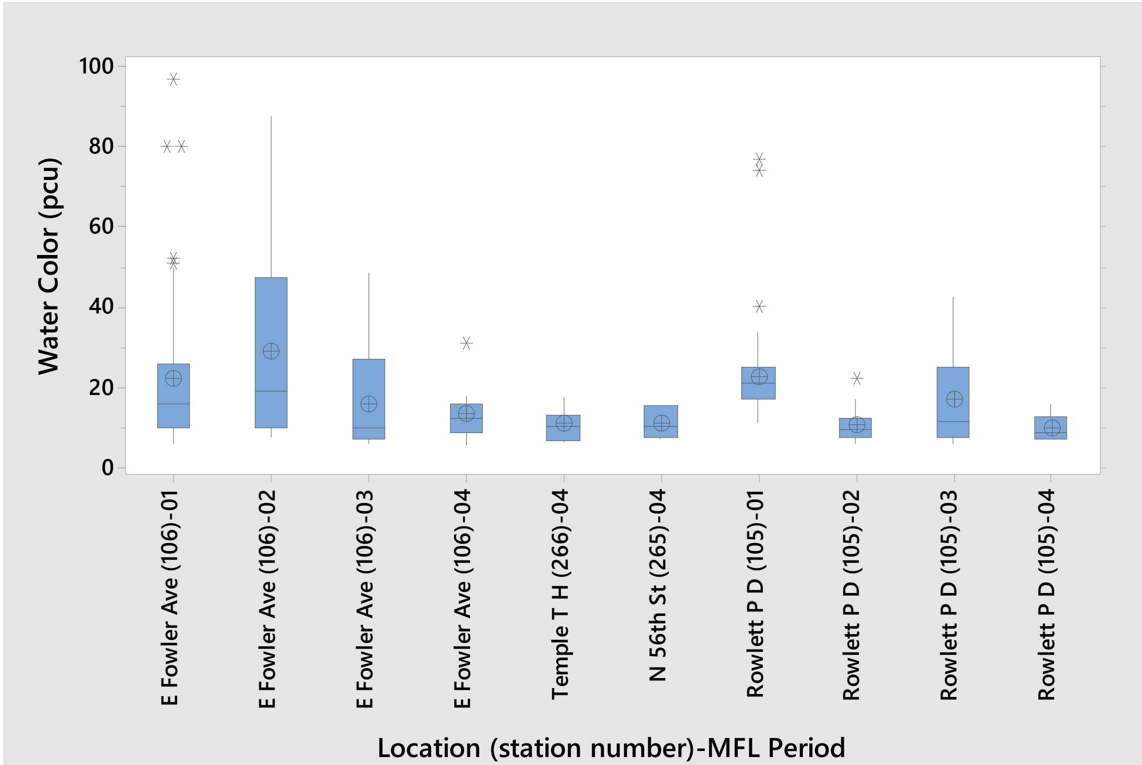


Figure 5.1-71. Average of monthly water color (pcu) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

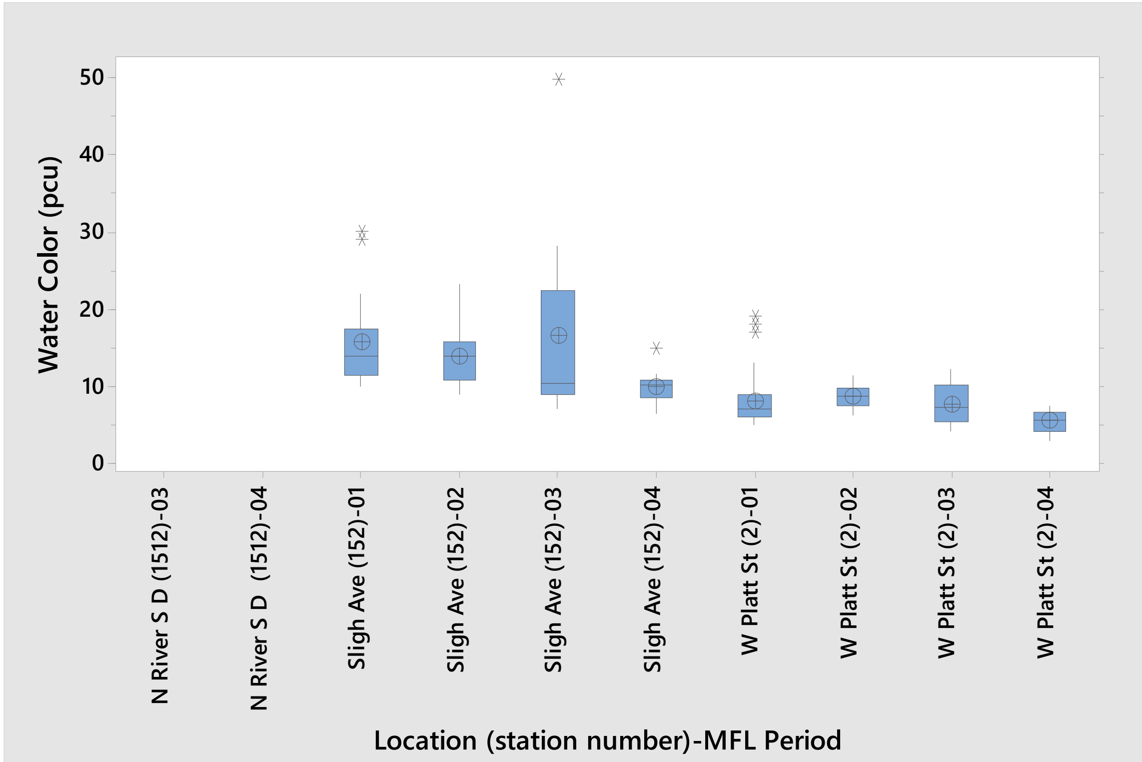


Figure 5.1-72. Average of monthly water color data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

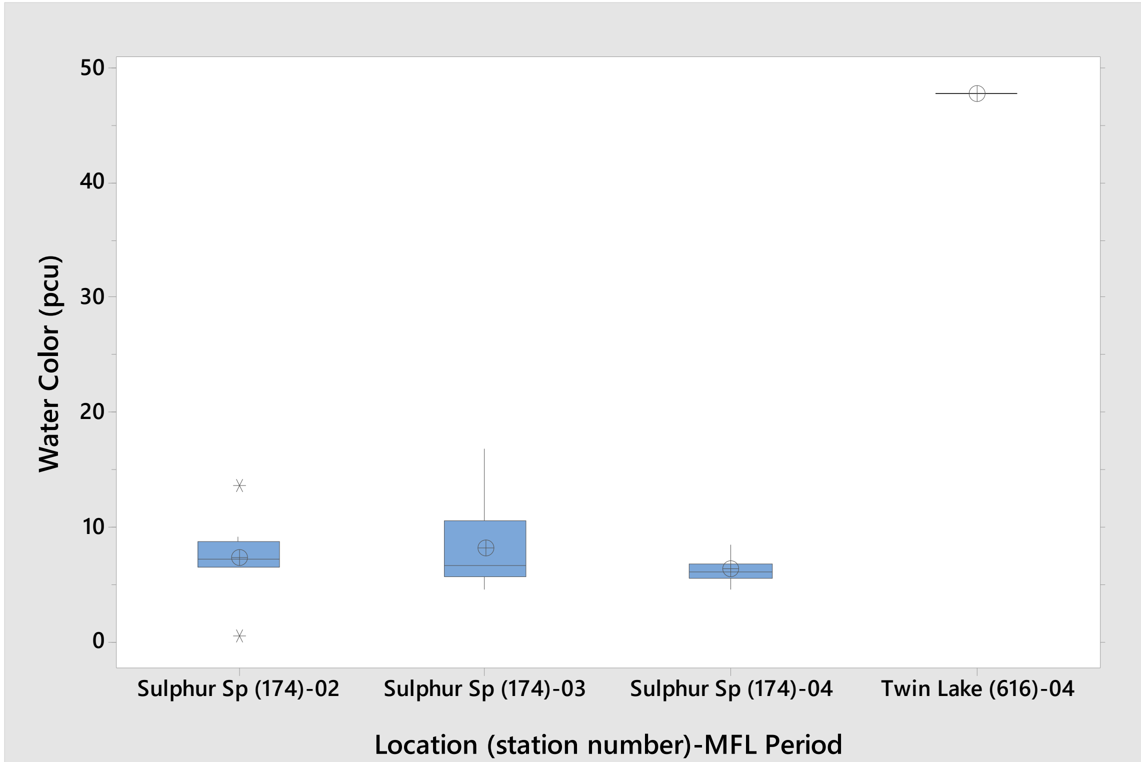


Figure 5.1-73. Average of monthly water color data recorded at EPCHC stations located in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

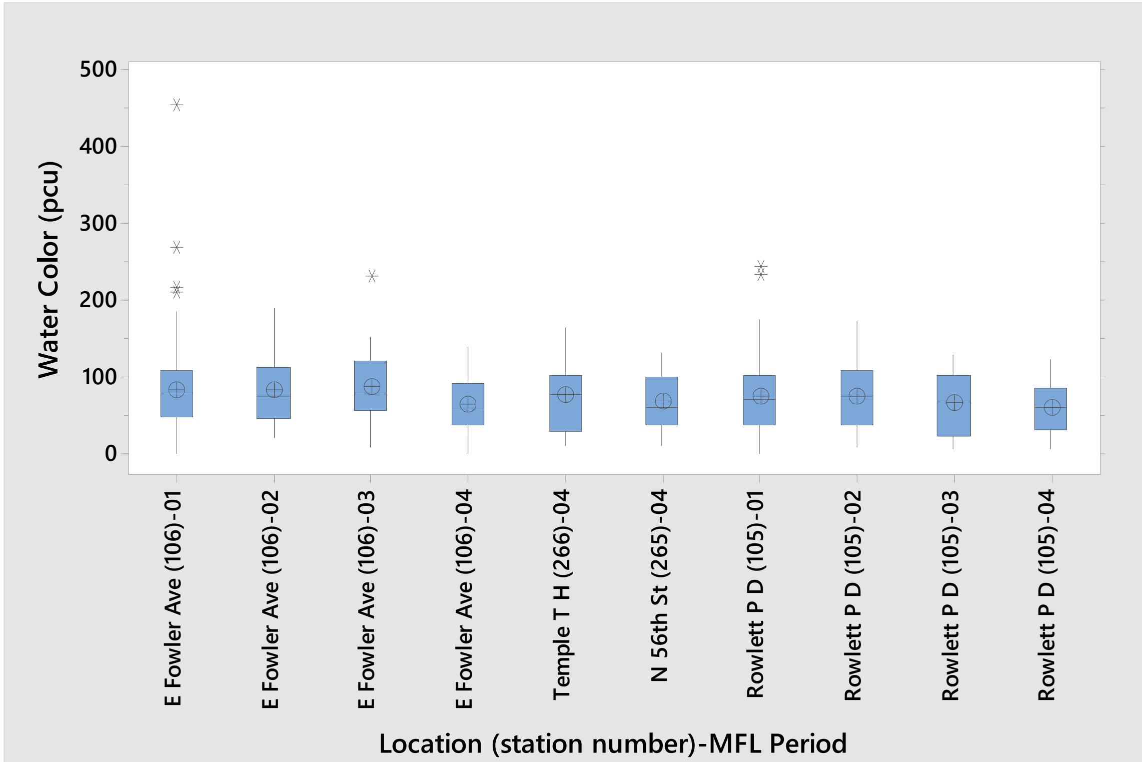


Figure 5.1-74. Average of monthly water color data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

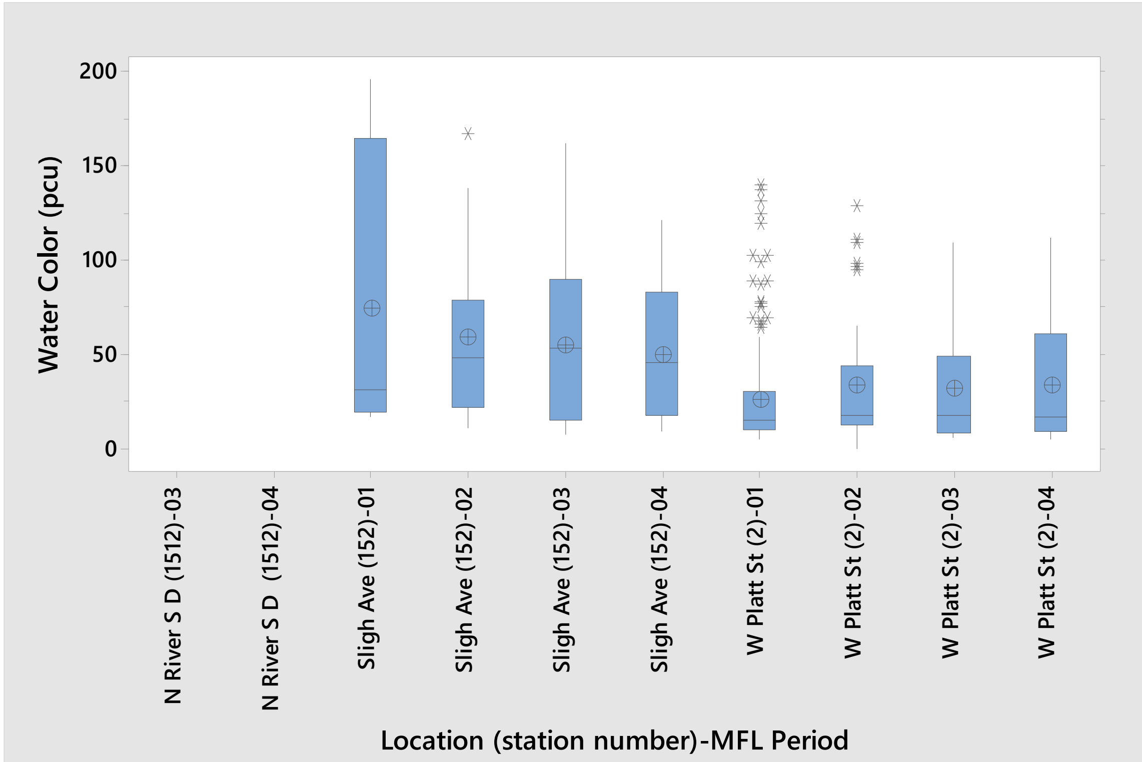


Figure 5.1-75. Average of monthly water color data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from the mouth) and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

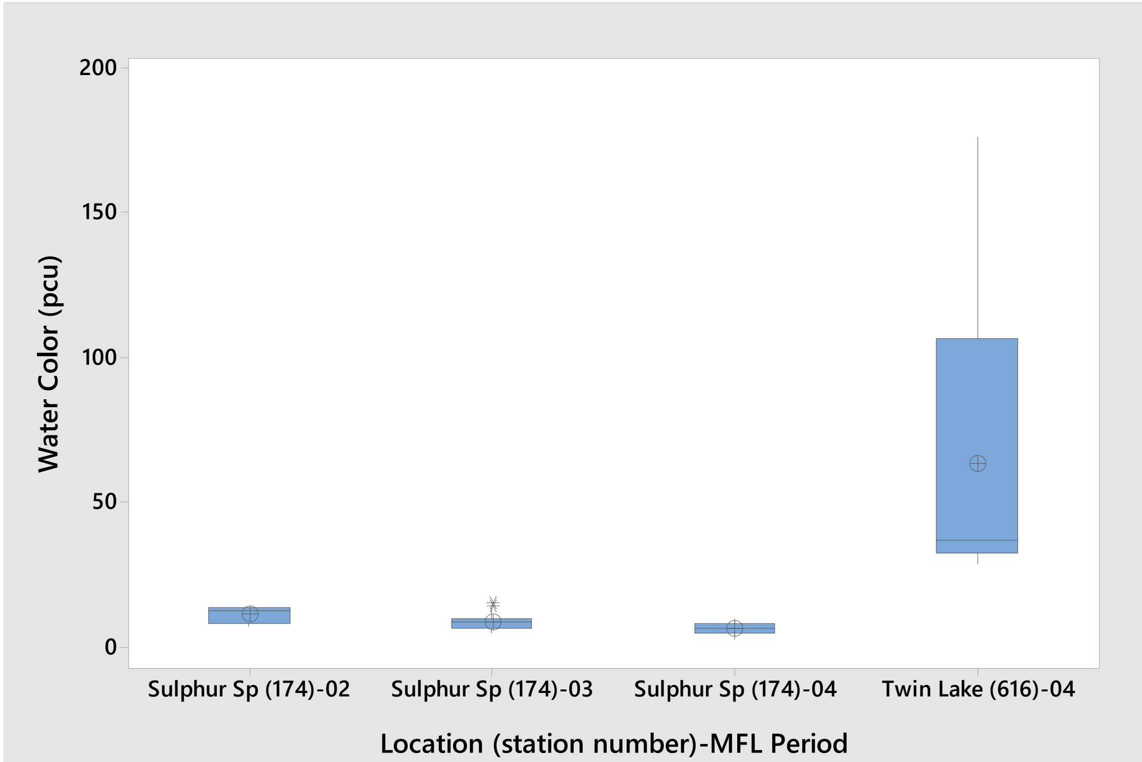


Figure 5.1-76. Average of monthly water color data recorded at EPCHC stations in LHR tributaries and when discharge was occurring over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

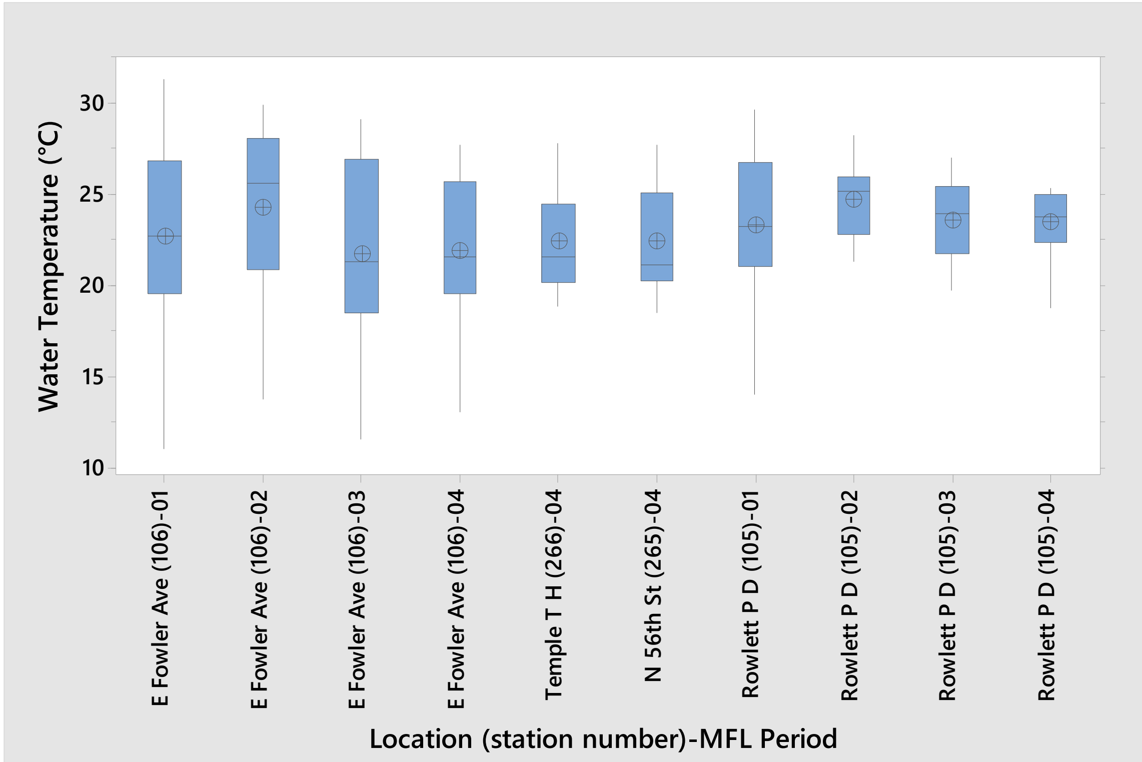


Figure 5.1-77. Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR upper segment (≥14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

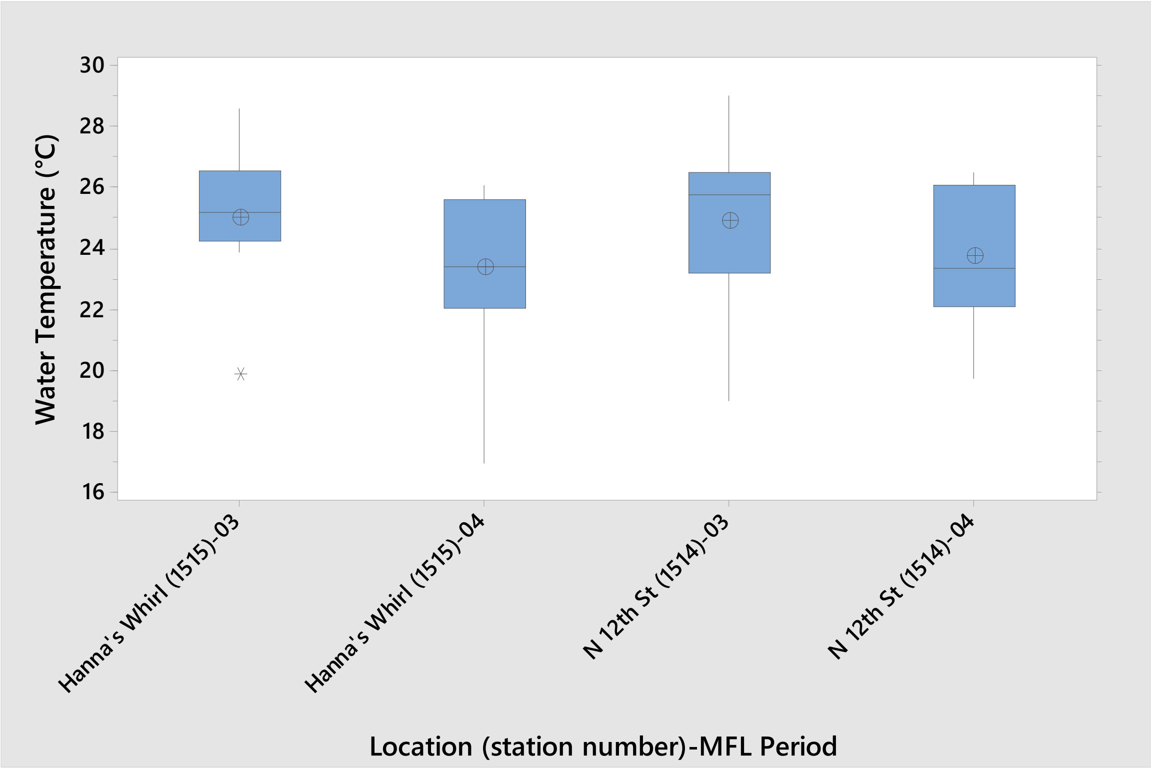


Figure 5.1-78. Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR middle segment (12.6 to < 14.5 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

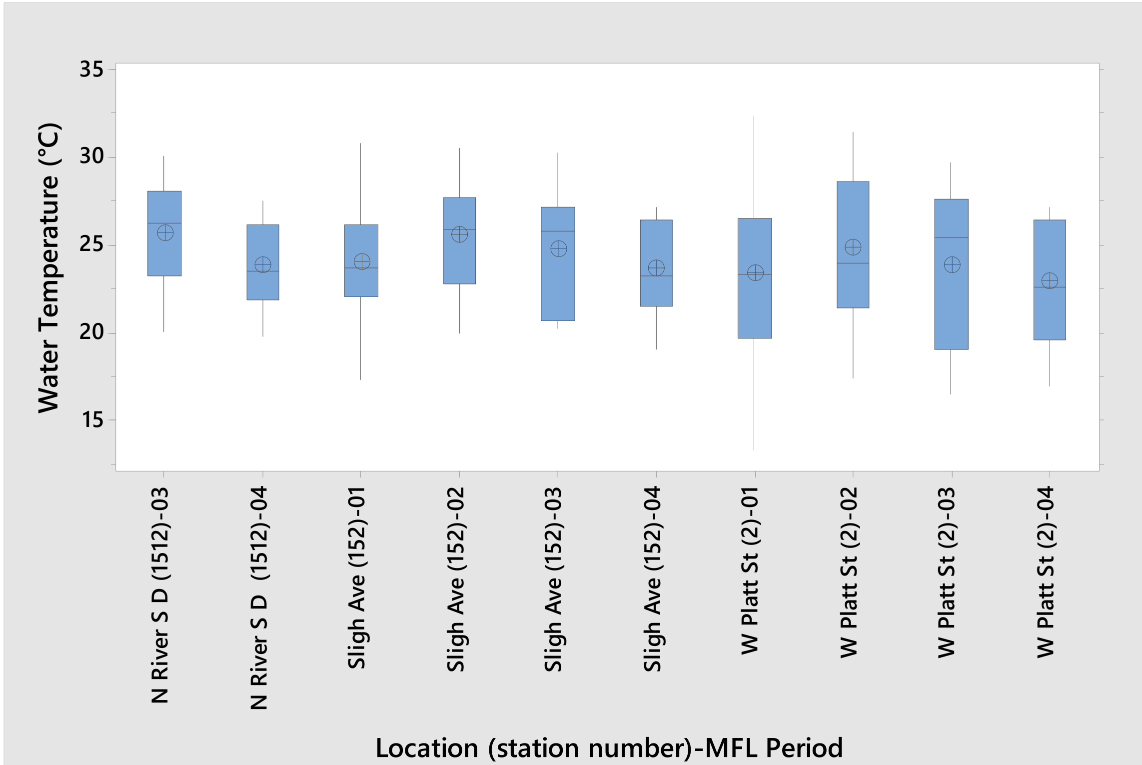


Figure 5.1-79. Average of monthly water temperature (°C) data recorded at EPCHC stations in the LHR lower segment (<12.6 river kilometers from mouth) and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.

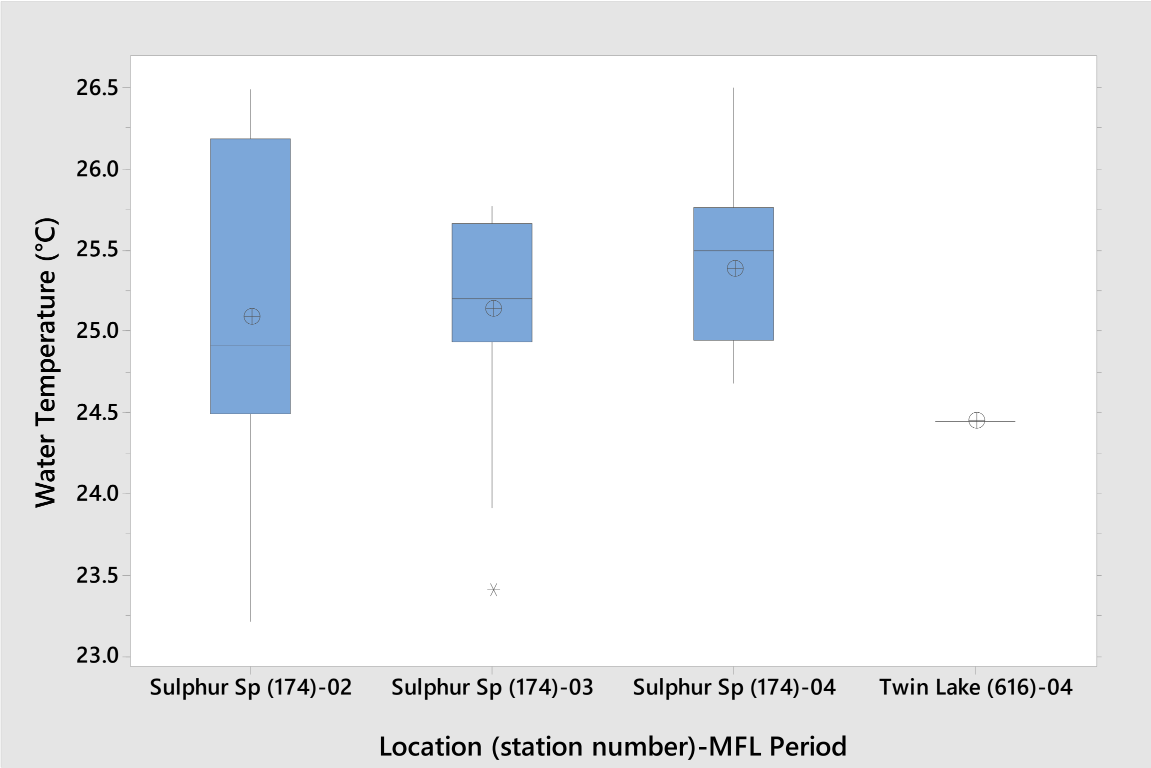
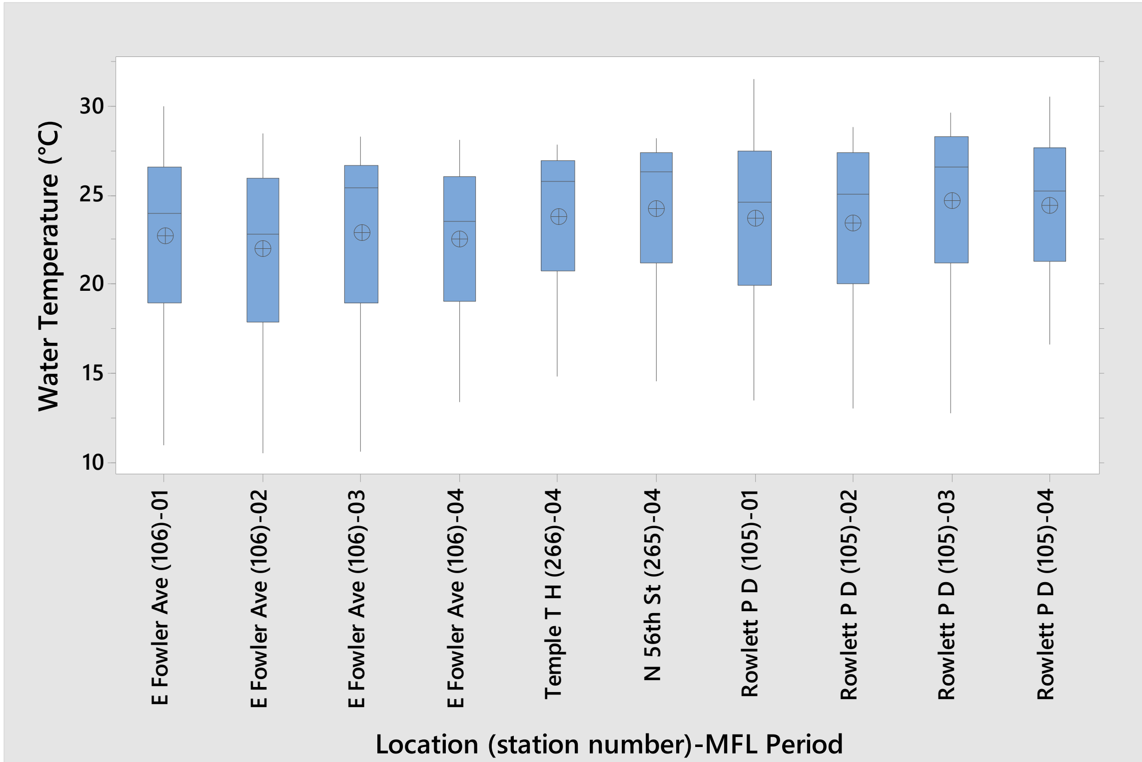


Figure 5.1-80. Average of monthly water temperature (°C) data recorded at EPCHC stations in LHR tributaries and without discharge over the Hillsborough River dam (crosshairs = mean, horizontal line = median, interquartile range box = the middle 50% of the data, whisker lines = the maximum and minimum data points within 1.5 box heights, asterisk = outlier data points). Sites on the left of the x axis are upstream and downstream on the right. Each site is subdivided into MFL periods: 1 = no MFL from 1979-2001, 2 = 10 cfs MFL from 2002-2007, 3 = 20/24 cfs MFL from 2008-2018, and 4 = 20/24 cfs MFL from 2013-2018.



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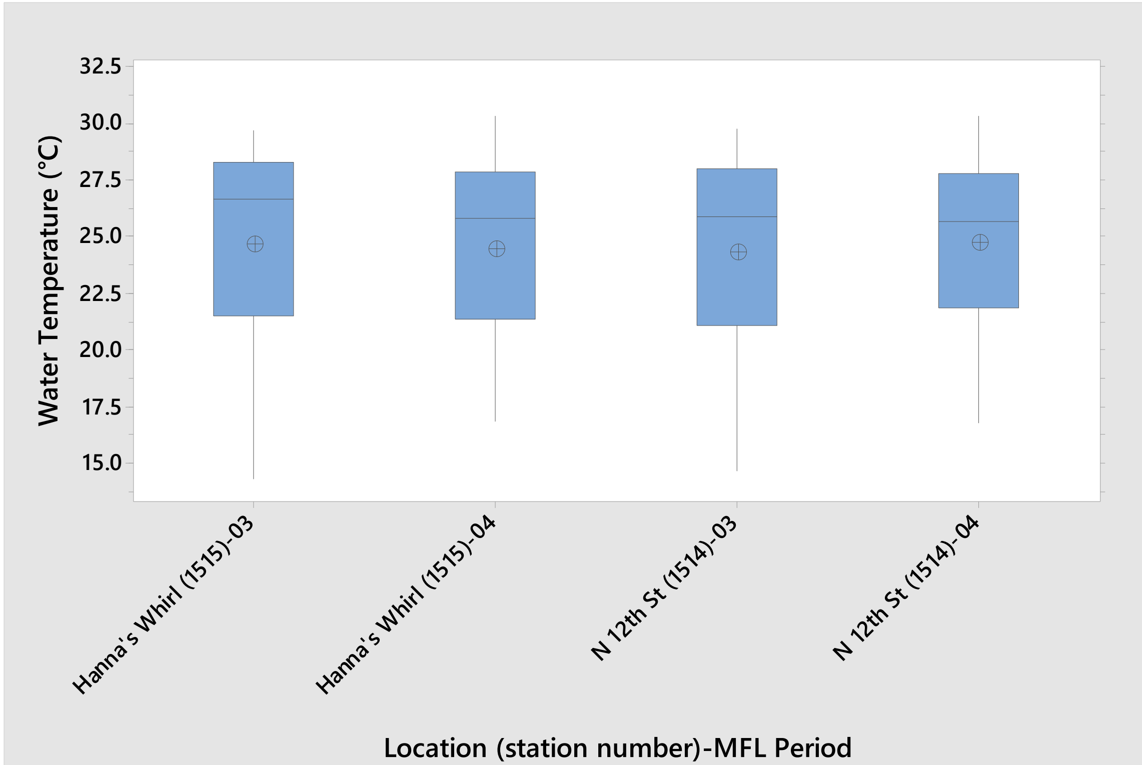

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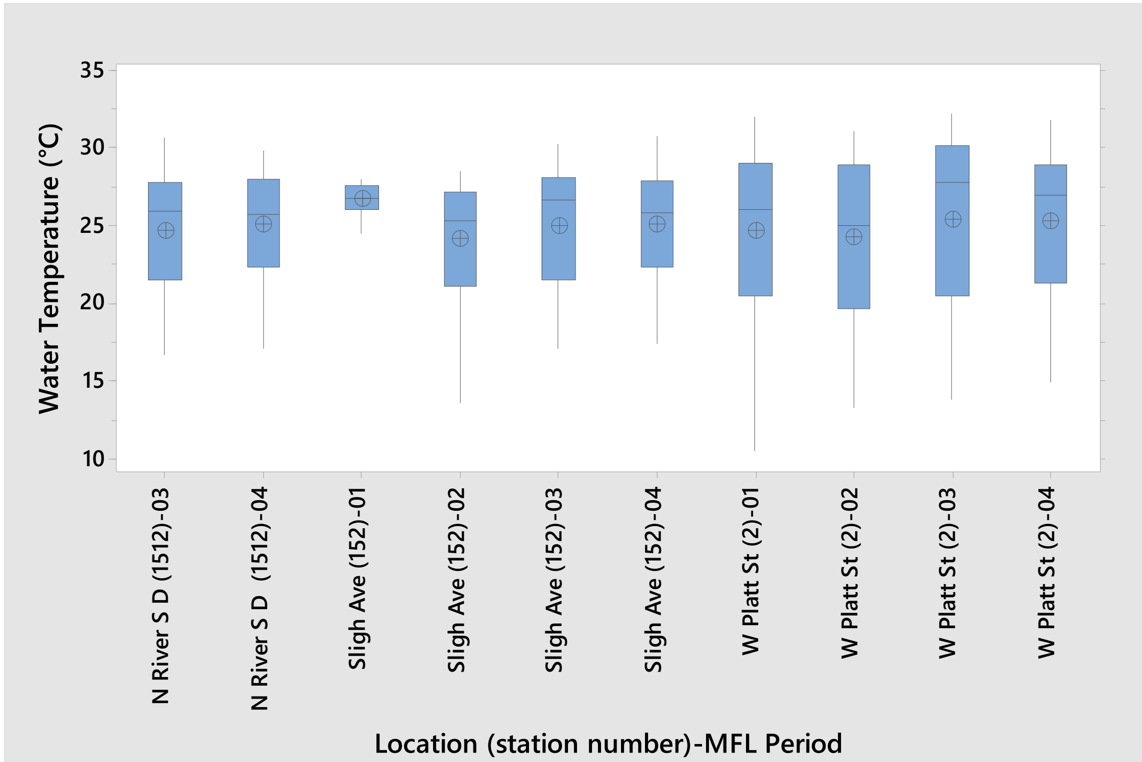

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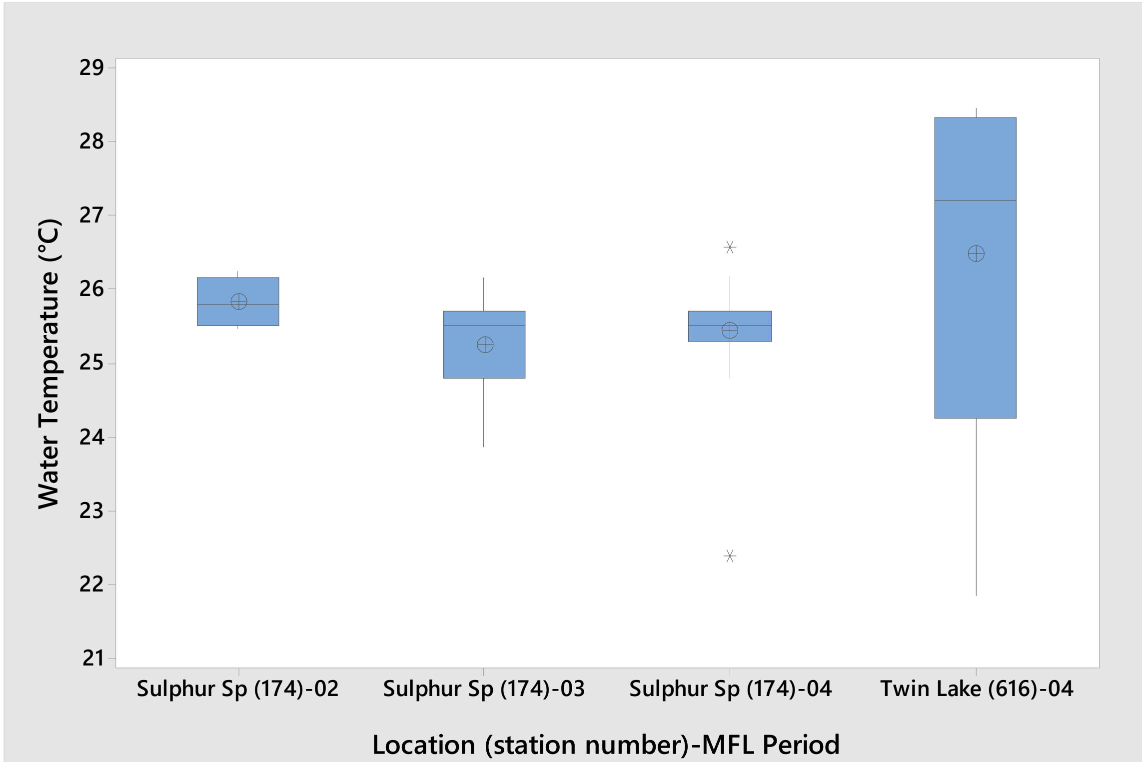

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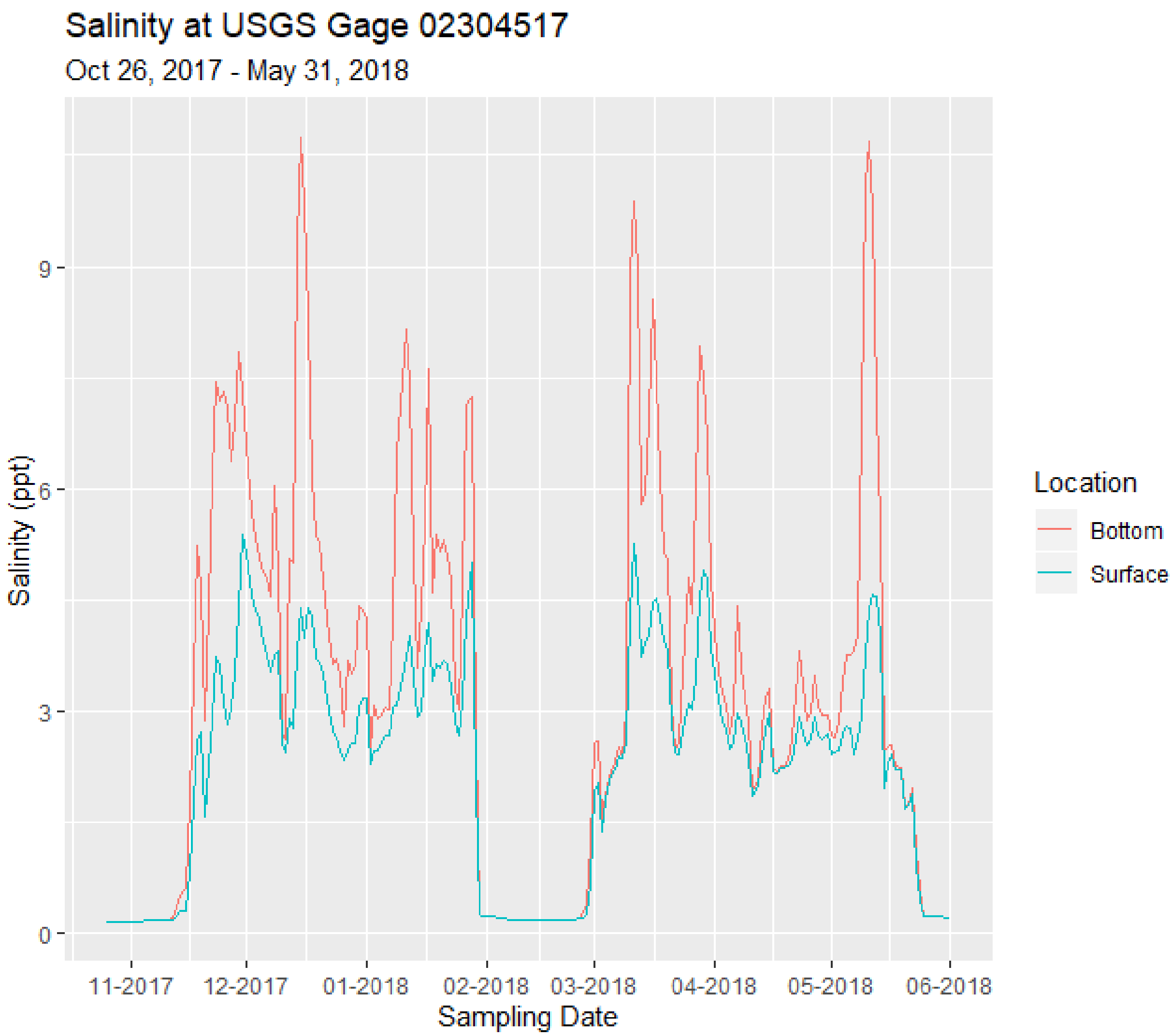

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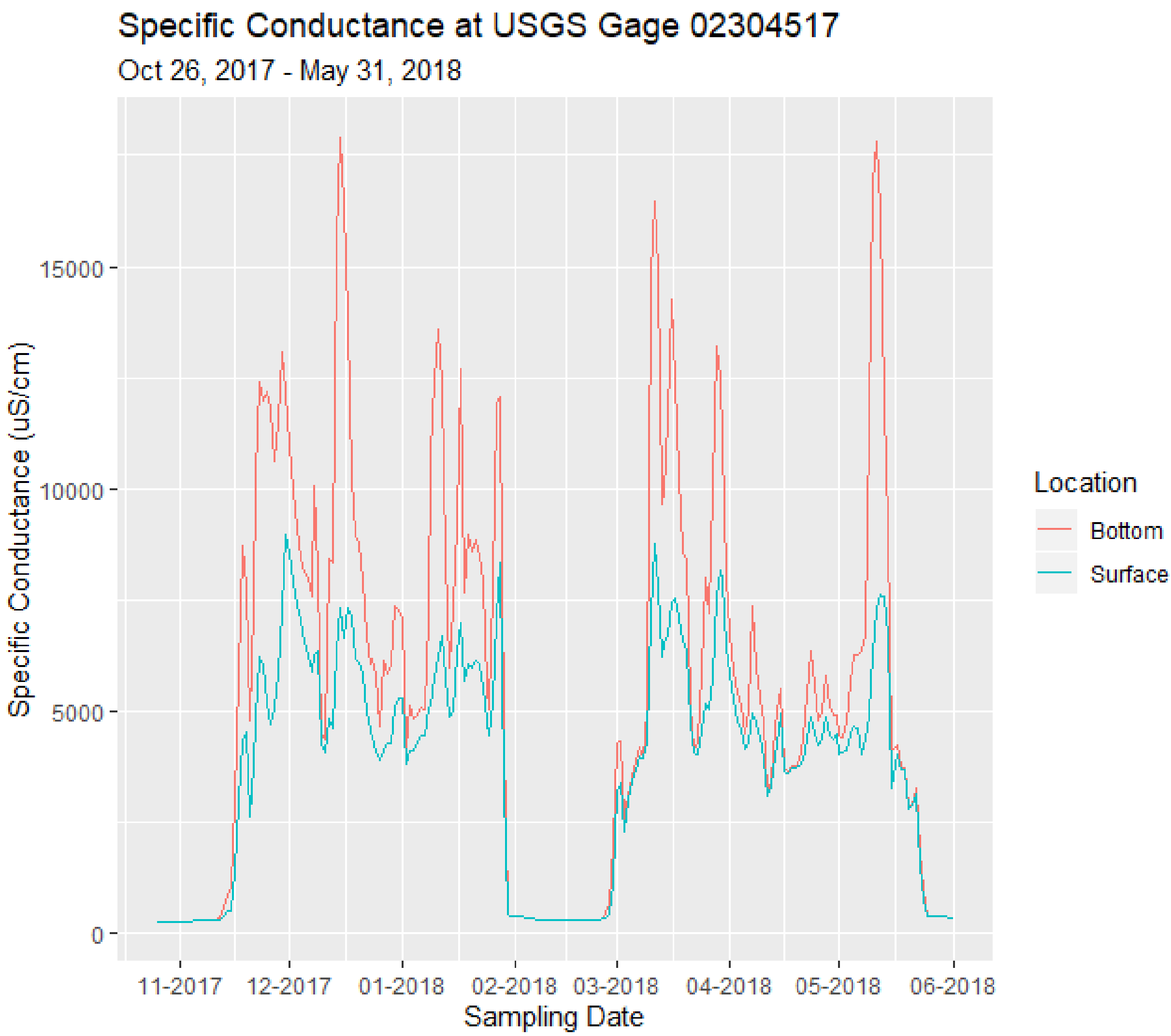

