NC Division of Water Resources
Water Sciences Section

July 26, 2021

Memorandum

To: Danny Smith – Water Resources Director

CC: Julie Grzyb
Scott Vinson

From: Sarah Segars, Sean Buczek

Through: Eric Morris

Subject: Study for the Ongoing Assessment of Water Quality in B. Everett Jordan Lake, Including Identification of Select Emerging Compounds: 2020 Results

Purpose: The objective of this study is to evaluate progress in reducing nutrient and nutrient-related pollution in B. Everett Jordan Lake (WS-IV,B;NSW,CA), as required by the Jordan Lake Water Supply Nutrient Strategy (15A NCAC 02B.0262) (i.e. the "Jordan Lake Rules"). Additionally, samples were collected to monitor the presence of per- and poly-fluorinated alkyl substances (PFAS) and 1,4-dioxane in Jordan Lake as part of an initiative to provide baseline emerging compounds data for public drinking water supply reservoirs. This report summarizes results of *in situ* monitoring and chemical analyses of surface water samples collected in 2020**.**

Study for the Ongoing Assessment of Water Quality in B. Everett Jordan Lake, Including Identification of Select Emerging Compounds: 2020 Results

Cape Fear River Basin

HUC: 0303000206, 0303000207

North Carolina Department of Environmental Quality
Division of Water Resources
Water Sciences Section
Intensive Survey Branch
July 2021

Division of Water Resources

Study for the Ongoing Assessment of Water Quality in B. Everett Jordan Lake, Including Identification of Select Emerging Compounds: 2020 Results

Cape Fear River Basin

HUC: 0303000206, 0303000207

Introduction

Monthly water quality monitoring on B. Everett Jordan Lake (Jordan Lake) is conducted to evaluate progress in reducing nutrient and nutrient-related pollution in Jordan Lake (WS-IV,B;NSW,CA) as required by the Jordan Lake Water Supply Nutrient Strategy (15A NCAC 02B.0262) (i.e. the "Jordan Lake Rules"). This report summarizes results of *in situ* monitoring and chemical analyses of surface water samples collected by the Intensive Survey Branch (ISB) in 2020, including an assessment of the presence and concentrations of select per- and poly-fluorinated alkyl substances (PFAS) and 1,4-dioxane.

Background

Since long before passage of the Jordan Lake Rules in 2009, routine water quality monitoring has been conducted on Jordan Lake to evaluate the impacts of nutrient-related pollution. The Division of Water Resources began collecting ambient data at Jordan Lake as early as 1982 when the lake was still being filled. The data record from the Haw River in areas now inundated by Jordan Lake extends back even further. This document summarizes the physical and chemical data collected in 2020 and provides updates to a previous survey conducted in 2018 to evaluate the presence of PFAS and 1,4-dioxane in public water supply reservoirs in the Cape Fear River Basin[1]. That effort identified the Haw River as a potential source of these emerging compounds in Jordan Lake, and warranted additional study.

Methods

Water quality sampling was conducted at 9 monitoring stations (Figure 1) located throughout Jordan Lake. Samples were collected in accordance with ISB's *Standard Operating Procedures Manual: Physical and Chemical Monitoring v2.1, Dec. 2014*[2]. Physical parameters presented in this document were collected at the surface (0.15 m) using an In-Situ multiparameter hydrosonde. Chemical samples were collected as composites of the photic zone, which is defined as being from the water's surface to twice the Secchi depth. Duplicate samples were collected at one station per sampling event on a rotating schedule for quality control. Samples for PFAS and I,4-dioxane were collected as surface grabs (0.15 m) at five of the nine monitoring stations (Figure 1) in accordance with ISB's DRAFT *Standard Operating Procedures Manual: Per- and Poly-Fluorinated Alkyl Substances (PFAS) - Field Collection Method*. Appropriate QA/QC samples were collected during each sampling event including trip blanks, field blanks, duplicates, matrix spikes and matrix spike duplicates. All chemical samples were analyzed by the DWR central laboratory in Raleigh. A list of the physical and chemical parameters collected are shown below in Table 1.