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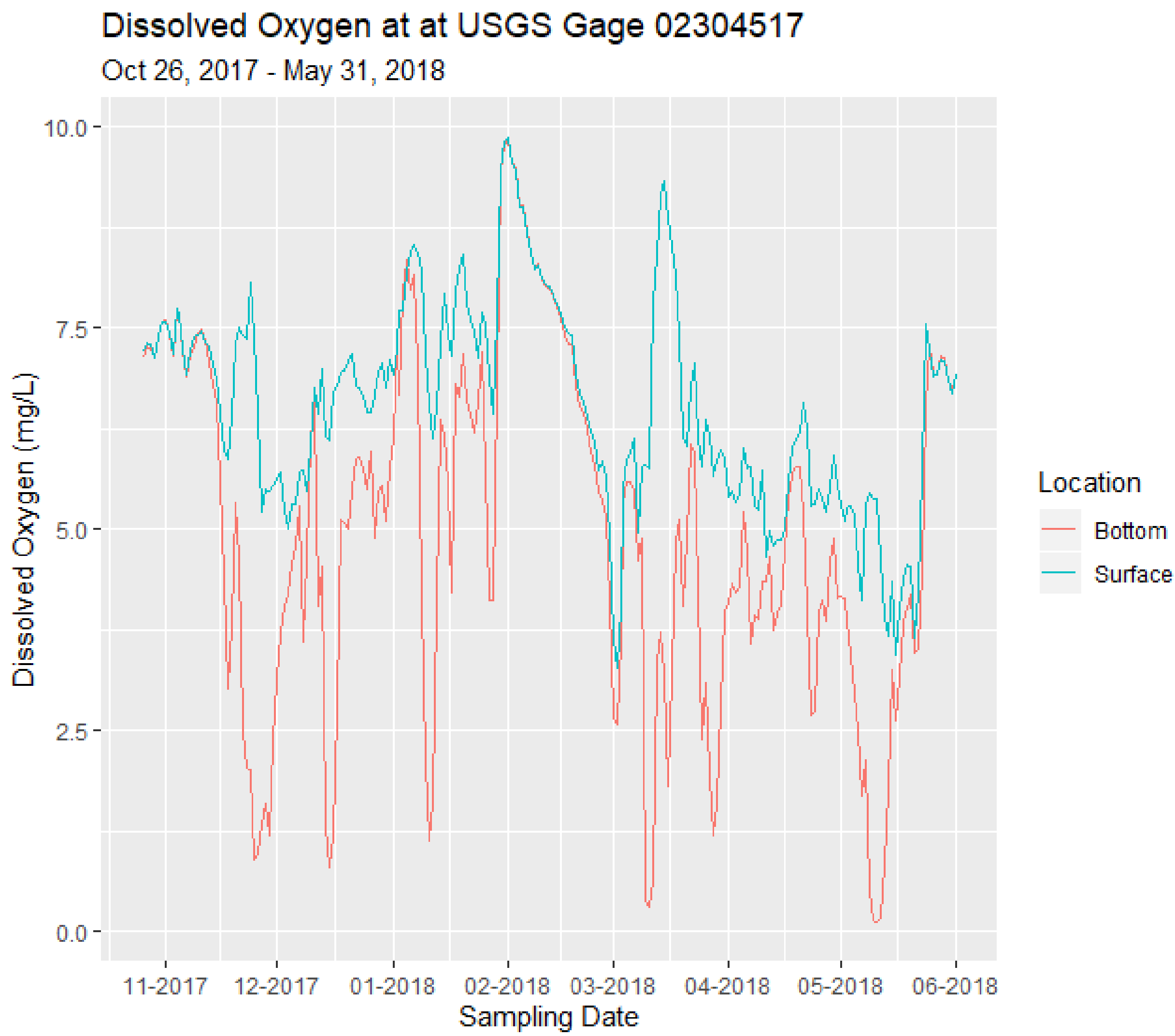

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APPENDIX 5.1-3

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Figure 5.2.2.2-14 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than Rowlett Park Drive (blue), Hanna's Whirl (blue), North 12th Street (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-15 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly higher than Hanna's Whirl (blue), North 12th Street (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-16 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than North River Shore Drive (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-17 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-18 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than North 12th Street (blue), Nebraska Avenue (blue), Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-19 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Temple Terrace Hwy (red), North

56th Street (red), and Rowlett Park Drive (red) were significantly lower than Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-20 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Hanna's Whirl (red), North 12th Street (red), and Sulphur Springs (red) were significantly lower than West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-21 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) and Sulphur Springs (red) were significantly higher than Hanna's Whirl (blue), North 12th Street (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-22 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Temple Terrace Hwy (red), North 56th Street (red), and West Platt Street (red) were significantly higher than North 12th Street (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-23 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than North River Shore Drive (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-24 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than Rowlett Park Drive (blue), Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

Figure 5.2.2.2-25 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) and Nebraska Avenue (red) were significantly lower than West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-26 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than East Fowler Avenue (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-27 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than East Fowler Avenue (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-28 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 2 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) and Rowlett Park Drive (red) were significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-29 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 2 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Nebraska Avenue (blue), Hwy I-275 (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-30 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 2 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than East Fowler Avenue (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-31 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna' Whirl, N 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than N 12th Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-32 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna' Whirl, N 12th Street, Nebraska Avenue, North River Shore Drive, Sligh

Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red), Rowlett Park Drive (red), and Hanna' Whirl (red) were significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), and Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-33 Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna' Whirl, N 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than N 12th Street (blue), Nebraska Avenue (blue), North River Shore Drive (blue), Sligh Avenue (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-34 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than East Fowler Avenue (blue), Hanna's Whirl (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-35 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than East Fowler Avenue (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-36 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red), North 56th Street (red), and Rowlett Park Drive (red) were significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-37 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Temple Terrace Hwy and Hanna's Whirl (red) were significantly lower than Hwy I-275 (blue),

North River Shore Drive (blue), Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-38 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. North 12th Street (red) was significantly lower than North River Shore Drive (blue), Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-39 Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Nebraska Avenue (blue), Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), Sulphur Springs (blue), and Twin Lakes Outfall (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-40 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) and Temple Terrace Hwy (red) were significantly lower than Rowlett Park Drive (blue), Hanna's Whirl (blue), North 12th Street, (blue), Sulphur Springs (blue), and Twin Lakes Outfall (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-41 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. North 56th Street (red) was significantly lower than Rowlett Park Drive (blue), Hanna's Whirl (blue), Sulphur Springs (blue), and Twin Lakes Outfall (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-42 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than North 12th Street (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-43 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Hanna's Whirl (red) was significantly higher than Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.2.2-44 Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

Figure 5.2.3-1 Number of monthly sampling days that dissolved oxygen percent saturation value from top water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

Figure 5.2.3-2 Number of monthly sampling days that dissolved oxygen percent saturation value from middle water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

Figure 5.2.3-3 Number of monthly sampling days that dissolved oxygen percent saturation value from bottom water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

Figure 5.2.3-4 Number of monthly sampling days that salinity value from top water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

Figure 5.2.3-5 Number of monthly sampling days that salinity value from middle water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

Figure 5.2.3-6 Number of monthly sampling days that salinity value from bottom water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

Figure 5.2.3-7 Number of monthly sampling days that dissolved oxygen percent saturation value from top water samples was less than the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

Figure 5.2.3-8 Number of monthly sampling days that dissolved oxygen percent saturation value from middle water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

Figure 5.2.3-9 Number of monthly sampling days that dissolved oxygen percent saturation value from bottom water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

Figure 5.2.3-10 Number of monthly sampling days that salinity value from top water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

Figure 5.2.3-11 Number of monthly sampling days that salinity value from middle water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations

Figure 5.2.3-12 Number of monthly sampling days that salinity value from bottom water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

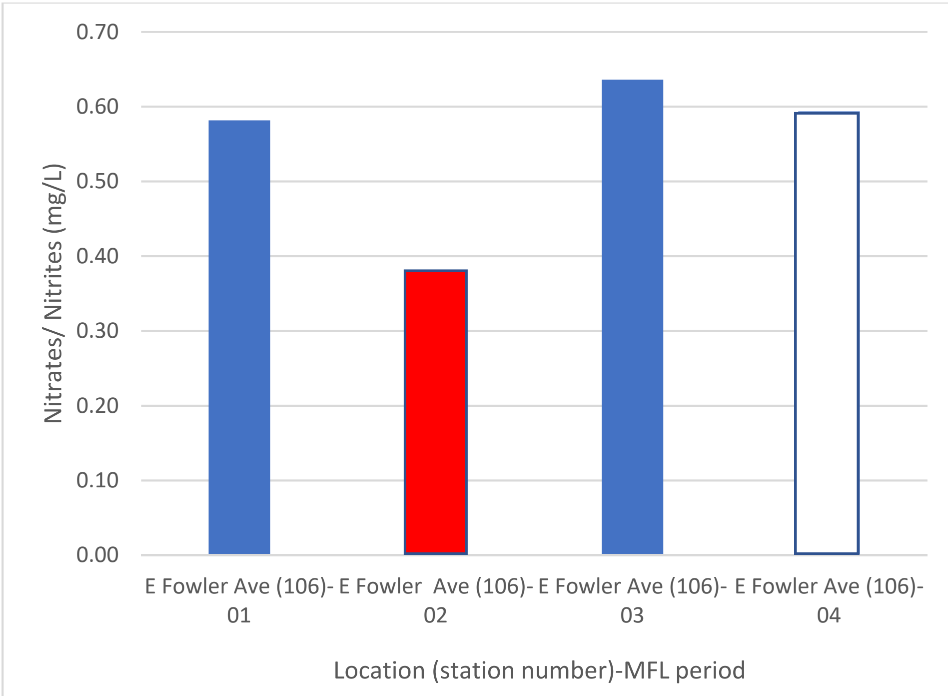

Figure 5.2.2.1-1. Average monthly nitrates/nitrites (mg/L) at East Fowler Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL period 1 (blue) and 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

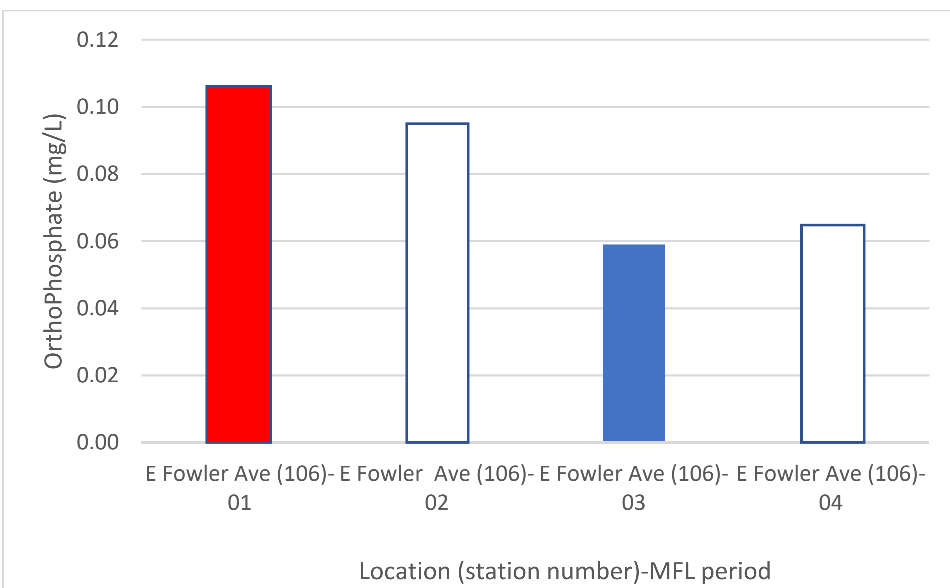

Figure 5.2.2.1-2. Average monthly orthophosphate (mg/L) at East Fowler Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

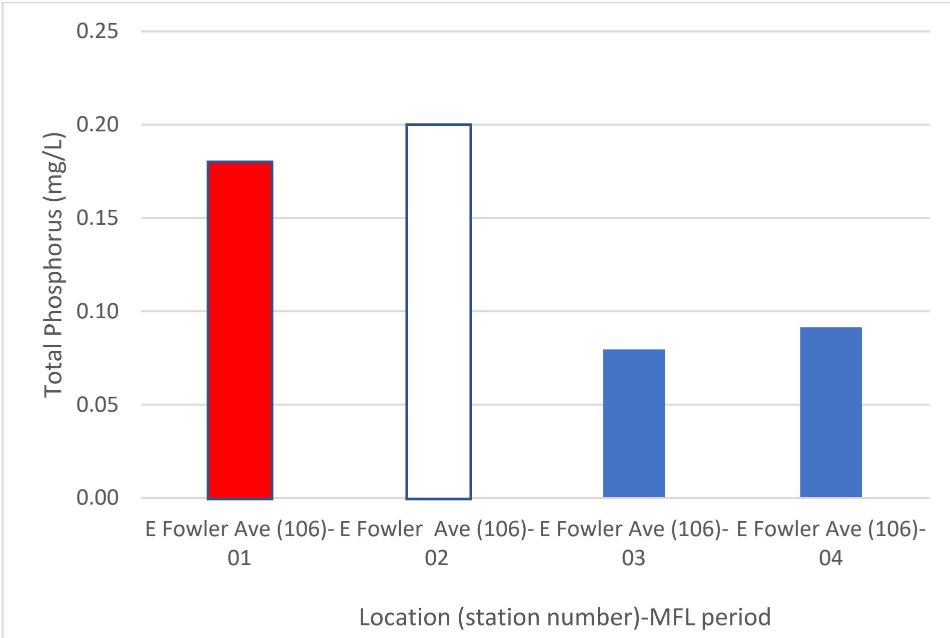

Figure 5.2.2.1-3. Average monthly total phosphorus (mg/L) at East Fowler Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

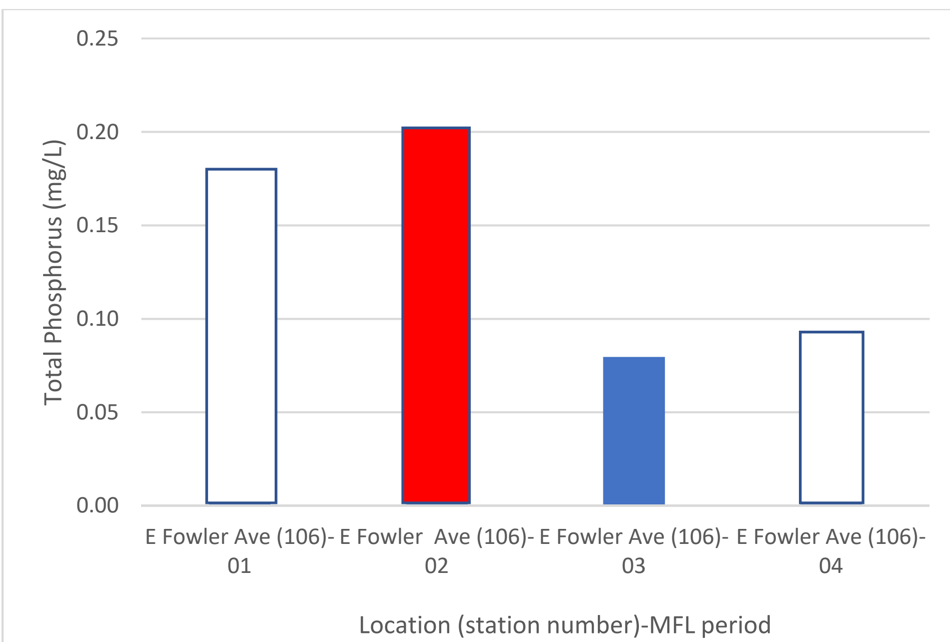

Figure 5.2.2.1-4. Average monthly total phosphorus (mg/L) at East Fowler Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

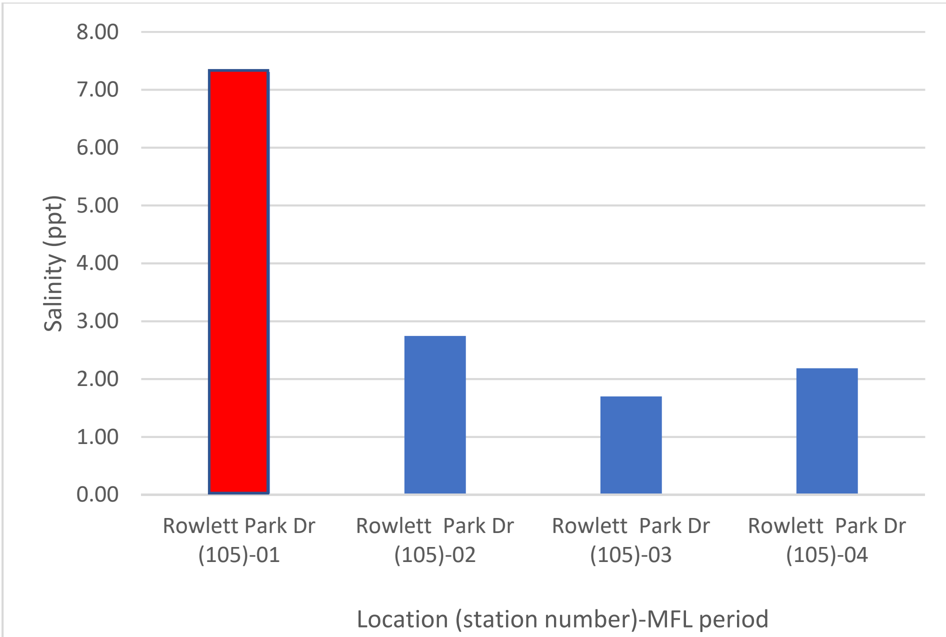

Figure 5.2.2.1-5. Average monthly salinity (ppt) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

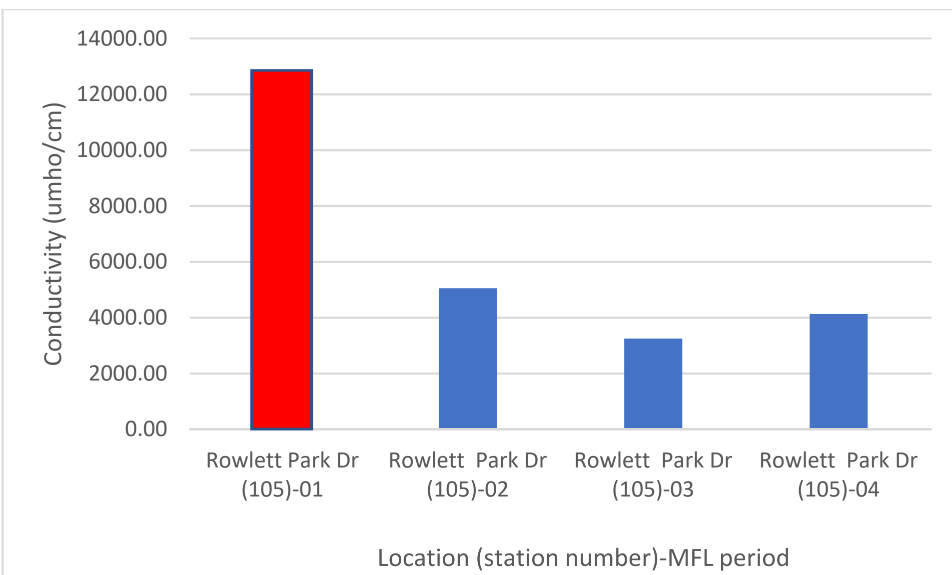

Figure 5.2.2.1-6. Average monthly conductivity (umho/cm) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

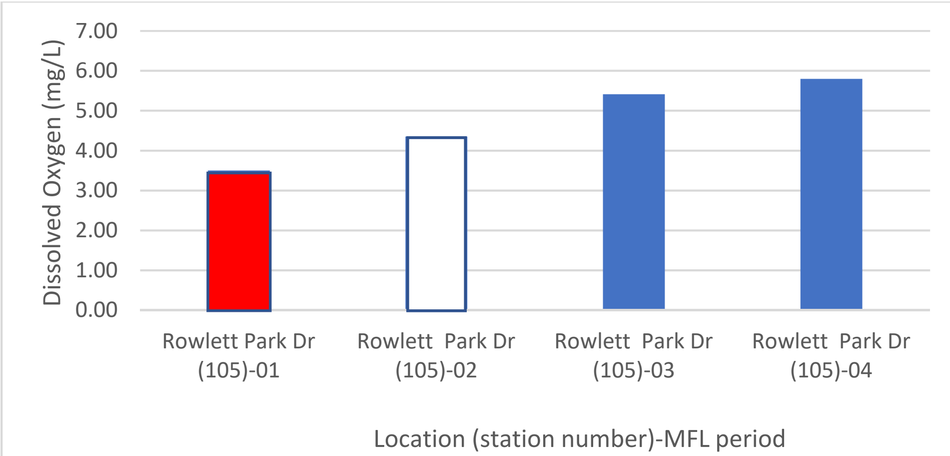

Figure 5.2.2.1-7. Average monthly dissolved oxygen (mg/L) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly lower than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

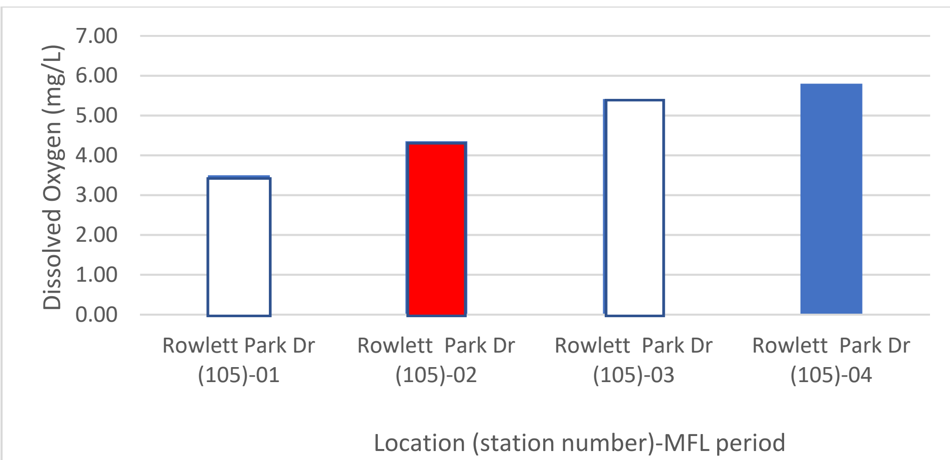

Figure 5.2.2.1-8. Average monthly dissolved oxygen (mg/L) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

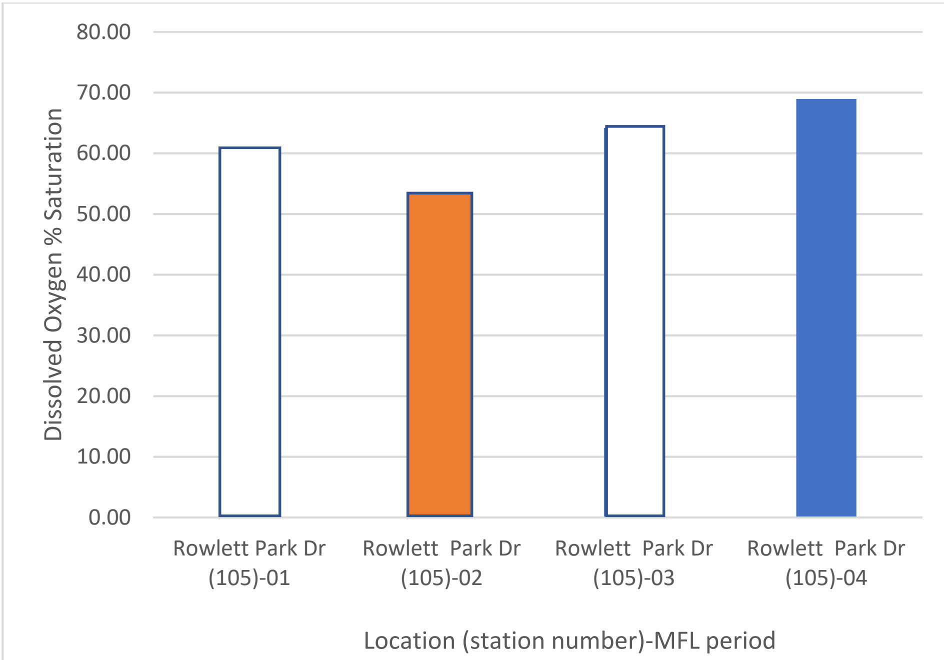

Figure 5.2.2.1-9. Average monthly dissolved oxygen percent saturation (%) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

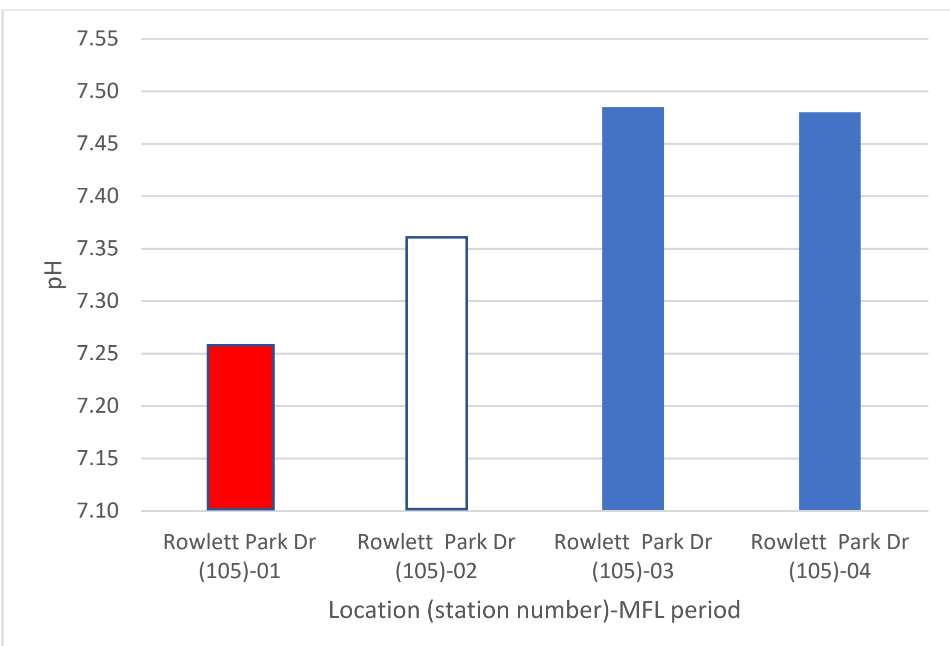

Figure 5.2.2.1-10. Average monthly pH at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly lower than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

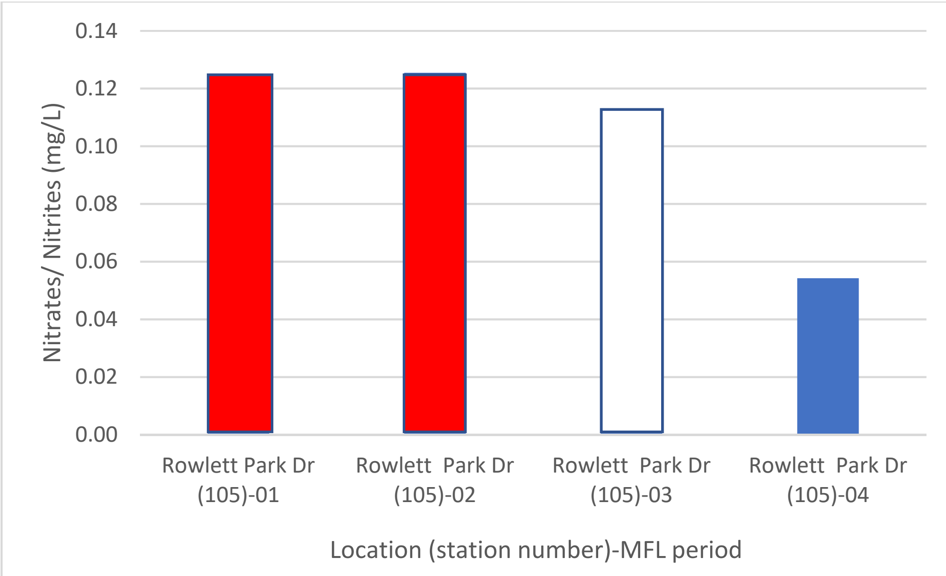

Figure 5.2.2.1-11. Average monthly nitrates/nitrites (mg/L) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 1 (red) and 2 (red) were significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

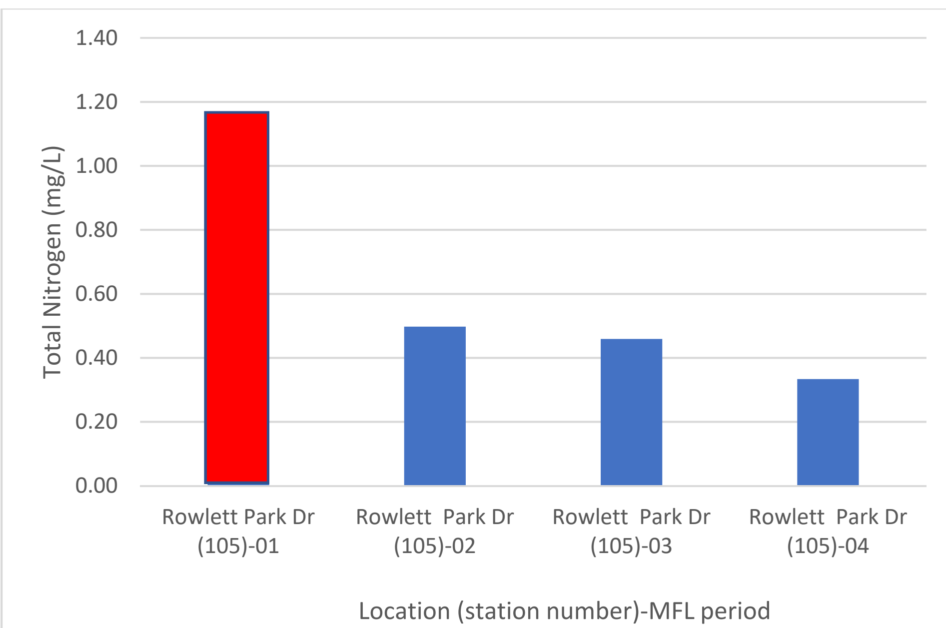

Figure 5.2.2.1-12. Average monthly total nitrogen (mg/L) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

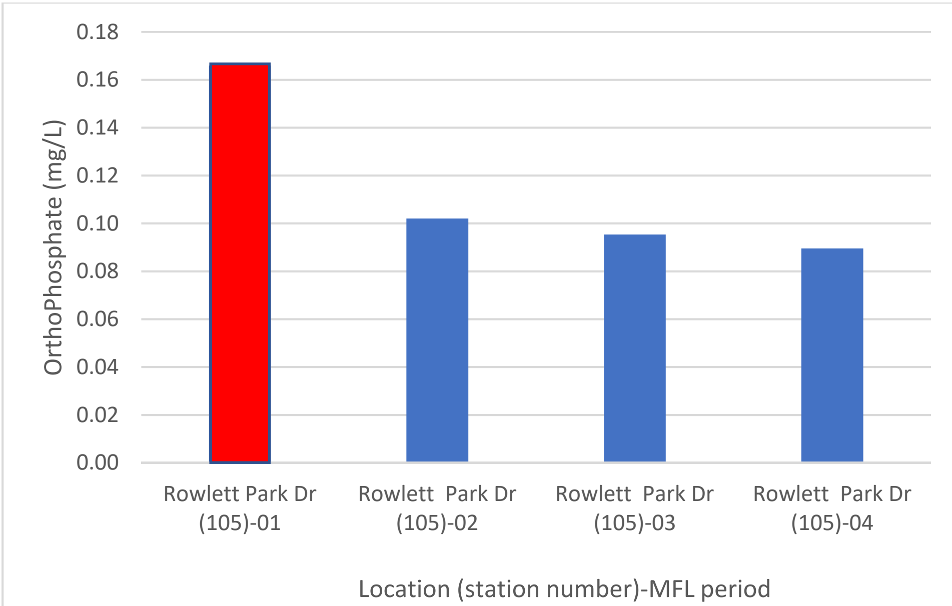

Figure 5.2.2.1-13. Average monthly orthophosphate (mg/L) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

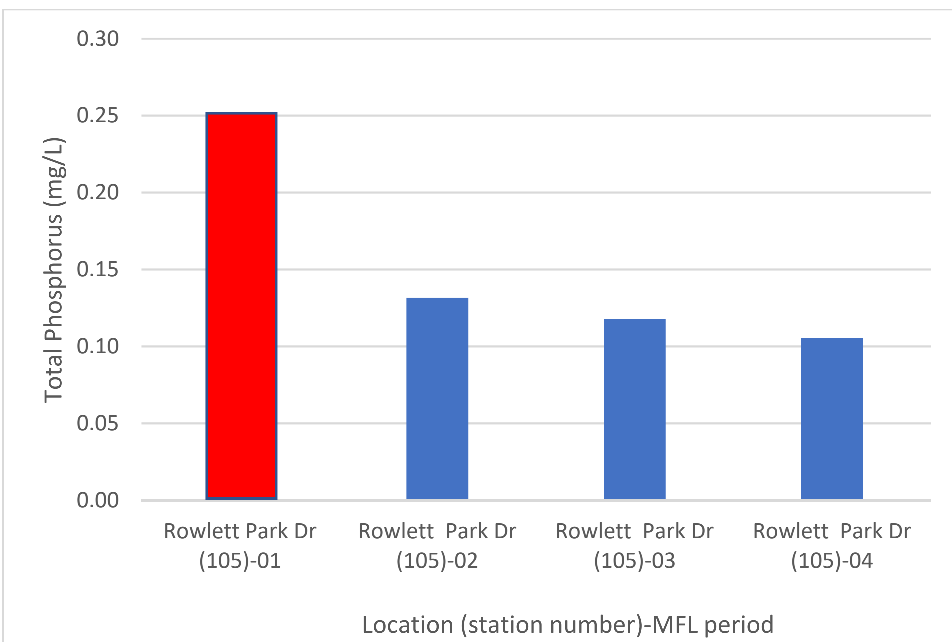

Figure 5.2.2.1-14. Average monthly total phosphorus (mg/L) at Rowlett Park Drive by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

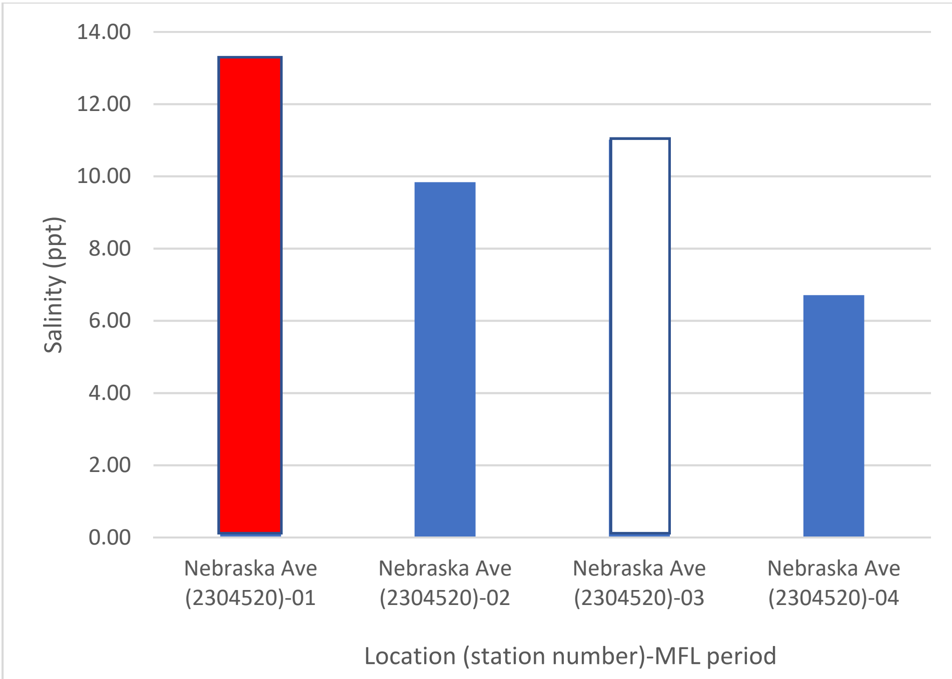

Figure 5.2.2.1-15. Average monthly salinity (ppt) at Nebraska Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

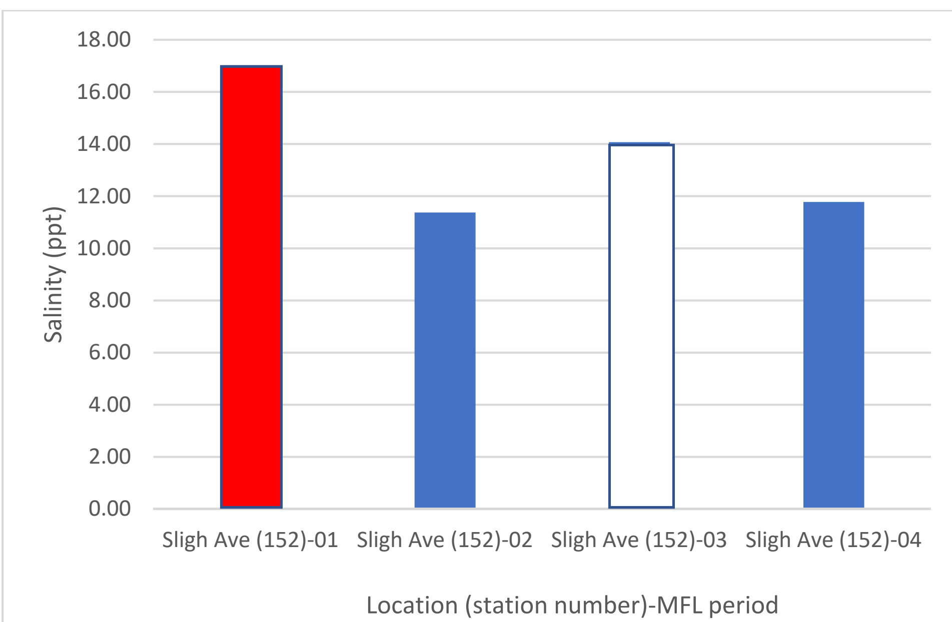

Figure 5.2.2.1-16. Average monthly salinity (ppt) at Sligh Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

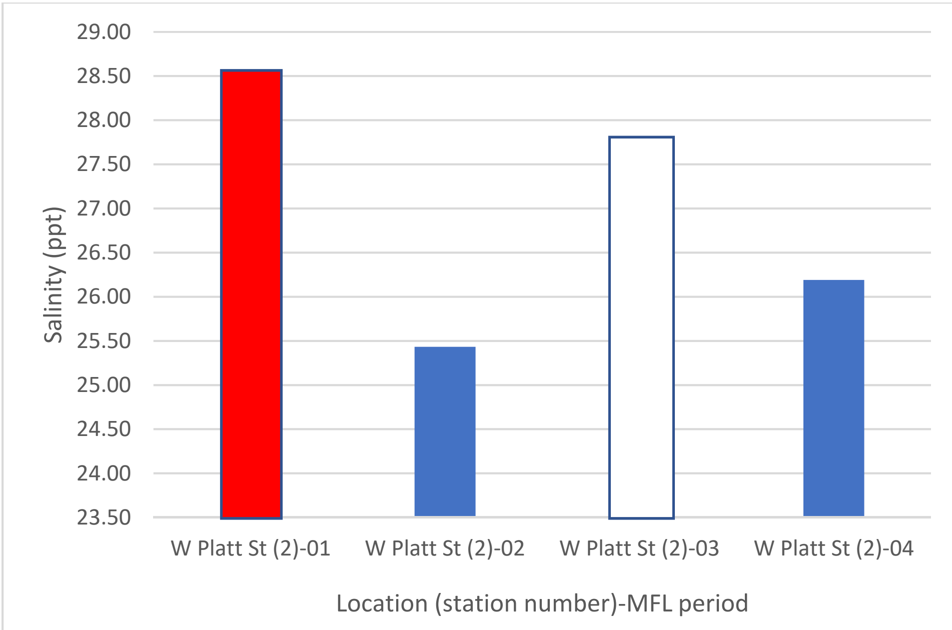

Figure 5.2.2.1-17. Average monthly salinity (ppt) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

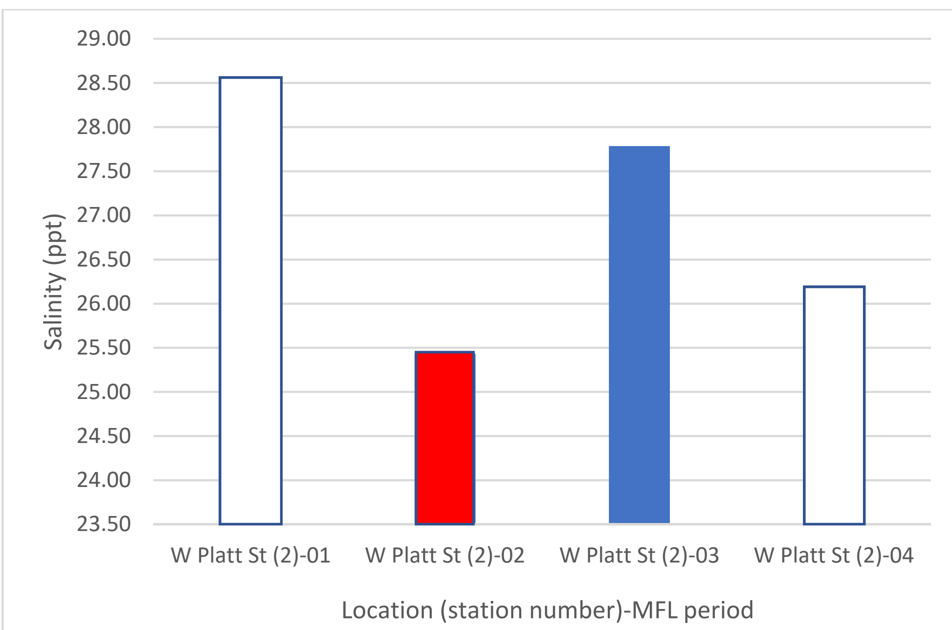

Figure 5.2.2.1-18. Average monthly salinity (ppt) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

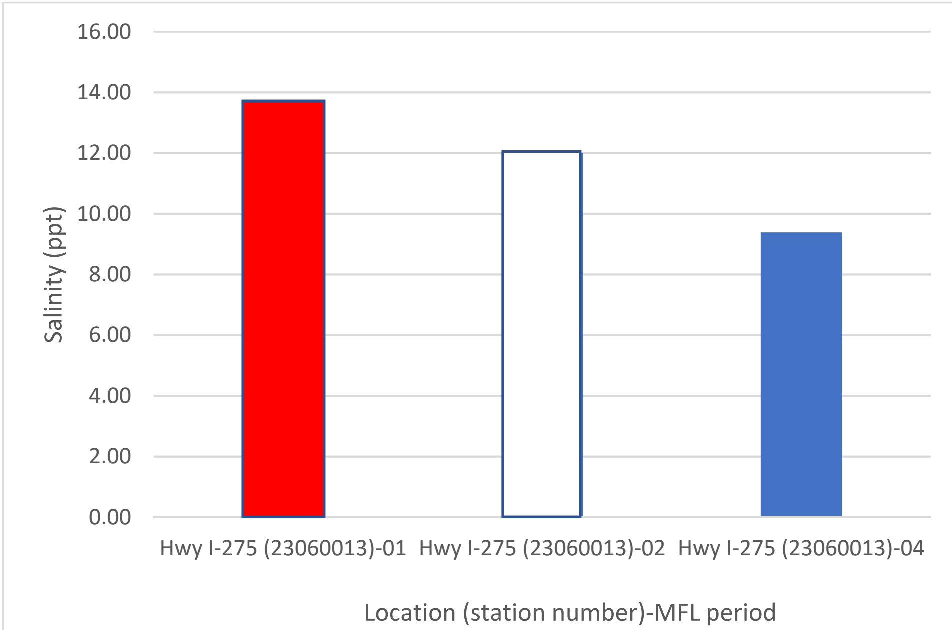

Figure 5.2.2.1-19. Average monthly salinity (ppt) at Hwy I-275 by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

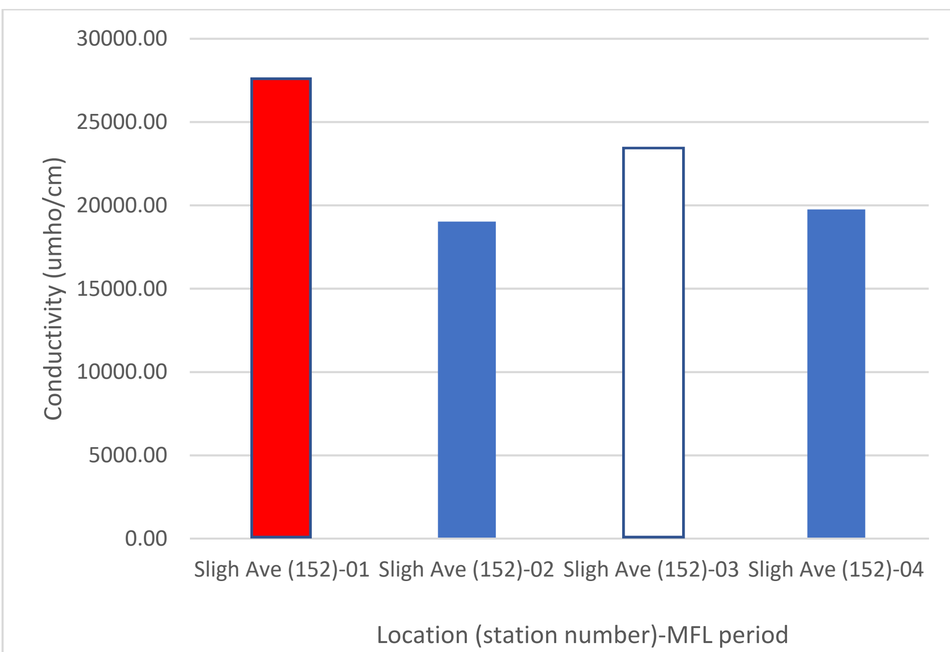

Figure 5.2.2.1-20. Average monthly conductivity (umho/cm) at Sligh Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

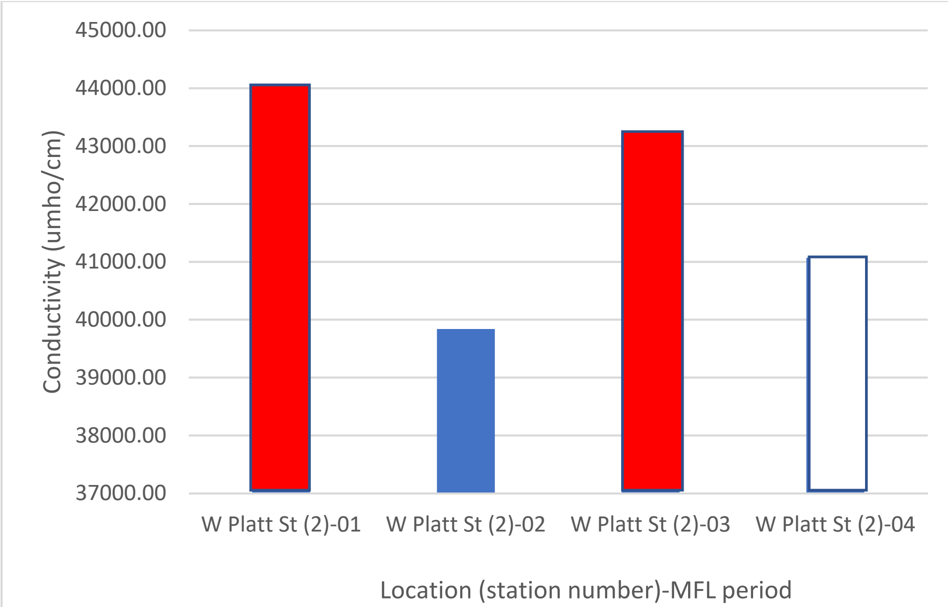

Figure 5.2.2.1-21. Average monthly conductivity (umho/cm) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 1 (red) and 3 (red) were significantly higher than MFL period 2 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

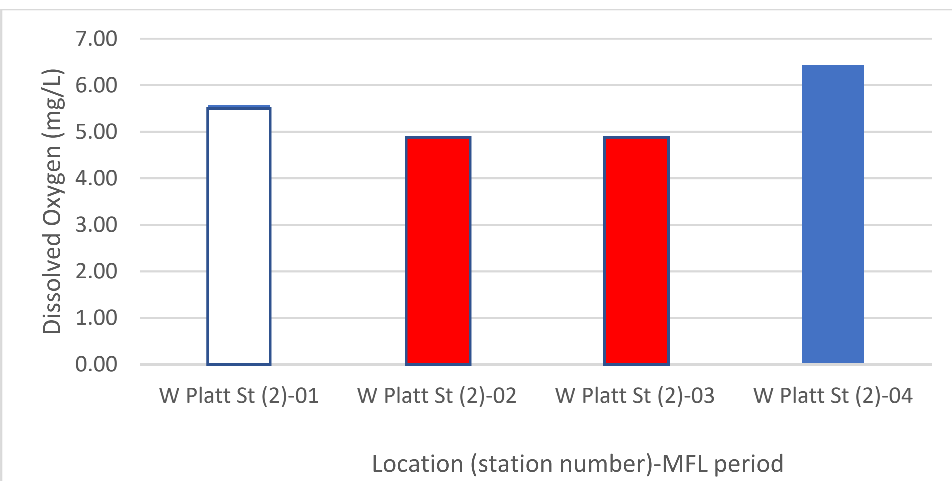

Figure 5.2.2.1-22. Average monthly dissolved oxygen (mg/L) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 2 (red) and 3 (red) were significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

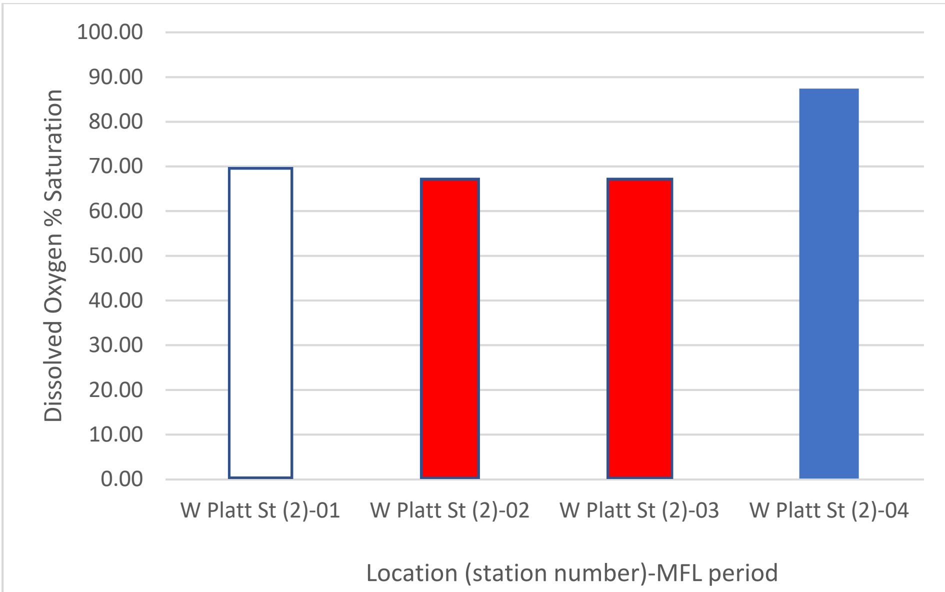

Figure 5.2.2.1-23. Average monthly dissolved oxygen percent saturation (%) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 2 (red) and 3 (red) were significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

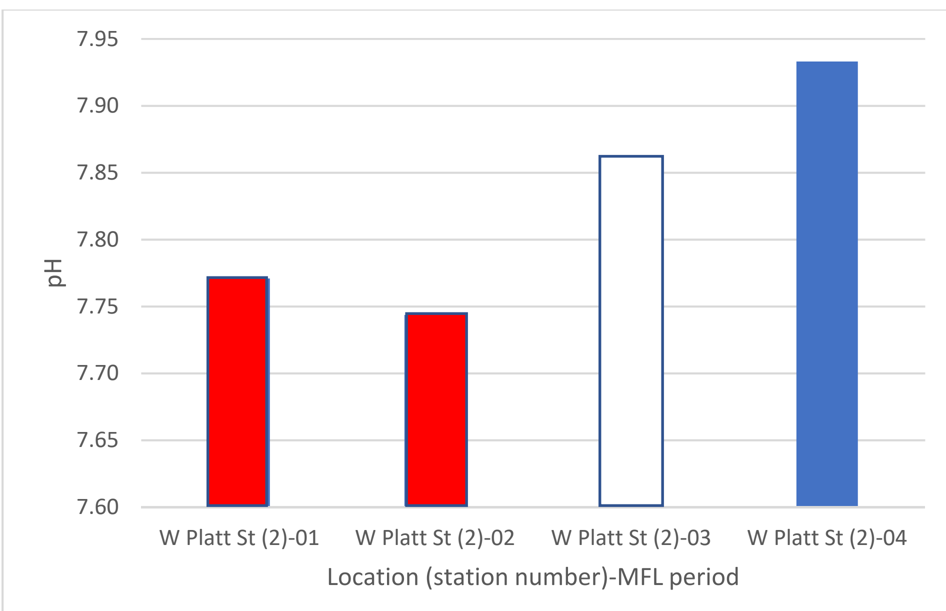

Figure 5.2.2.1-24. Average monthly pH at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 1 (red) and 2 (red) were significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

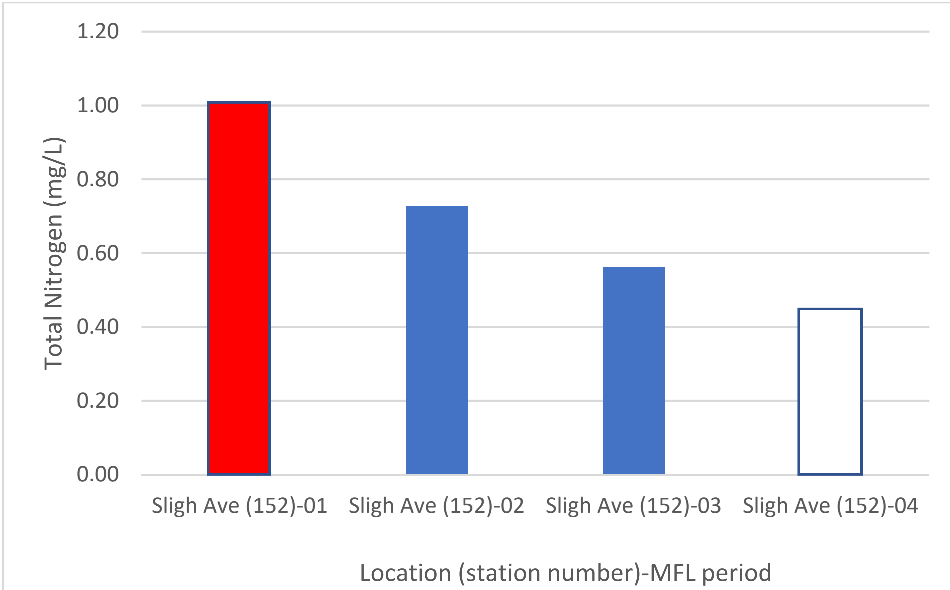

Figure 5.2.2.1-25. Average monthly total nitrogen (mg/L) at Sligh Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue) and 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

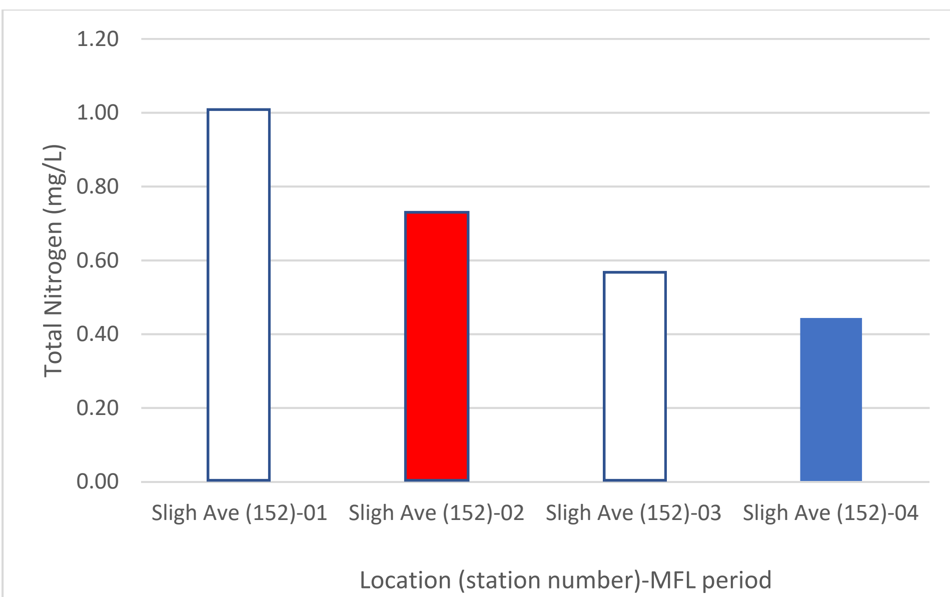

Figure 5.2.2.1-26. Average monthly total nitrogen (mg/L) at Sligh Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

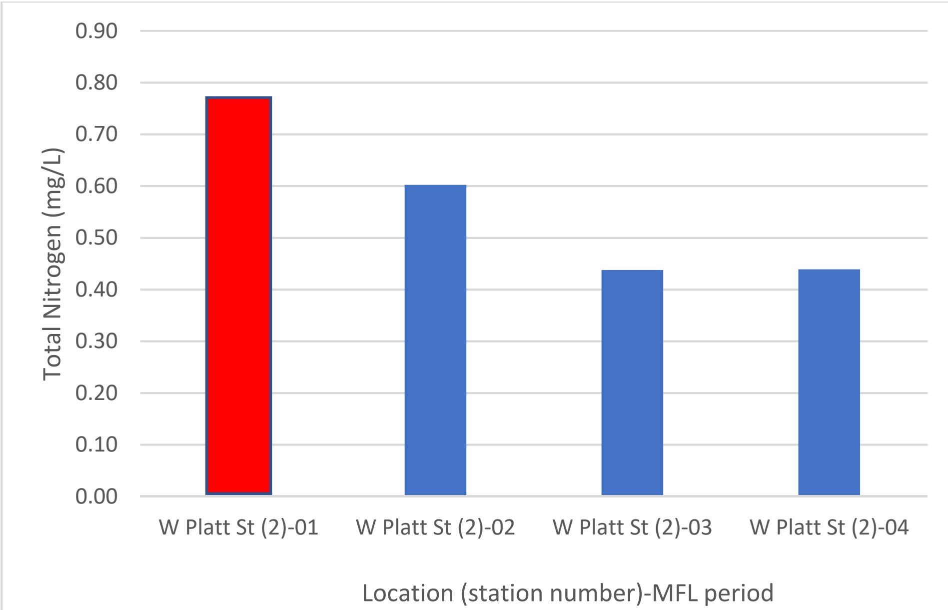

Figure 5.2.2.1-27. Average monthly total nitrogen (mg/L) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

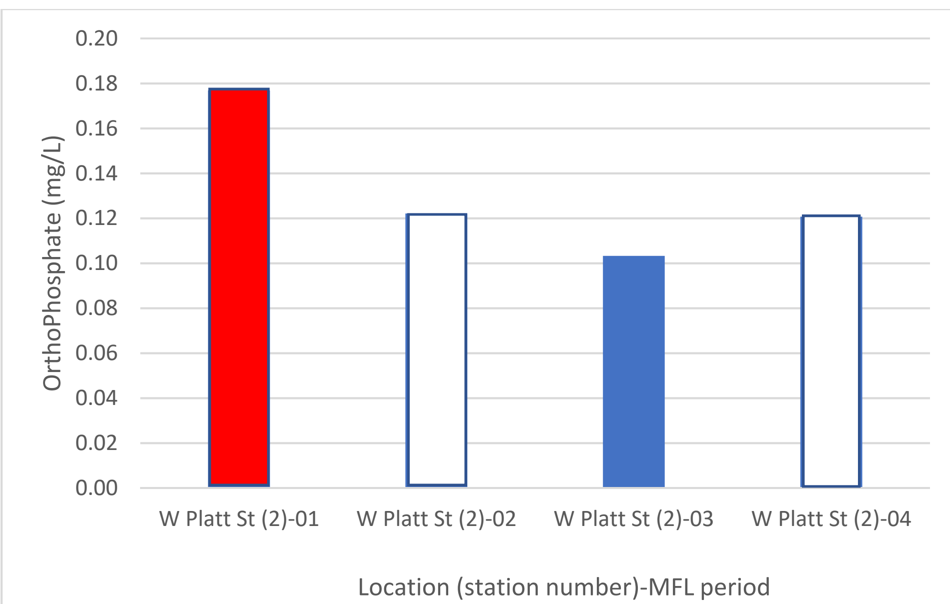

Figure 5.2.2.1-28. Average monthly orthophosphate (mg/L) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

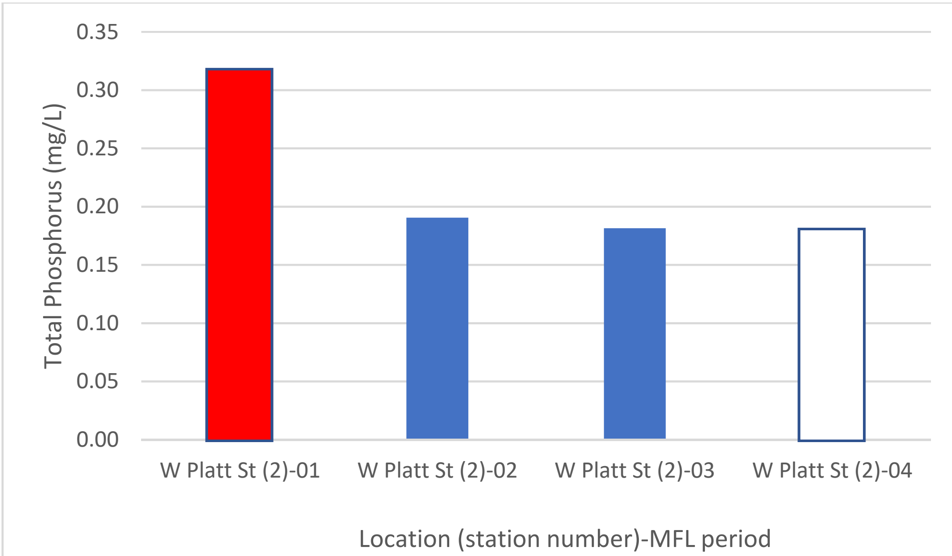

Figure 5.2.2.1-29. Average monthly total phosphorus (mg/L) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue) and 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

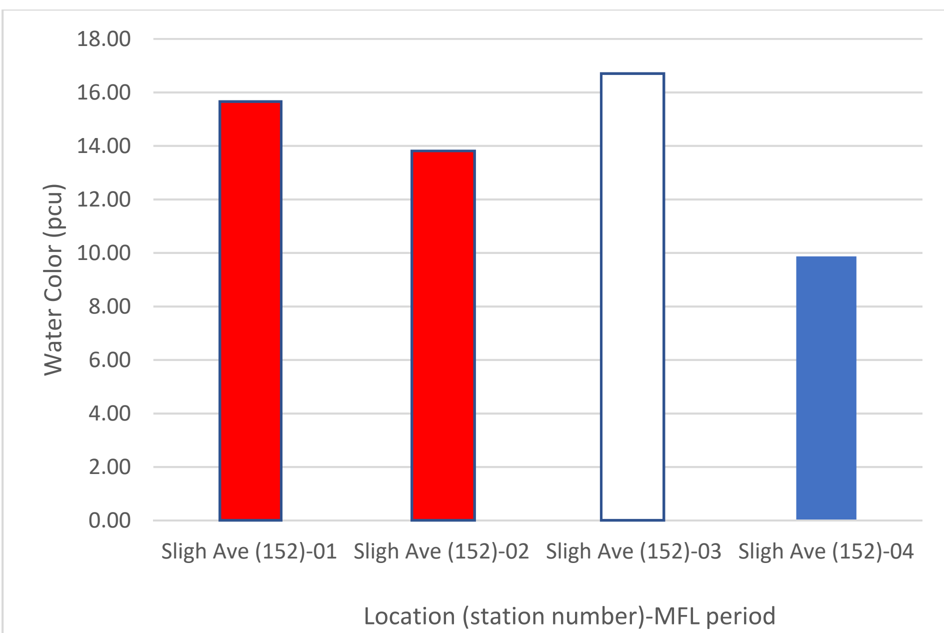

Figure 5.2.2.1-30. Average monthly water color (pcu) at Sligh Avenue by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 1 (red) and 2 (red) were significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

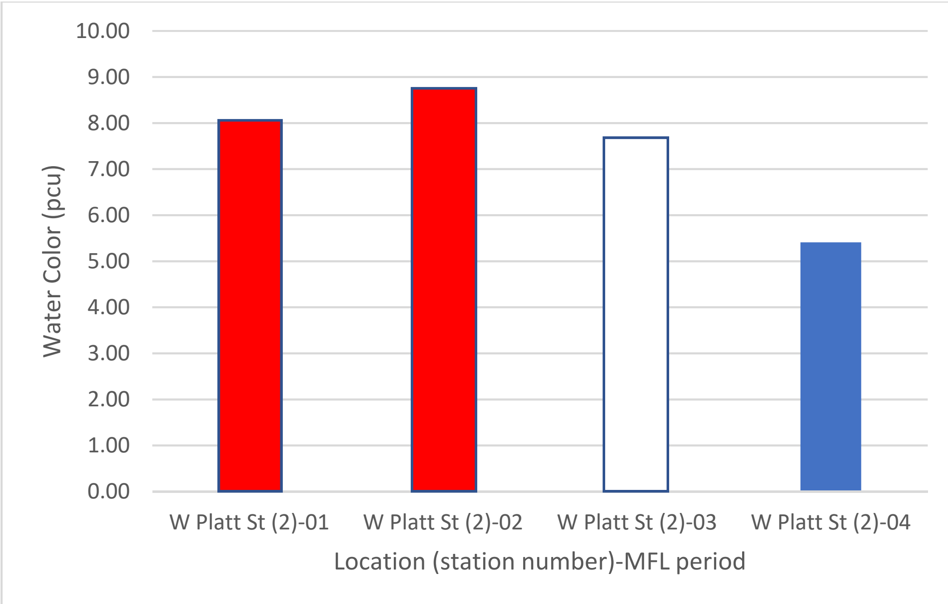

Figure 5.2.2.1-31. Average monthly water color (pcu) at West Platt Street by MFL period without water flow over the dam from October 1979 to May 2018. MFL periods 1 and 2 (red) were significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

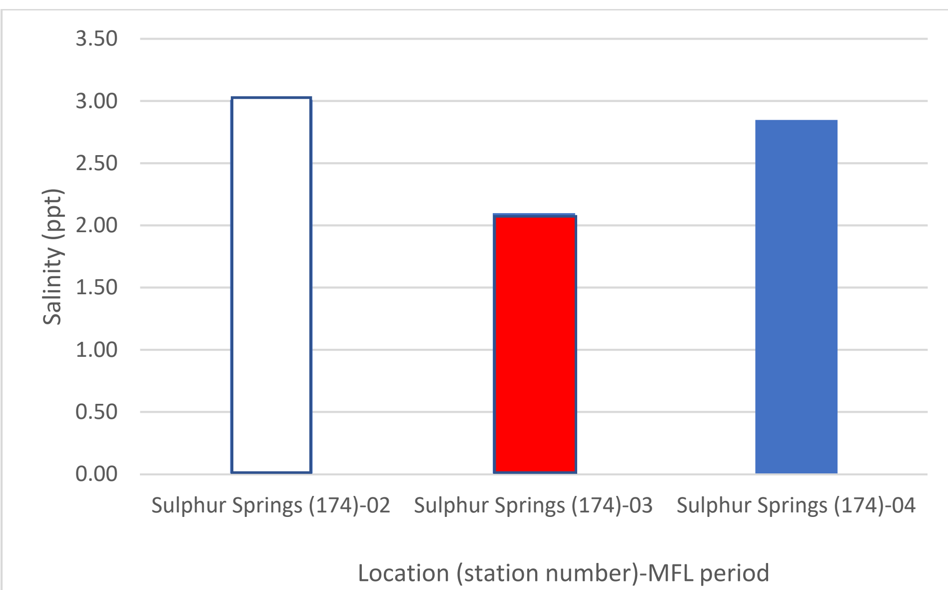

Figure 5.2.2.1-32. Average monthly salinity (ppt) at Sulphur Springs by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 3 (red) was significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

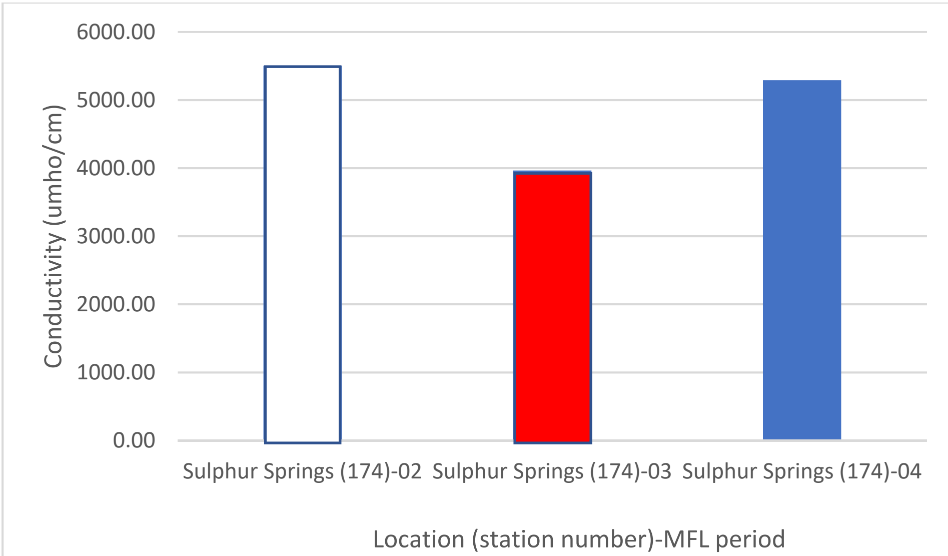

Figure 5.2.2.1-33. Average monthly conductivity (umho/cm) at Sulphur Springs by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 3 (red) was significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

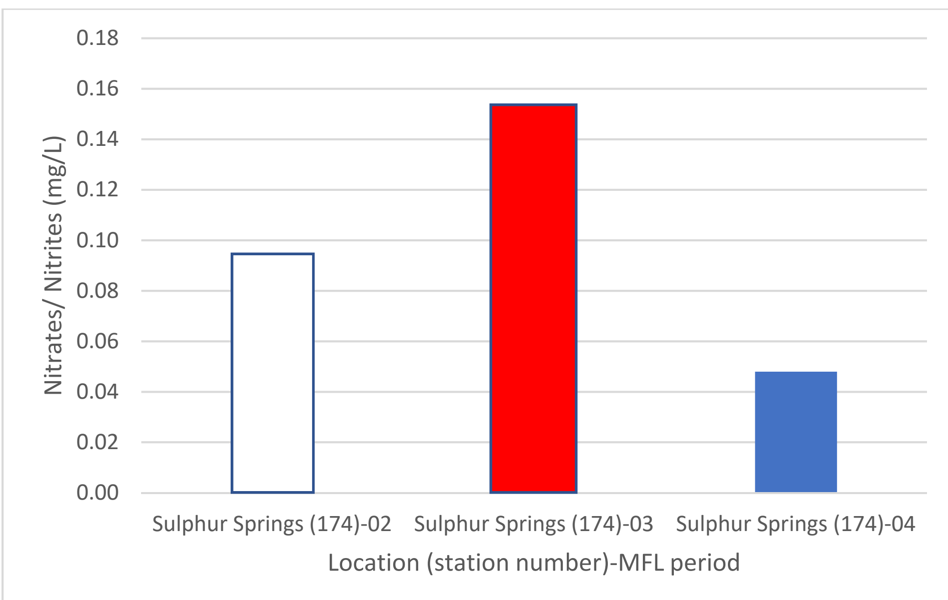

Figure 5.2.2.1-34. Average monthly nitrates/nitrites (mg/L) at Sulphur Springs by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 3 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

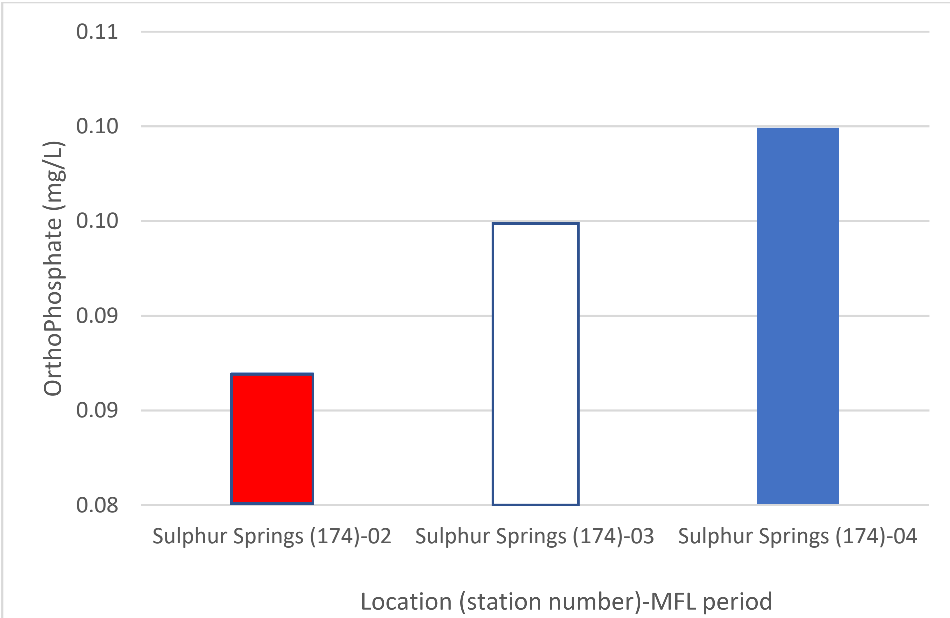

Figure 5.2.2.1-35. Average monthly orthophosphate (mg/L) at Sulphur Springs by MFL period without water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

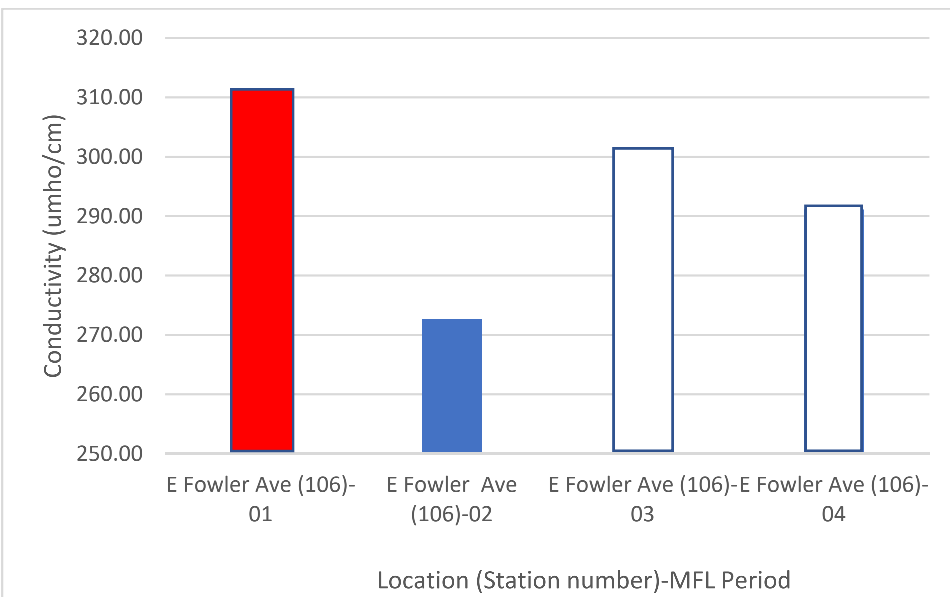

Figure 5.2.2.1-36. Average monthly conductivity (umho/cm) at East Fowler Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 2 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

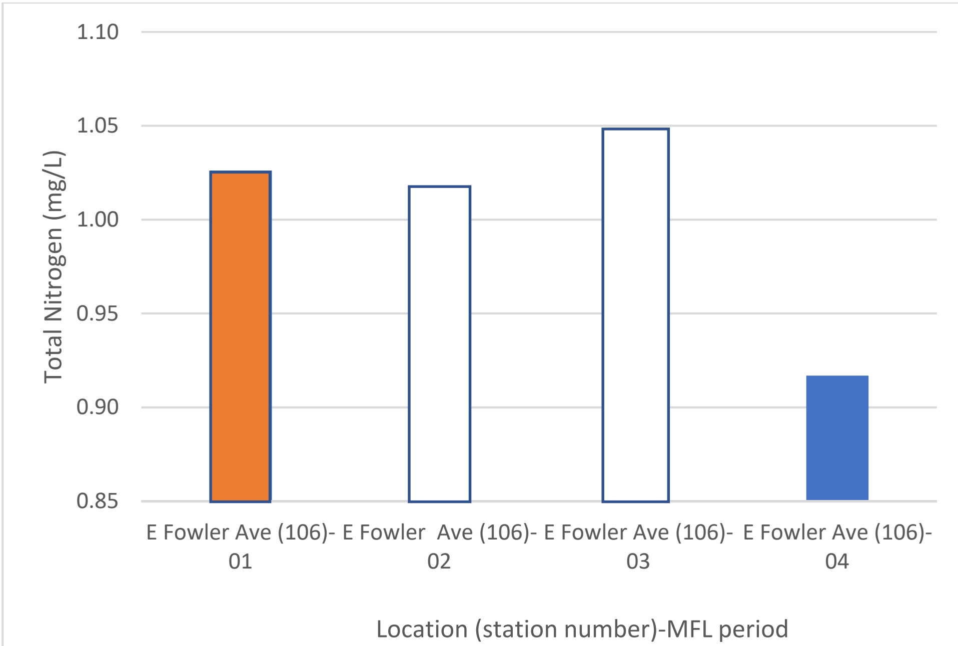

Figure 5.2.2.1-37. Average monthly total nitrogen (mg/L) at East Fowler Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

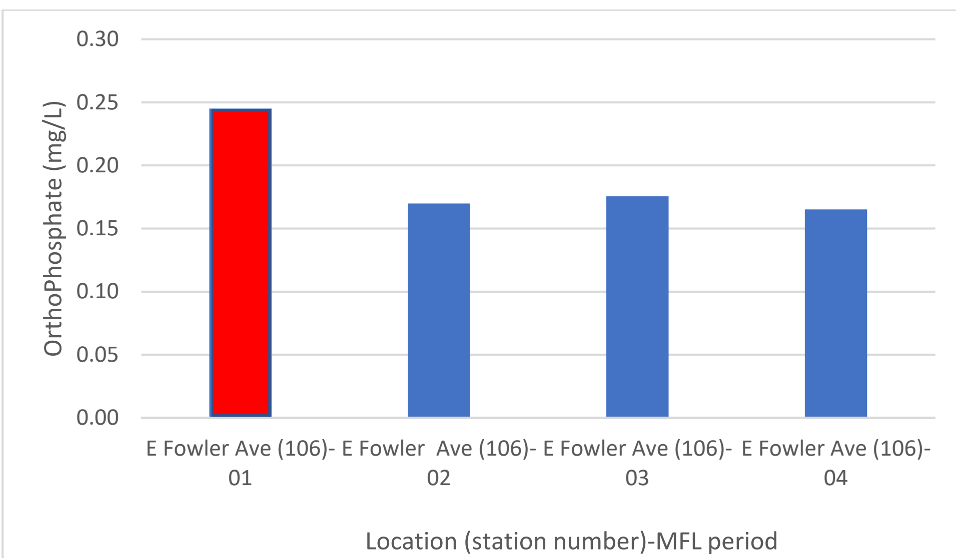

Figure 5.2.2.1-38. Average monthly orthophosphate (mg/L) at East Fowler Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

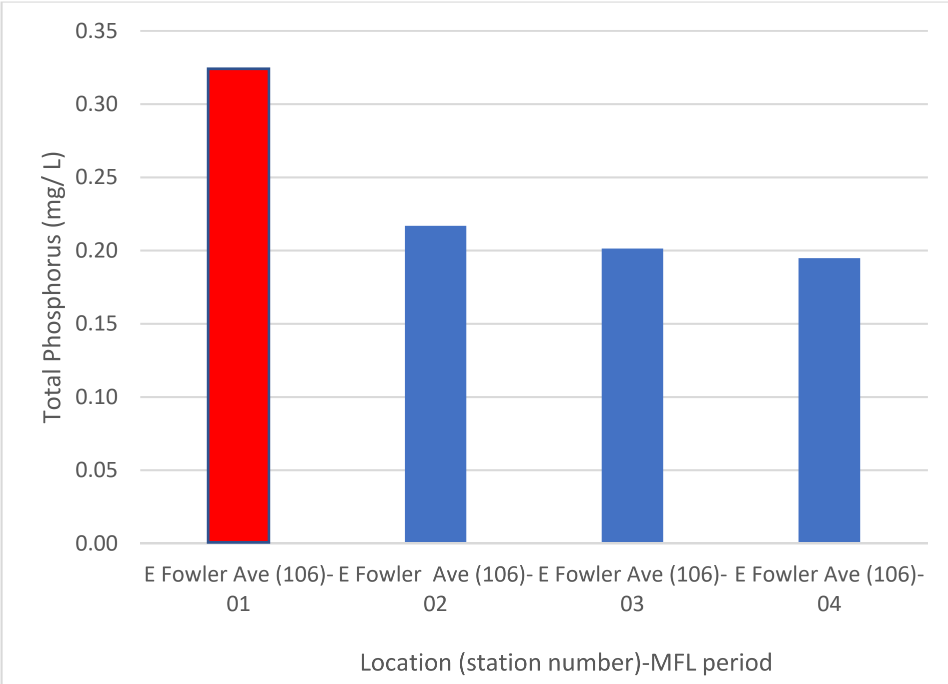

Figure 5.2.2.1-39. Average monthly total phosphorus (mg/L) at East Fowler Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

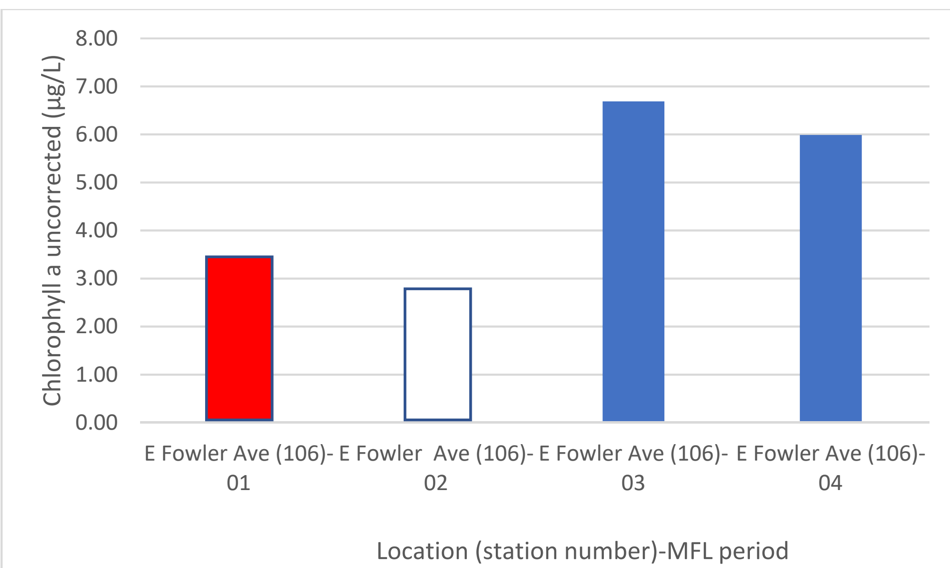

Figure 5.2.2.1-40. Average monthly chlorophyll a uncorrected (µg/L) at East Fowler Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly lower than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

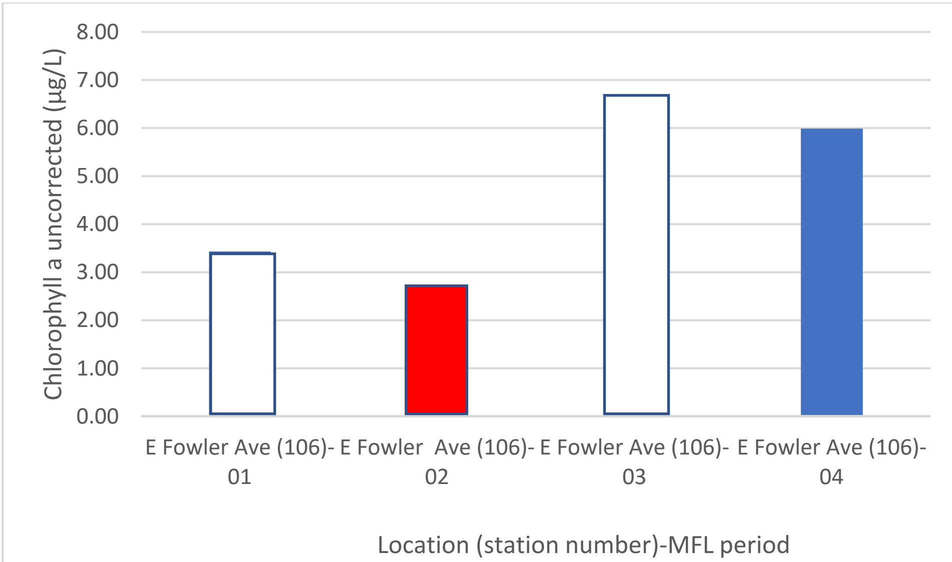

Figure 5.2.2.1-41. Average monthly chlorophyll *a* uncorrected (µg/L) at East Fowler Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

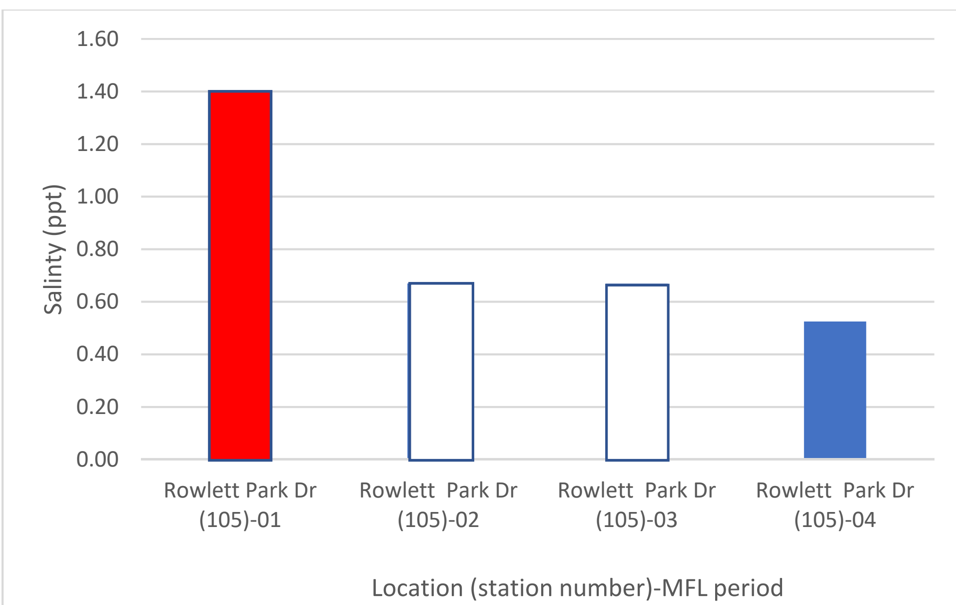

Figure 5.2.2.1-42. Average monthly salinity (ppt) at Rowlett Park Drive by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

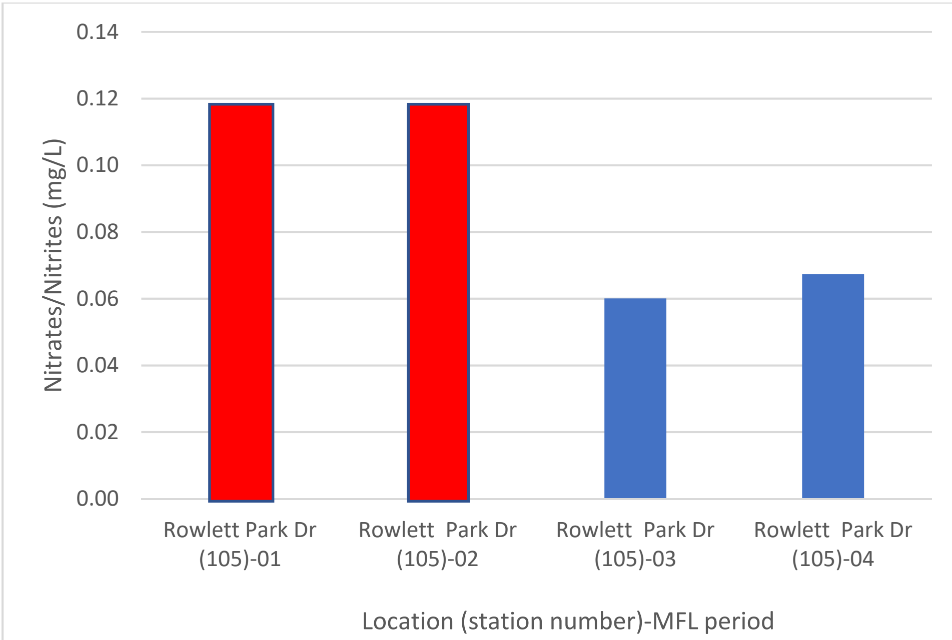

Figure 5.2.2-43. Average monthly nitrates/nitrites (mg/L) at Rowlett Park Drive by MFL period with water flow over the dam from October 1979 to May 2018. MFL periods 1 (red) and 2 (red) were significantly higher than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

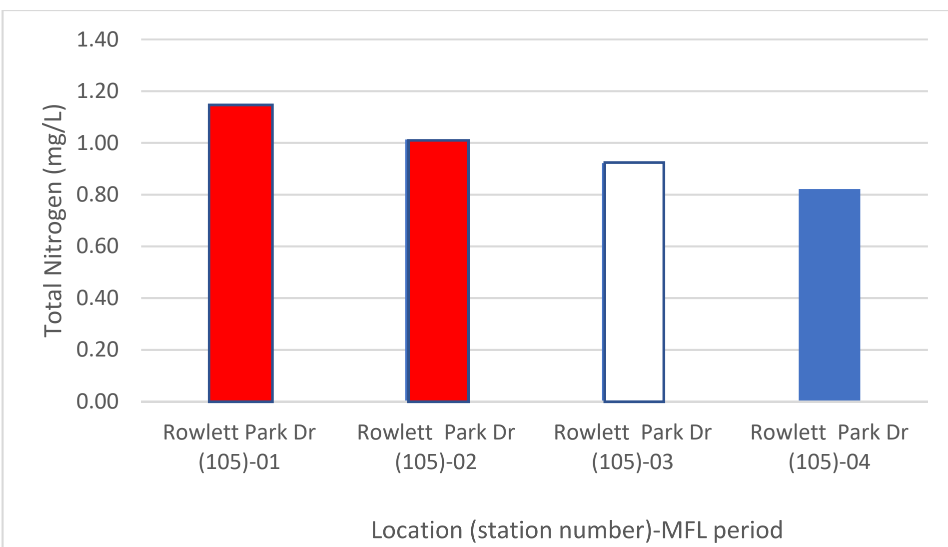

Figure 5.2.2.1-44. Average monthly total nitrogen (mg/L) at Rowlett Park Drive by MFL period with water flow over the dam from October 1979 to May 2018. MFL periods 1 (red) and 2 (red) were significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

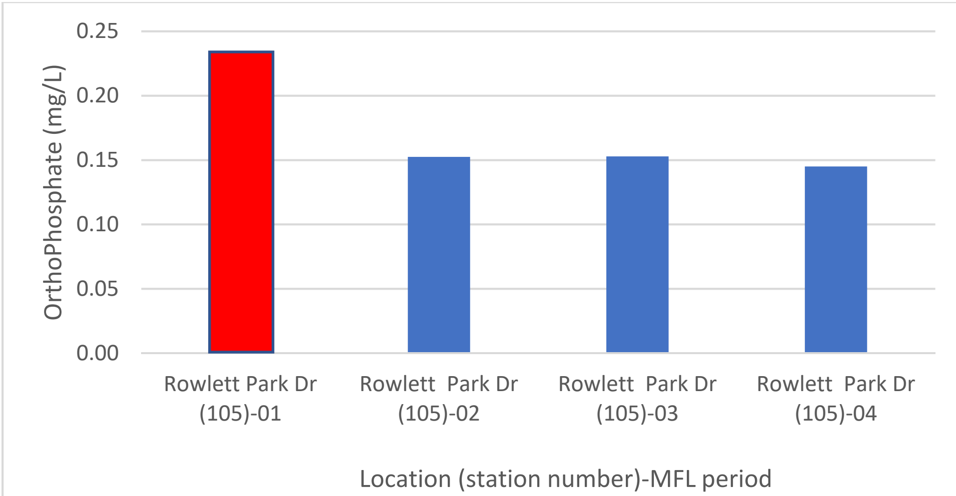

Figure 5.2.2.1-45. Average monthly orthophosphate (mg/L) at Rowlett Park Drive by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 1 (blue), 2 (blue), and 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

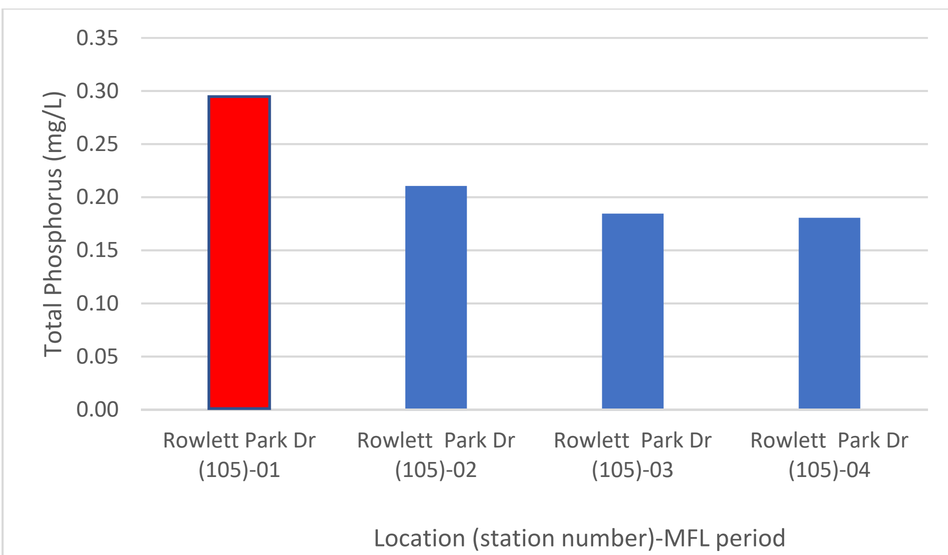

Figure 5.2.2.1-46. Average monthly total phosphorus (mg/L) at Rowlett Park Drive by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

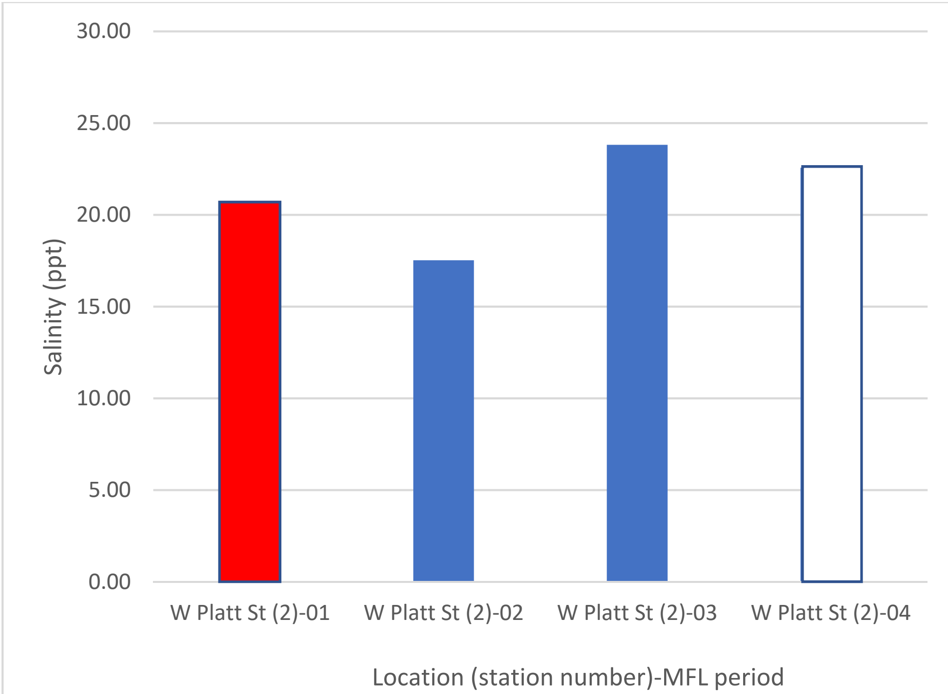

Figure 5.2.2.1-47. Average monthly salinity (ppt) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 2 (blue) and lower than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

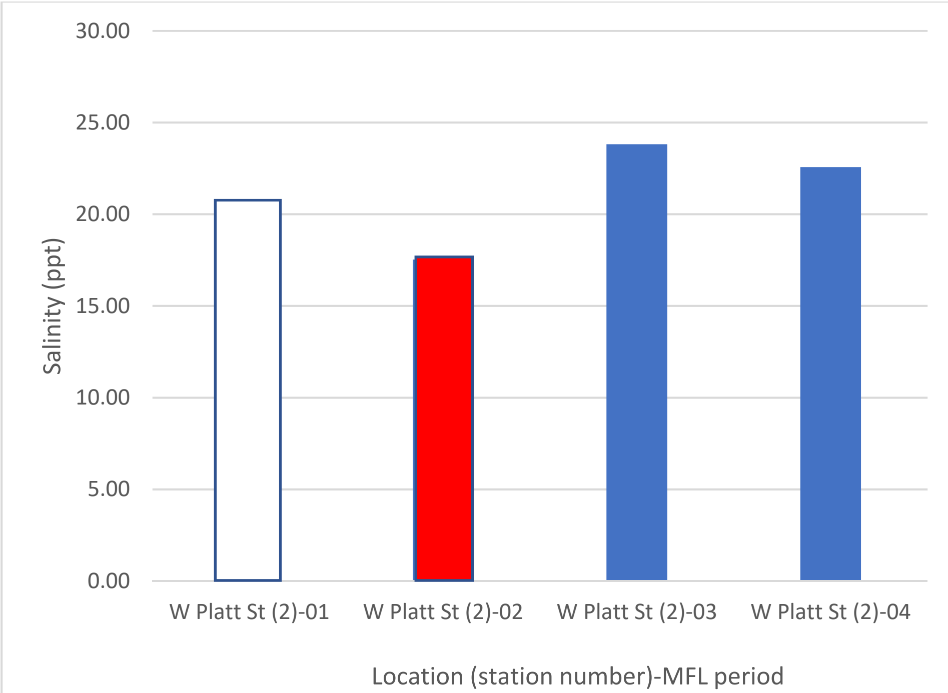

Figure 5.2.2.1-48. Average monthly salinity (ppt) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

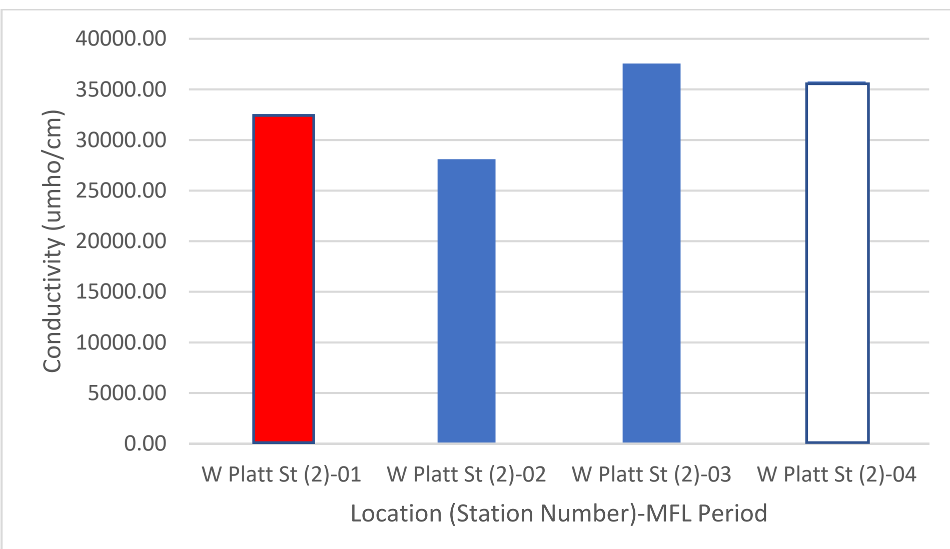

Figure 5.2.2.1-49. Average monthly conductivity (umho/cm) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 2 (blue) and lower than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