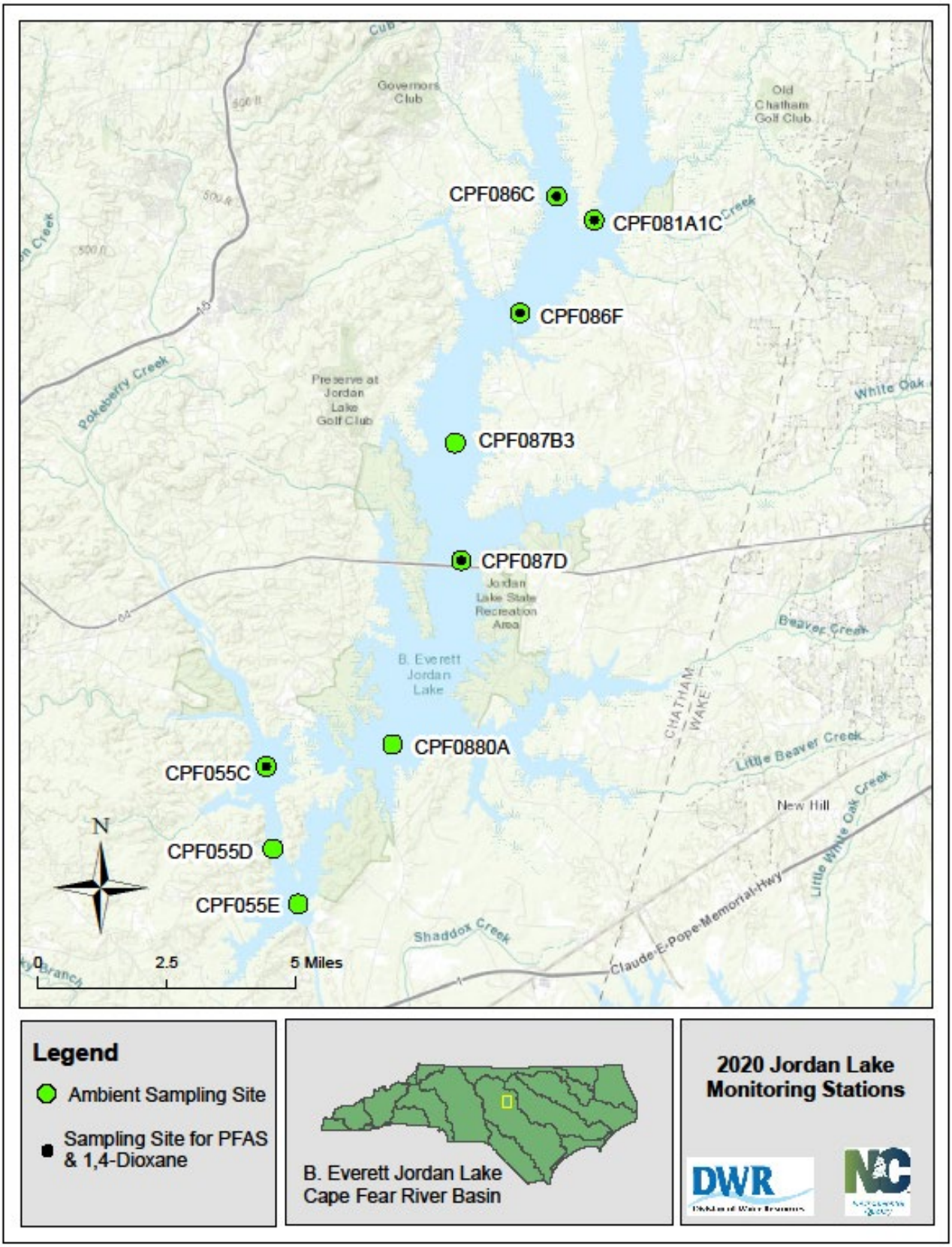


***Figure 1**. B. Everett Jordan Lake monitoring stations.*

.