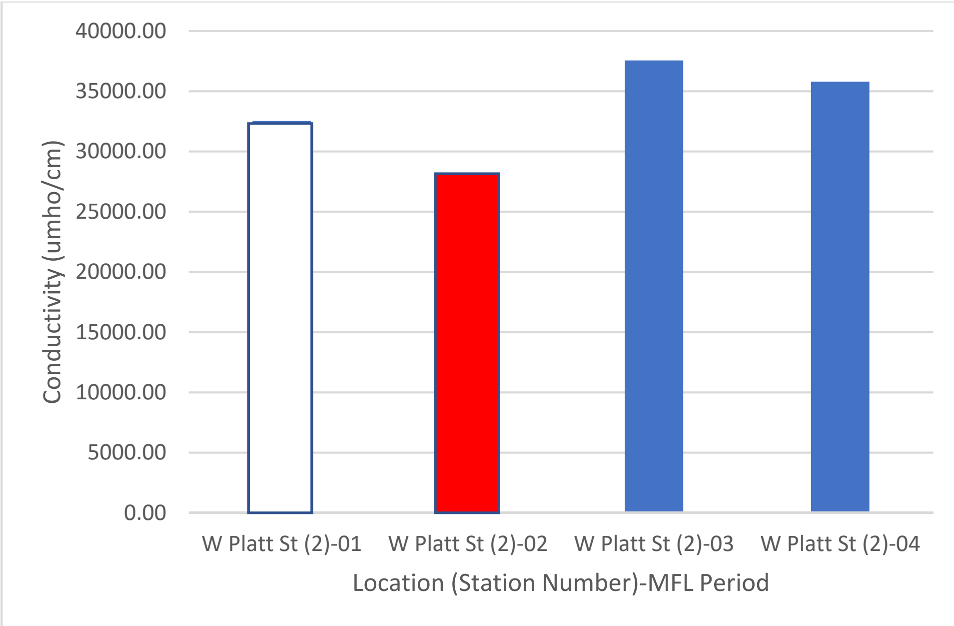

Figure 5.2.2.1-50. Average monthly conductivity (umho/cm) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly lower than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

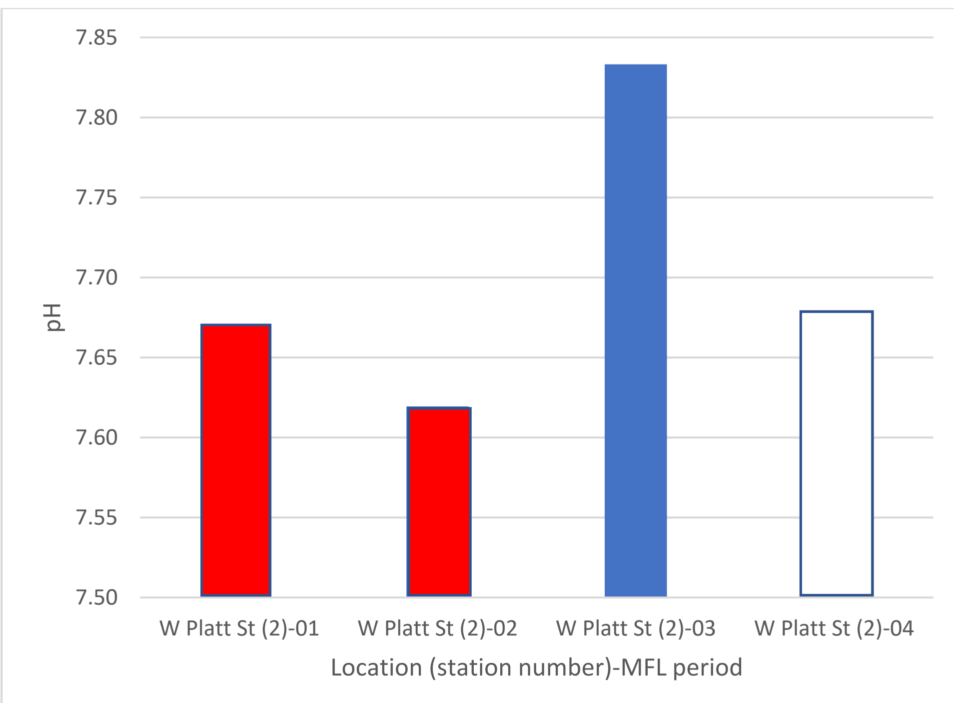

Figure 5.2.2.1-51. Average monthly pH at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL periods 1 and 2 (red) were significantly lower than MFL period 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

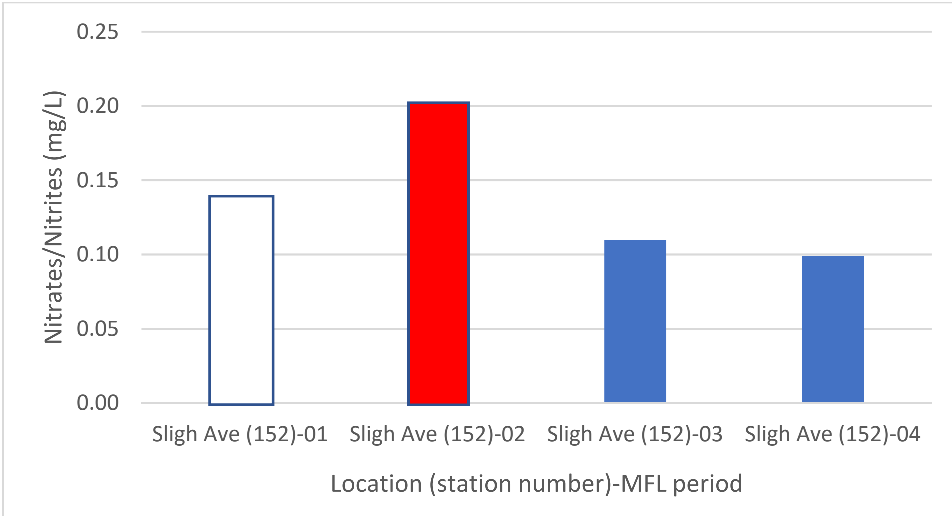

Figure 5.2.2.1-52. Average monthly nitrates/nitrites (mg/L) at Sligh Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL periods 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

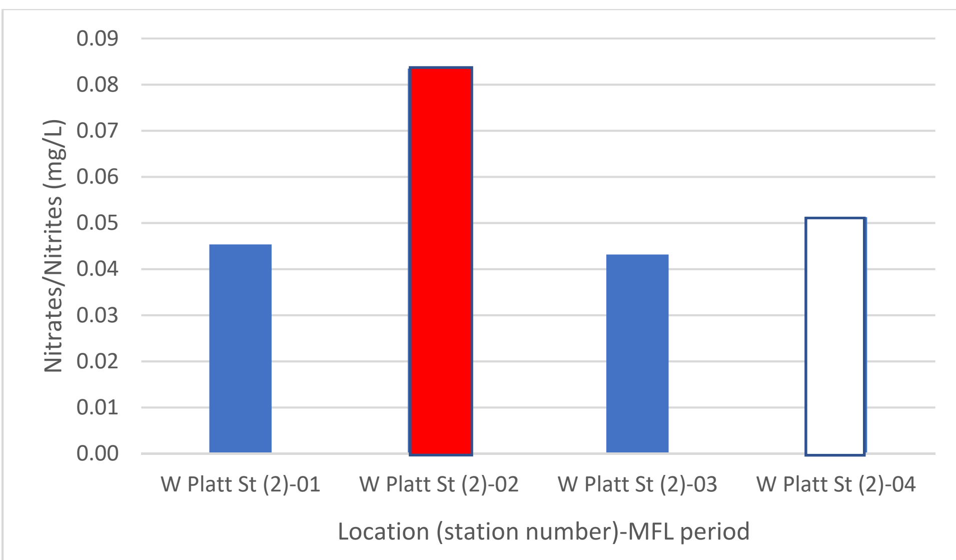

Figure 5.2.2.1-53. Average monthly nitrates/nitrites (mg/L) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL periods 1 (blue) and 3 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

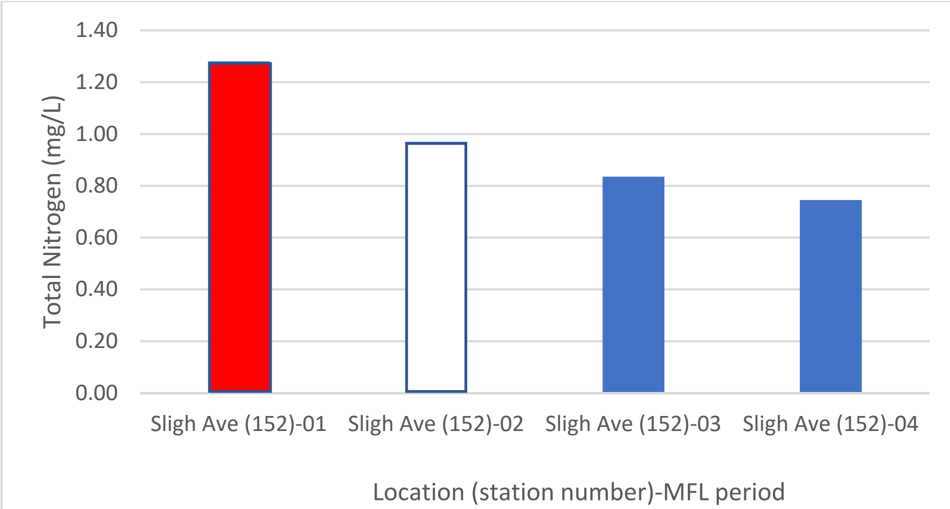

Figure 5.2.2.1-54. Average monthly total nitrogen (mg/L) at Sligh Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL period 3 (blue) and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

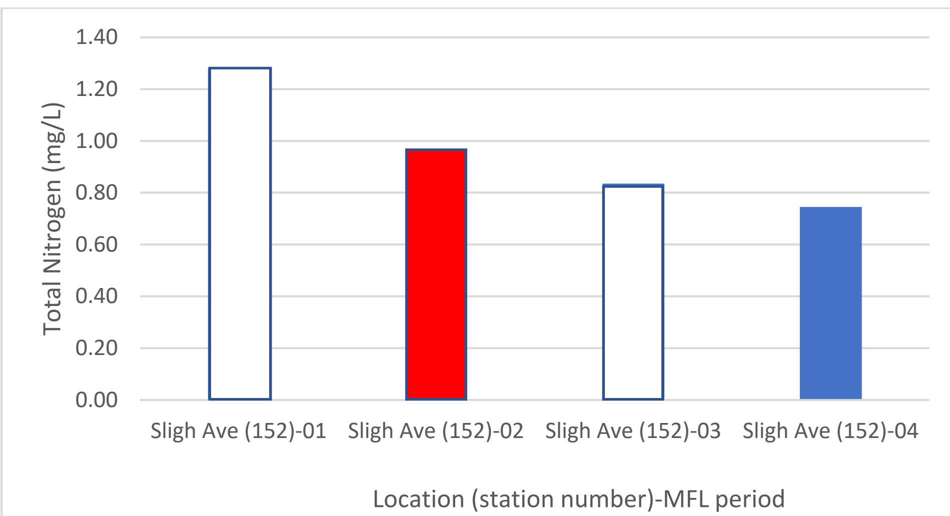

Figure 5.2.2.1-55. Average monthly total nitrogen (mg/L) at Sligh Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

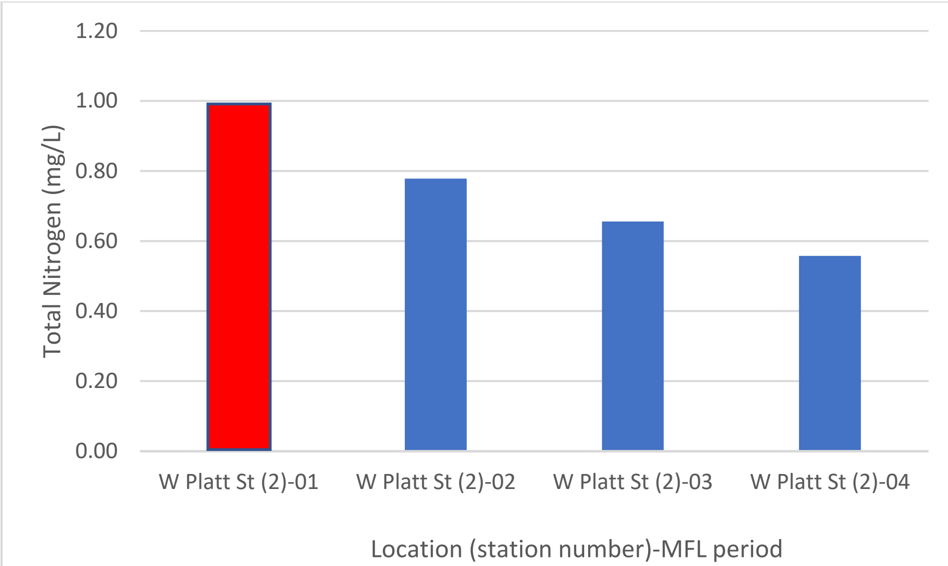

Figure 5.2.2.1-56. Average monthly total nitrogen (mg/L) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

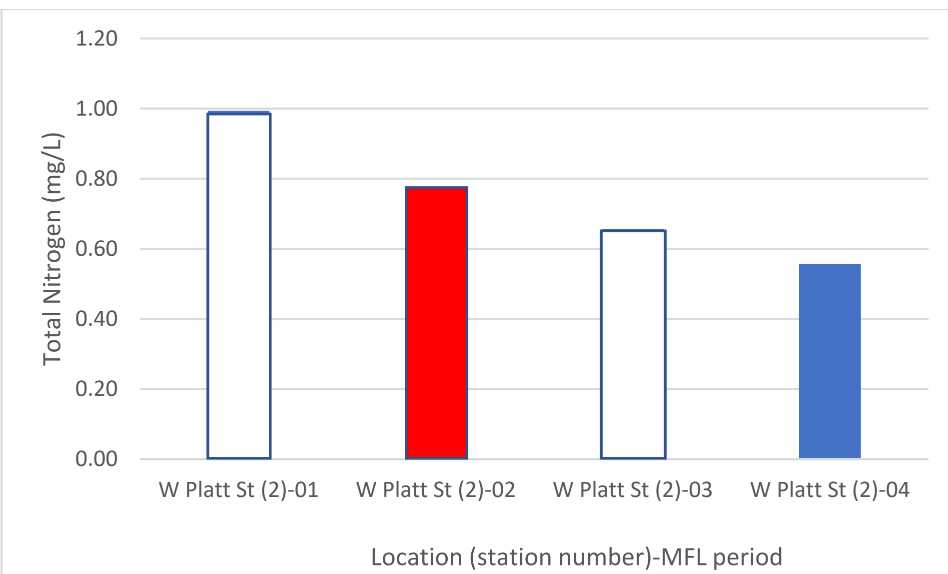

Figure 5.2.2.1-57. Average monthly total nitrogen (mg/L) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

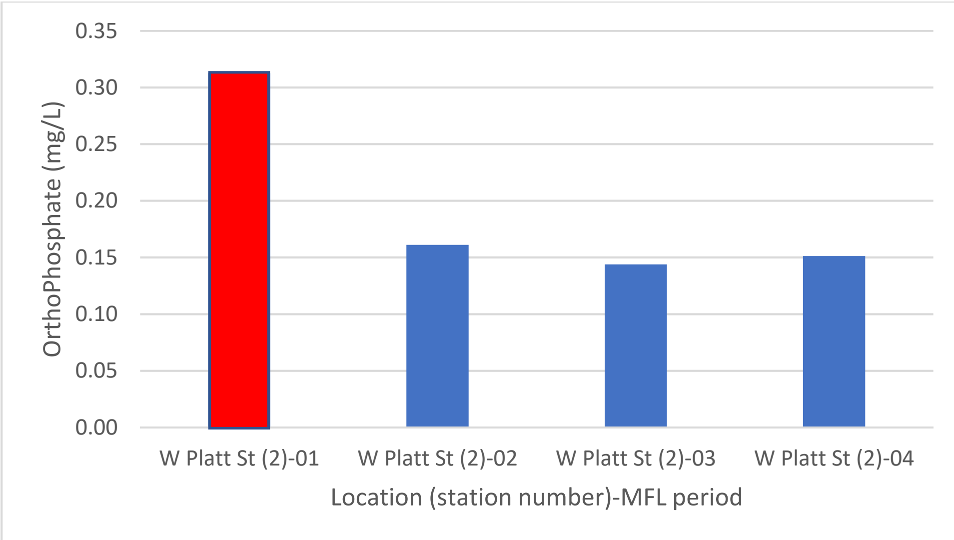

Figure 5.2.2.1-58. Average monthly orthophosphate (mg/L) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

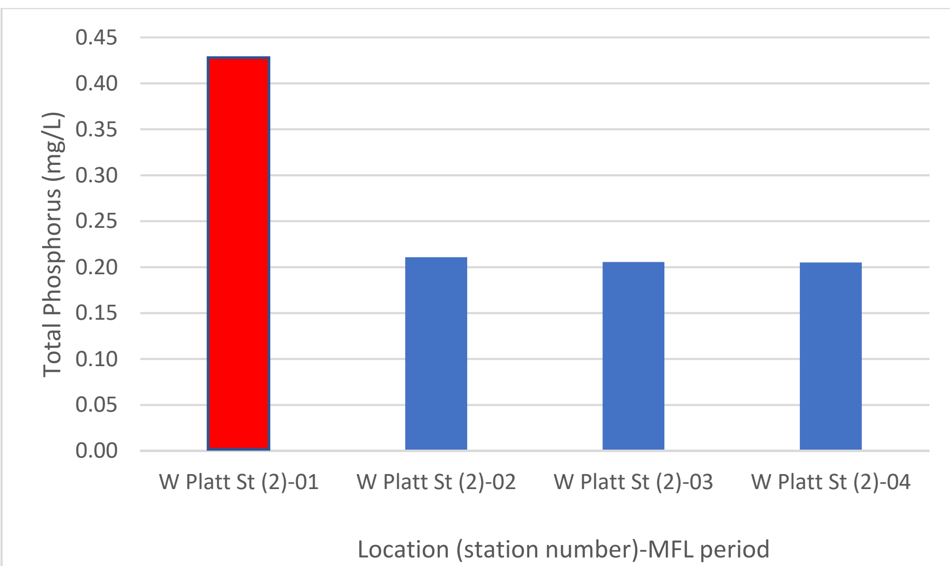

Figure 5.2.2.1-59. Average monthly total phosphorus (mg/L) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 1 (red) was significantly higher than MFL periods 2 (blue), 3 (blue), and 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

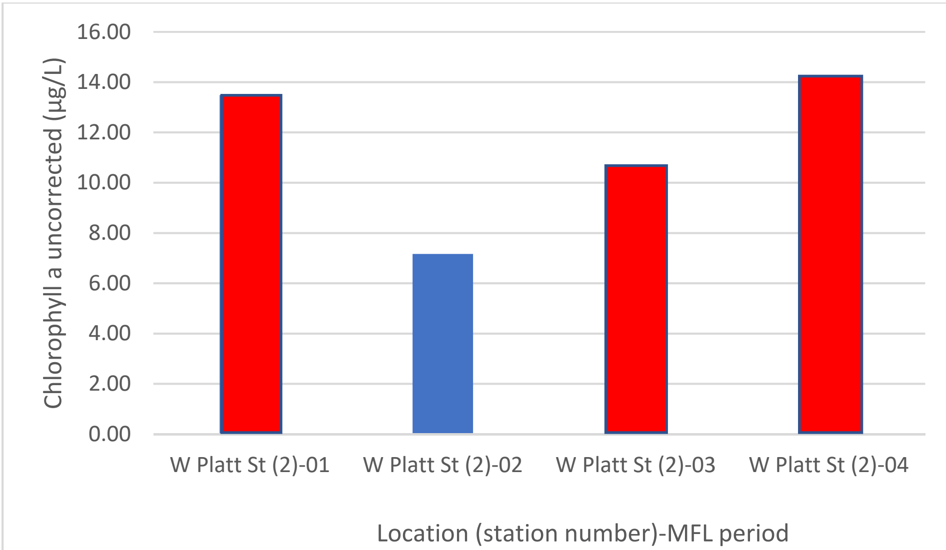

Figure 5.2.2.1-60. Average monthly chlorophyll *a* uncorrected (µg/L) at West Platt Street by MFL period with water flow over the dam from October 1979 to May 2018. MFL periods 1 (red), 3 (red), and 4 (red) were significantly higher than MFL period 2 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

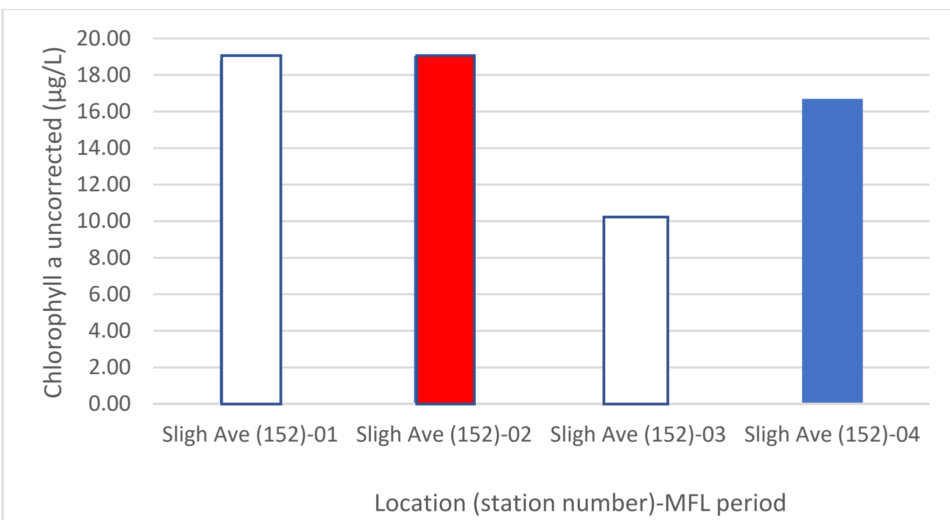

Figure 5.2.2.1-61. Average monthly chlorophyll *a* uncorrected (µg/L) at Sligh Avenue by MFL period with water flow over the dam from October 1979 to May 2018. MFL period 2 (red) was significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

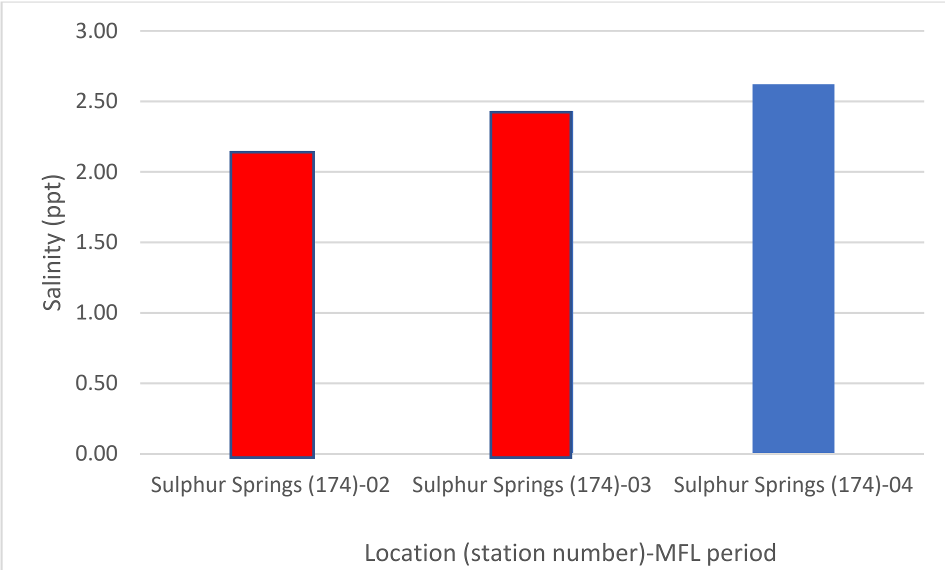

Figure 5.2.2.1-62. Average monthly salinity (ppt) at Sulphur Springs by MFL period with water flow over the dam from October 1979 to May 2018. MFL periods 2 (red) and 3 (red) were significantly lower than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

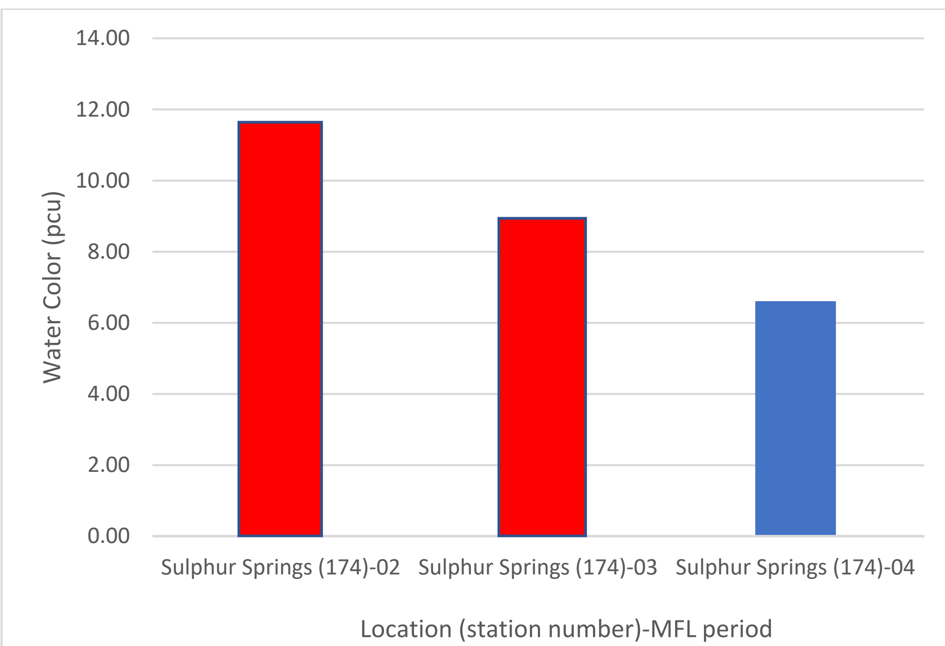

Figure 5.2.2.1-63. Average monthly water color (pcu) at Sulphur Springs by MFL period with water flow over the dam from October 1979 to May 2018. MFL periods 2 (red) and 3 (red) were significantly higher than MFL period 4 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

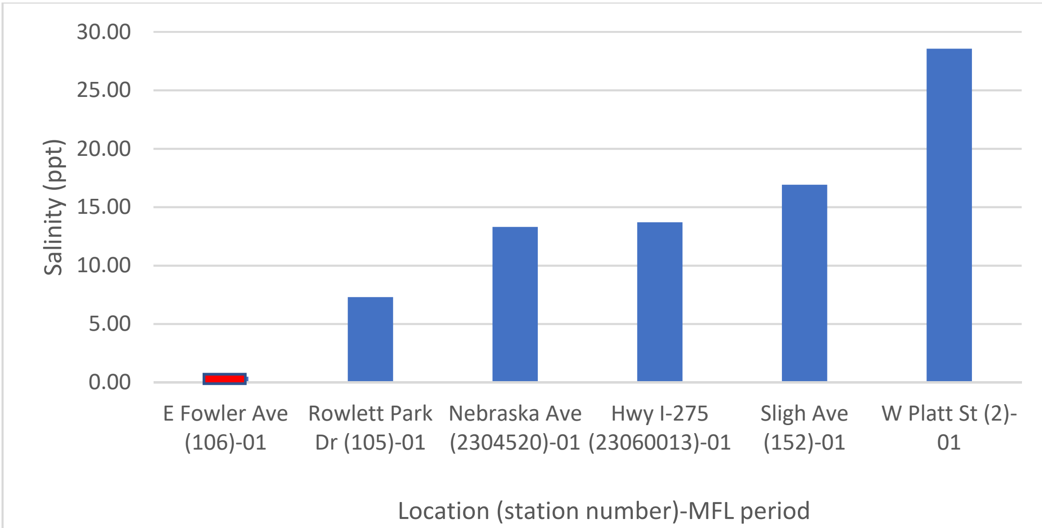

Figure 5.2.2.2-1. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than Rowlett Park Drive (blue), Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

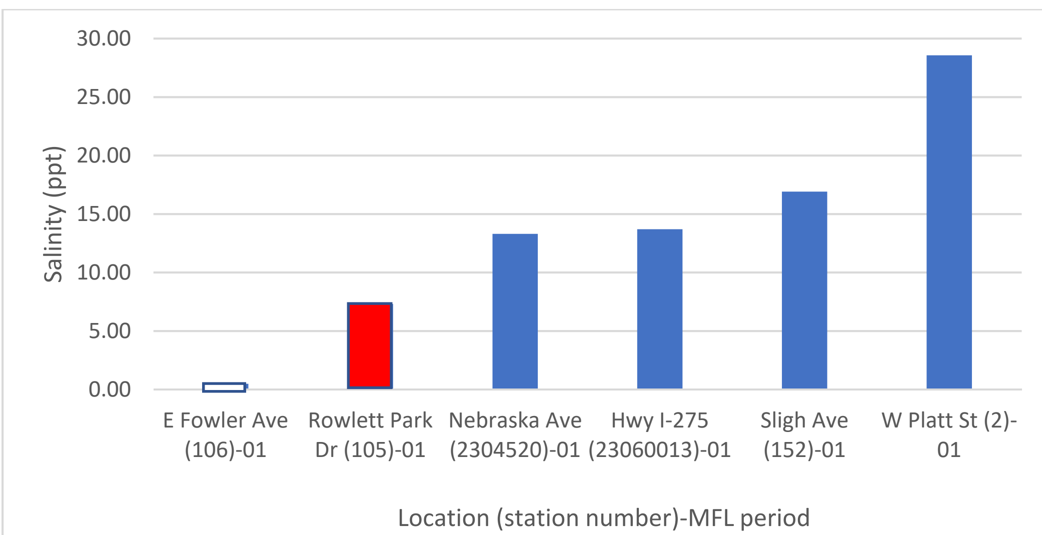

Figure 5.2.2.2-2. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 without water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

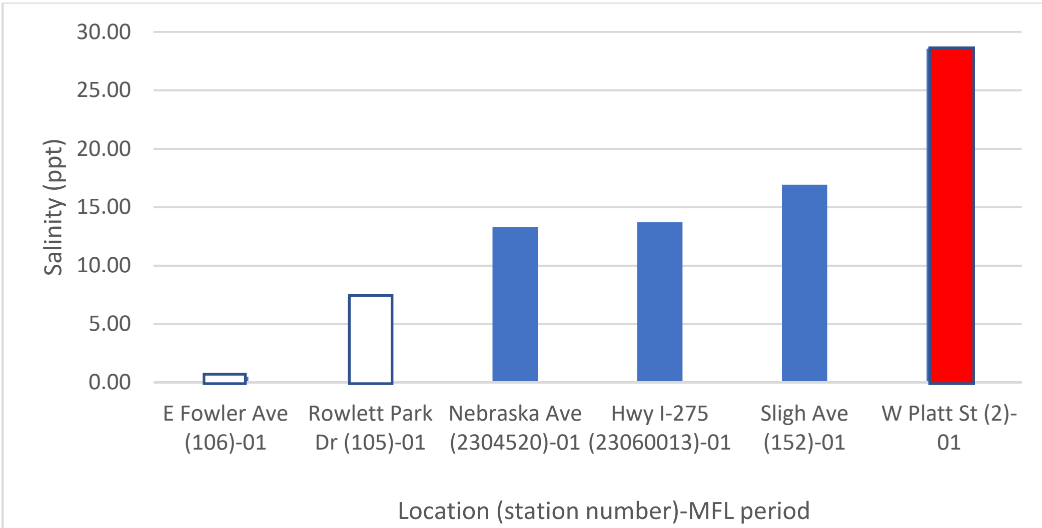

Figure 5.2.2.2-3. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 without water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

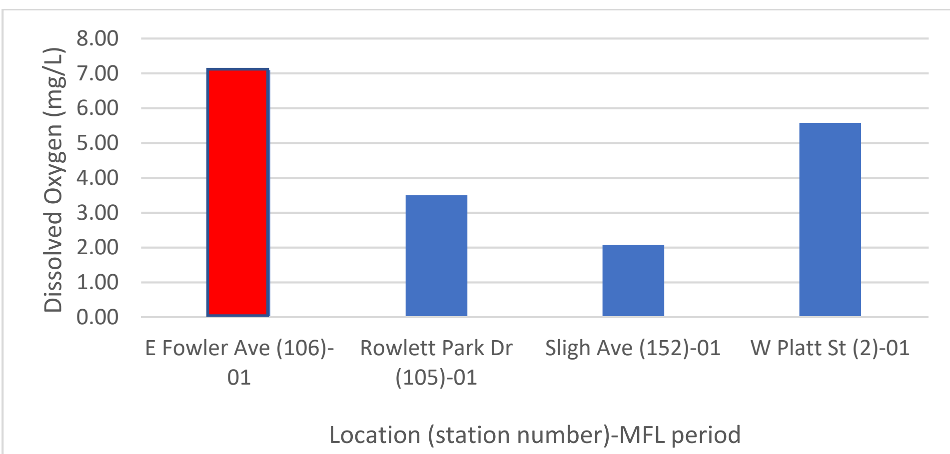

Figure 5.2.2.2-4. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 1 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly higher than Rowlett Park Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

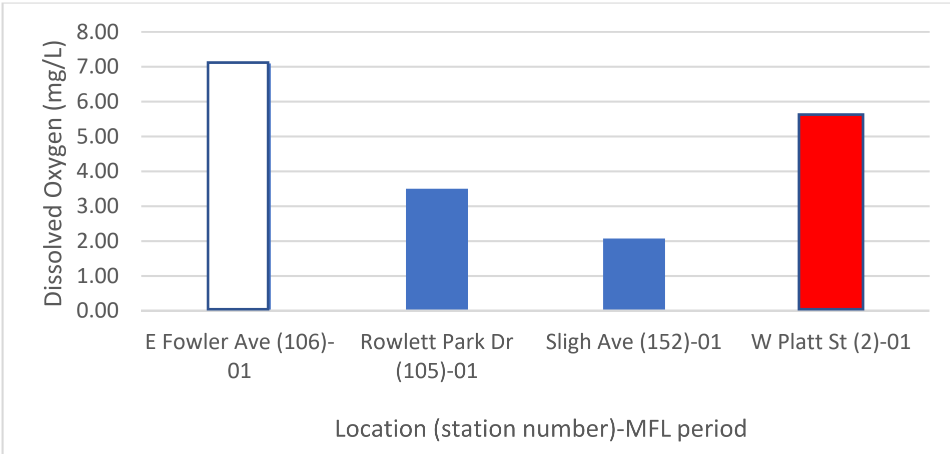

Figure 5.2.2.2-5. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 1 without water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Rowlett Park Drive (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

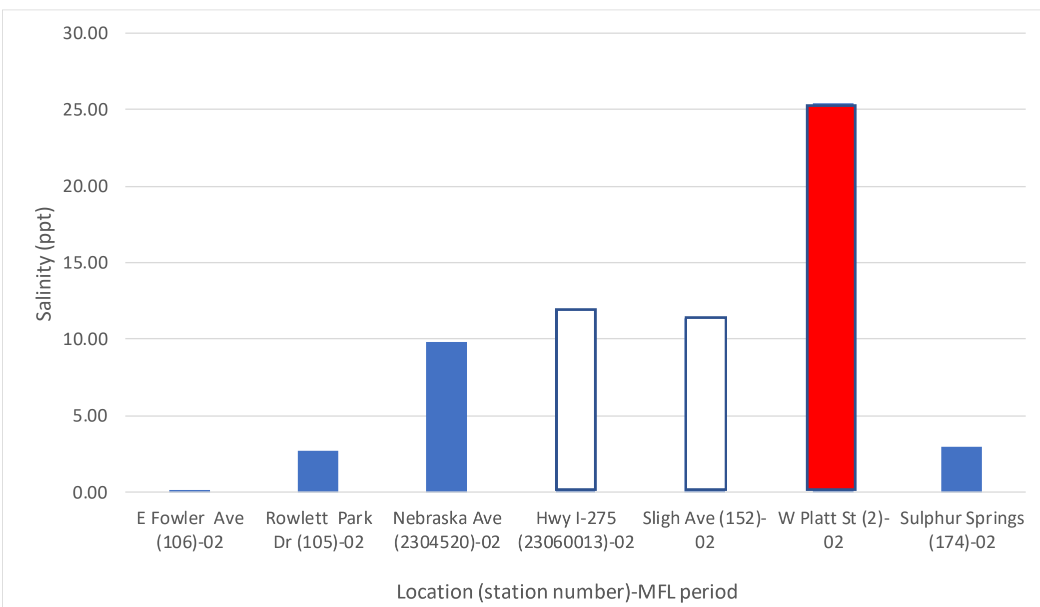

Figure 5.2.2.2-6. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, West Platt Street, Sulphur Springs from MFL period 2 without water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than East Fowler Avenue (blue), Rowlett Park Drive (blue), Nebraska Avenue (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

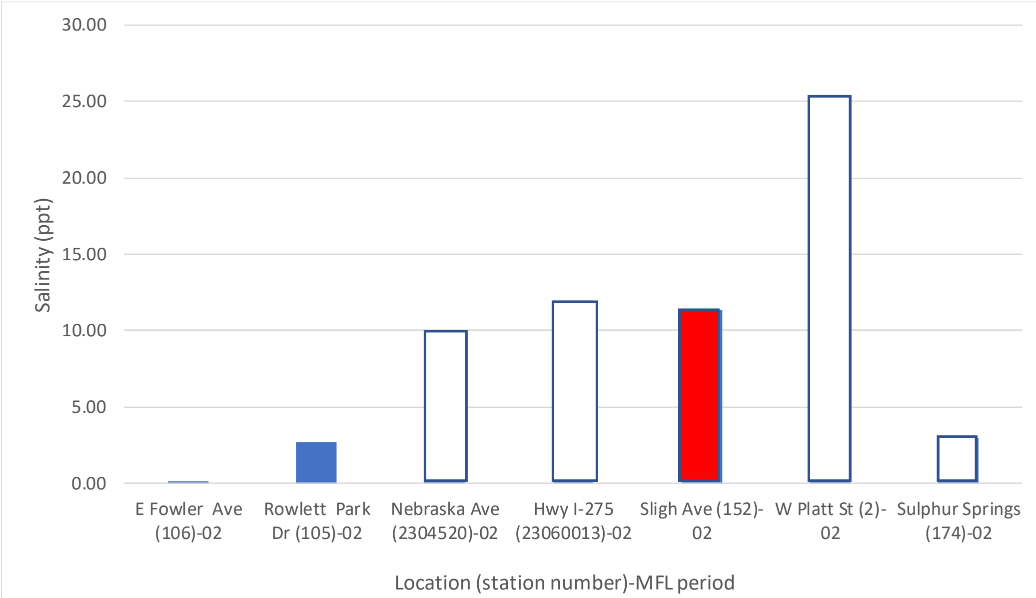

Figure 5.2.2.2-7. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, West Platt Street, Sulphur Springs from MFL period 2 without water flow over the dam from October 1979 to May 2018. Sligh Avenue (red) was significantly higher than East Fowler Avenue (blue) and Rowlett Park Drive (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

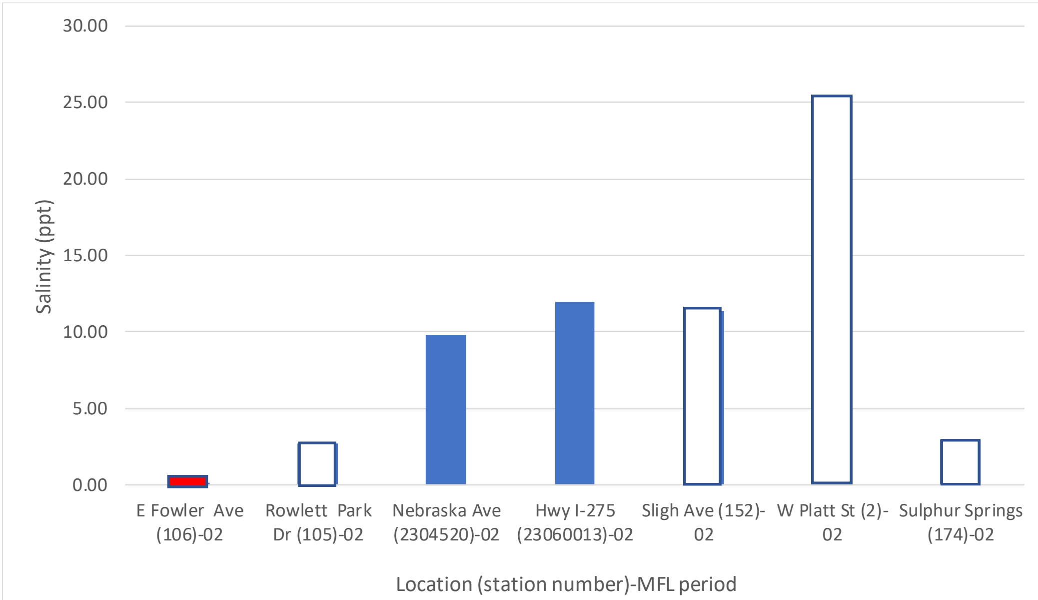

Figure 5.2.2.2-8. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 2 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than Nebraska Avenue (blue) and Hwy I-275 (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

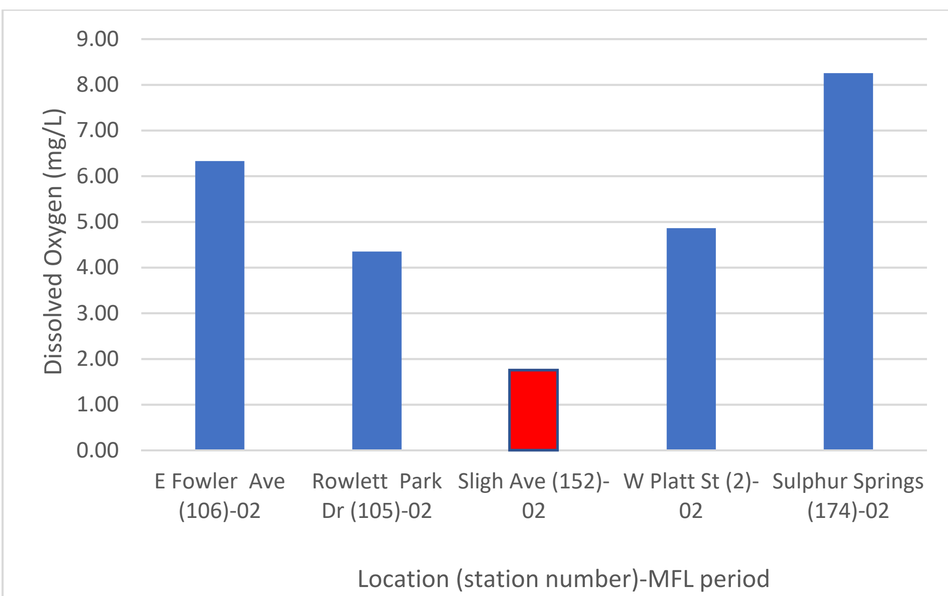

Figure 5.2.2.2-9. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 2 without water flow over the dam from October 1979 to May 2018. Sligh Avenue (red) was significantly lower than East Fowler Avenue (blue), Rowlett Park Drive (blue) and West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

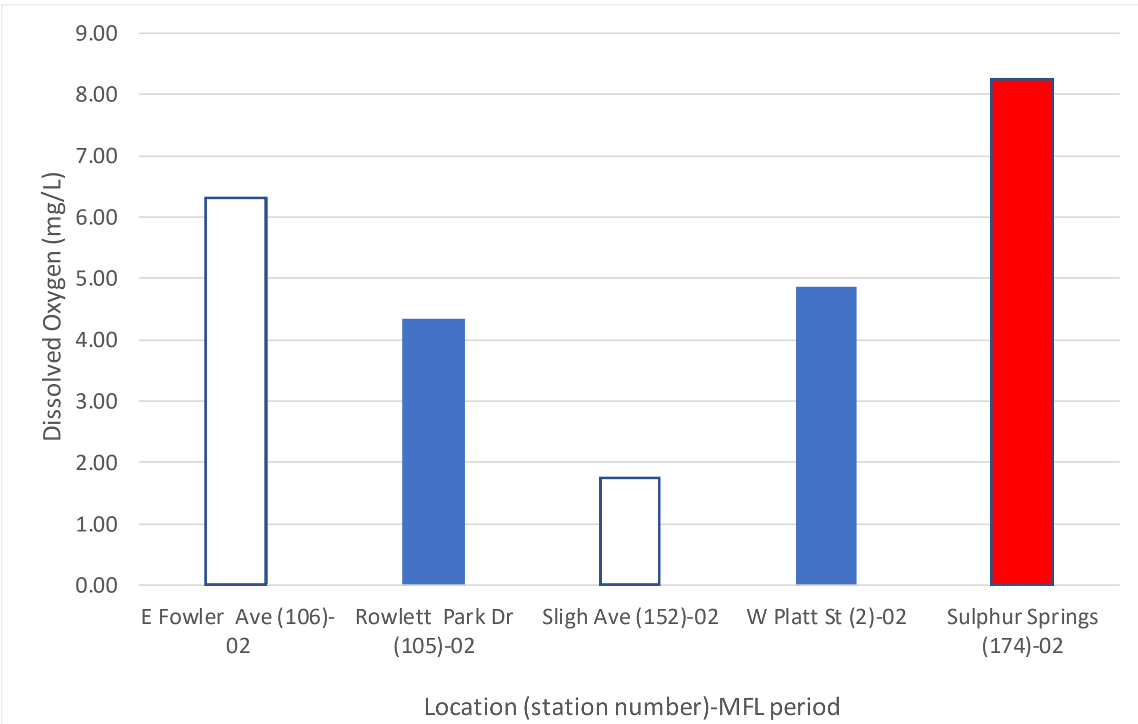

Figure 5.2.2.2-10. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 2 without water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than Rowlett Park Drive (blue) and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

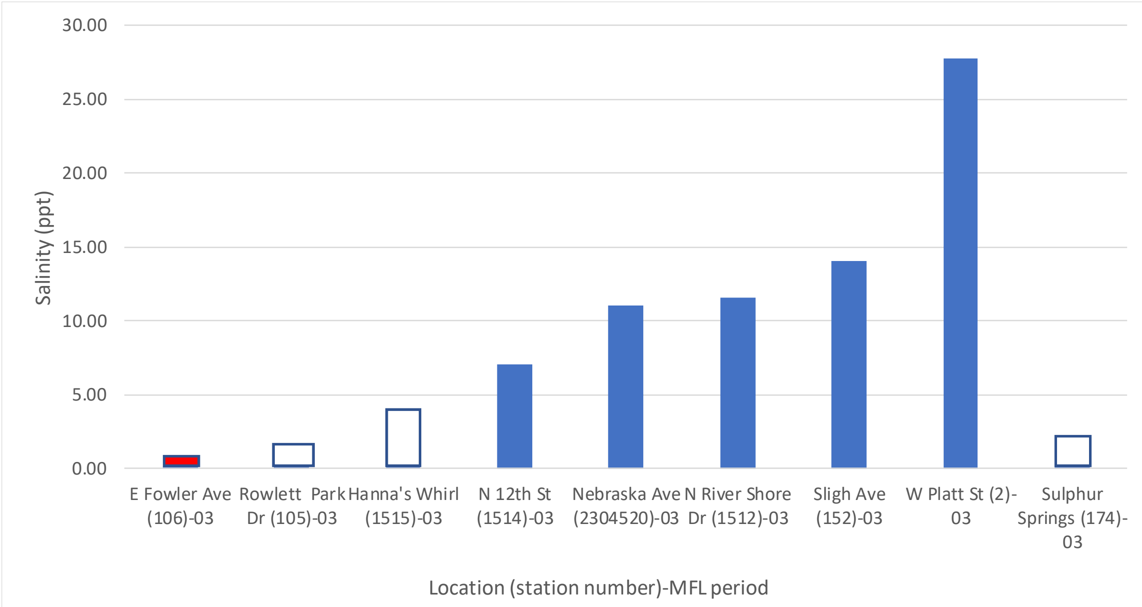

Figure 5.2.2.2-11. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than North 12th Street (blue), Nebraska Avenue (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