Physical and Chemical Results

One-year summary results are presented by station for the three management areas: Upper New Hope (Figure 2), Lower New Hope (Figure 3), and Haw River Arm (Figure 4). The tables display annual mean, minimum, and maximum concentrations for total phosphorus (TP -- mg/L), total nitrogen (TN -- mg/L), chlorophyll *a* (Chl*a* -- μg/L), turbidity (NTU), dissolved oxygen (DO -- mg/L), and pH (s.u.). Data summaries are calculated from 11 sampling events (n) for all sites. Samples were not collected in April due to travel restrictions related to Covid-19. Percent exceedance of state fresh surface water quality standards is shown for each station. Exceedance is defined by Chl*a* >40 μg/L; turbidity >25 NTU; DO <4 mg/L; pH >9 or <6 s.u. All nitrate + nitrite and ammonia data below the practical quantitation limit (PQL) of 0.02 mg/L were quantified as 0.01 mg/L to calculate TN values. NCDWR defines the PQL as the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Emerging Compound Results

Laboratory analysis for 1,4-dioxane did not yield a detection above the PQL of 1.0 μg/L at any station throughout the duration of the study. These findings are improved based on the 2018 ISB study on Jordan Lake that yielded several 1,4-dioxane detections above the NC Protective Value for Surface Water of 0.35 μg/L[3] in the lower Haw River arm of the lake.

Analytical results for PFAS indicated the presence of at least one PFAS analyte above the laboratory PQL (2.0 ng/L) at each sampling event and station during the 2020 sampling season (Figure 5). Of the 28 PFAS compounds selected for this study, the following twelve compounds were found at or above the PQL on at least one occasion: 6:2FTS, PFBS, PFBA, PFHpA, PFHxA, PFHxS, PFNA, PFPeS, PFHpS, PFOA, PFOS, and PFPeA. These results demonstrate the widespread distribution of detectable PFAS in Jordan Lake; however, surface water results for PFOA and PFOS combined did not exceed the USEPA established health advisory level for PFOA, PFOS, or combined PFOA and PFOS, of 70 ppt (ng/L)[4] in finished drinking water. Values of detected compounds and the associated detection dates for sites with compounds above the PQL are listed in Appendix 2.

Full datasets are available upon request. For further questions regarding this or other studies, please contact Eric Morris, Intensive Survey Branch Supervisor, directly at (919) 743-8496 or eric.morris@ncdenr.gov.

https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/intensive-survey-branch/falls-jordan-lakes-monitoring

Physical Parameters	**Chemical Parameters** (ng/L unless otherwise noted)		
Temperature (°C) pH (s.u.) Dissolved Oxygen (mg/L) Conductivity (µS/cm) Secchi Depth (m) Turbidity (mg/L)	Nutrients (mg/L) Chl-*a* (µg/L) 4:2FTS 6:2FTS 8:2FTS ADONA I HFPO-DA N-EtFOSAA N-MeFOSAA PFBA 11Cl-PFOUdS	PFBS PFDA PFDoA PFDS PFHpA PFHpS PFHxA PFHxS PFNA PFNS PFOA	PFOS PFPeA PFPeS PFTeDA PFTrDA PFUnA PFUdA 9Cl-PF3ONS 1,4-Dioxane (µg/L)

Table 1. *Summary of physical and chemical parameters collected. See Appendix I for a detailed list of PFAS chemical parameters*

CPF086C						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.08	1.07	59.5	11.9	10.8	8.55
Min	0.05	0.87	35.0	6.70	8.6	7.60
Max	0.13	1.31	91.0	16.0	13.4	9.20
n>Standard			*9*	*0*	*0*	*4*
% Exceedance			*81.8%*	*0.0%*	*0.0%*	*36.4%*
% Confidence			*100.0%*	*N/A*	*N/A*	*98.1%*

CPF081A1C						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.09	1.09	55.0	14.4	10.4	8.19
Min	0.05	0.86	30.0	6.90	7.10	7.50
Max	0.13	1.31	107.0	29.0	13.4	9.30
n>Standard			*9*	*1*	*0*	*3*
% Exceedance			*81.8%*	*9.1%*	*0.0%*	*27.3%*
% Confidence			*100.0%*	*31.4%*	*N/A*	*91.0%*

CPF086F						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.07	1.04	57.9	9.61	10.7	8.28
Min	0.05	0.83	29.0	5.90	7.70	7.40
Max	0.09	1.25	91.0	16.0	13.0	9.30
n>Standard			*8*	*0*	*0*	*2*
% Exceedance			*72.7%*	*0.0%*	*0.0%*	*18.2%*
% Confidence			*100.0%*	*N/A*	*N/A*	*69.7%*

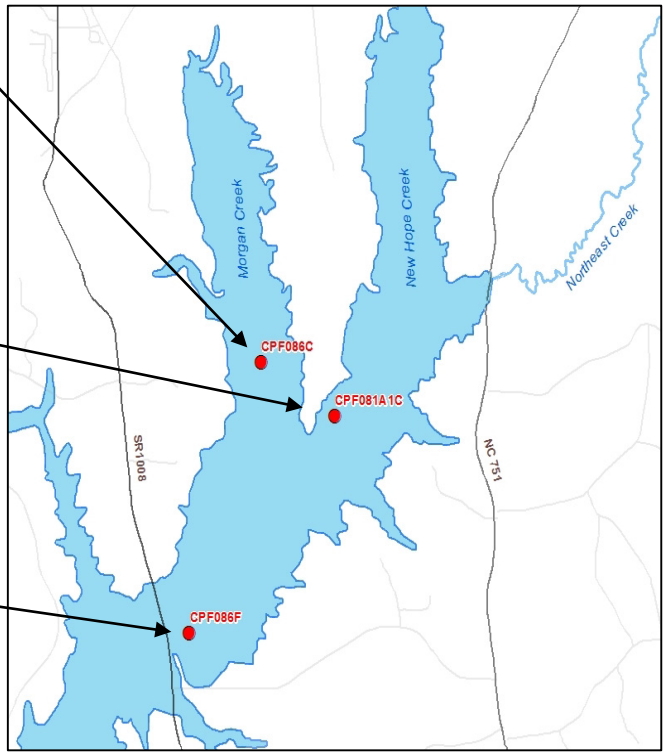
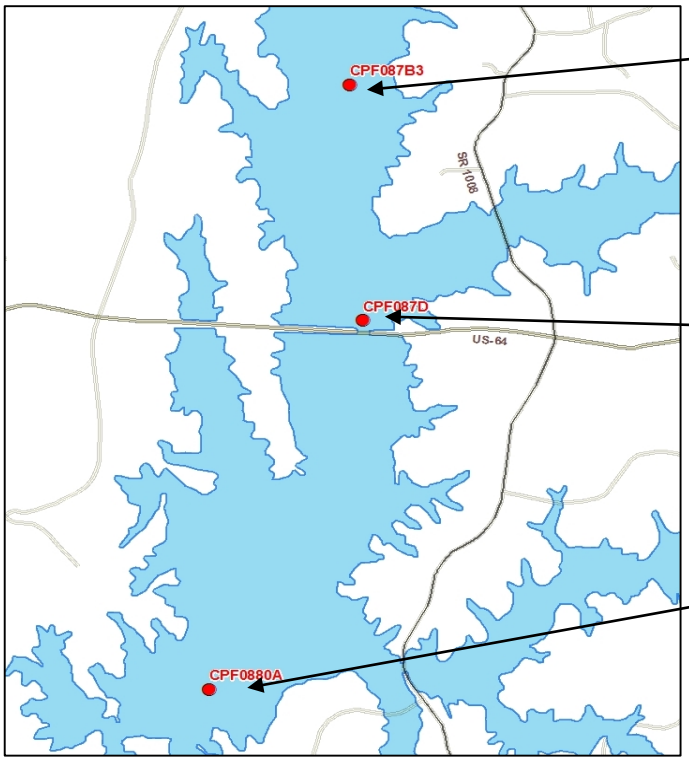