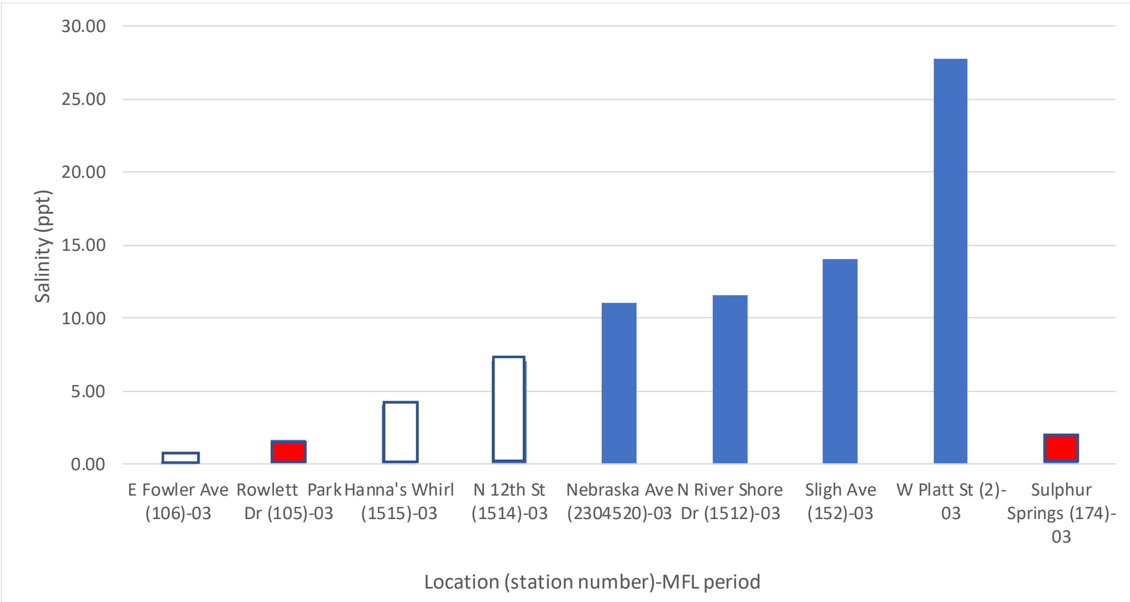

Figure 5.2.2.2-12. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) and Sulphur Springs (red) were significantly lower than Nebraska Avenue (blue) and North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

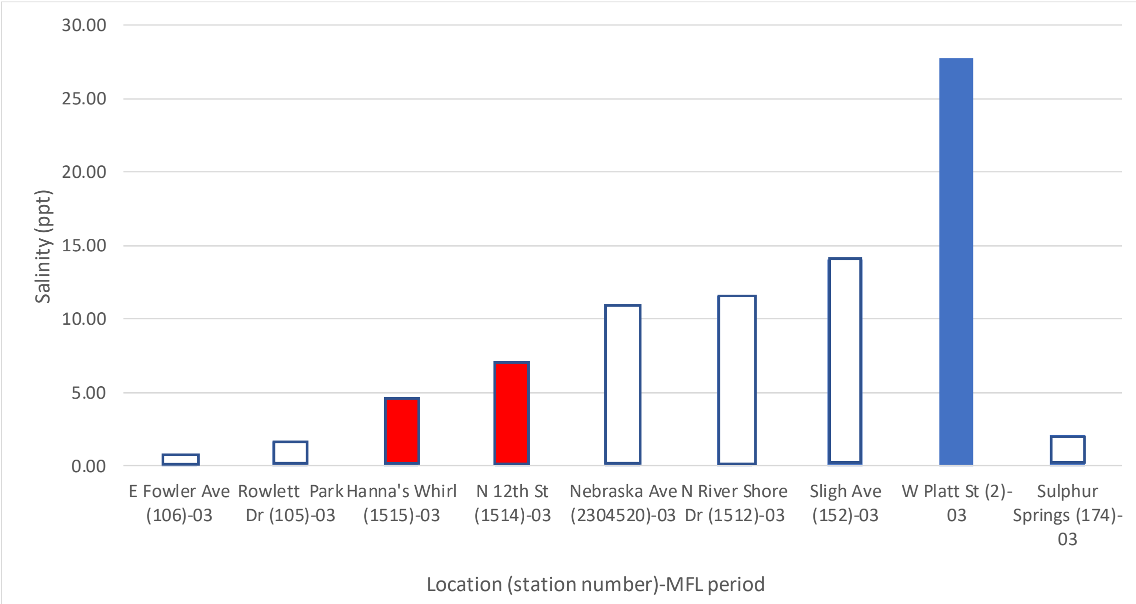

Figure 5.2.2.2-13. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. Hanna's Whirl (red) and North 12th Street (red) were significantly lower than West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

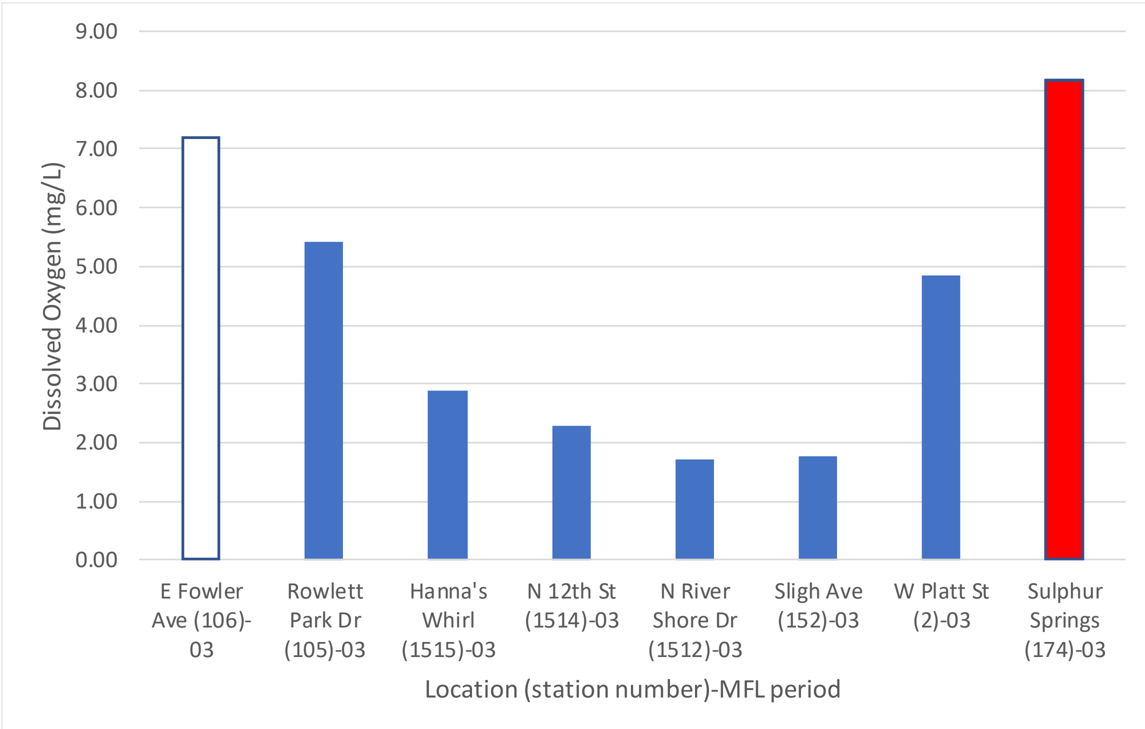

Figure 5.2.2.2-14. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than Rowlett Park Drive (blue), Hanna's Whirl (blue), North 12th Street (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

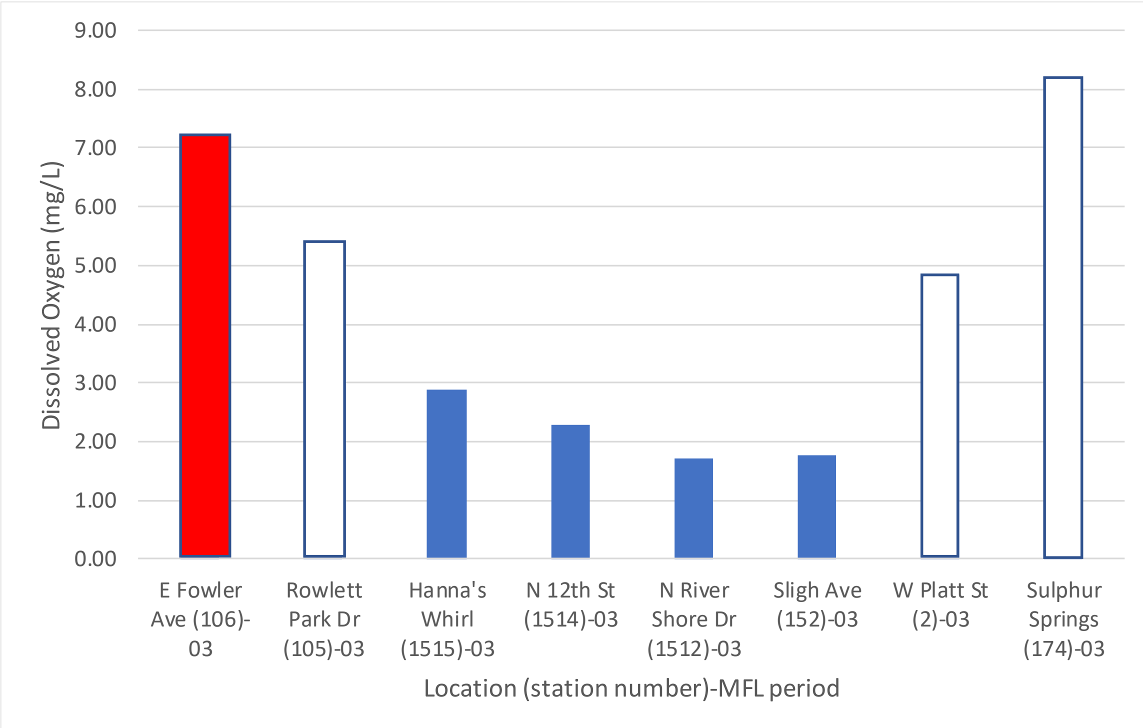

Figure 5.2.2.2-15. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly higher than Hanna's Whirl (blue), North 12th Street (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

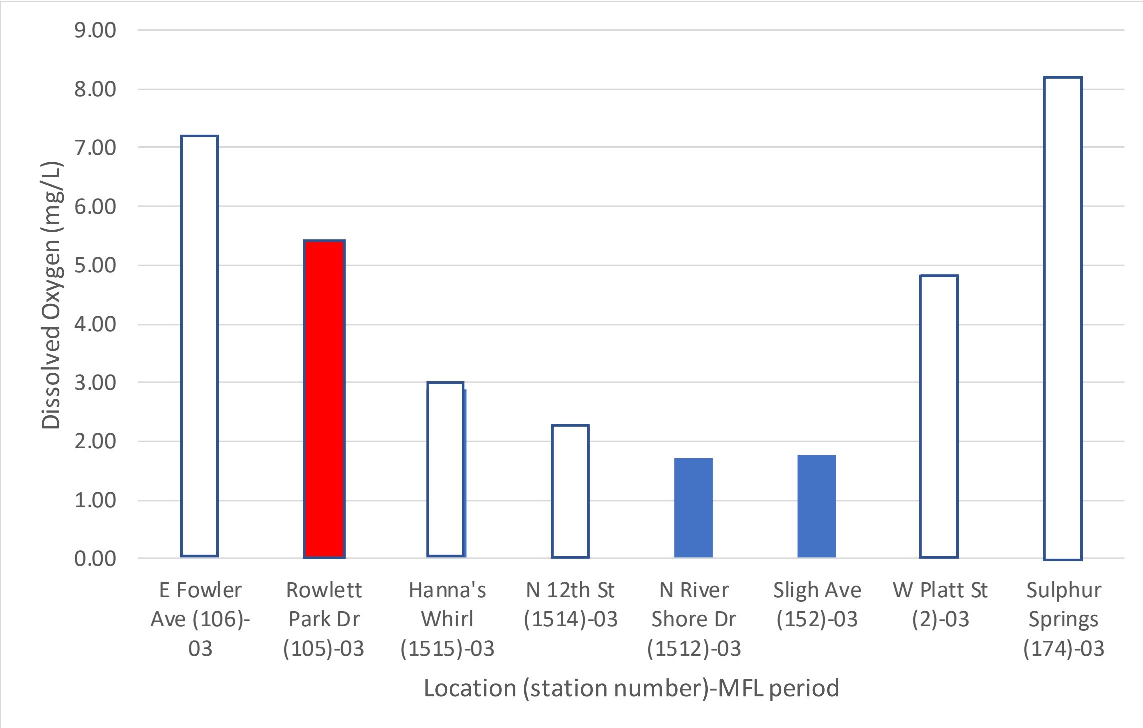

Figure 5.2.2.2-16. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than North River Shore Drive (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

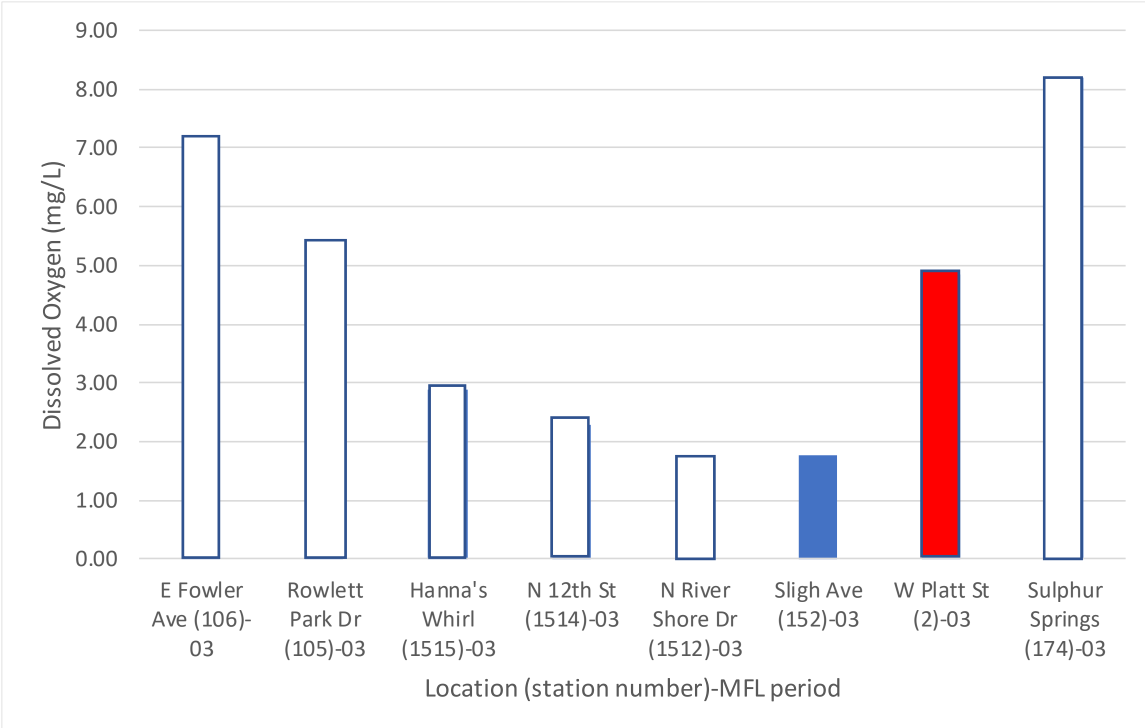

Figure 5.2.2.2-17. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 without water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

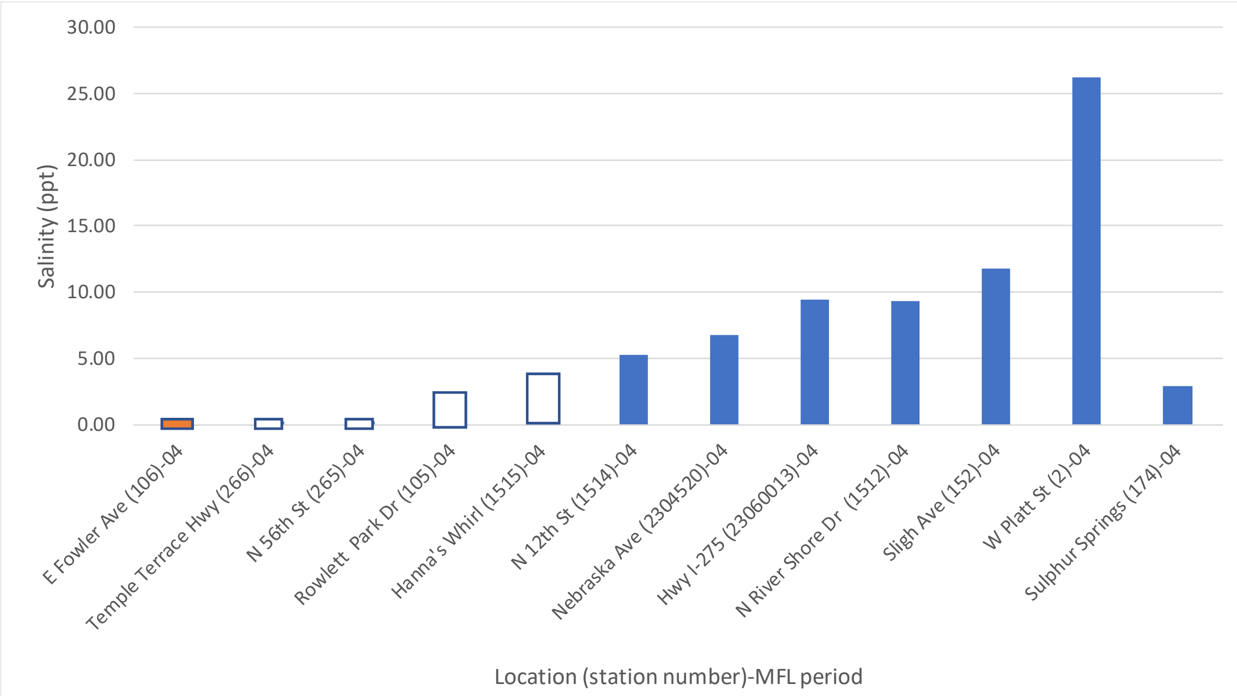

Figure 5.2.2.2-18. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than North 12th Street (blue), Nebraska Avenue (blue), Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

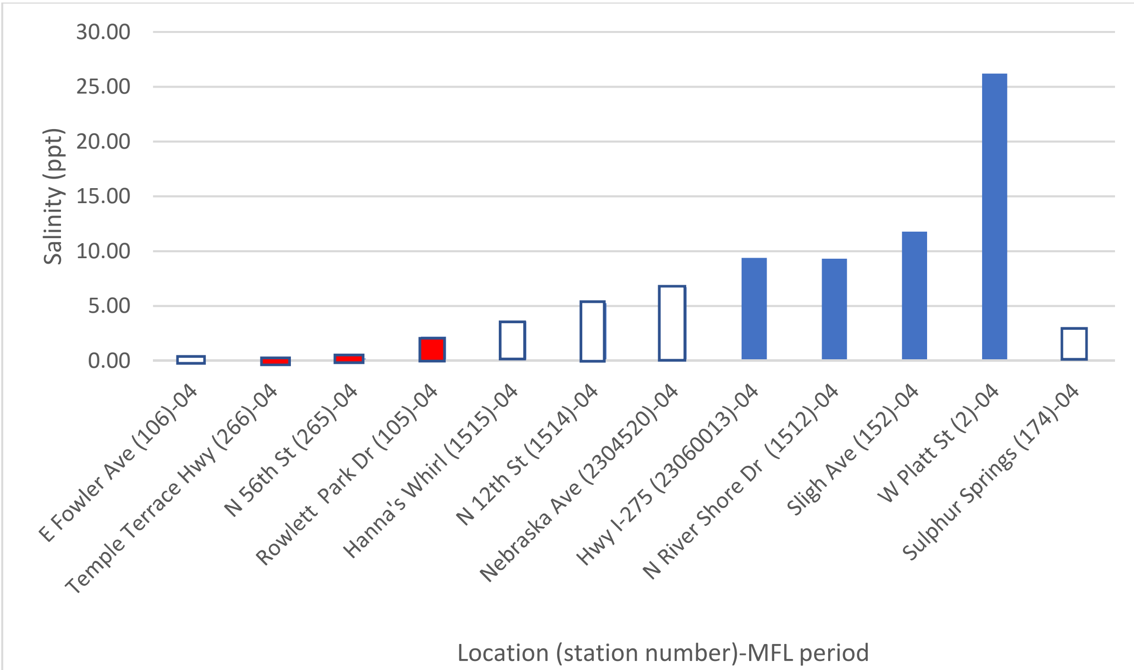

Figure 5.2.2.2-19. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Temple Terrace Hwy (red), North 56th Street (red), and Rowlett Park Drive (red) were significantly lower than Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

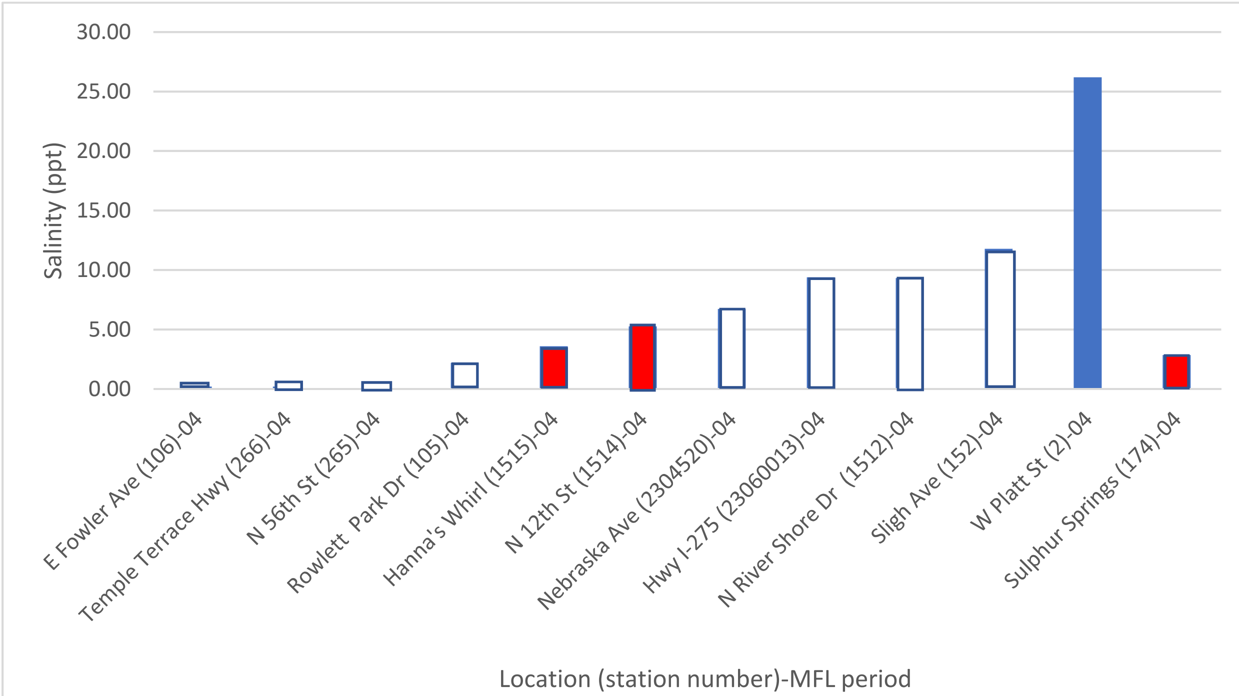

Figure 5.2.2.2-20. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Hanna's Whirl (red), North 12th Street (red), and Sulphur Springs (red) were significantly lower than West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

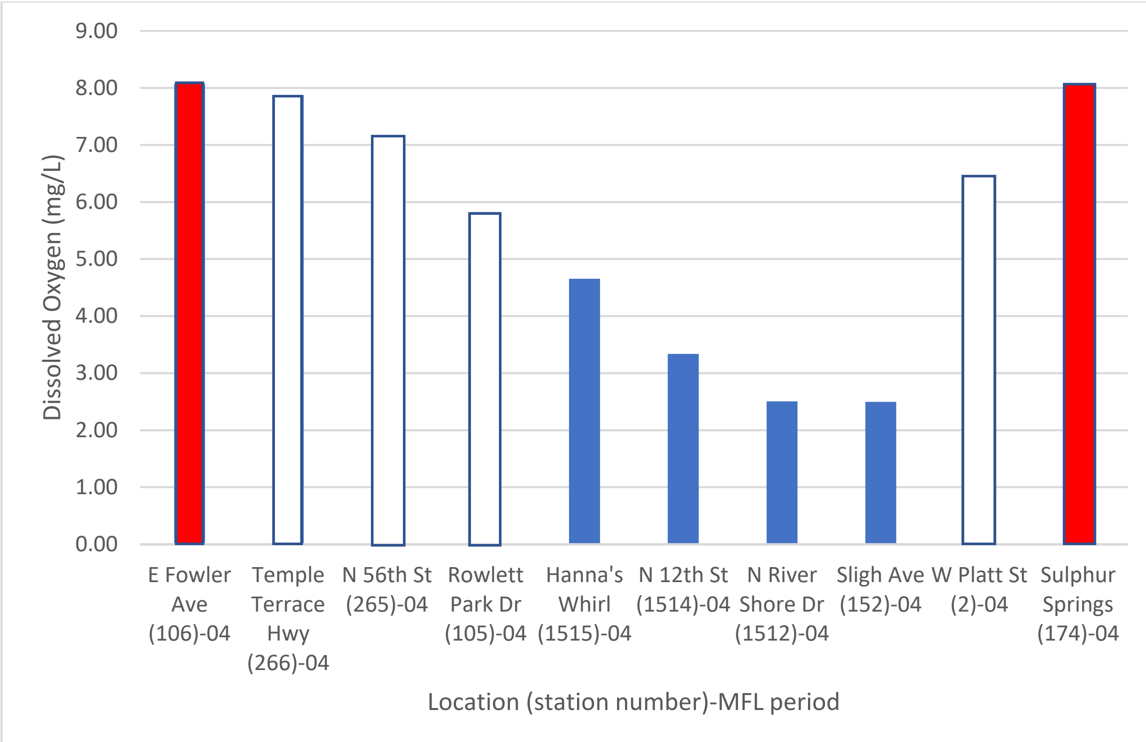

Figure 5.2.2.2-21. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) and Sulphur Springs (red) were significantly higher than Hanna's Whirl (blue), North 12th Street (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

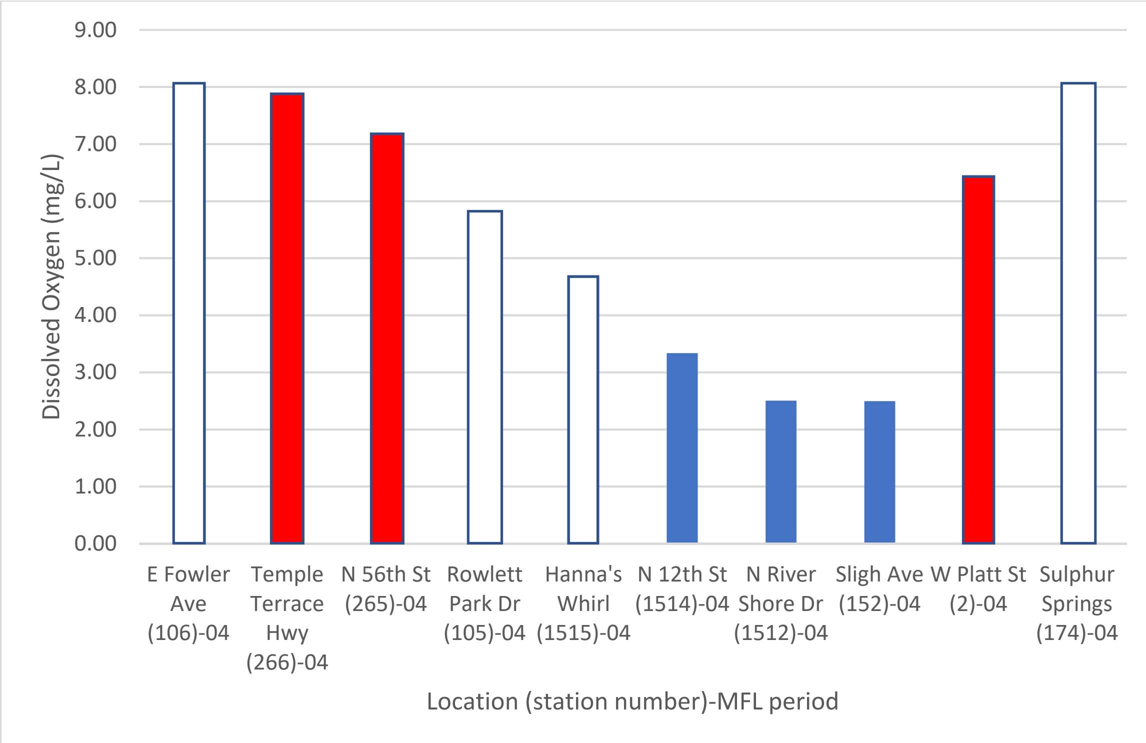

Figure 5.2.2.2-22. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Temple Terrace Hwy (red), North 56th Street (red), and West Platt Street (red) were significantly higher than North 12th Street (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

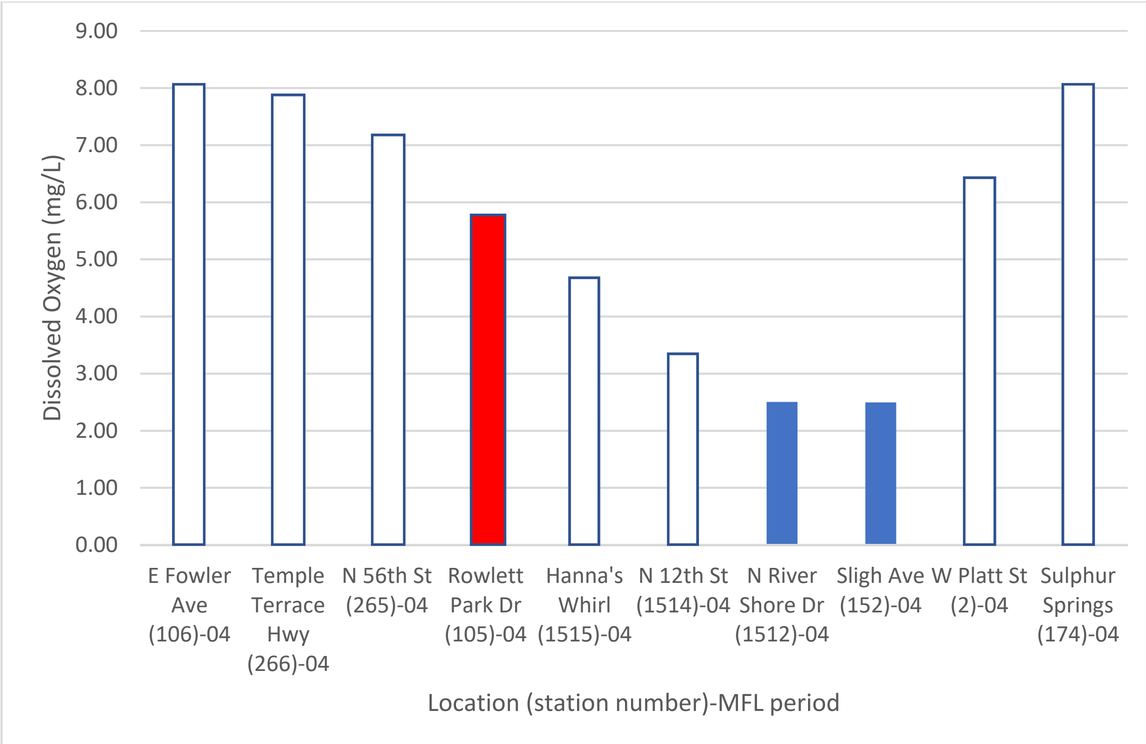

Figure 5.2.2.2-23. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 4 without water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than North River Shore Drive (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

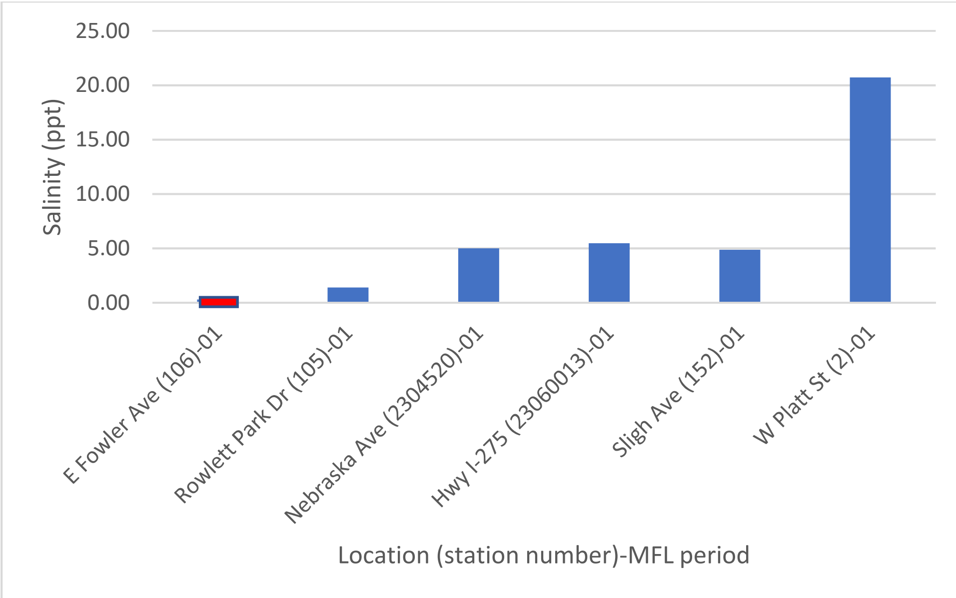

Figure 5.2.2.2-24. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than Rowlett Park Drive (blue), Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

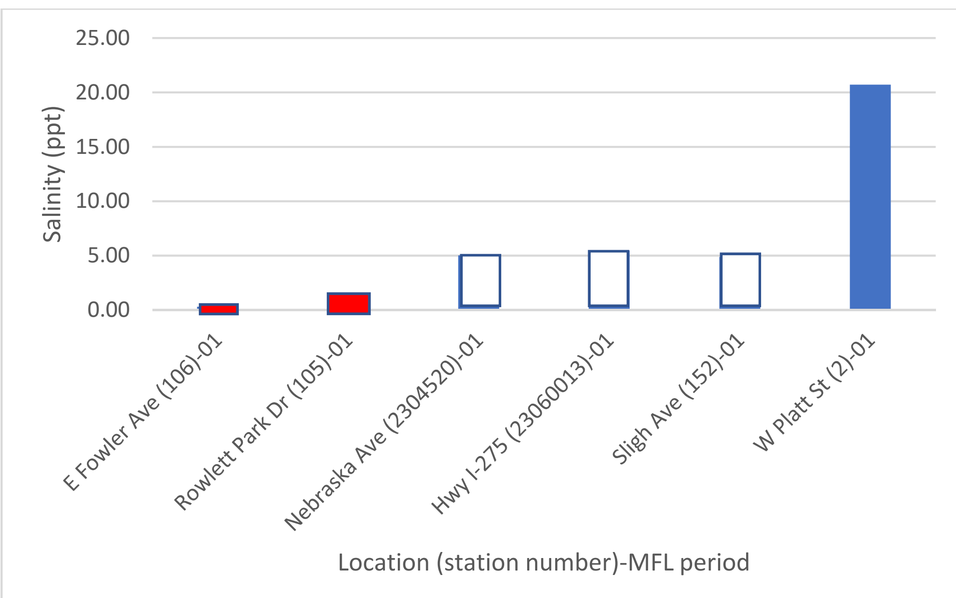

Figure 5.2.2.2-25. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) and Nebraska Avenue (red) were significantly lower than West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

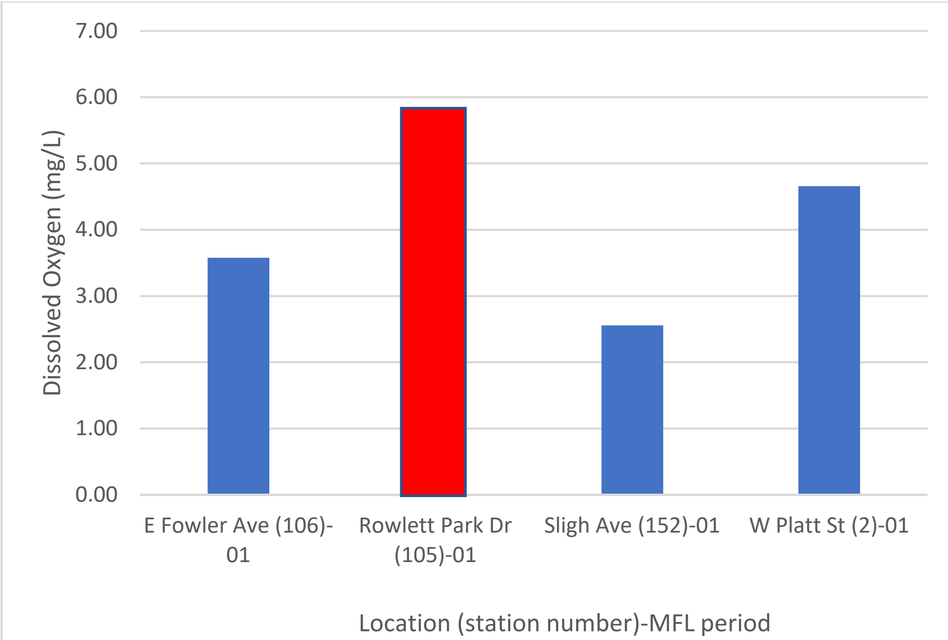

Figure 5.2.2.2-26. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than East Fowler Avenue (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

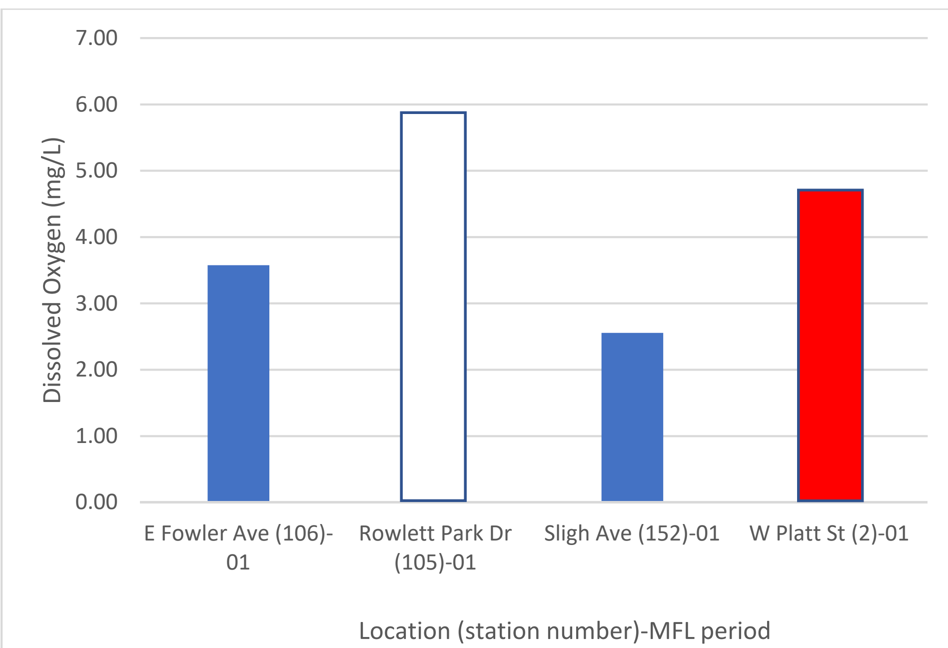

Figure 5.2.2.2-27. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 1 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than East Fowler Avenue (blue) and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

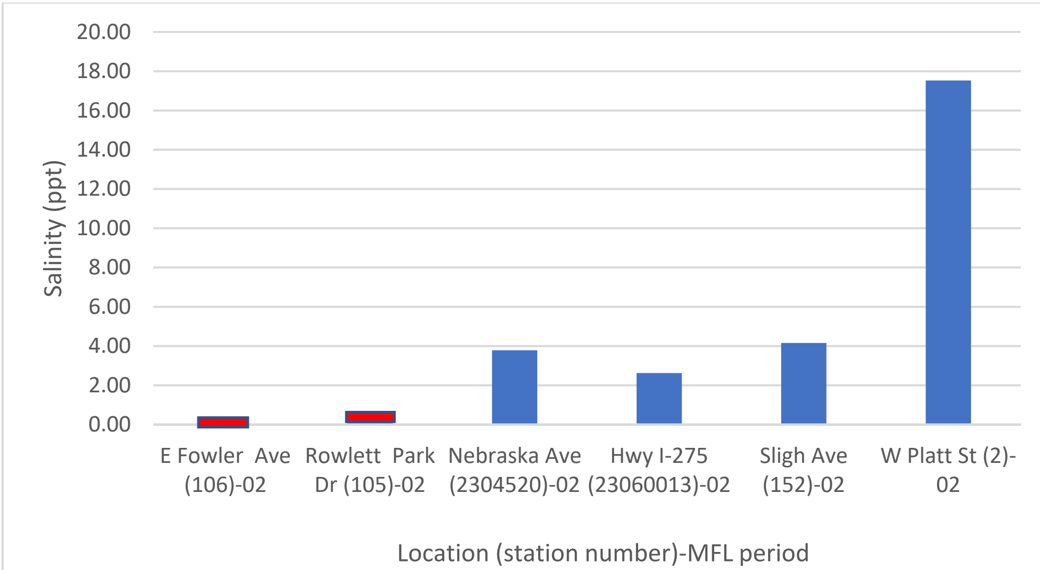

Figure 5.2.2.2-28. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 2 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) and Rowlett Park Drive (red) were significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

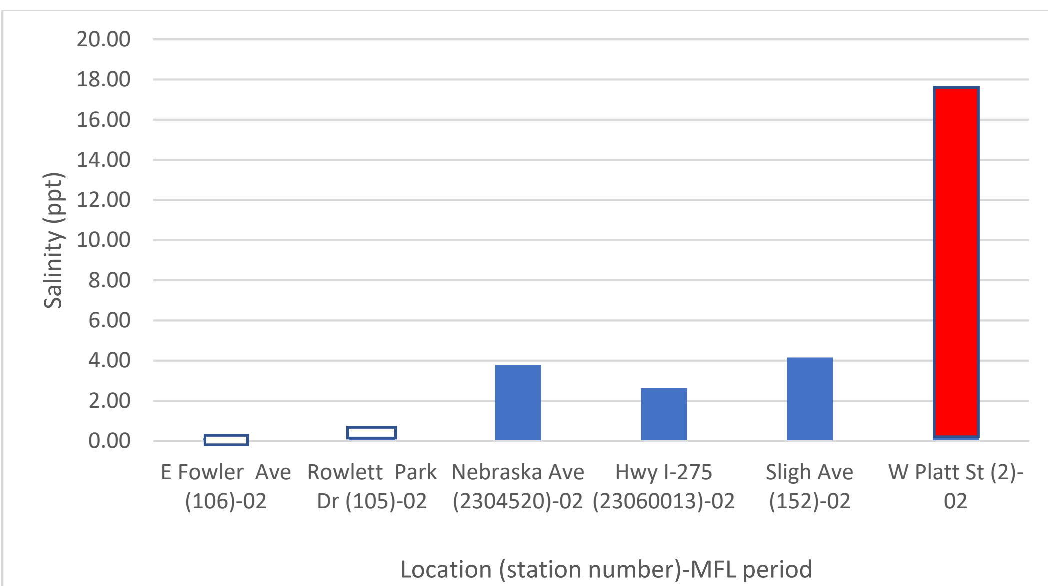

Figure 5.2.2.2-29. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Nebraska Avenue, Hwy I-275, Sligh Avenue, and West Platt Street from MFL period 2 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Nebraska Avenue (blue), Hwy I-275 (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

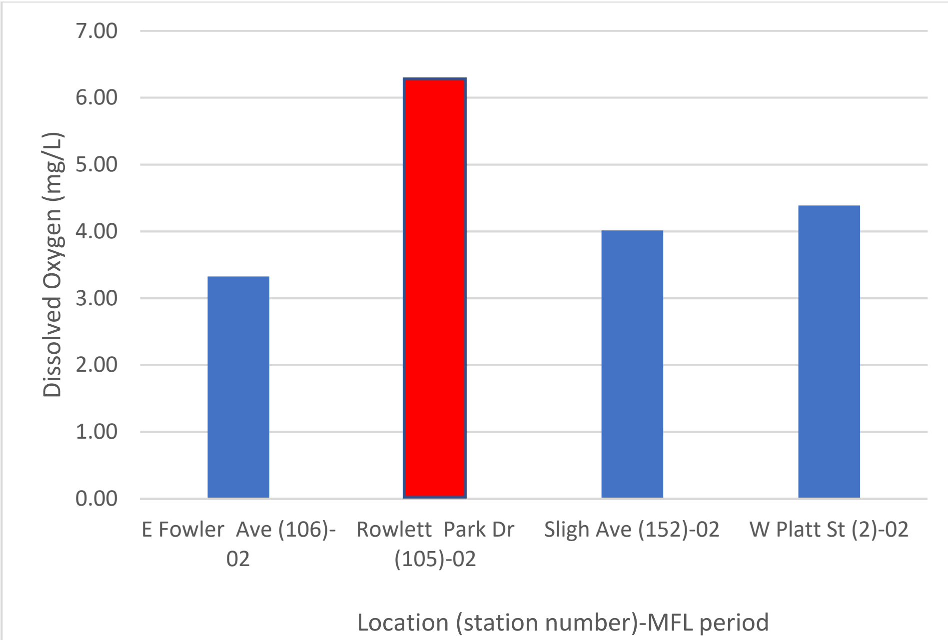

Figure 5.2.2.2-30. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Sligh Avenue, and West Platt Street from MFL period 2 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than East Fowler Avenue (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn’s Test.

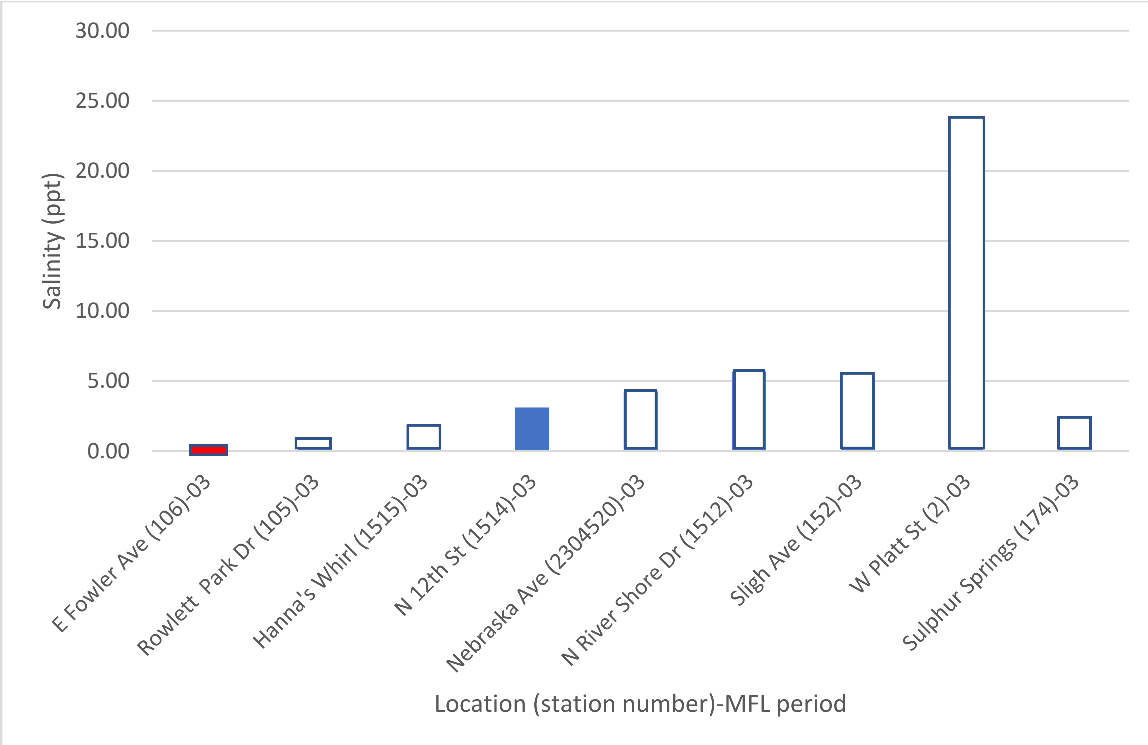

Figure 5.2.2.2-31. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna' Whirl, N 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) was significantly lower than N 12th Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

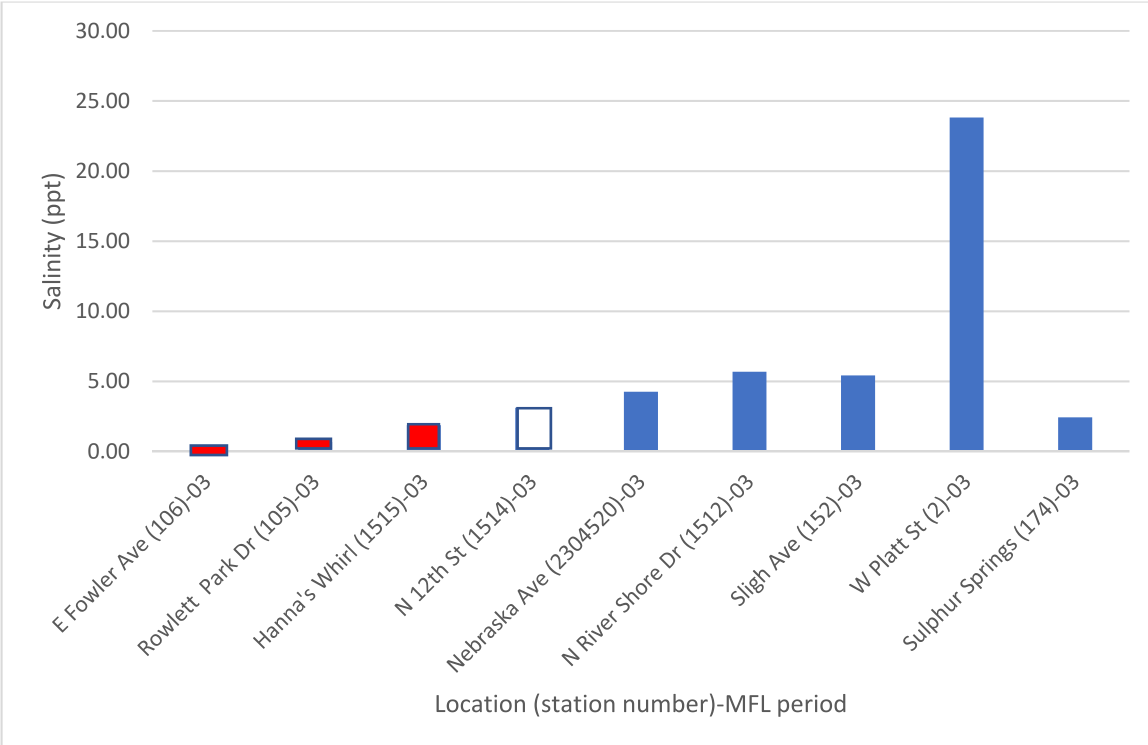

Figure 5.2.2.2-32. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna' Whirl, N 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red), Rowlett Park Drive (red), and Hanna' Whirl (red) were significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), and Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

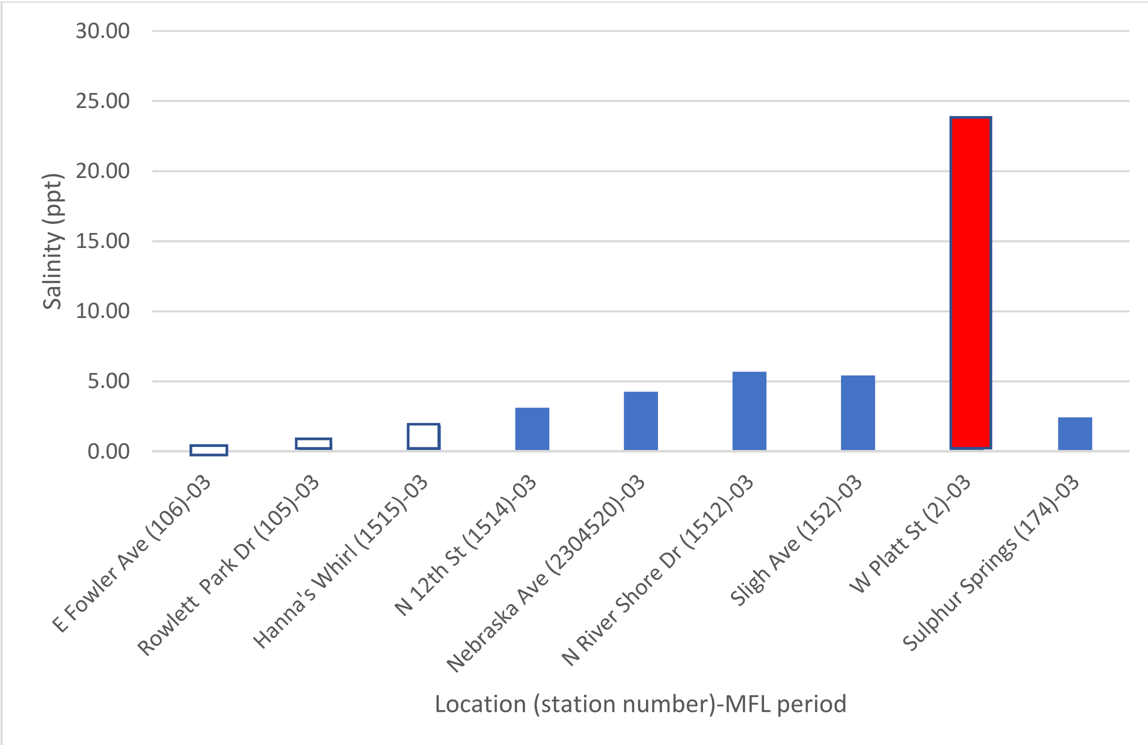

Figure 5.2.2.2-33. Average monthly salinity (ppt) at East Fowler Avenue, Rowlett Park Drive, Hanna' Whirl, N 12th Street, Nebraska Avenue, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than N 12th Street (blue), Nebraska Avenue (blue), North River Shore Drive (blue), Sligh Avenue (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

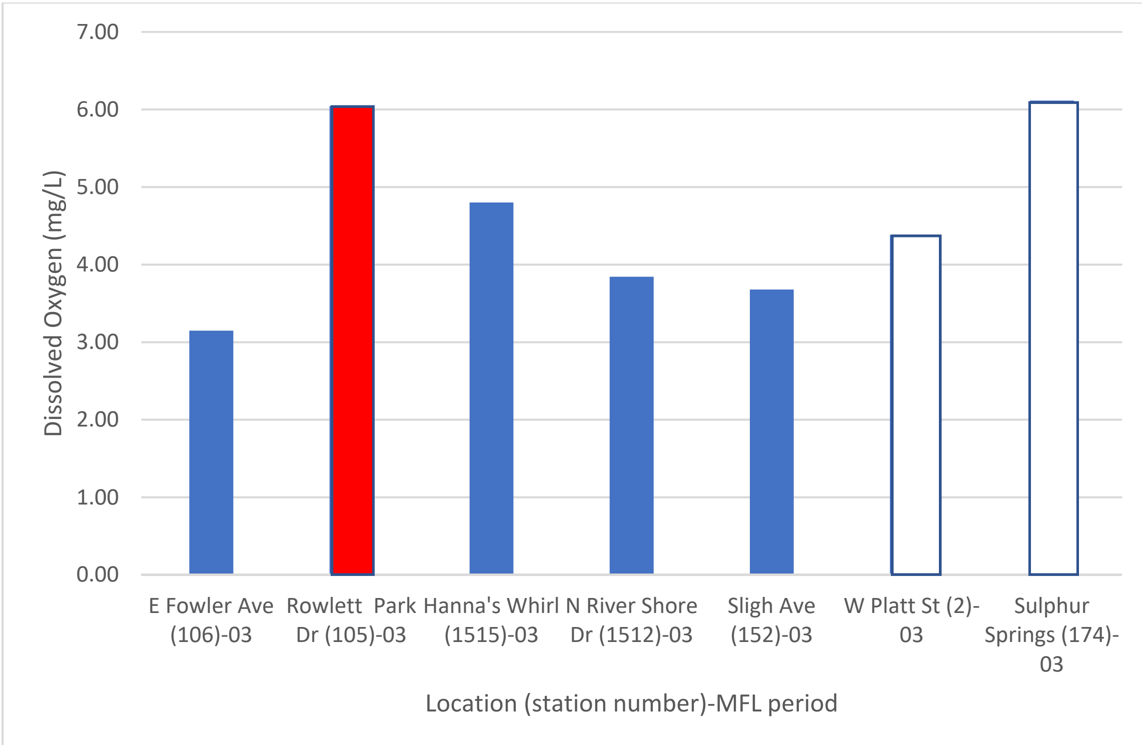

Figure 5.2.2.2-34. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than East Fowler Avenue (blue), Hanna's Whirl (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

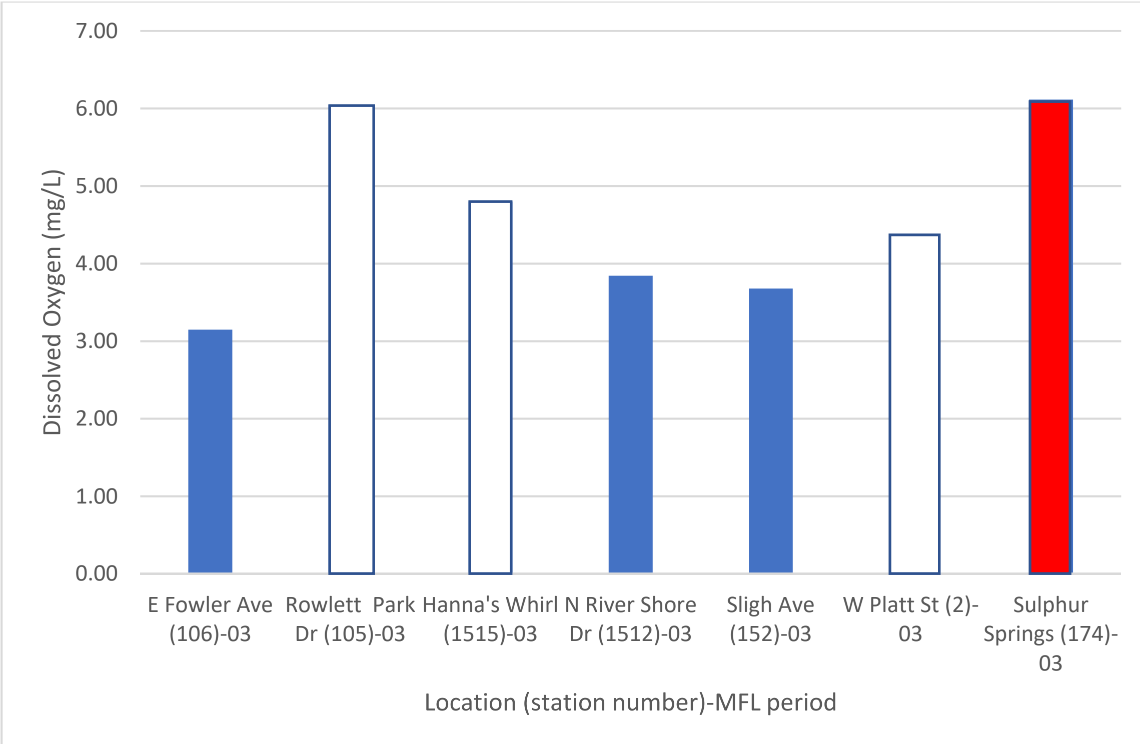

Figure 5.2.2.2-35. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Rowlett Park Drive, Hanna's Whirl, North River Shore Drive, Sligh Avenue, West Platt Street, and Sulphur Springs from MFL period 3 with water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than East Fowler Avenue (blue), North River Shore Drive (blue), and Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

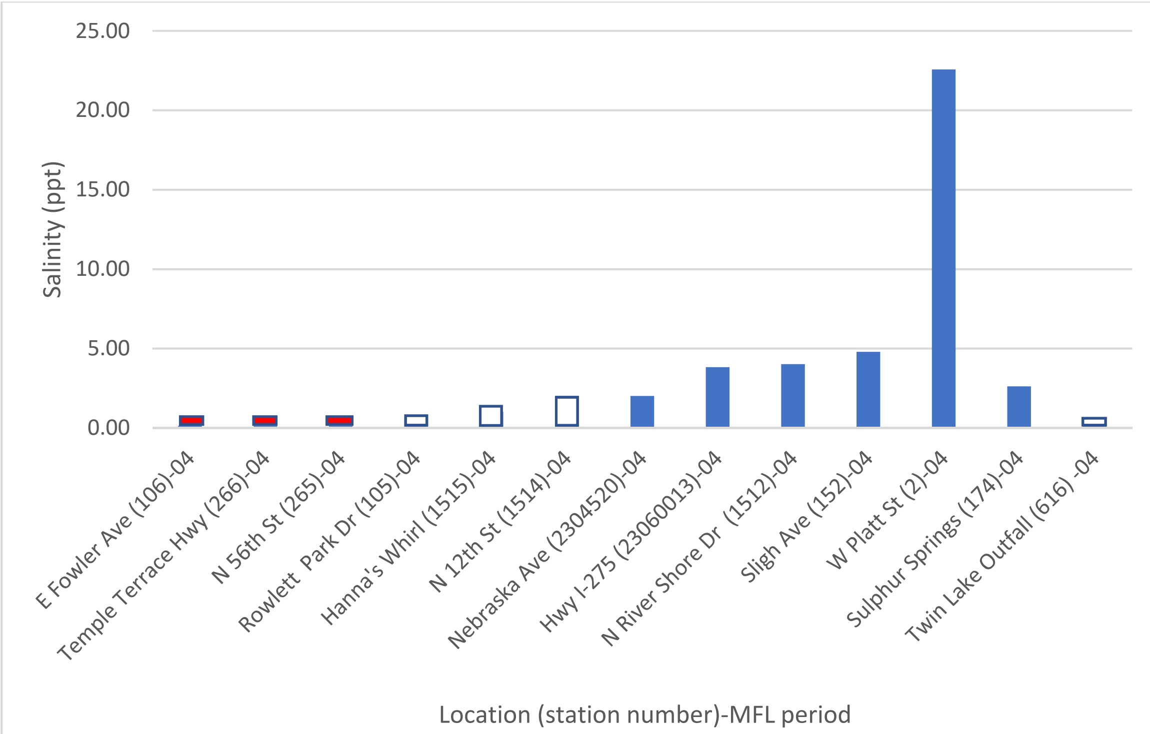

Figure 5.2.2.2-36. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red), North 56th Street (red), and Rowlett Park Drive (red) were significantly lower than Nebraska Avenue (blue), Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

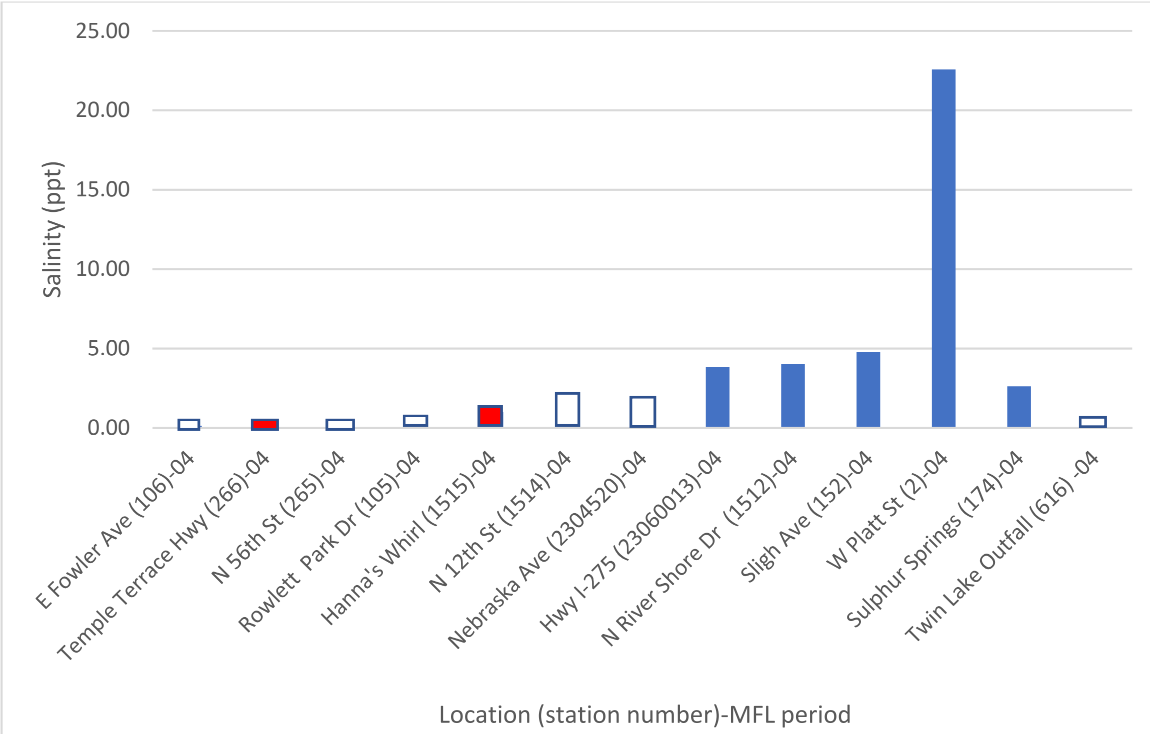

Figure 5.2.2.2-37. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Temple Terrace Hwy and Hanna's Whirl (red) were significantly lower than Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

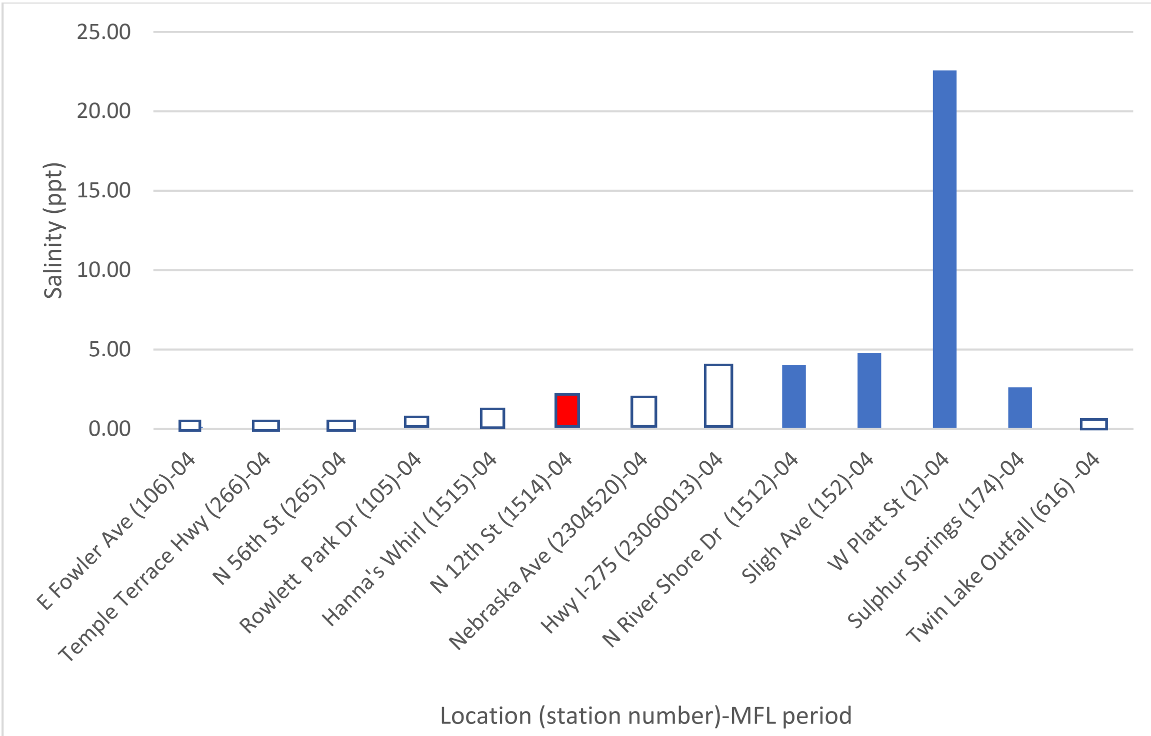

Figure 5.2.2.2-38. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. North 12th Street (red) was significantly lower than North River Shore Drive (blue), Sligh Avenue (blue), West Platt Street (blue), and Sulphur Springs (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

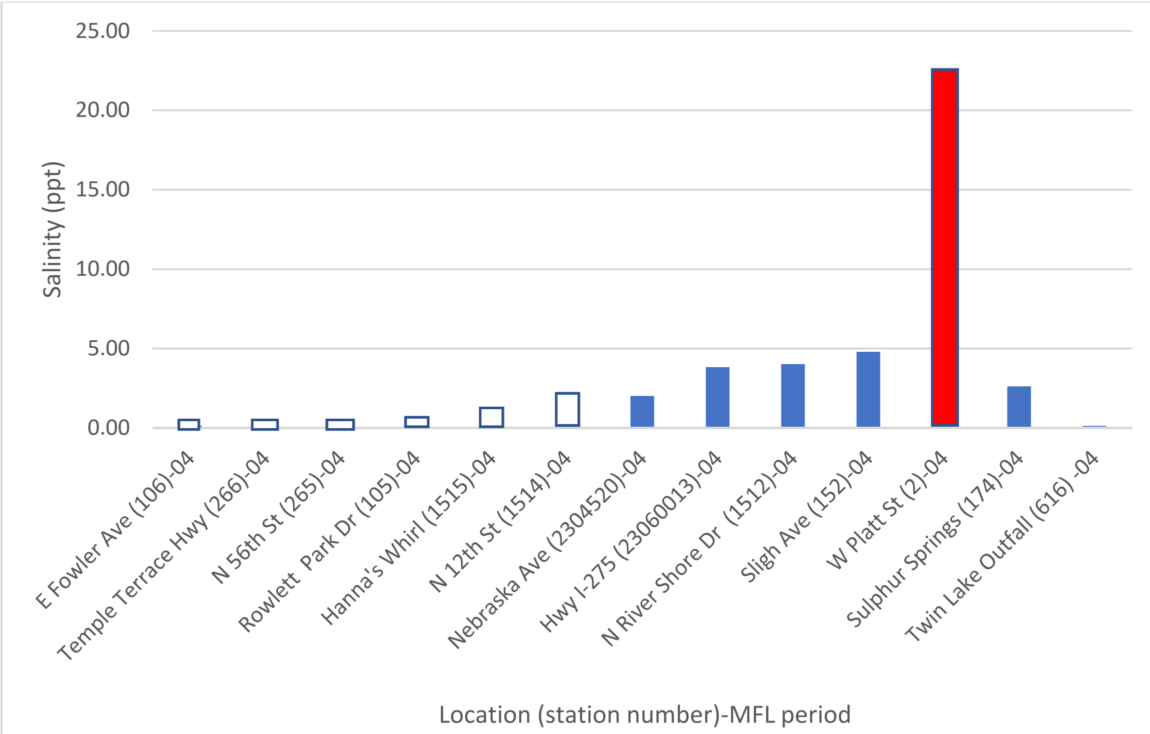

Figure 5.2.2.2-39. Average monthly salinity (ppt) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, Nebraska Avenue, Hwy I-275, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. West Platt Street (red) was significantly higher than Nebraska Avenue (blue), Hwy I-275 (blue), North River Shore Drive (blue), Sligh Avenue (blue), Sulphur Springs (blue), and Twin Lakes Outfall (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

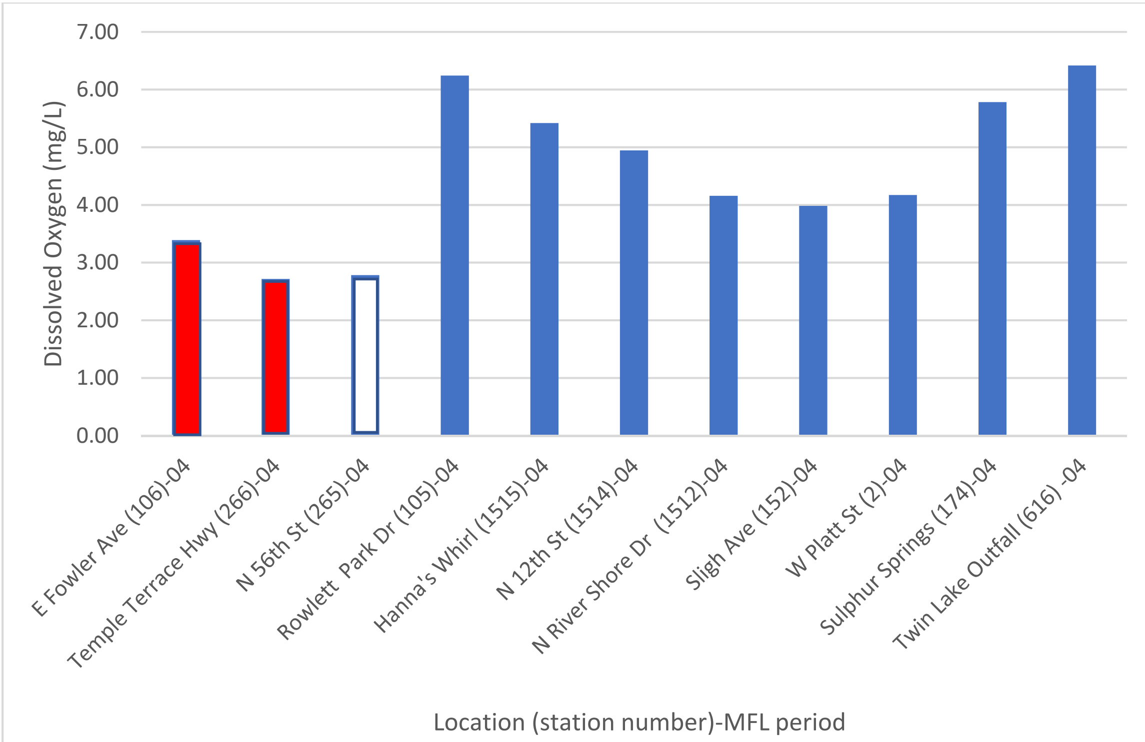

Figure 5.2.2.2-40. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. East Fowler Avenue (red) and Temple Terrace Hwy (red) were significantly lower than Rowlett Park Drive (blue), Hanna's Whirl (blue), North 12th Street, (blue), Sulphur Springs (blue), and Twin Lakes Outfall (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

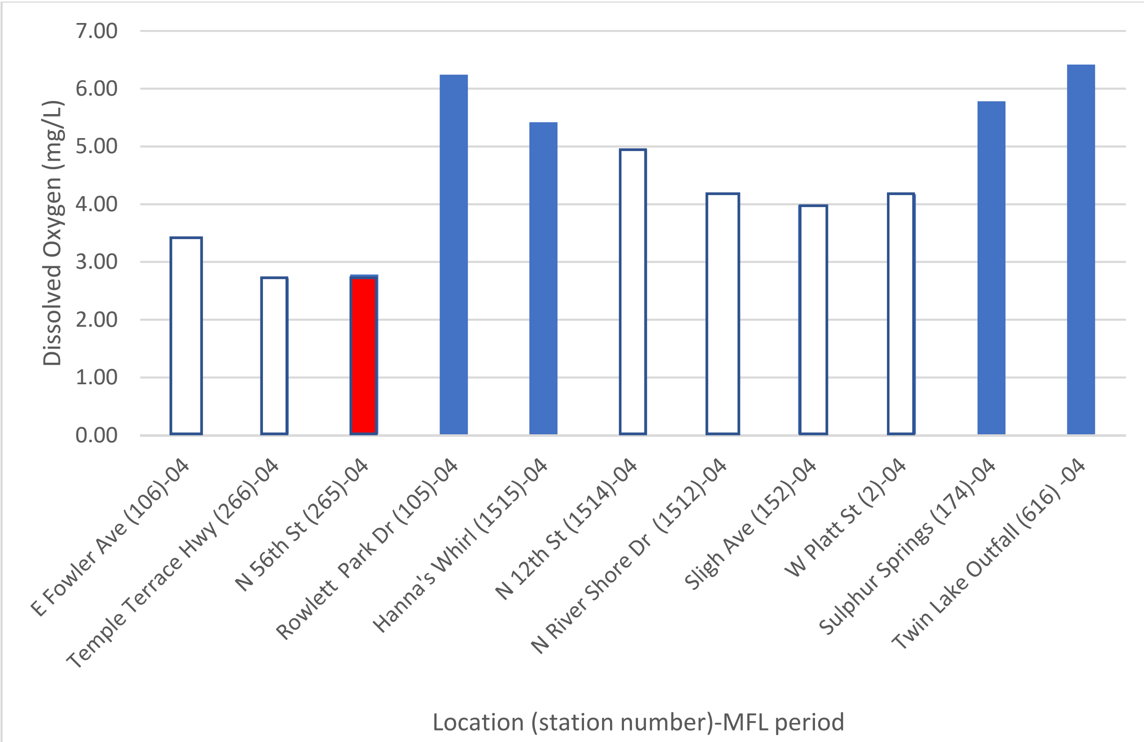

Figure 5.2.2.2-41. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. North 56th Street (red) was significantly lower than Rowlett Park Drive (blue), Hanna's Whirl (blue), Sulphur Springs (blue), and Twin Lakes Outfall (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

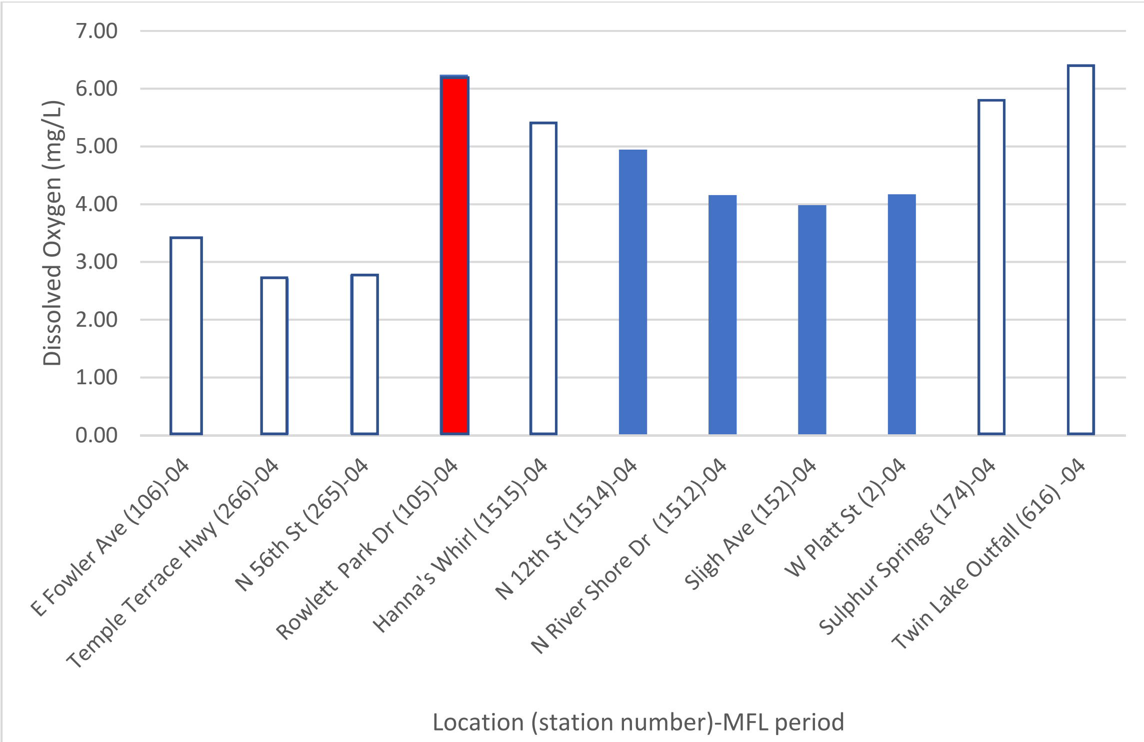

Figure 5.2.2.2-42. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Rowlett Park Drive (red) was significantly higher than North 12th Street (blue), North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

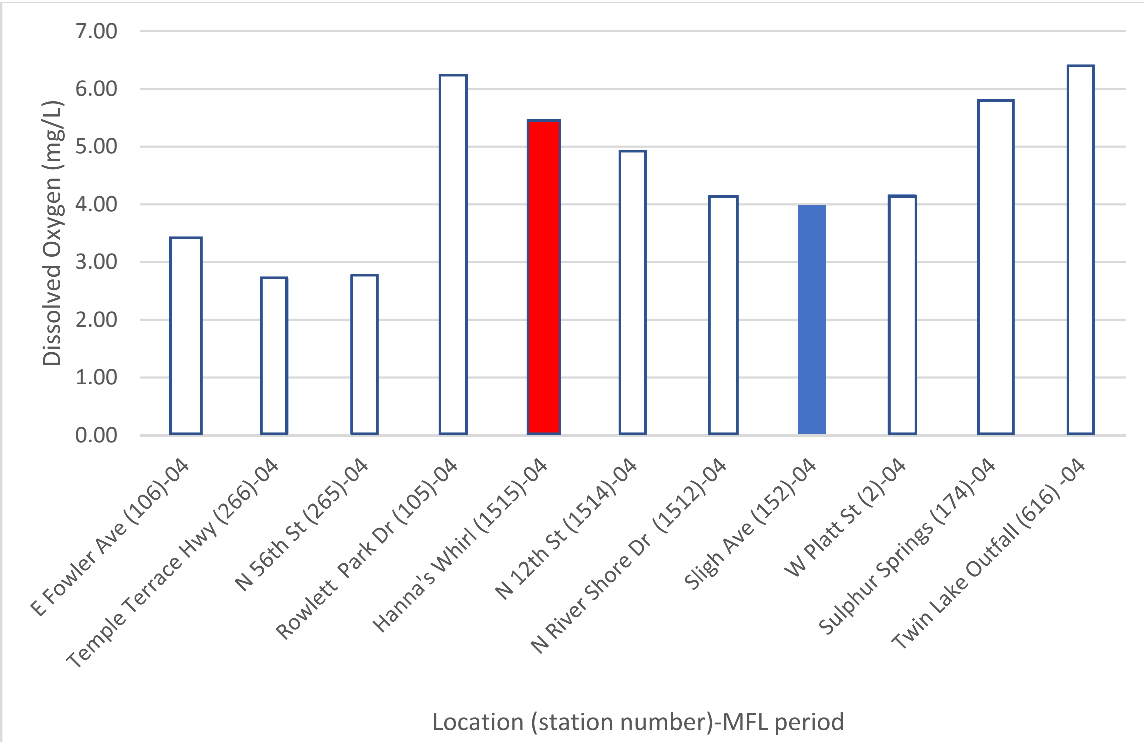

Figure 5.2.2.2-43. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Hanna's Whirl (red) was significantly higher than Sligh Avenue (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

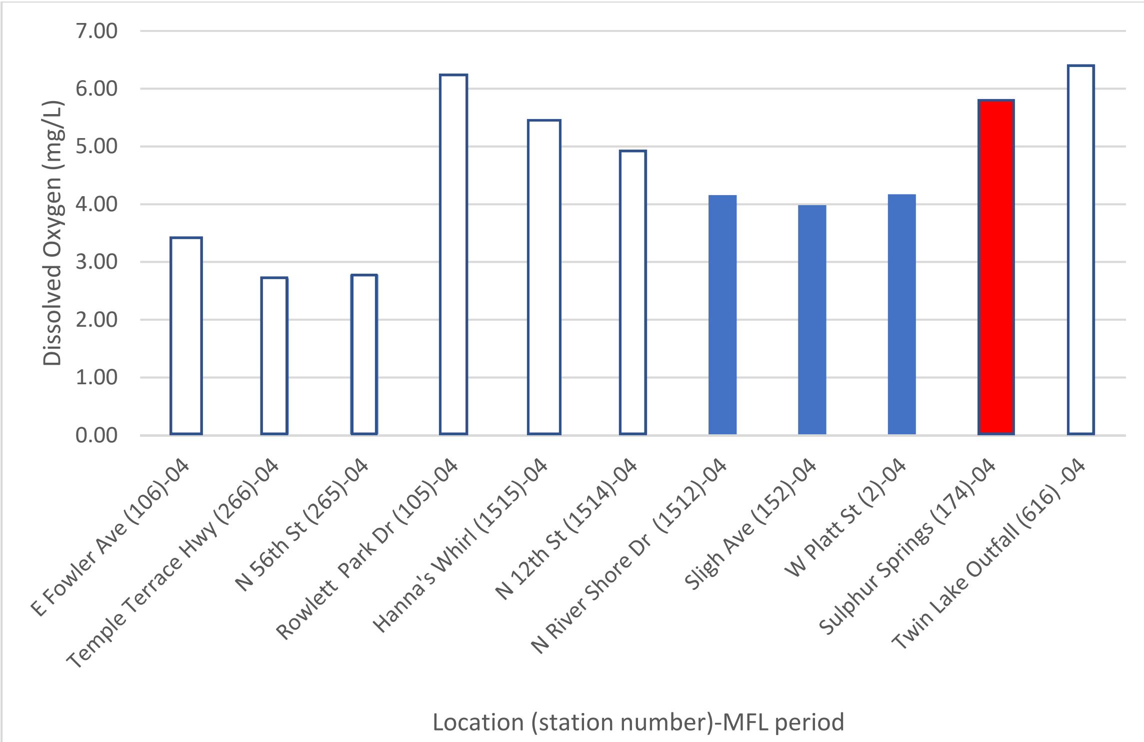

Figure 5.2.2.2-44. Average monthly dissolved oxygen (mg/L) at East Fowler Avenue, Temple Terrace Hwy, North 56th Street, Rowlett Park Drive, Hanna's Whirl, North 12th Street, North River Shore Drive, Sligh Avenue, West Platt Street, Sulphur Springs, and Twin Lakes Outfall from MFL period 4 with water flow over the dam from October 1979 to May 2018. Sulphur Springs (red) was significantly higher than North River Shore Drive (blue), Sligh Avenue (blue), and West Platt Street (blue) based on a Kruskal-Wallis analysis with multiple comparison Dunn's Test.

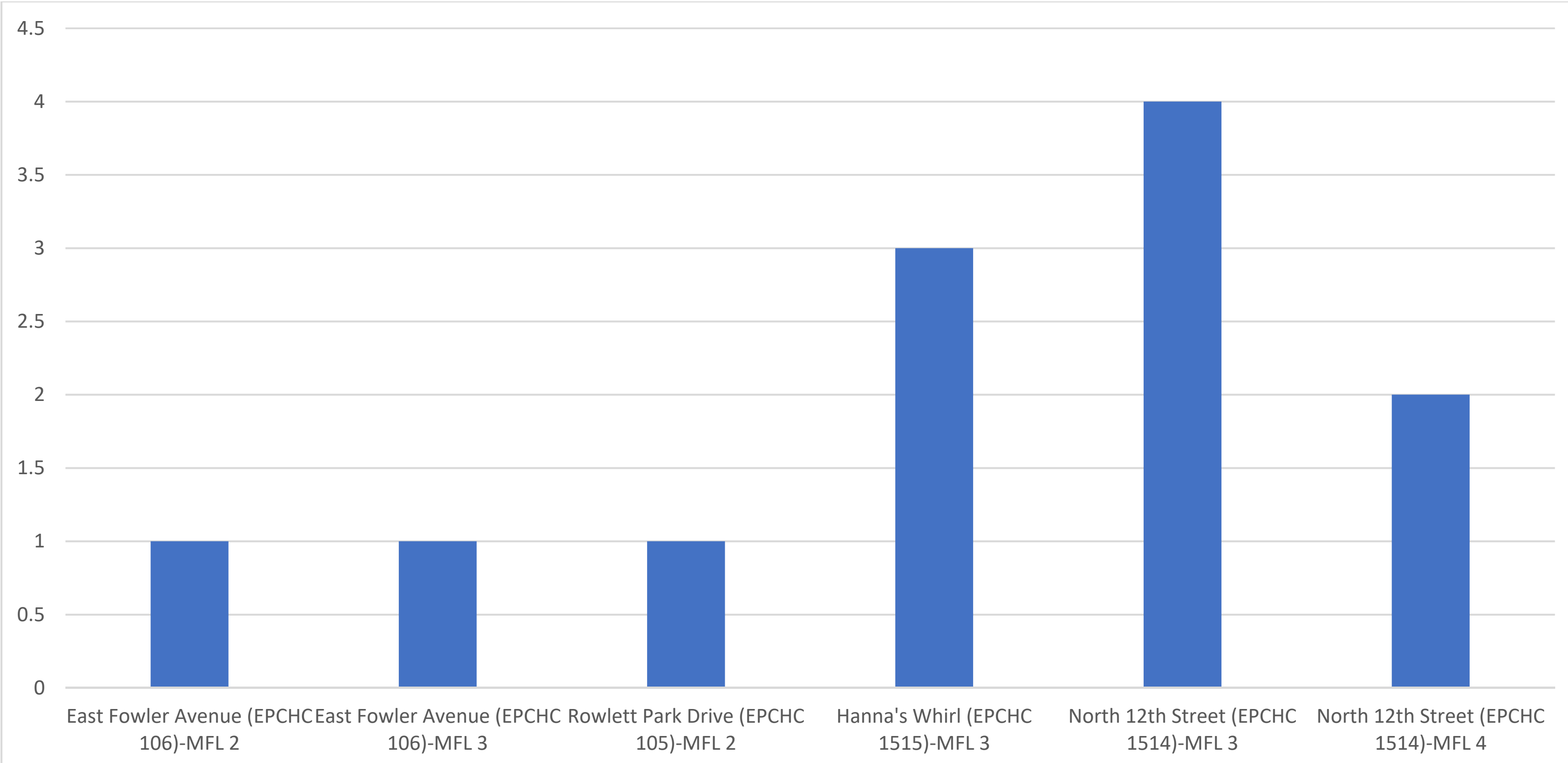

Figure 5.2.3-1. Number of monthly sampling days that dissolved oxygen percent saturation value from top water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

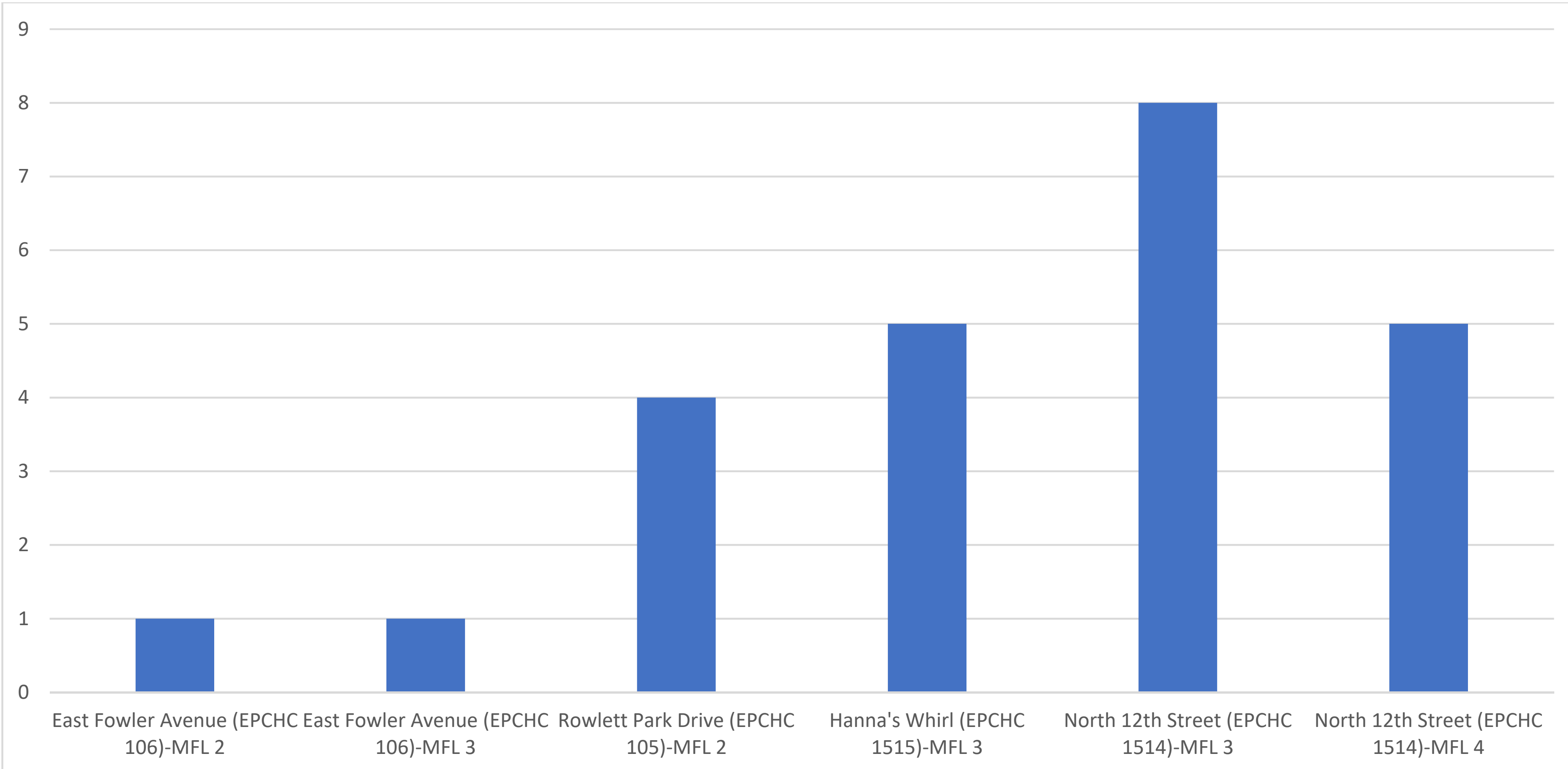

Figure 5.2.3-2. Number of monthly sampling days that dissolved oxygen percent saturation value from middle water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

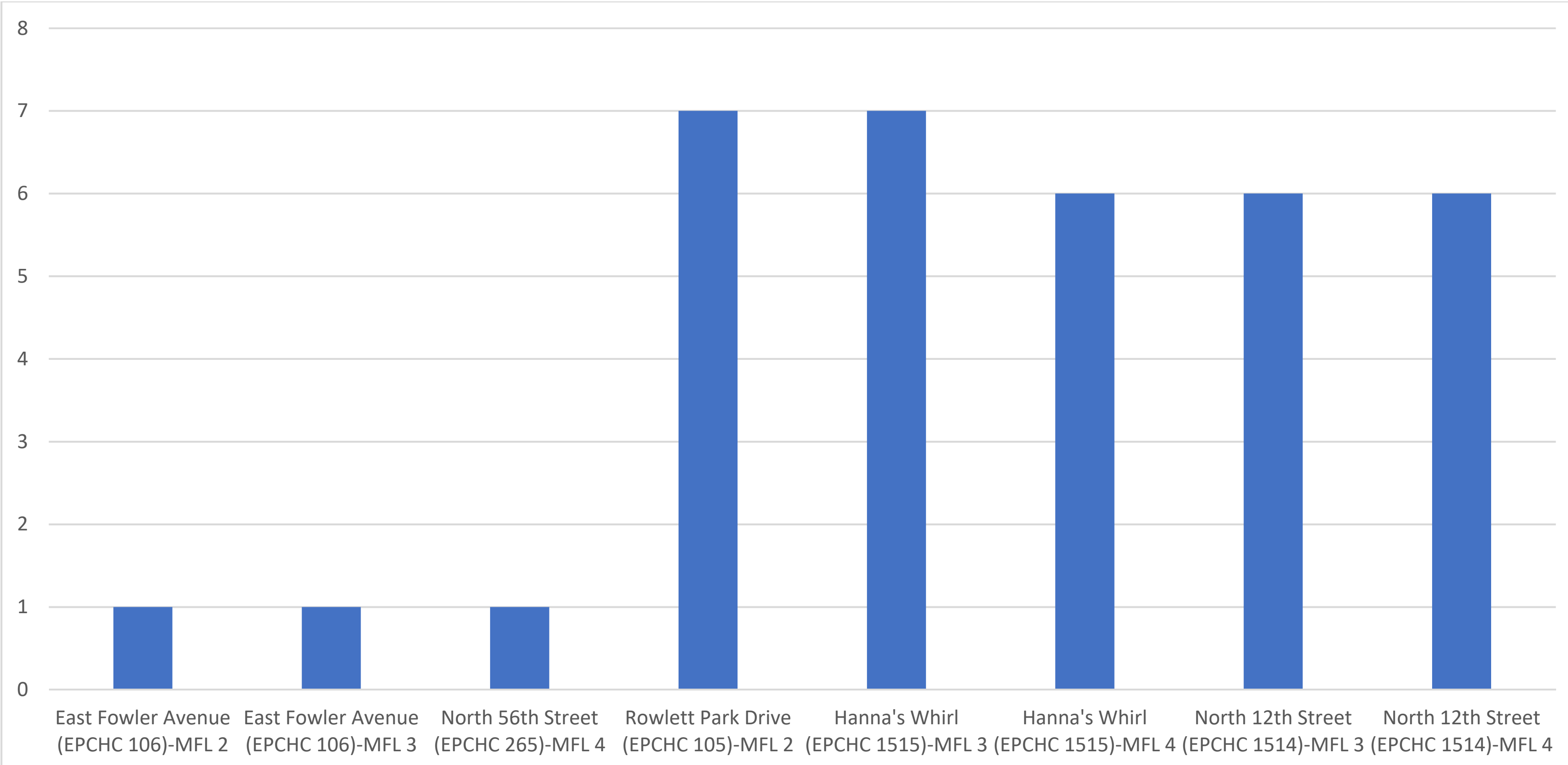

Figure 5.2.3-3. Number of monthly sampling days that dissolved oxygen percent saturation value from bottom water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

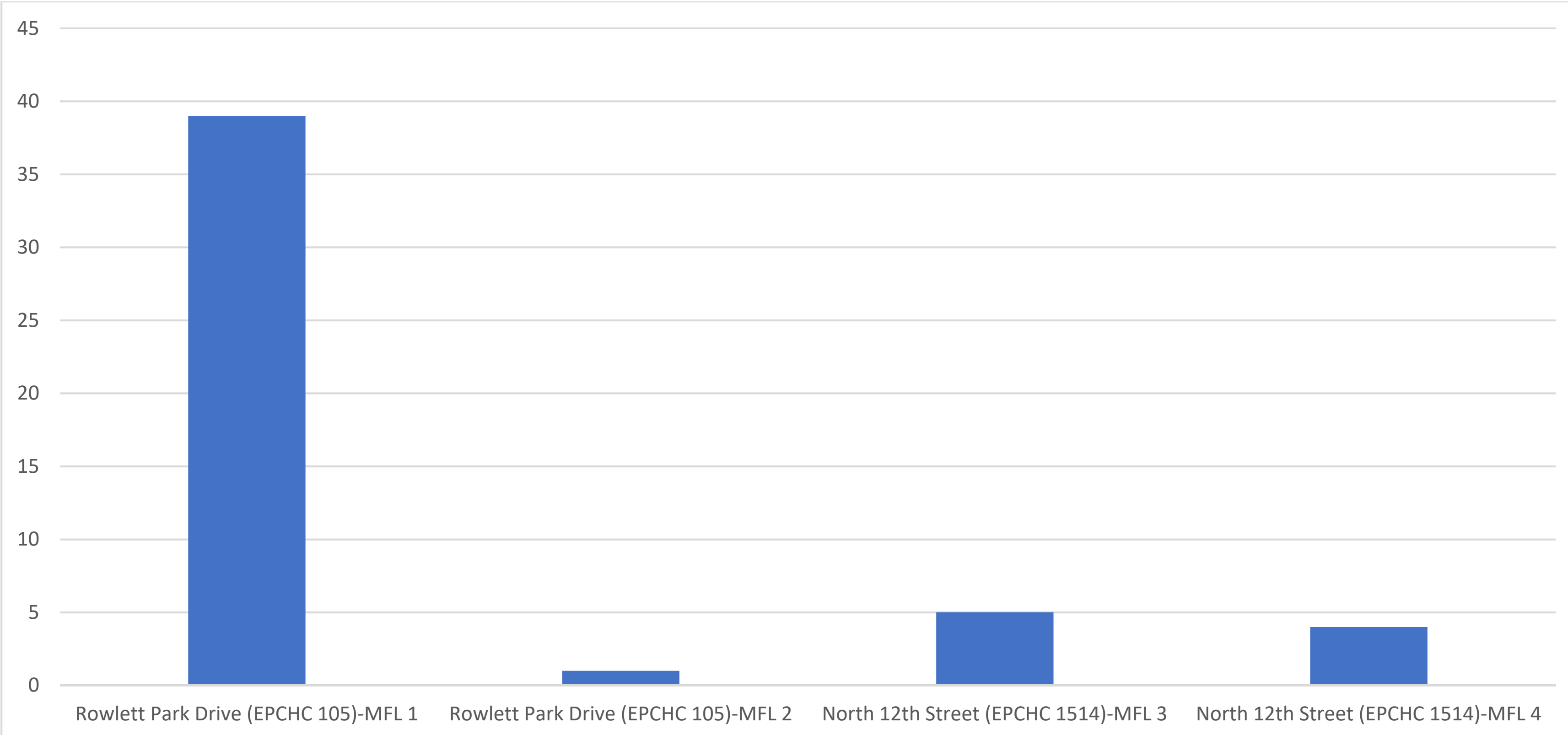

Figure 5.2.3-4. Number of monthly sampling days that salinity value from top water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

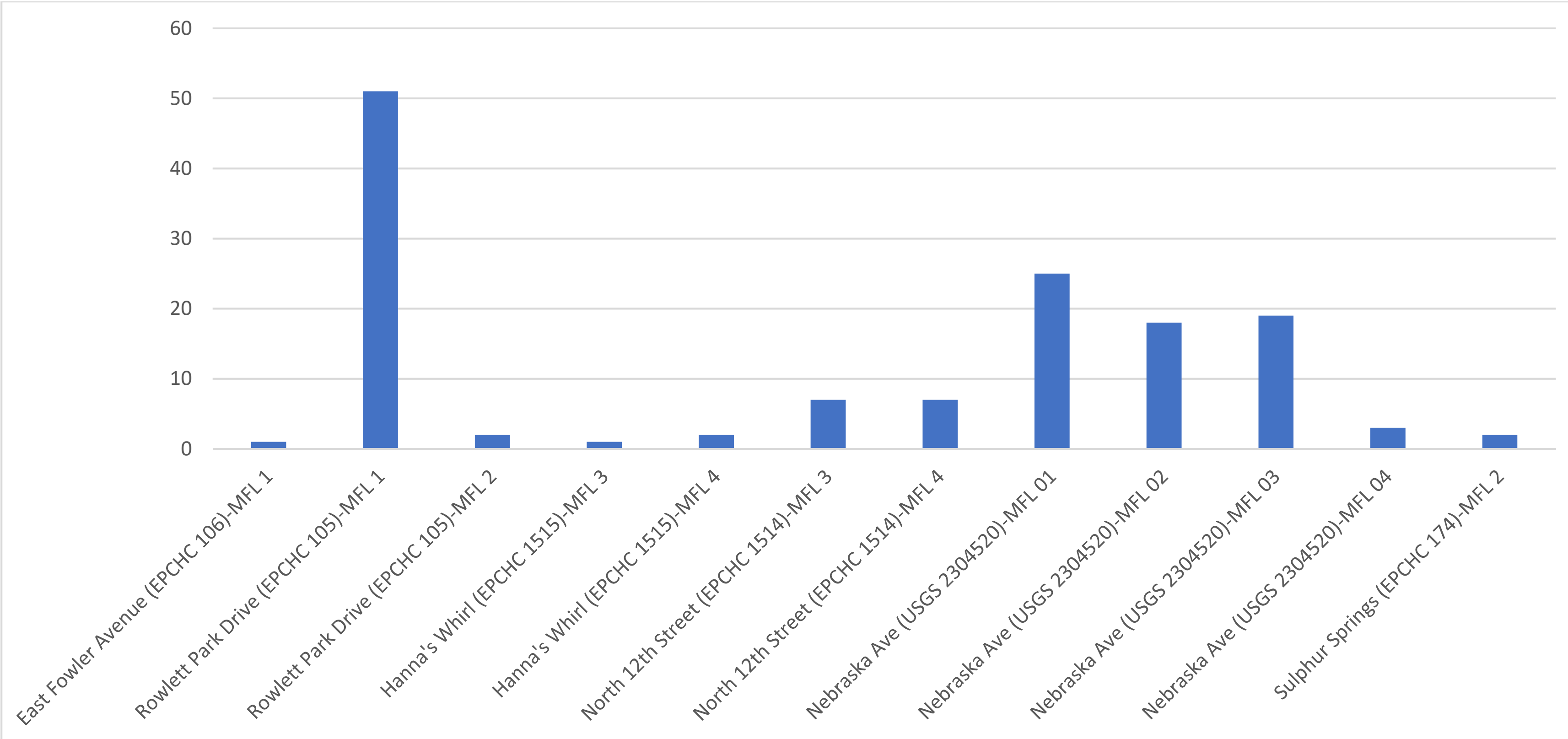

Figure 5.2.3-5. Number of monthly sampling days that salinity value from middle water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

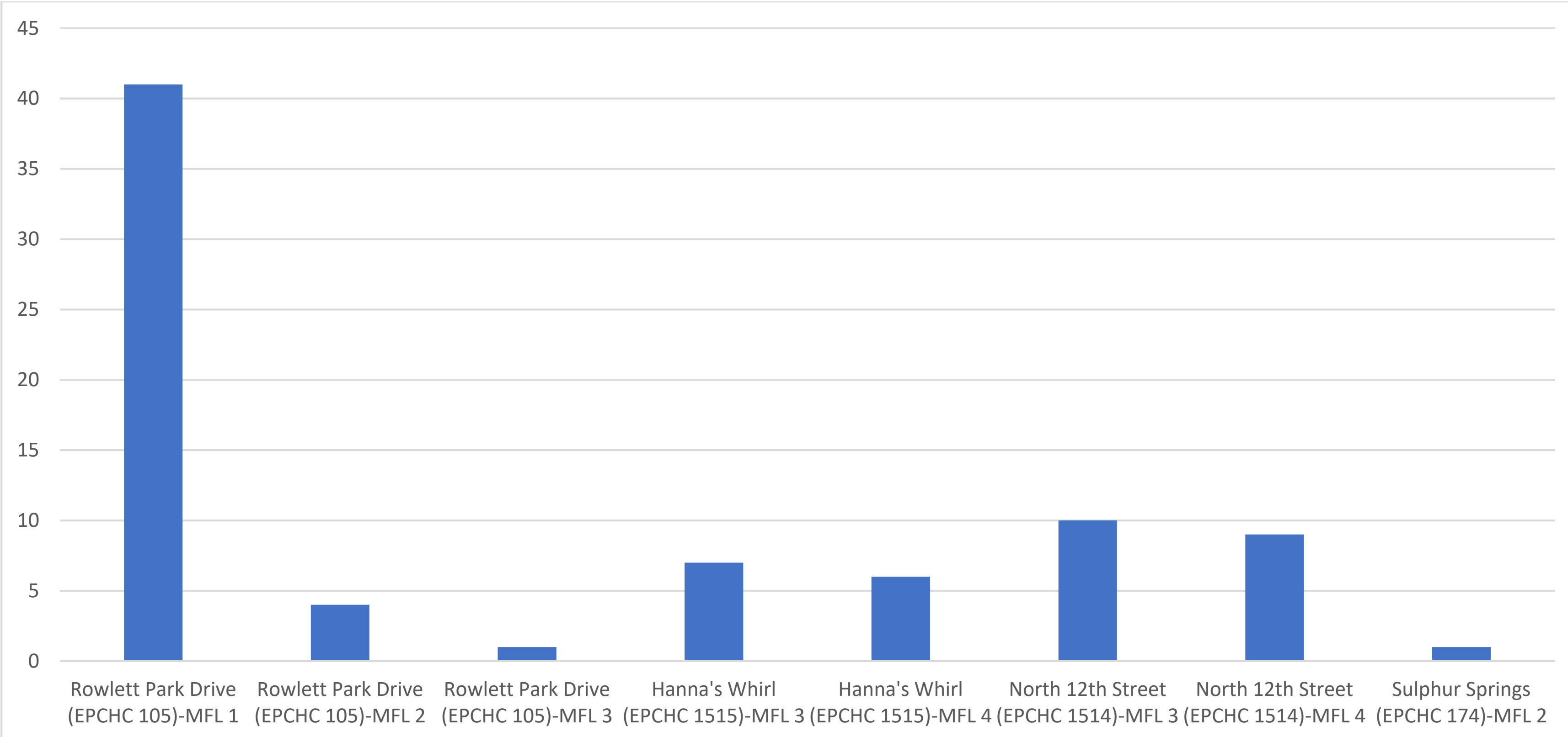

Figure 5.2.3-6. Number of monthly sampling days that salinity value from bottom water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 without water flow over the dam.

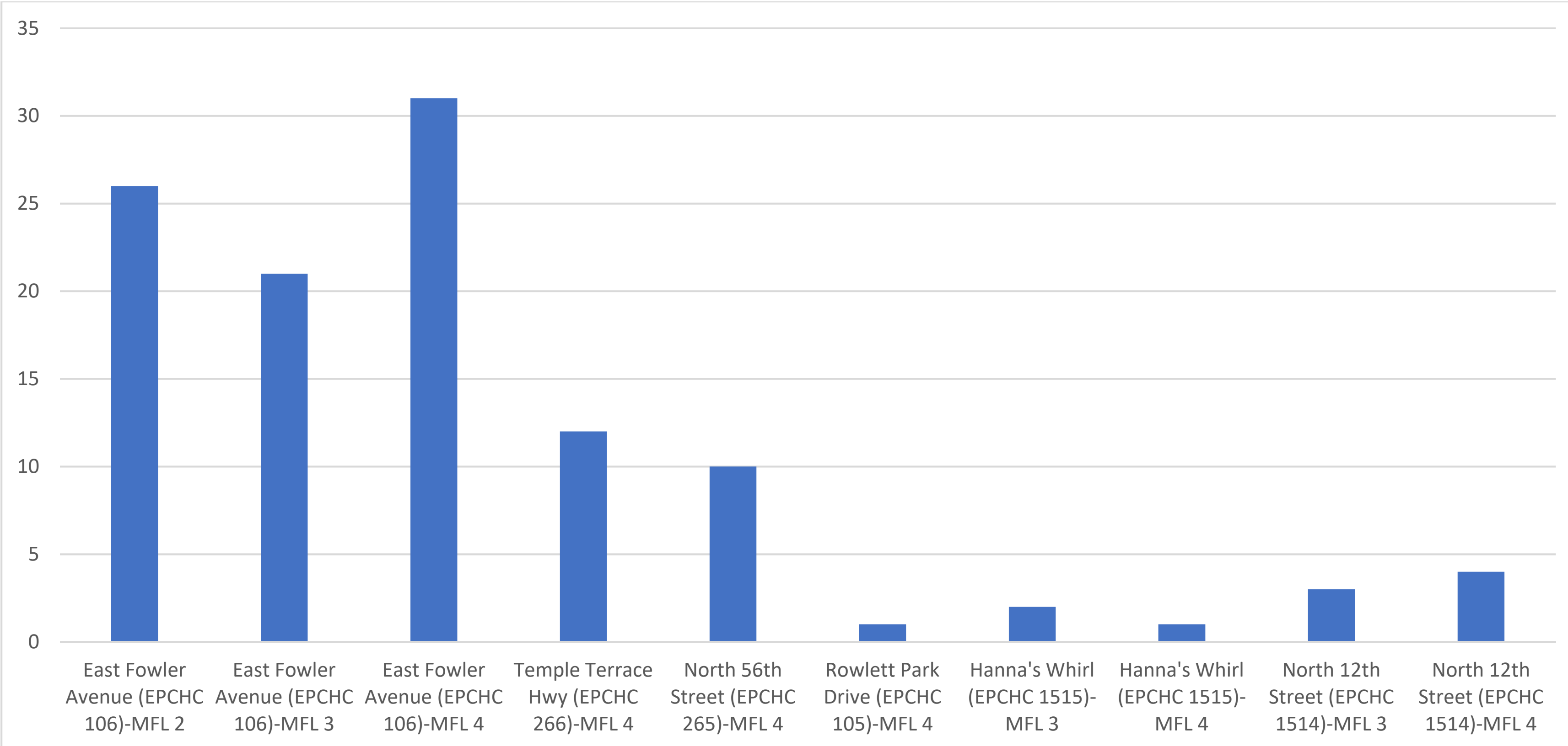

Figure 5.2.3-7. Number of monthly sampling days that dissolved oxygen percent saturation value from top water samples was less than the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

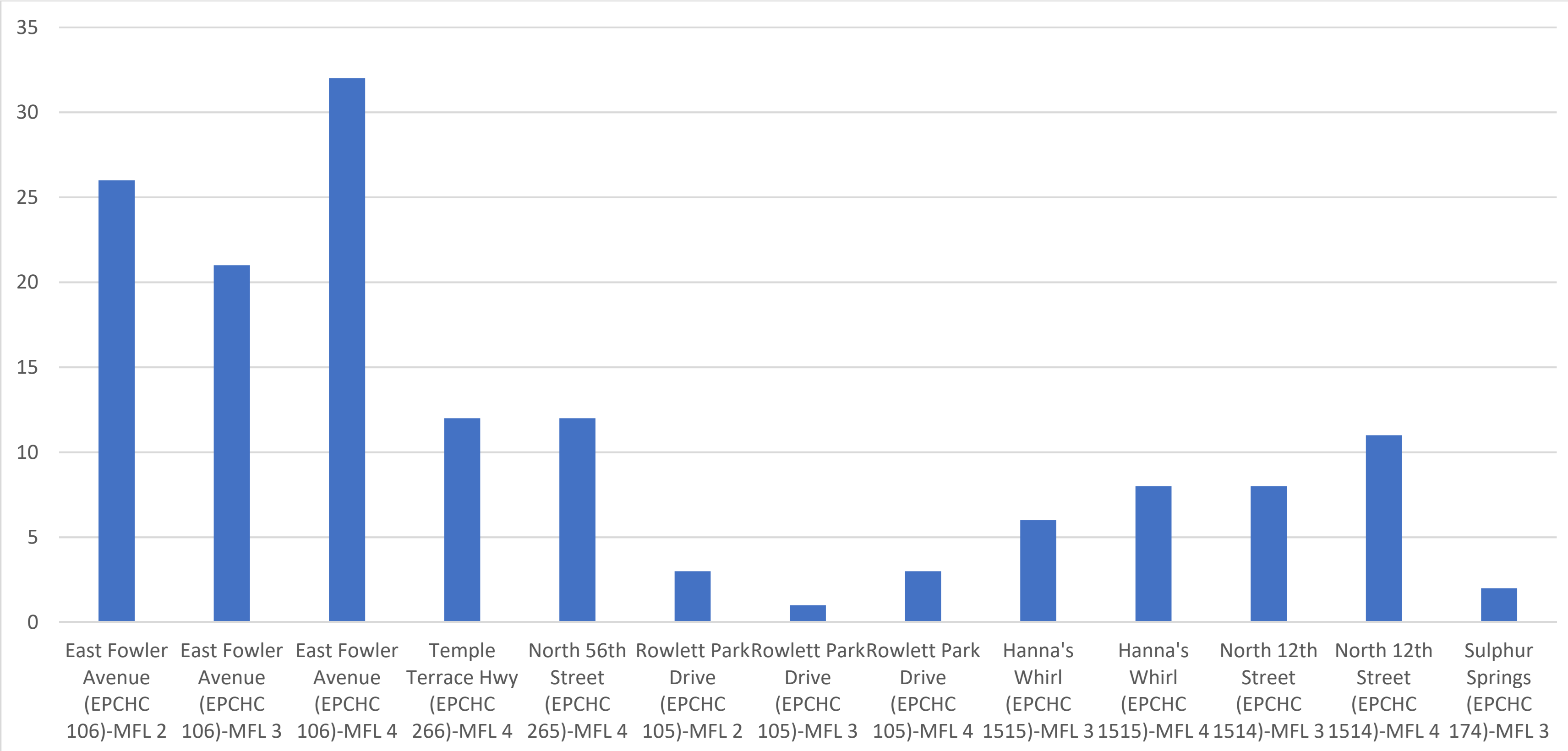

Figure 5.2.3-8. Number of monthly sampling days that dissolved oxygen percent saturation value from middle water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

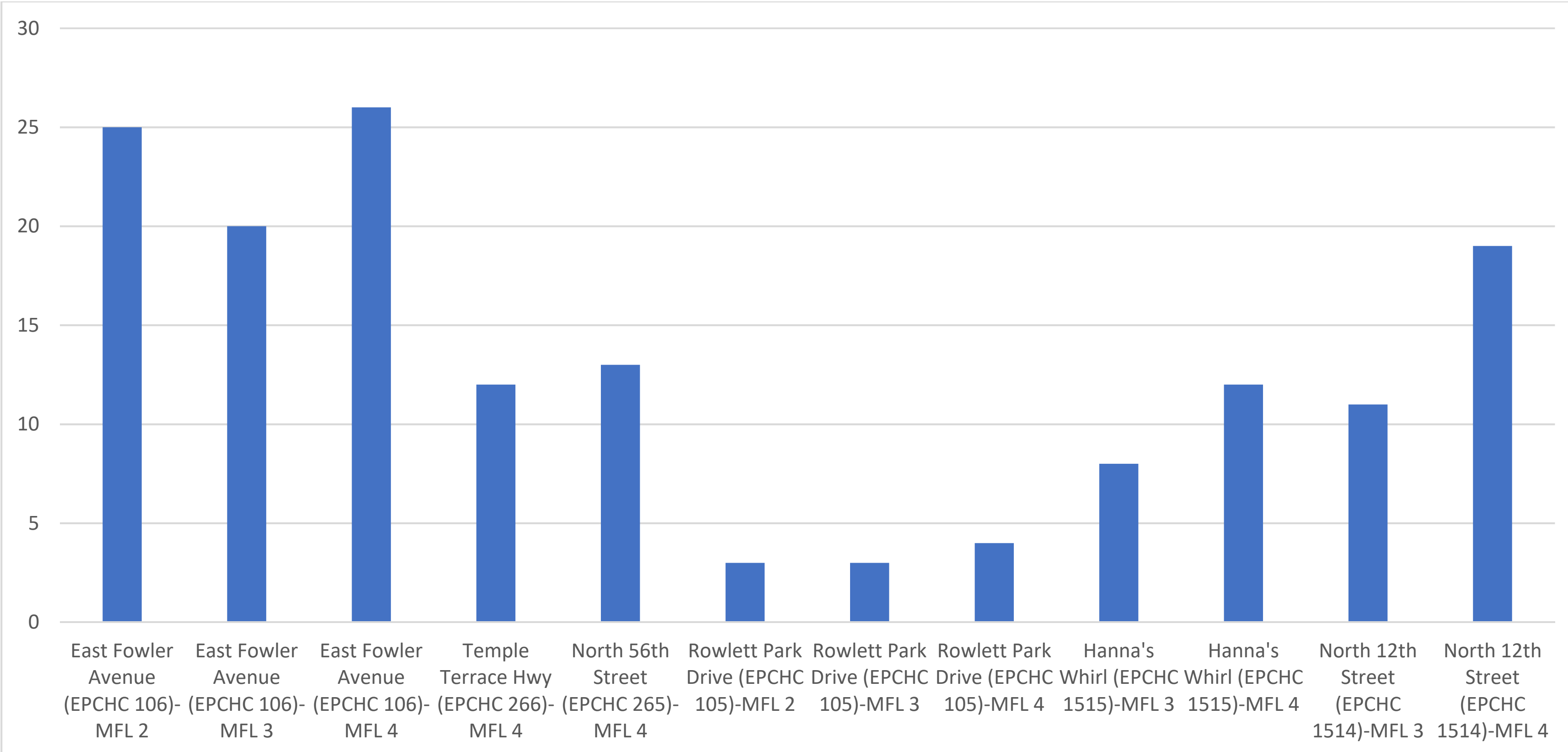

Figure 5.2.3-9. Number of monthly sampling days that dissolved oxygen percent saturation value from bottom water samples was under the Florida state water quality standard of 38% for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

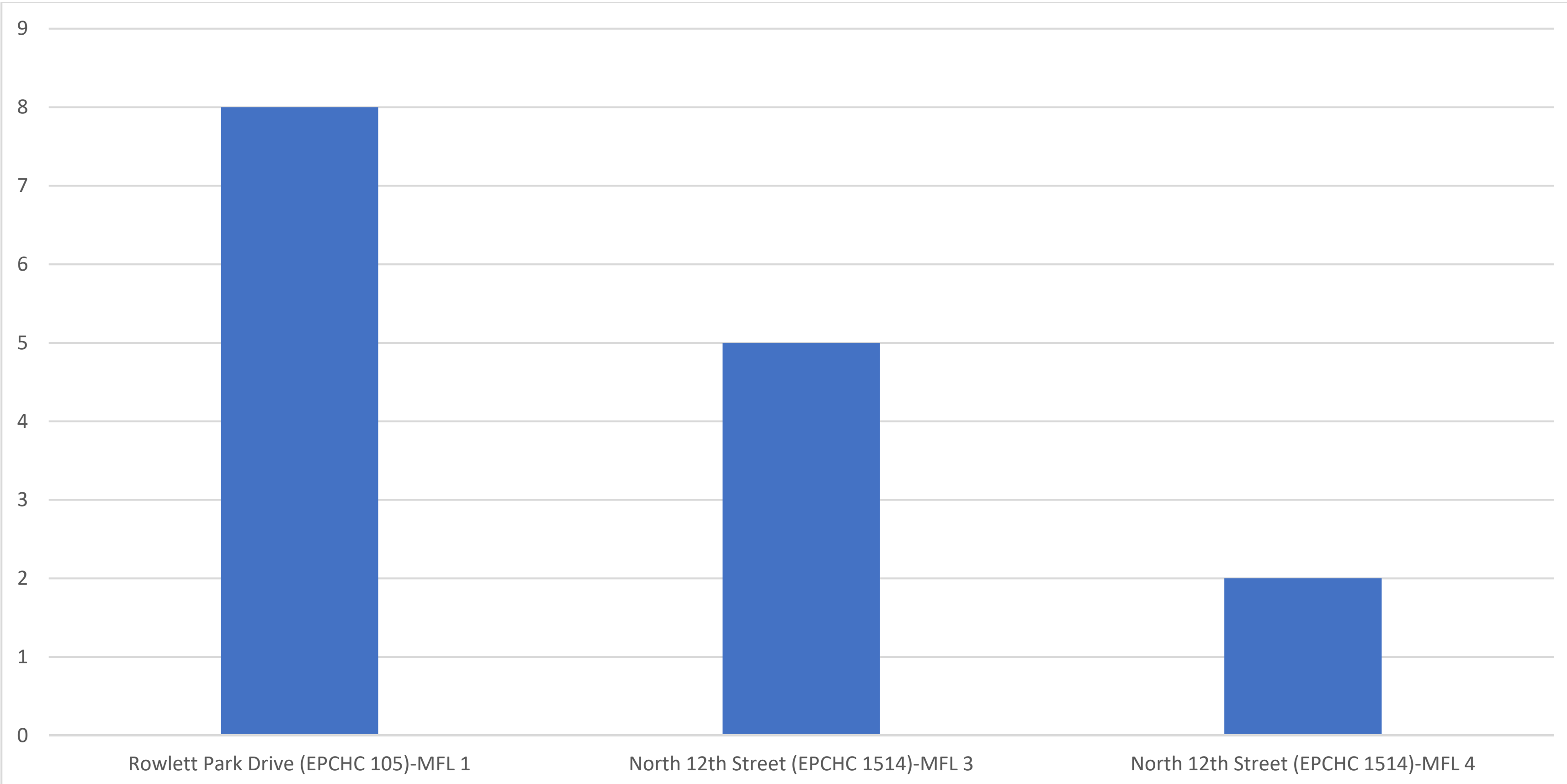

Figure 5.2.3-10. Number of monthly sampling days that salinity value from top water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

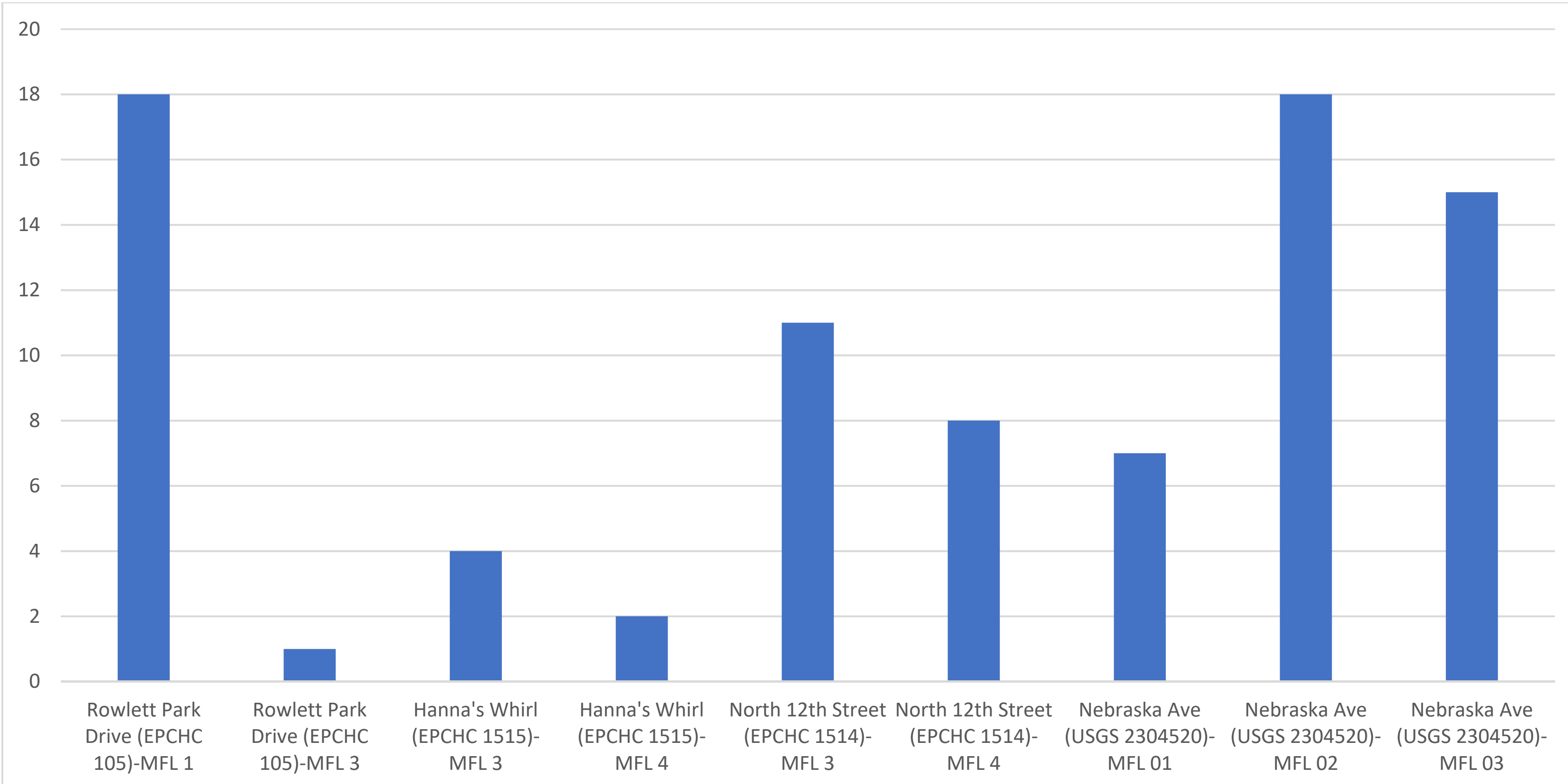

Figure 5.2.3-11. Number of monthly sampling days that salinity value from middle water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

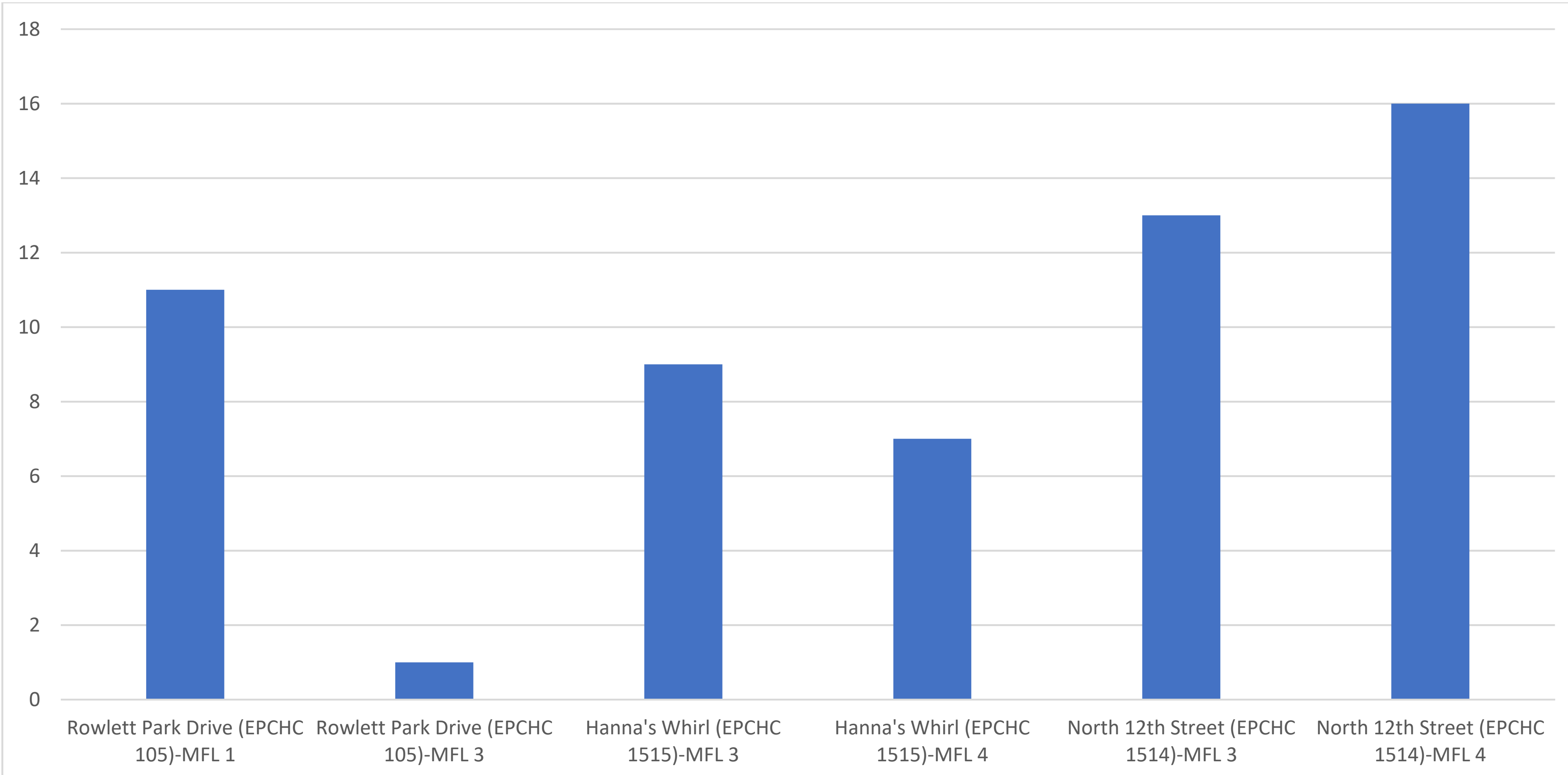

Figure 5.2.3-12. Number of monthly sampling days that salinity value from bottom water samples was above the 5.0 (ppt) MFL goal for the EPCHC and USGS stations by MFL period from October 1979 to May 2018 when water was flowing over the dam.

APPENDIX 6.2-A

NEKTON ANOSIM RESULTS

Appendix 6.2-A: Nekton ANOSIM Results

Two-Way Crossed - AxB

Resemblance worksheet
Name: Resem1
Data type: Similarity

Factors

Place	Name	Type	Levels
A	MFL Period	Unordered	4
B	Segment	Unordered	3

MFL Period levels
1
2
3
4

Segment levels
Lower
Middle
Upper

Tests for differences between unordered MFL Period groups
(across all Segment groups)
Global Test
Sample statistic (Average R): 0.122
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)
Number of permuted statistics greater than or equal to Average R: 0

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
1, 2	0.072	0.5	Very large	999	4
1, 3	0.112	0.1	Very large	999	0
1, 4	0.378	0.1	Very large	999	0
2, 3	0.128	0.1	Very large	999	0
2, 4	0.36	0.4	Very large	999	3
3, 4	0.027	34.8	Very large	999	347

Tests for differences between unordered Segment groups
(across all MFL Period groups)
Global Test
Sample statistic (Average R): 0.107
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)
Number of permuted statistics greater than or equal to Average R: 0

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Lower, Middle	0.099	0.1	Very large	999	0
Lower, Upper	0.172	0.1	Very large	999	0
Middle, Upper	0.03	11.7	Very large	999	116

APPENDIX 6.2-B

NEKTON DIVERSITY

Appendix 6.2-B: Nekton Diversity Results

Date Station	Taxon Richness	Total # of Individuals	Pielou's Evenness	Shannon Index	Simpson's Dominance
2000-05-23 10.742	14	2092	0.201	0.531	0.757
2000-05-23 11.155	15	2495	0.358	0.970	0.464
2000-05-23 13.106	4	42890	0.506	0.701	0.509
2000-05-23 15.72	12	366	0.739	1.835	0.203
2000-06-16 12.03	11	1589	0.353	0.846	0.667
2000-06-16 12.549	10	136	0.675	1.554	0.272
2000-06-16 12.966	8	4230	0.324	0.673	0.662
2000-06-16 15.441	10	882	0.686	1.580	0.261
2000-07-11 10.646	6	3720	0.250	0.448	0.786
2000-07-11 11.523	10	11773	0.229	0.528	0.695
2000-07-11 14.123	5	697	0.526	0.846	0.512
2000-07-11 14.88	7	896	0.621	1.208	0.396
2000-11-27 10.909	10	161	0.739	1.702	0.213
2000-11-27 11.19	11	457	0.639	1.532	0.308
2000-11-27 14.126	7	485	0.465	0.905	0.549
2000-11-27 14.231	12	698	0.662	1.645	0.234
2000-12-12 11.243	13	8478	0.329	0.844	0.579
2000-12-12 15.055	6	876	0.813	1.456	0.262
2000-12-12 15.568	6	3808	0.481	0.861	0.505
2001-01-09 11.486	10	983	0.301	0.693	0.609
2001-01-09 12.589	13	6931	0.301	0.772	0.637
2001-01-09 13.475	8	3945	0.440	0.916	0.507
2001-01-09 13.668	8	1292	0.445	0.926	0.450
2001-02-13 11.034	2	10	0.881	0.611	0.533
2001-02-13 11.102	6	335	0.616	1.104	0.385
2001-02-13 14.573	7	454	0.666	1.297	0.310
2001-02-13 14.992	3	99	0.519	0.570	0.688
2001-03-05 11.372	12	1056	0.524	1.302	0.348
2001-03-05 12.41	11	368	0.676	1.621	0.249
2001-03-05 13.054	9	2018	0.433	0.951	0.527
2001-03-05 14.399	6	584	0.479	0.858	0.550
2001-04-18 11.215	23	1239	0.464	1.456	0.340
2001-04-18 12.832	20	1308	0.615	1.842	0.211
2001-04-18 13.766	8	131	0.633	1.316	0.323
2001-05-15 11.517	6	632	0.501	0.898	0.582
2001-05-15 12.518	8	373	0.612	1.272	0.340
2001-05-15 13.914	15	281	0.647	1.751	0.251
2001-05-15 15.566	6	225	0.648	1.161	0.378

Date Station	Taxon Richness	Total # of Individuals	Pielou's Evenness	Shannon Index	Simpson's Dominance
2001-06-21 10.798	10	1659	0.361	0.831	0.488
2001-06-21 15.496	7	182	0.680	1.323	0.347
2001-06-21 15.851	9	560	0.379	0.832	0.549
2001-07-25 11.749	12	577	0.426	1.058	0.558
2001-07-25 12.802	10	2388	0.439	1.012	0.450
2001-07-25 14.473	8	112	0.645	1.342	0.327
2001-12-11 12.529	5	502	0.036	0.057	0.984
2001-12-11 13.038	6	428	0.060	0.108	0.968
2001-12-11 15.069	4	31	0.476	0.659	0.658
2002-01-03 11.446	8	199	0.274	0.569	0.761
2002-01-03 13.647	4	50	0.564	0.781	0.594
2002-01-03 14.051	3	66	0.143	0.157	0.940
2002-02-04 12.046	3	85	0.576	0.632	0.594
2002-02-04 12.426	7	30	0.906	1.762	0.159
2002-02-04 13.538	8	51	0.832	1.731	0.194
2002-02-04 14.584	5	73	0.505	0.814	0.517
2002-03-18 10.593	9	504	0.072	0.158	0.953
2002-03-18 11.509	6	199	0.386	0.692	0.675
2002-03-18 12.972	0	0	NA	0.000	NA
2002-03-18 14.773	5	46	0.608	0.979	0.504
2002-04-17 12.407	3	25	0.482	0.530	0.710
2002-04-17 12.64	8	47	0.812	1.688	0.205
2002-04-17 13.281	11	317	0.589	1.413	0.347
2002-04-17 13.644	3	69	0.188	0.207	0.915
2002-05-21 11.912	14	668	0.276	0.727	0.726
2002-05-21 11.98	14	1891	0.374	0.987	0.580
2002-05-21 14.042	8	509	0.345	0.718	0.643
2002-05-21 15.967	5	150	0.574	0.923	0.503
2002-06-05 10.79	14	477	0.357	0.941	0.626
2002-06-05 11.096	7	505	0.302	0.587	0.745
2002-06-05 14.77	14	834	0.723	1.908	0.186
2002-06-05 14.907	13	348	0.562	1.441	0.372

Date Station	Taxon Richness	Total # of Individuals	Pielou's Evenness	Shannon Index	Simpson's Dominance
2006-04-27 10.769	10	1655	0.098	0.225	0.923
2006-04-27 13.646	4	395	0.103	0.142	0.950
2006-04-27 14.993	4	202	0.578	0.801	0.477
2006-05-08 10.575	12	434	0.650	1.616	0.300
2006-05-08 12.436	3	57	0.641	0.704	0.598
2006-05-08 13.456	9	266	0.648	1.424	0.310
2006-05-08 14.541	7	804	0.065	0.127	0.961
2006-06-20 11.224	6	963	0.233	0.418	0.826
2006-06-20 12.609	7	51	0.868	1.689	0.198
2006-06-20 14.888	11	81	0.840	2.015	0.163
2006-06-20 15.843	10	165	0.702	1.615	0.274
2006-07-17 12.012	13	795	0.463	1.189	0.522
2006-07-17 12.133	12	570	0.475	1.181	0.476
2006-07-17 13.59	10	44	0.856	1.972	0.148
2006-07-17 13.875	4	42	0.298	0.414	0.818
2006-11-13 11.609	13	1281	0.325	0.833	0.651
2006-11-13 11.871	8	838	0.616	1.281	0.346
2006-11-13 14.402	6	42	0.679	1.216	0.380
2006-11-13 14.981	1	1	NA	0.000	NA
2006-12-13 10.807	5	209	0.435	0.701	0.635
2006-12-13 11.97	9	1026	0.120	0.264	0.899
2006-12-13 13.419	6	420	0.079	0.142	0.953
2006-12-13 13.943	6	180	0.235	0.421	0.814
2007-01-18 11.87	10	829	0.395	0.910	0.458
2007-01-18 11.921	10	751	0.403	0.928	0.583
2007-01-18 13.081	12	939	0.480	1.193	0.341
2007-01-18 13.109	11	773	0.439	1.052	0.427
2007-02-22 10.609	5	34	0.575	0.926	0.521
2007-02-22 12.119	10	2723	0.211	0.485	0.801
2007-02-22 12.977	7	186	0.458	0.891	0.564
2007-02-22 14.263	9	565	0.240	0.527	0.773

Date Station	Taxon Richness	Total # of Individuals	Pielou's Evenness	Shannon Index	Simpson's Dominance
2007-03-21 11.197	11	570	0.413	0.991	0.441
2007-03-21 11.436	3	17	0.736	0.808	0.478
2007-03-21 14.24	11	419	0.714	1.713	0.239
2007-03-21 15.318	6	237	0.661	1.185	0.381
2007-04-09 10.568	15	1434	0.517	1.400	0.313
2007-04-09 11.147	11	378	0.568	1.362	0.368
2007-04-09 13.107	14	498	0.561	1.481	0.327
2007-04-09 15.162	13	666	0.525	1.347	0.358
2007-05-16 11.675	10	311	0.497	1.144	0.440
2007-05-16 12.593	17	1636	0.449	1.272	0.392
2007-05-16 14.792	15	483	0.578	1.564	0.326
2007-05-16 15.136	16	2270	0.314	0.870	0.613
2007-06-04 11.422	15	1556	0.605	1.638	0.272
2007-06-04 11.622	13	202	0.756	1.938	0.198
2007-06-04 13.615	15	639	0.684	1.852	0.214
2007-06-04 15.209	15	305	0.597	1.618	0.275
2007-07-11 11.719	7	2388	0.320	0.622	0.610
2007-07-11 12.708	11	436	0.194	0.464	0.838
2007-07-11 14.985	9	281	0.679	1.492	0.311
2007-07-11 15.965	7	151	0.587	1.142	0.394
2008-01-22 11.453	8	468	0.545	1.133	0.453
2008-01-22 12.422	9	221	0.698	1.534	0.248
2008-01-22 13.206	9	46	0.747	1.641	0.248
2008-01-22 13.409	13	201	0.352	0.902	0.654
2008-06-18 11.414	9	172	0.642	1.410	0.341
2008-06-18 11.815	10	747	0.417	0.961	0.572
2008-06-18 14.074	8	83	0.336	0.699	0.698
2008-06-18 15.945	4	46	0.869	1.205	0.323
2008-07-07 12.541	11	513	0.639	1.533	0.277
2008-07-07 12.649	10	233	0.711	1.637	0.248
2008-07-07 14.272	9	115	0.677	1.488	0.336
2008-07-07 14.397	6	26	0.867	1.554	0.228
2008-10-27 10.606	5	155	0.364	0.585	0.671
2008-10-27 11.933	16	489	0.420	1.165	0.558
2008-10-27 14.362	3	100	0.438	0.482	0.737
2008-10-27 14.523	5	27	0.762	1.226	0.331
2008-11-13 13.374	12	400	0.279	0.693	0.720
2008-11-13 15.034	8	58	0.784	1.630	0.219

Date Station	Taxon Richness	Total # of Individuals	Pielou's Evenness	Shannon Index	Simpson's Dominance
2008-12-16 11.473	8	1050	0.084	0.175	0.940
2008-12-16 12.698	8	115	0.544	1.132	0.467
2008-12-16 12.951	8	339	0.495	1.030	0.437
2008-12-16 14.592	7	95	0.366	0.713	0.696
2009-01-06 11.574	11	26	0.863	2.068	0.126
2009-01-06 12.16	6	13	0.851	1.525	0.218
2009-01-06 13.162	5	76	0.649	1.045	0.465
2009-01-06 14.696	4	17	0.773	1.071	0.382
2009-02-04 10.608	13	1707	0.333	0.854	0.649
2009-02-04 14.713	7	388	0.642	1.249	0.320
2009-02-04 15.786	10	251	0.447	1.028	0.547
2009-03-04 11.324	7	356	0.267	0.520	0.774
2009-03-04 12.022	11	765	0.545	1.307	0.418
2009-03-04 13.632	5	1007	0.550	0.885	0.458
2009-03-04 15.215	8	163	0.684	1.422	0.288
2009-04-20 10.833	18	464	0.682	1.971	0.222
2009-04-20 11.37	14	1235	0.455	1.200	0.384
2009-04-20 13.717	11	1303	0.246	0.590	0.759
2009-04-20 15.588	6	40	0.606	1.086	0.394
2009-05-18 10.605	6	130	0.408	0.731	0.646
2009-05-18 11.925	6	35	0.830	1.488	0.262
2009-05-18 13.496	4	9	0.876	1.215	0.250
2009-05-18 14.692	5	526	0.566	0.912	0.500
2009-12-07 11.062	5	65	0.715	1.151	0.394
2009-12-07 11.792	4	17	0.804	1.115	0.346
2009-12-07 15.316	1	1	NA	0.000	NA
2009-12-07 15.637	5	23	0.505	0.813	0.609
2010-11-08 12.004	8	351	0.311	0.646	0.670
2010-11-08 12.804	10	47	0.771	1.776	0.233
2010-11-08 12.974	7	48	0.765	1.489	0.283
2010-12-06 10.757	6	78	0.697	1.249	0.350
2010-12-06 11.867	4	35	0.456	0.632	0.689
2010-12-06 14.124	3	9	0.773	0.849	0.444
2010-12-06 14.228	3	14	0.597	0.656	0.615
2011-06-20 12.244	3	221	0.652	0.716	0.496
2011-06-20 12.537	4	132	0.145	0.201	0.926
2011-06-20 13.389	3	177	0.156	0.172	0.934
2011-06-20 13.998	1	1	NA	0.000	NA
2012-03-12 10.862	5	27	0.834	1.342	0.276
2012-03-12 15.336	5	49	0.473	0.762	0.597
2012-03-12 15.386	3	3	1.000	1.099	0.000

Date Station	Taxon Richness	Total # of Individuals	Pielou's Evenness	Shannon Index	Simpson's Dominance
2012-04-10 10.802	9	37	0.641	1.409	0.392
2012-04-10 11.392	2	2	1.000	0.693	0.000
2012-04-10 14.492	6	52	0.685	1.227	0.336
2012-04-10 16.044	4	77	0.286	0.396	0.827
2012-05-14 10.711	8	573	0.089	0.184	0.942
2012-05-14 10.849	5	126	0.204	0.329	0.864
2012-05-14 12.749	8	863	0.160	0.332	0.876
2012-05-14 15.223	7	30	0.912	1.775	0.163
2012-06-11 11.149	11	62	0.749	1.795	0.223
2012-06-11 12.002	5	46	0.634	1.020	0.499
2012-06-11 14.557	6	33	0.730	1.308	0.339
2012-06-11 16.034	3	485	0.049	0.054	0.984
2018-04-09 13.2	9	55	0.672	1.477	0.343
2018-04-09 14.25	9	599	0.190	0.418	0.818
2018-04-09 15.35	5	220	0.588	0.946	0.496
2018-04-11 11.5	9	132	0.557	1.224	0.399
2018-04-11 10.8	13	251	0.600	1.539	0.293
2018-04-11 15.65	8	153	0.657	1.365	0.302
2018-05-07 14.25	13	143	0.490	1.258	0.381
2018-05-07 15.35	17	681	0.406	1.150	0.490
2018-05-07 15.65	12	129	0.718	1.785	0.248
2018-05-08 11.5	5	72	0.923	1.485	0.229
2018-05-08 10.8	11	315	0.565	1.354	0.327
2018-05-08 13.2	15	414	0.672	1.820	0.229

APPENDIX 6.2-C

DESCRIPTIVE STATISTICS FOR *IN-SITU* WATER QUALITY ASSOCIATED WITH NEKTON SAMPLES

Appendix 6.2-C: Nekton *In-situ* Water Quality Descriptive Statistics

Table 1. Average salinity (ppt). n = the number of water quality profiles (samples), “Std Dev” = standard deviation

MFL Period	River Segment	n	Mean	Std Dev	Median
1	Lower	24	12.29	4.50	11.68
	Mid	18	10.63	4.00	10.13
	Upper	12	11.83	2.89	12.00
2	Lower	30	9.58	3.78	10.97
	Mid	21	6.46	2.83	6.30
	Upper	16	3.51	1.94	3.38
3	Lower	31	8.28	3.27	7.55
	Mid	22	4.79	2.66	4.28
	Upper	18	2.73	2.36	2.18
4	Lower	4	9.33	3.96	9.42
	Mid	4	5.87	4.22	4.64
	Upper	4	1.98	0.06	1.95

Table 2. Average dissolved oxygen (mg/L). n = the number of water quality profiles (samples), “Std Dev” = standard deviation

MFL Period	River Segment	n	Mean	Std Dev	Median
1	Lower	24	3.96	2.14	3.45
	Mid	18	3.45	1.34	3.37
	Upper	12	3.96	2.40	2.99
2	Lower	30	4.08	1.59	3.87
	Mid	21	3.67	1.86	3.03
	Upper	16	5.41	2.79	4.48
3	Lower	31	3.21	1.81	2.60
	Mid	22	3.72	1.66	3.50
	Upper	18	5.93	2.33	5.78
4	Lower	4	1.72	0.56	1.71
	Mid	4	2.82	1.41	2.73
	Upper	4	6.62	1.49	6.45

Table 3. Average pH. n = the number of water quality profiles (samples), “Std Dev” = standard deviation

MFL Period	River Segment	n	Mean	Std Dev	Median
1	Lower	24	7.36	0.30	7.20
	Mid	18	7.32	0.31	7.20
	Upper	12	7.37	0.26	7.30
2	Lower	30	7.34	0.22	7.30
	Mid	21	7.34	0.21	7.27
	Upper	16	7.45	0.38	7.34
3	Lower	31	7.33	0.22	7.30
	Mid	22	7.41	0.19	7.40
	Upper	18	7.60	0.25	7.55
4	Lower	4	7.13	0.47	7.23
	Mid	4	7.32	0.28	7.30
	Upper	4	7.39	0.34	7.34

Table 4. Average water temperature (°C). n = the number of water quality profiles (samples), “Std Dev” = standard deviation

MFL Period	River Segment	n	Mean	Std Dev	Median
1	Lower	24	24.78	3.74	24.20
	Mid	18	23.65	4.28	23.87
	Upper	12	25.60	3.63	24.65
2	Lower	30	24.93	3.06	25.97
	Mid	21	24.55	3.29	25.63
	Upper	16	26.02	2.11	26.21
3	Lower	31	23.49	3.55	23.80
	Mid	22	23.38	3.62	23.22
	Upper	18	23.14	3.04	23.21
4	Lower	4	25.11	1.16	25.07
	Mid	4	25.87	0.35	25.88
	Upper	4	25.34	0.66	25.08

APPENDIX 6.2-D

NEKTON SIMPER RESULTS

Appendix 6.2-D: Nekton SIMPER Results

Similarity Percentages - species contributions

Two-Way Analysis

Data worksheet
Name: Data1
Data type: Abundance
Sample selection: All
Variable selection: All

Parameters
Resemblance: S17 Bray-Curtis similarity
Cut off for low contributions: 70.00%

Factor Groups

```
Sample              MFL Period x Segment
2000-05-23 10.742  1 x Lower
2000-05-23 11.155  1 x Lower
2000-06-16 12.03   1 x Lower
2000-06-16 12.549  1 x Lower
2000-07-11 10.646  1 x Lower
2000-07-11 11.523  1 x Lower
2000-11-27 10.909  1 x Lower
2000-11-27 11.19   1 x Lower
2000-12-12 11.243  1 x Lower
2001-01-09 11.486  1 x Lower
2001-01-09 12.589  1 x Lower
2001-02-13 11.034  1 x Lower
2001-02-13 11.102  1 x Lower
2001-03-05 11.372  1 x Lower
2001-03-05 12.41   1 x Lower
2001-04-18 11.215  1 x Lower
2001-05-15 11.517  1 x Lower
2001-05-15 12.518  1 x Lower
2001-06-21 10.798  1 x Lower
2001-07-25 11.749  1 x Lower
2001-12-11 12.529  1 x Lower
2002-01-03 11.446  1 x Lower
2002-02-04 12.046  1 x Lower
2002-02-04 12.426  1 x Lower
2000-05-23 13.106  1 x Middle
2000-06-16 12.966  1 x Middle
2000-07-11 14.123  1 x Middle
2000-11-27 14.126  1 x Middle
2000-11-27 14.231  1 x Middle
2001-01-09 13.475  1 x Middle
2001-01-09 13.668  1 x Middle
2001-03-05 13.054  1 x Middle
2001-03-05 14.399  1 x Middle
2001-04-18 12.832  1 x Middle
2001-04-18 13.766  1 x Middle
2001-05-15 13.914  1 x Middle
2001-07-25 12.802  1 x Middle
2001-07-25 14.473  1 x Middle
2001-12-11 13.038  1 x Middle
2002-01-03 13.647  1 x Middle
2002-01-03 14.051  1 x Middle
2002-02-04 13.538  1 x Middle
2000-05-23 15.72   1 x Upper
```

2000-06-16	15.441	1	x	Upper
2000-07-11	14.88	1	x	Upper
2000-12-12	15.055	1	x	Upper
2000-12-12	15.568	1	x	Upper
2001-02-13	14.573	1	x	Upper
2001-02-13	14.992	1	x	Upper
2001-05-15	15.566	1	x	Upper
2001-06-21	15.496	1	x	Upper
2001-06-21	15.851	1	x	Upper
2001-12-11	15.069	1	x	Upper
2002-02-04	14.584	1	x	Upper
2002-03-18	10.593	2	x	Lower
2002-03-18	11.509	2	x	Lower
2002-04-17	12.407	2	x	Lower
2002-05-21	11.912	2	x	Lower
2002-05-21	11.98	2	x	Lower
2002-06-05	10.79	2	x	Lower
2002-06-05	11.096	2	x	Lower
2006-04-27	10.769	2	x	Lower
2006-05-08	10.575	2	x	Lower
2006-05-08	12.436	2	x	Lower
2006-06-20	11.224	2	x	Lower
2006-07-17	12.012	2	x	Lower
2006-07-17	12.133	2	x	Lower
2006-11-13	11.609	2	x	Lower
2006-11-13	11.871	2	x	Lower
2006-12-13	10.807	2	x	Lower
2006-12-13	11.97	2	x	Lower
2007-01-18	11.87	2	x	Lower
2007-01-18	11.921	2	x	Lower
2007-02-22	10.609	2	x	Lower
2007-02-22	12.119	2	x	Lower
2007-03-21	11.197	2	x	Lower
2007-03-21	11.436	2	x	Lower
2007-04-09	10.568	2	x	Lower
2007-04-09	11.147	2	x	Lower
2007-05-16	11.675	2	x	Lower
2007-05-16	12.593	2	x	Lower
2007-06-04	11.422	2	x	Lower
2007-06-04	11.622	2	x	Lower
2007-07-11	11.719	2	x	Lower
2002-03-18	12.972	2	x	Middle
2002-04-17	12.64	2	x	Middle
2002-04-17	13.281	2	x	Middle
2002-04-17	13.644	2	x	Middle
2002-05-21	14.042	2	x	Middle
2006-04-27	13.646	2	x	Middle
2006-05-08	13.456	2	x	Middle
2006-06-20	12.609	2	x	Middle
2006-07-17	13.59	2	x	Middle
2006-07-17	13.875	2	x	Middle
2006-11-13	14.402	2	x	Middle
2006-12-13	13.419	2	x	Middle
2006-12-13	13.943	2	x	Middle
2007-01-18	13.081	2	x	Middle
2007-01-18	13.109	2	x	Middle
2007-02-22	12.977	2	x	Middle
2007-02-22	14.263	2	x	Middle
2007-03-21	14.24	2	x	Middle
2007-04-09	13.107	2	x	Middle
2007-06-04	13.615	2	x	Middle
2007-07-11	12.708	2	x	Middle
2002-03-18	14.773	2	x	Upper
2002-05-21	15.967	2	x	Upper

2002-06-05	14.77	2	x	Upper
2002-06-05	14.907	2	x	Upper
2006-04-27	14.993	2	x	Upper
2006-05-08	14.541	2	x	Upper
2006-06-20	14.888	2	x	Upper
2006-06-20	15.843	2	x	Upper
2006-11-13	14.981	2	x	Upper
2007-03-21	15.318	2	x	Upper
2007-04-09	15.162	2	x	Upper
2007-05-16	14.792	2	x	Upper
2007-05-16	15.136	2	x	Upper
2007-06-04	15.209	2	x	Upper
2007-07-11	14.985	2	x	Upper
2007-07-11	15.965	2	x	Upper
2008-01-22	11.453	3	x	Lower
2008-01-22	12.422	3	x	Lower
2008-06-18	11.414	3	x	Lower
2008-06-18	11.815	3	x	Lower
2008-07-07	12.541	3	x	Lower
2008-10-27	10.606	3	x	Lower
2008-10-27	11.933	3	x	Lower
2008-12-16	11.473	3	x	Lower
2009-01-06	11.574	3	x	Lower
2009-01-06	12.16	3	x	Lower
2009-02-04	10.608	3	x	Lower
2009-03-04	11.324	3	x	Lower
2009-03-04	12.022	3	x	Lower
2009-04-20	10.833	3	x	Lower
2009-04-20	11.37	3	x	Lower
2009-05-18	10.605	3	x	Lower
2009-05-18	11.925	3	x	Lower
2009-12-07	11.062	3	x	Lower
2009-12-07	11.792	3	x	Lower
2010-11-08	12.004	3	x	Lower
2010-12-06	10.757	3	x	Lower
2010-12-06	11.867	3	x	Lower
2011-06-20	12.244	3	x	Lower
2011-06-20	12.537	3	x	Lower
2012-03-12	10.862	3	x	Lower
2012-04-10	10.802	3	x	Lower
2012-04-10	11.392	3	x	Lower
2012-05-14	10.711	3	x	Lower
2012-05-14	10.849	3	x	Lower
2012-06-11	11.149	3	x	Lower
2012-06-11	12.002	3	x	Lower
2008-01-22	13.206	3	x	Middle
2008-01-22	13.409	3	x	Middle
2008-06-18	14.074	3	x	Middle
2008-07-07	12.649	3	x	Middle
2008-07-07	14.272	3	x	Middle
2008-07-07	14.397	3	x	Middle
2008-10-27	14.362	3	x	Middle
2008-11-13	13.374	3	x	Middle
2008-12-16	12.698	3	x	Middle
2008-12-16	12.951	3	x	Middle
2009-01-06	13.162	3	x	Middle
2009-03-04	13.632	3	x	Middle
2009-04-20	13.717	3	x	Middle
2009-05-18	13.496	3	x	Middle
2010-11-08	12.804	3	x	Middle
2010-11-08	12.974	3	x	Middle
2010-12-06	14.124	3	x	Middle
2010-12-06	14.228	3	x	Middle
2011-06-20	13.389	3	x	Middle

2011-06-20	13.998	3	x	Middle
2012-04-10	14.492	3	x	Middle
2012-05-14	12.749	3	x	Middle
2008-06-18	15.945	3	x	Upper
2008-10-27	14.523	3	x	Upper
2008-11-13	15.034	3	x	Upper
2008-12-16	14.592	3	x	Upper
2009-01-06	14.696	3	x	Upper
2009-02-04	14.713	3	x	Upper
2009-02-04	15.786	3	x	Upper
2009-03-04	15.215	3	x	Upper
2009-04-20	15.588	3	x	Upper
2009-05-18	14.692	3	x	Upper
2009-12-07	15.316	3	x	Upper
2009-12-07	15.637	3	x	Upper
2012-03-12	15.336	3	x	Upper
2012-03-12	15.386	3	x	Upper
2012-04-10	16.044	3	x	Upper
2012-05-14	15.223	3	x	Upper
2012-06-11	14.557	3	x	Upper
2012-06-11	16.034	3	x	Upper
2018-04-11	11.5	4	x	Lower
2018-04-11	10.8	4	x	Lower
2018-05-08	11.5	4	x	Lower
2018-05-08	10.8	4	x	Lower
2018-04-09	13.2	4	x	Middle
2018-04-09	14.25	4	x	Middle
2018-05-07	14.25	4	x	Middle
2018-05-08	13.2	4	x	Middle
2018-04-09	15.35	4	x	Upper
2018-04-11	15.65	4	x	Upper
2018-05-07	15.35	4	x	Upper
2018-05-07	15.65	4	x	Upper

Examines MFL Period groups
(across all Segment groups)
Group 1
Average similarity: 39.13

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Menidia spp.	3.39	11.92	1.42	30.46	30.46
Gambusia holbrooki	2.19	6.61	0.88	16.89	47.35
Palaemonetes pugio	2.20	5.12	0.77	13.07	60.43
Lucania parva	1.50	3.08	0.72	7.86	68.29
Poecilia latipinna	1.43	2.91	0.72	7.43	75.72

Group 2
Average similarity: 41.39

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Menidia spp.	3.36	14.12	1.61	34.13	34.13
Gambusia holbrooki	1.90	7.26	1.32	17.55	51.68
Lucania parva	1.32	3.10	0.69	7.50	59.18
Cyprinodon variegatus	1.23	2.99	0.72	7.23	66.41
Palaemonetes pugio	1.17	2.91	0.71	7.02	73.43

Group 3
Average similarity: 26.19

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lucania parva	1.45	5.71	0.84	21.81	21.81
Menidia spp.	1.24	3.68	0.51	14.05	35.86
Gambusia holbrooki	1.23	3.61	0.56	13.78	49.64
Palaemonetes pugio	0.90	2.50	0.47	9.54	59.19
Trinectes maculatus	0.64	2.42	0.45	9.24	68.43
Cyprinodon variegatus	0.61	1.61	0.48	6.16	74.59

Group 4
Average similarity: 49.88

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Menidia spp.	2.94	14.30	3.92	28.67	28.67
Eucinostomus harengulus	2.10	8.96	1.79	17.96	46.63
Trinectes maculatus	1.41	6.58	1.40	13.19	59.82
Gambusia holbrooki	1.88	6.49	1.14	13.01	72.83

Groups 1 & 2
Average dissimilarity = 61.53

Species	Group 1 Av.Abund	Group 2 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	3.39	3.36	6.38	0.98	10.37	10.37
Palaemonetes pugio	2.20	1.17	5.70	1.08	9.27	19.63
Gambusia holbrooki	2.19	1.90	4.68	1.04	7.61	27.24
Lucania parva	1.50	1.32	4.12	1.16	6.70	33.94
Poecilia latipinna	1.43	0.68	3.71	1.03	6.03	39.97
Anchoa mitchilli	0.84	0.53	3.31	0.62	5.38	45.35
Cyprinodon variegatus	0.51	1.23	3.14	1.03	5.10	50.45
Brevoortia spp.	1.07	0.21	2.98	0.58	4.84	55.29
Trinectes maculatus	0.86	0.87	2.75	1.01	4.47	59.75
Microgobius gulosus	0.69	0.78	2.55	1.03	4.14	63.89
Oreochromis spp.	0.58	0.80	2.43	0.92	3.95	67.84
Fundulus grandis	0.59	0.50	1.94	0.91	3.15	70.99

Groups 1 & 3
Average dissimilarity = 72.01

Species	Group 1 Av.Abund	Group 3 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	3.39	1.24	9.19	1.22	12.76	12.76
Palaemonetes pugio	2.20	0.90	6.70	1.10	9.30	22.06
Gambusia holbrooki	2.19	1.23	6.09	1.07	8.46	30.52
Lucania parva	1.50	1.45	4.96	1.15	6.89	37.41
Anchoa mitchilli	0.84	0.64	4.19	0.65	5.82	43.23
Poecilia latipinna	1.43	0.42	4.09	1.04	5.68	48.92
Brevoortia spp.	1.07	0.24	3.48	0.61	4.83	53.74
Trinectes maculatus	0.86	0.64	3.16	0.99	4.39	58.13
Cyprinodon variegatus	0.51	0.61	2.45	0.92	3.41	61.54
Microgobius gulosus	0.69	0.19	2.22	0.89	3.08	64.61
Oreochromis spp.	0.58	0.23	2.00	0.74	2.78	67.40
Fundulus grandis	0.59	0.15	1.89	0.80	2.63	70.03

Groups 2 & 3
Average dissimilarity = 70.02

Species	Group 2 Av.Abund	Group 3 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	3.36	1.24	9.45	1.33	13.50	13.50
Gambusia holbrooki	1.90	1.23	5.63	1.13	8.04	21.53
Lucania parva	1.32	1.45	5.15	1.06	7.36	28.89

Palaemonetes pugio	1.17	0.90	4.56	1.00	6.51	35.40
Cyprinodon variegatus	1.23	0.61	3.97	1.05	5.68	41.07
Anchoa mitchilli	0.53	0.64	3.38	0.56	4.83	45.90
Trinectes maculatus	0.87	0.64	3.22	0.90	4.60	50.50
Microgobius gulosus	0.78	0.19	2.69	0.87	3.85	54.35
Poecilia latipinna	0.68	0.42	2.66	0.81	3.80	58.15
Oreochromis spp.	0.80	0.23	2.55	0.87	3.65	61.80
Eucinostomus harengulus	0.27	0.48	2.09	0.71	2.99	64.79
Gobiosoma bosc	0.55	0.20	1.98	0.79	2.82	67.61
Eucinostomus spp.	0.18	0.41	1.77	0.55	2.53	70.14

Groups 1 & 4
Average dissimilarity = 69.87

Species	Group 1 Av.Abund	Group 4 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Eucinostomus harengulus	0.14	2.10	6.13	1.92	8.77	8.77
Menidia spp.	3.39	2.94	5.79	1.25	8.28	17.06
Palaemonetes pugio	2.20	0.17	5.77	1.07	8.26	25.31
Gambusia holbrooki	2.19	1.88	4.50	1.17	6.44	31.76
Poecilia latipinna	1.43	0.08	3.61	1.05	5.16	36.92
Lucania parva	1.50	0.62	3.59	1.10	5.14	42.06
Trinectes maculatus	0.86	1.41	3.08	1.19	4.40	46.47
Fundulus seminolis	0.02	1.14	3.05	1.19	4.36	50.83
Brevoortia spp.	1.07	0.00	2.64	0.55	3.78	54.61
Micropterus salmoides	0.00	0.88	2.46	0.99	3.52	58.13
Anchoa mitchilli	0.84	0.00	2.29	0.48	3.27	61.40
Leiostomus xanthurus	0.41	0.54	2.10	0.82	3.00	64.40
Mugil cephalus	0.21	0.64	2.09	0.69	2.99	67.39
Microgobius gulosus	0.69	0.36	1.96	0.99	2.80	70.19

Groups 2 & 4
Average dissimilarity = 65.75

Species	Group 2 Av.Abund	Group 4 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Eucinostomus harengulus	0.27	2.10	6.20	1.79	9.44	9.44
Menidia spp.	3.36	2.94	5.60	1.20	8.52	17.96
Lucania parva	1.32	0.62	3.93	1.20	5.98	23.94
Gambusia holbrooki	1.90	1.88	3.82	1.20	5.81	29.75
Cyprinodon variegatus	1.23	0.00	3.33	1.03	5.06	34.81
Trinectes maculatus	0.87	1.41	3.20	1.05	4.87	39.68
Palaemonetes pugio	1.17	0.17	3.16	0.96	4.81	44.49
Fundulus seminolis	0.22	1.14	3.02	1.12	4.60	49.09
Micropterus salmoides	0.29	0.88	2.46	0.99	3.74	52.83

Microgobius gulosus	0.78	0.36	2.30	1.00	3.51	56.33
Oreochromis spp.	0.80	0.17	2.19	0.93	3.33	59.66
Mugil cephalus	0.40	0.64	2.10	0.68	3.20	62.86
Gobiosoma bosc	0.55	0.42	1.84	0.91	2.79	65.66
Poecilia latipinna	0.68	0.08	1.81	0.75	2.75	68.41
Leiostomus xanthurus	0.20	0.54	1.80	0.89	2.73	71.14

Groups 3 & 4
Average dissimilarity = 72.64

Species	Group 3 Av.Abund	Group 4 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	1.24	2.94	8.03	1.39	11.05	11.05
Eucinostomus harengulus	0.48	2.10	6.53	1.62	8.99	20.03
Gambusia holbrooki	1.23	1.88	5.58	1.30	7.68	27.72
Lucania parva	1.45	0.62	4.33	1.17	5.96	33.68
Trinectes maculatus	0.64	1.41	3.95	1.23	5.44	39.12
Fundulus seminolis	0.33	1.14	3.64	1.16	5.01	44.13
Micropterus salmoides	0.23	0.88	3.01	1.07	4.14	48.27
Palaemonetes pugio	0.90	0.17	2.97	0.80	4.08	52.35
Mugil cephalus	0.14	0.64	2.56	0.71	3.52	55.88
Anchoa mitchilli	0.64	0.00	2.04	0.44	2.81	58.68
Cyprinodon variegatus	0.61	0.00	1.90	0.76	2.62	61.30
Callinectes sapidus	0.06	0.54	1.88	0.98	2.59	63.89
Leiostomus xanthurus	0.05	0.54	1.85	0.84	2.55	66.45
Lepomis macrochirus	0.29	0.42	1.79	0.59	2.47	68.92
Lucania goodei	0.09	0.53	1.79	0.66	2.46	71.38

Examines Segment groups
(across all MFL Period groups)
Group Lower
Average similarity: 35.90

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Menidia spp.	3.26	11.63	1.19	32.40	32.40
Gambusia holbrooki	1.36	4.08	0.79	11.36	43.77
Lucania parva	1.28	3.50	0.75	9.76	53.53
Palaemonetes pugio	1.44	3.09	0.63	8.60	62.13
Cyprinodon variegatus	1.02	2.57	0.65	7.15	69.27
Poecilia latipinna	0.93	1.81	0.61	5.04	74.32

Group Middle
Average similarity: 33.87

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Gambusia holbrooki	2.13	7.78	1.05	22.96	22.96
Menidia spp.	2.02	6.11	0.76	18.03	40.99
Lucania parva	1.34	5.13	0.82	15.15	56.14
Palaemonetes pugio	1.46	4.64	0.72	13.71	69.85
Trinectes maculatus	0.79	2.53	0.57	7.47	77.32

Group Upper
Average similarity: 33.09

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Menidia spp.	2.21	7.75	0.96	23.43	23.43
Gambusia holbrooki	1.91	7.31	0.92	22.10	45.53
Lucania parva	1.57	4.52	0.64	13.67	59.21
Trinectes maculatus	0.92	3.59	0.58	10.84	70.04

Groups Lower & Middle
Average dissimilarity = 67.59

	Group Lower	Group Middle				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	3.26	2.02	7.44	1.10	11.00	11.00
Gambusia holbrooki	1.36	2.13	5.60	1.10	8.28	19.28
Palaemonetes pugio	1.44	1.46	5.30	1.07	7.84	27.13
Lucania parva	1.28	1.34	4.59	1.10	6.79	33.92
Anchoa mitchilli	0.81	0.56	3.92	0.59	5.80	39.72
Cyprinodon variegatus	1.02	0.57	3.42	0.96	5.06	44.78
Poecilia latipinna	0.93	0.71	3.21	1.00	4.74	49.52
Trinectes maculatus	0.79	0.79	3.07	0.94	4.54	54.06
Microgobius gulosus	0.66	0.52	2.41	0.87	3.56	57.62
Oreochromis spp.	0.43	0.65	2.33	0.86	3.44	61.06
Brevoortia spp.	0.51	0.51	2.33	0.49	3.44	64.50
Fundulus grandis	0.69	0.20	1.97	0.82	2.92	67.42
Eucinostomus harengulus	0.53	0.39	1.93	0.63	2.86	70.28

Groups Lower & Upper
Average dissimilarity = 69.86

	Group Lower	Group Upper				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	3.26	2.21	7.46	1.06	10.68	10.68
Lucania parva	1.28	1.57	5.71	1.18	8.17	18.85
Gambusia holbrooki	1.36	1.91	5.19	1.03	7.43	26.28

Palaemonetes pugio	1.44	0.80	4.85	0.90	6.94	33.22
Cyprinodon variegatus	1.02	0.50	3.41	0.98	4.88	38.10
Trinectes maculatus	0.79	0.92	3.32	0.96	4.75	42.85
Anchoa mitchilli	0.81	0.37	3.24	0.60	4.64	47.49
Poecilia latipinna	0.93	0.50	2.96	0.96	4.24	51.73
Lepomis macrochirus	0.09	0.53	2.29	0.57	3.28	55.01
Microgobius gulosus	0.66	0.30	2.08	0.81	2.98	57.99
Fundulus seminolis	0.12	0.51	1.95	0.59	2.79	60.78
Fundulus grandis	0.69	0.09	1.94	0.79	2.77	63.55
Gobiosoma bosc	0.53	0.30	1.91	0.74	2.73	66.28
Eucinostomus harengulus	0.53	0.24	1.89	0.58	2.71	68.99
Oreochromis spp.	0.43	0.45	1.88	0.73	2.69	71.67

Groups Middle & Upper
Average dissimilarity = 67.60

Species	Group Middle Av.Abund	Group Upper Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Menidia spp.	2.02	2.21	6.72	0.93	9.94	9.94
Lucania parva	1.34	1.57	6.43	1.13	9.51	19.45
Gambusia holbrooki	2.13	1.91	6.10	1.06	9.02	28.46
Palaemonetes pugio	1.46	0.80	5.25	1.03	7.77	36.23
Trinectes maculatus	0.79	0.92	3.65	0.92	5.40	41.63
Anchoa mitchilli	0.56	0.37	3.36	0.52	4.97	46.60
Cyprinodon variegatus	0.57	0.50	2.78	0.85	4.12	50.72
Poecilia latipinna	0.71	0.50	2.76	0.58	4.09	54.81
Lepomis macrochirus	0.20	0.53	2.74	0.59	4.05	58.86
Oreochromis spp.	0.65	0.45	2.43	0.83	3.59	62.45
Micropterus salmoides	0.26	0.48	2.38	0.66	3.52	65.97
Fundulus seminolis	0.26	0.51	2.37	0.67	3.50	69.47
Microgobius gulosus	0.52	0.30	1.99	0.66	2.94	72.41

APPENDIX 6.3-A

BENTHIC MACROINVERTEBRATE ANOSIM RESULTS

Appendix 6.3-A: Benthic Macroinvertebrate ANOSIM Results

Analysis of Similarities

Two-Way Crossed - AxB

Resemblance worksheet Name: Resem1 Data type: Similarity Selection: All

Factors

Place	Name	Type	Levels
A	MFL Period	Unordered	4
B	Segment	Unordered	3

MFL Period levels
1
2
3
4

Segment levels
Lower
Middle
Upper

Tests for differences between unordered MFL Period groups
(across all Segment groups)
Global Test
Sample statistic (Average R): 0.339
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)
Number of permuted statistics greater than or equal to Average R: 0

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
1, 2	0.421	0.1	Very large	999	0
1, 3	0.378	0.2	40990950	999	1
1, 4	0.54	0.1	23648625	999	0
2, 3	0.078	16	55747692	999	159
2, 4	0.317	0.5	27327300	999	4
3, 4	0.448	0.1	110250	999	0

Tests for differences between unordered Segment groups
(across all MFL Period groups)
Global Test
Sample statistic (Average R): 0.153
Significance level of sample statistic: 0.8%
Number of permutations: 999 (Random sample from a large number)
Number of permuted statistics greater than or equal to Average R: 7

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Lower, Middle	0.069	9	Very large	999	89
Lower, Upper	0.399	0.2	12612600	999	1
Middle, Upper	-0.023	53.8	14714700	999	537

APPENDIX 6.3-B

BENTHIC MACROINVERTEBRATE DIVERSITY

Appendix 6.3-B: Benthic Macroinvertebrate Diversity Results

Date Station	Total # Organisms per m^2	Taxon Richness	Pielou's Evenness	Shannon Index	Simpson's Dominance
2000-07-30 11.523	1050	1	NA	0.000	1.000
2000-07-30 11.589	0	0	NA	0.000	NA
2000-07-30 14.435	0	0	NA	0.000	NA
2000-07-30 14.88	1325	7	0.496	0.965	0.563
2001-01-15 10.898	175	2	0.592	0.410	0.754
2001-01-15 12.589	25	1	NA	0.000	1.000
2001-01-15 13.475	0	0	NA	0.000	NA
2001-01-15 13.668	450	2	0.650	0.451	0.722
2001-02-23 11.034	400	2	0.337	0.234	0.883
2001-02-23 12.313	0	0	NA	0.000	NA
2001-02-23 14.573	0	0	NA	0.000	NA
2001-02-23 14.992	2275	6	0.651	1.166	0.405
2001-03-07 11.372	275	2	0.439	0.305	0.834
2001-03-07 12.512	1125	4	0.545	0.756	0.566
2001-03-07 13.461	0	0	NA	0.000	NA
2001-03-07 14.399	0	0	NA	0.000	NA
2001-07-26 11.173	625	4	0.548	0.759	0.606
2001-07-26 12.944	850	1	NA	0.000	1.000
2002-02-25 11.54	350	3	0.691	0.759	0.560
2002-02-25 12.345	300	2	0.414	0.287	0.847
2002-02-25 13.35	425	5	0.748	1.203	0.397
2002-02-25 13.385	450	4	0.549	0.761	0.623
2002-03-28 12.06	3875	7	0.529	1.029	0.430
2002-03-28 12.833	5150	8	0.380	0.789	0.659
2002-03-28 13.252	2875	6	0.464	0.832	0.566
2006-07-28 11.67	0	0	NA	0.000	NA
2006-07-28 11.921	0	0	NA	0.000	NA
2006-07-28 13.359	975	6	0.793	1.421	0.296
2006-07-28 14.172	6625	7	0.547	1.065	0.425
2006-08-04 10.863	975	4	0.604	0.837	0.554
2006-08-04 11.693	0	0	NA	0.000	NA
2006-08-04 13.412	3275	5	0.347	0.558	0.703
2006-08-04 13.433	1375	4	0.856	1.187	0.336
2007-01-05 10.854	4575	7	0.282	0.548	0.769
2007-01-05 13.247	9275	12	0.669	1.661	0.267
2007-01-05 13.402	47875	13	0.352	0.902	0.472

Date Station	Total # Organisms per m^2	Taxon Richness	Pielou's Evenness	Shannon Index	Simpson's Dominance
2007-02-13 10.748	20300	5	0.537	0.864	0.510
2007-02-13 11.734	5125	6	0.399	0.714	0.614
2007-02-13 13.632	16050	11	0.440	1.056	0.480
2007-02-13 13.712	7225	15	0.495	1.339	0.456
2007-03-14 10.646	725	5	0.662	1.065	0.407
2007-03-14 14.193	9975	11	0.361	0.867	0.634
2007-03-14 14.597	16625	14	0.491	1.295	0.376
2007-07-23 10.583	775	8	0.821	1.707	0.225
2007-07-23 12.984	14475	6	0.170	0.304	0.872
2007-07-23 15.745	31225	11	0.384	0.920	0.453
2008-01-10 11.354	18800	12	0.396	0.984	0.568
2008-01-10 13.002	675	4	0.473	0.655	0.679
2008-01-10 13.322	1850	8	0.434	0.902	0.593
2009-01-14 11.857	7125	11	0.217	0.520	0.815
2009-01-14 13.205	1700	3	0.234	0.257	0.888
2009-01-14 13.719	6700	6	0.342	0.613	0.726
2009-02-10 12.325	1425	1	NA	0.000	1.000
2009-02-10 12.788	10350	25	0.646	2.079	0.204
2009-02-10 14.528	2175	13	0.826	2.118	0.156
2009-03-16 11.41	13025	10	0.273	0.628	0.750
2009-03-16 13.358	6900	11	0.372	0.893	0.643
2009-03-16 15.336	11175	15	0.607	1.645	0.247
2018-04-10 11.40	4224	12	0.826	2.053	0.155
2018-04-10 12.155	1336	5	0.679	1.093	0.411
2018-04-10 13.60	86	2	1.000	0.693	0.494
2018-04-10 13.85	5259	6	0.525	0.941	0.522
2018-04-10 15.35	9095	21	0.718	2.187	0.173
2018-04-10 15.75	13233	24	0.554	1.762	0.357
2018-05-09 11.40	7155	18	0.731	2.113	0.167
2018-05-09 12.155	1422	6	0.610	1.092	0.478
2018-05-09 13.60	43	1	NA	0.000	1.000
2018-05-09 13.85	14353	22	0.679	2.100	0.223
2018-05-09 15.35	12414	22	0.739	2.285	0.152
2018-05-09 15.75	2802	20	0.654	1.958	0.307

APPENDIX 6.3-C

BENTHIC MACROINVERTEBRATE SIMPER RESULTS

Appendix 6.3-C: Benthic Macroinvertebrate SIMPER Results

Similarity Percentages - species contributions

Two-Way Analysis

Data worksheet

Name: Data1

Data type: Abundance

Sample selection: All

Variable selection: All

Parameters

Resemblance: S17 Bray-Curtis similarity

Cut off for low contributions: 70.00%

Factor Groups

Sample	MFL Period x Segment
2000-07-30 11.523	1 x Lower
2000-07-30 11.589	1 x Lower
2001-01-15 10.898	1 x Lower
2001-01-15 12.589	1 x Lower
2001-02-23 11.034	1 x Lower
2001-02-23 12.313	1 x Lower
2001-03-07 11.372	1 x Lower
2001-03-07 12.512	1 x Lower
2001-07-26 11.173	1 x Lower
2002-02-25 11.54	1 x Lower
2002-02-25 12.345	1 x Lower
2000-07-30 14.435	1 x Middle
2001-01-15 13.475	1 x Middle
2001-01-15 13.668	1 x Middle
2001-03-07 13.461	1 x Middle
2001-03-07 14.399	1 x Middle
2001-07-26 12.944	1 x Middle
2002-02-25 13.35	1 x Middle
2002-02-25 13.385	1 x Middle
2000-07-30 14.88	1 x Upper
2001-02-23 14.573	1 x Upper
2001-02-23 14.992	1 x Upper
2002-03-28 12.06	2 x Lower
2006-07-28 11.67	2 x Lower
2006-07-28 11.921	2 x Lower
2006-08-04 10.863	2 x Lower
2006-08-04 11.693	2 x Lower

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2007-01-05 10.854  2 x Lower
2007-02-13 10.748  2 x Lower
2007-02-13 11.734  2 x Lower
2007-03-14 10.646  2 x Lower
2007-07-23 10.583  2 x Lower
2002-03-28 12.833  2 x Middle
2002-03-28 13.252  2 x Middle
2006-07-28 13.359  2 x Middle
2006-07-28 14.172  2 x Middle
2006-08-04 13.412  2 x Middle
2006-08-04 13.433  2 x Middle
2007-01-05 13.247  2 x Middle
2007-01-05 13.402  2 x Middle
2007-02-13 13.632  2 x Middle
2007-02-13 13.712  2 x Middle
2007-03-14 14.193  2 x Middle
2007-07-23 12.984  2 x Middle
2007-03-14 14.597  2 x Upper
2007-07-23 15.745  2 x Upper
2008-01-10 11.354  3 x Lower
2009-01-14 11.857  3 x Lower
2009-02-10 12.325  3 x Lower
2009-03-16 11.41   3 x Lower
2008-01-10 13.002  3 x Middle
2008-01-10 13.322  3 x Middle
2009-01-14 13.205  3 x Middle
2009-01-14 13.719  3 x Middle
2009-02-10 12.788  3 x Middle
2009-03-16 13.358  3 x Middle
2009-02-10 14.528  3 x Upper
2009-03-16 15.336  3 x Upper
2018-04-10 11.40   4 x Lower
2018-04-10 12.155  4 x Lower
2018-05-09 11.40   4 x Lower
2018-05-09 12.155  4 x Lower
2018-04-10 13.60   4 x Middle
2018-04-10 13.85   4 x Middle
2018-05-09 13.60   4 x Middle
2018-05-09 13.85   4 x Middle
2018-04-10 15.35   4 x Upper
2018-04-10 15.75   4 x Upper
2018-05-09 15.35   4 x Upper
2018-05-09 15.75   4 x Upper
```

Examines MFL Period groups
(across all Segment groups)

Group 1
Average similarity: 22.97

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Stenoninereis martini	2.31	20.69	0.81	90.07	90.07

Group 2
Average similarity: 25.94

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Melanoides tuberculata	4.31	7.06	0.93	27.22	27.22
Stenoninereis martini	3.44	4.30	0.61	16.59	43.82
Laeonereis culveri	2.54	3.25	0.49	12.52	56.34
Tubificoid Naididae spp.	2.53	2.94	0.55	11.35	67.69
Hydrobiidae spp.	2.90	2.71	0.57	10.45	78.14

Group 3
Average similarity: 34.91

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Stenoninereis martini	5.77	19.39	1.89	55.55	55.55
Mytilopsis leucophaeata	2.53	3.21	0.62	9.21	64.76
Grandidierella bonnieroides	2.51	2.34	0.63	6.69	71.45

Group 4
Average similarity: 32.80

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Mytilopsis leucophaeata	3.30	6.25	0.98	19.06	19.06
Pyrgophorus platyrachis	3.33	3.29	1.00	10.03	29.09
Chironomus spp.	2.22	2.99	0.60	9.12	38.21
Laeonereis culveri	2.29	2.00	0.46	6.10	44.31
Ablabesmyia rhamphe group	1.39	1.54	0.69	4.71	49.02
Polypedilum halterale group	1.79	1.54	0.68	4.70	53.72
Streblospio spp.	0.99	1.36	0.43	4.14	57.86
Cassidinidea ovalis	2.20	1.36	0.43	4.14	61.99
Helobdella stagnalis	1.36	1.33	0.68	4.07	66.06
Tubificoid Naididae spp.	2.38	1.26	0.52	3.84	69.90
Hydroptila spp.	1.10	1.17	0.67	3.58	73.48

Groups 1 & 2
Average dissimilarity = 88.91

Species	Group 1 Av.Abund	Group 2 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	2.31	3.44	16.40	0.88	18.45	18.45
Melanoides tuberculata	0.00	4.31	11.73	1.19	13.19	31.64
Laeonereis culveri	0.71	2.54	9.62	0.68	10.81	42.46
Tubificoid Naididae spp.	0.20	2.53	6.35	0.73	7.14	49.60
Streblospio spp.	0.58	1.55	6.25	0.67	7.03	56.63
Hydrobiidae spp.	0.13	2.90	6.23	0.91	7.01	63.64
Mytilopsis leucophaeata	0.52	1.47	5.00	0.69	5.63	69.27
Grandidierella bonnieroides	0.12	1.58	3.95	0.64	4.44	73.71

Groups 1 & 3
Average dissimilarity = 80.27

Species	Group 1 Av.Abund	Group 3 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	2.31	5.77	15.97	0.84	19.90	19.90
Streblospio spp.	0.58	2.67	6.41	0.77	7.99	27.89
Mytilopsis leucophaeata	0.52	2.53	5.91	1.01	7.37	35.25
Grandidierella bonnieroides	0.12	2.51	5.73	1.02	7.14	42.40
Melanoides tuberculata	0.00	2.36	4.54	0.88	5.65	48.05
Laeonereis culveri	0.71	1.47	3.51	0.76	4.37	52.41
Hydrobiidae spp.	0.13	1.66	3.31	0.53	4.12	56.54
Polydora cornuta sp. complex	0.00	1.65	3.26	0.79	4.06	60.60
Dicrotendipes spp.	0.00	1.40	3.11	0.79	3.88	64.48
Chironomus spp.	0.42	1.27	2.42	0.73	3.02	67.49
Melita nitida complex	0.00	0.56	2.25	0.50	2.81	70.30

Groups 2 & 3
Average dissimilarity = 73.17

Species	Group 2 Av.Abund	Group 3 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	3.44	5.77	10.59	0.67	14.47	14.47
Melanoides tuberculata	4.31	2.36	6.11	1.03	8.35	22.82
Laeonereis culveri	2.54	1.47	5.09	0.87	6.95	29.77
Streblospio spp.	1.55	2.67	4.78	0.71	6.53	36.30
Tubificoid Naididae spp.	2.53	1.66	4.21	0.82	5.75	42.05
Hydrobiidae spp.	2.90	1.66	4.15	0.99	5.67	47.72
Mytilopsis leucophaeata	1.47	2.53	4.10	1.07	5.60	53.33
Grandidierella bonnieroides	1.58	2.51	4.01	1.06	5.49	58.81
Polydora cornuta sp. complex	0.48	1.65	2.65	0.81	3.63	62.44
Chironomus spp.	0.83	1.27	2.17	0.81	2.97	65.41

Rhithropanopeus harrisii	0.82	0.70	2.09	0.78	2.86	68.27
Dicrotendipes spp.	0.48	1.40	2.07	0.87	2.83	71.10

Groups 1 & 4
Average dissimilarity = 89.29

Species	Group 1 Av.Abund	Group 4 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironomus spp.	0.42	2.22	11.23	0.55	12.58	12.58
Mytilopsis leucophaeata	0.52	3.30	11.23	1.00	12.58	25.16
Stenoninereis martini	2.31	0.94	7.46	0.63	8.35	33.51
Laeonereis culveri	0.71	2.29	5.89	0.88	6.60	40.11
Pyrgophorus platyrachis	0.19	3.33	5.72	1.18	6.40	46.51
Melanoides tuberculata	0.00	1.43	5.46	0.50	6.12	52.63
Streblospio spp.	0.58	0.99	3.68	0.72	4.12	56.75
Tubificoid Naididae spp.	0.20	2.38	3.38	0.46	3.78	60.54
Grandidierella bonnieroides	0.12	2.50	3.20	0.81	3.58	64.12
Littorinidops sp.	0.00	0.53	2.20	0.49	2.47	66.59
Bryozoa (LPIL)	0.00	0.43	1.61	0.44	1.80	68.39
Hydrozoa spp.	0.00	0.93	1.54	0.75	1.72	70.11

Groups 2 & 4
Average dissimilarity = 81.13

Species	Group 2 Av.Abund	Group 4 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	3.44	0.94	7.05	0.91	8.69	8.69
Melanoides tuberculata	4.31	1.43	6.57	1.03	8.09	16.78
Mytilopsis leucophaeata	1.47	3.30	6.34	1.00	7.81	24.59
Laeonereis culveri	2.54	2.29	6.27	0.85	7.72	32.32
Chironomus spp.	0.83	2.22	5.06	1.23	6.23	38.55
Hydrobiidae spp.	2.90	0.46	4.61	0.94	5.68	44.23
Tubificoid Naididae spp.	2.53	2.38	4.54	0.72	5.59	49.83
Pyrgophorus platyrachis	0.12	3.33	4.35	1.03	5.36	55.19
Grandidierella bonnieroides	1.58	2.50	3.79	0.91	4.67	59.86
Streblospio spp.	1.55	0.99	3.42	0.74	4.21	64.07
Rhithropanopeus harrisii	0.82	0.59	1.84	0.56	2.27	66.34
Littorinidops sp.	0.00	0.53	1.52	0.42	1.87	68.21
Dicrotendipes spp.	0.48	0.79	1.48	0.67	1.82	70.03

Groups 3 & 4
Average dissimilarity = 78.52

Group 3 Group 4

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	5.77	0.94	10.24	0.94	13.04	13.04
Mytilopsis leucophaeata	2.53	3.30	4.96	0.95	6.31	19.35
Chironomus spp.	1.27	2.22	4.65	0.99	5.92	25.27
Grandidierella bonnieroides	2.51	2.50	3.84	0.91	4.89	30.16
Melanoides tuberculata	2.36	1.43	3.55	0.85	4.52	34.68
Streblospio spp.	2.67	0.99	3.47	0.79	4.42	39.10
Pyrgophorus platyrachis	0.68	3.33	3.13	0.97	3.99	43.09
Hydrobiidae spp.	1.66	0.46	3.13	0.70	3.99	47.08
Tubificoid Naididae spp.	1.66	2.38	3.11	0.63	3.96	51.04
Laeonereis culveri	1.47	2.29	2.86	0.71	3.64	54.68
Dicrotendipes spp.	1.40	0.79	2.46	0.79	3.14	57.82
Polydora cornuta sp. complex	1.65	0.43	2.10	0.74	2.67	60.49
Rhithropanopeus harrisii	0.70	0.59	1.71	0.53	2.18	62.67
Melita nitida complex	0.56	0.00	1.43	0.43	1.82	64.49
Cassidinidea ovalis	0.67	2.20	1.42	0.73	1.80	66.30
Panopeidae spp.	0.80	0.00	1.00	0.54	1.28	67.57
Hydrozoa spp.	0.00	0.93	0.95	0.67	1.21	68.79
Dipolydora socialis	0.00	1.17	0.92	0.60	1.17	69.95
Boccardiella spp.	0.00	1.06	0.88	0.47	1.12	71.07

Examines Segment groups
(across all MFL Period groups)
Group Lower
Average similarity: 24.77

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Stenoninereis martini	3.09	14.84	0.66	59.90	59.90
Melanoides tuberculata	1.32	2.38	0.39	9.62	69.52
Laeonereis culveri	1.73	2.38	0.39	9.61	79.13

Group Middle
Average similarity: 26.96

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Stenoninereis martini	3.68	8.51	0.69	31.58	31.58
Melanoides tuberculata	2.47	4.93	0.77	18.27	49.85
Tubificoid Naididae spp.	1.93	2.85	0.54	10.58	60.43
Hydrobiidae spp.	1.74	2.24	0.52	8.29	68.73
Laeonereis culveri	1.66	1.93	0.35	7.14	75.87

Group Upper
Average similarity: 35.12

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Pyrgophorus platyrachis	2.73	3.11	1.23	8.86	8.86
Melanoides tuberculata	3.32	2.73	0.48	7.78	16.63
Cassidinidea ovalis	2.70	2.60	0.69	7.40	24.04
Ablabesmyia rhamphe group	1.52	2.53	1.04	7.19	31.23
Polypedilum halterale group	1.85	2.52	1.03	7.19	38.42
Tubificoid Naididae spp.	3.74	2.52	0.87	7.18	45.60
Helobdella stagnalis	1.49	2.18	1.03	6.22	51.82
Grandidierella bonnieroides	2.66	2.02	0.80	5.75	57.57
Hydroptila spp.	1.19	1.92	1.01	5.47	63.04
Hyalella spp.	1.28	1.85	1.04	5.26	68.31
Caenis diminuta	0.98	1.77	1.03	5.03	73.34

Groups Lower & Middle
Average dissimilarity = 76.64

Species	Group Lower Av.Abund	Group Middle Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	3.09	3.68	16.24	0.73	21.19	21.19
Laeonereis culveri	1.73	1.66	7.64	0.54	9.97	31.16
Streblospio spp.	2.24	0.76	6.23	0.69	8.13	39.29
Mytilopsis leucophaeata	1.42	1.96	5.32	0.64	6.94	46.23
Melanoides tuberculata	1.32	2.47	4.76	0.66	6.21	52.44
Tubificoid Naididae spp.	0.50	1.93	4.56	0.72	5.95	58.39
Hydrobiidae spp.	0.58	1.74	3.51	0.71	4.58	62.97
Grandidierella bonnieroides	0.96	1.45	3.38	0.70	4.41	67.38
Chironomus spp.	0.71	1.25	2.97	0.63	3.87	71.26

Groups Lower & Upper
Average dissimilarity = 86.74

Species	Group Lower Av.Abund	Group Upper Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	3.09	1.24	12.15	0.67	14.01	14.01
Laeonereis culveri	1.73	1.98	7.05	0.55	8.13	22.14
Hydrobiidae spp.	0.58	2.65	5.07	0.83	5.84	27.98
Tubificoid Naididae spp.	0.50	3.74	4.49	1.08	5.17	33.15
Streblospio spp.	2.24	0.56	4.25	0.58	4.89	38.05
Chironomus spp.	0.71	1.17	4.16	0.72	4.80	42.85
Melanoides tuberculata	1.32	3.32	3.92	0.67	4.52	47.37
Mytilopsis leucophaeata	1.42	1.54	3.52	0.64	4.06	51.43
Pyrgophorus platyrachis	0.52	2.73	3.20	0.60	3.68	55.11
Monopylephorus rubroniveus	0.00	0.51	3.06	0.41	3.53	58.64

Grandidierella bonnieroides	0.96	2.66	2.23	0.81	2.57	61.21
Cassidinidea ovalis	0.08	2.70	2.11	0.83	2.43	63.64
Hyale sp. A	0.00	0.33	1.99	0.41	2.30	65.94
Capitella capitata sp. complex	0.20	0.20	1.82	0.36	2.10	68.04
Corbicula fluminea	0.00	2.20	1.64	0.69	1.89	69.92
Carazziella hobsonae	0.08	0.24	1.53	0.43	1.77	71.69

Groups Middle & Upper
Average dissimilarity = 77.12

	Group Middle	Group Upper				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Stenoninereis martini	3.68	1.24	7.03	0.50	9.11	9.11
Laeonereis culveri	1.66	1.98	4.86	0.69	6.31	15.42
Hydrobiidae spp.	1.74	2.65	4.39	0.86	5.69	21.11
Tubificoid Naididae spp.	1.93	3.74	4.34	1.14	5.62	26.73
Chironomus spp.	1.25	1.17	4.15	0.74	5.38	32.11
Mytilopsis leucophaeata	1.96	1.54	3.51	0.66	4.54	36.65
Pyrgophorus platyrachis	0.34	2.73	3.39	0.65	4.40	41.05
Melanoides tuberculata	2.47	3.32	3.32	0.81	4.31	45.36
Grandidierella bonnieroides	1.45	2.66	2.78	0.85	3.60	48.96
Monopylephorus rubroniveus	0.21	0.51	2.65	0.37	3.44	52.40
Cassidinidea ovalis	0.44	2.70	2.24	0.82	2.90	55.30
Corbicula fluminea	0.40	2.20	1.96	0.78	2.54	57.84
Hyale sp. A	0.00	0.33	1.61	0.34	2.09	59.94
Streblospio spp.	0.76	0.56	1.48	0.50	1.92	61.86
Carazziella hobsonae	0.00	0.24	1.18	0.34	1.53	63.39
Exosphaeroma diminutum	0.00	0.24	1.18	0.34	1.53	64.92
Polypedilum halterale group	0.19	1.85	1.16	0.58	1.50	66.42
Capitella capitata sp. complex	0.07	0.20	1.05	0.36	1.36	67.78
Dicrotendipes spp.	0.82	0.77	1.04	0.70	1.35	69.13
Boonea impressa	0.00	0.20	0.99	0.34	1.29	70.42