Figure 2. *Upper New Hope Section of Jordan Lake*

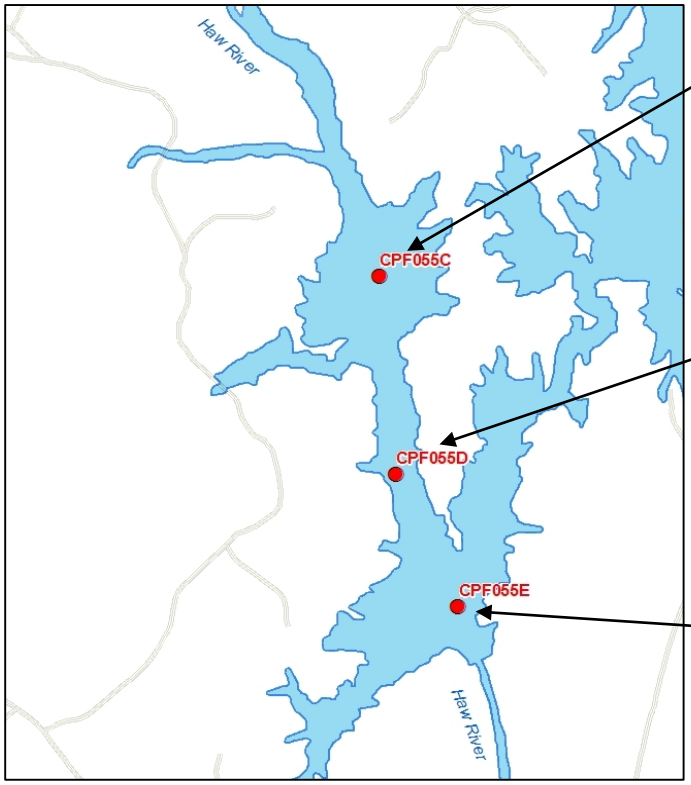


CPF087B3						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.05	0.97	46.8	6.39	9.78	7.98
Min	0.04	0.75	12.0	4.40	8.30	7.10
Max	0.06	1.18	81.0	9.80	12.9	9.20
n>Standard			*5*	*0*	*0*	*1*
% Exceedance			*45.5%*	*0.0%*	*0.0%*	*9.1%*
% Confidence			*99.7%*	*N/A*	*N/A*	*31.4%*

CPF087D						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.04	0.93	38.6	6.07	9.75	8.06
Min	0.04	0.68	20.0	3.80	7.30	6.80
Max	0.06	1.22	61.0	9.50	12.8	9.40
n>Standard			*4*	*0*	*0*	*1*
% Exceedance			*36.4%*	*0%*	*0%*	*9.1%*
% Confidence			*98.1%*	*N/A*	*N/A*	*31.4%*

CPF0880A						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.04	0.91	32.1	7.49	9.45	7.97
Min	0.02	0.68	8.90	3.40	6.50	7.10
Max	0.09	1.27	59.0	19.00	11.70	9.30
n>Standard			*3*	*0*	*0*	*2*
% Exceedance			*27.3%*	*0%*	*0%*	*18.2%*
% Confidence			*91.0%*	*N/A*	*N/A*	*69.7%*

Figure 3. *Lower New Hope Section of Jordan Lake*



CPF055C						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.08	1.13	31.7	12.4	10.65	8.18
Min	0.05	0.83	6.6	3.7	8.00	7.10
Max	0.17	1.51	55.0	29.0	12.00	9.20
n>Standard			4	2	0	4
% Exceedance			36.4%	18.2%	0%	36.4%
% Confidence			98.1%	69.7%	N/A	98.1%

CPF055D						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.07	1.09	31.0	11.53	10.03	8.12
Min	0.04	0.86	7.3	3.90	6.60	7.10
Max	0.12	1.47	48.0	32.00	12.30	9.30
n>Standard			*3*	*1*	*0*	*2*
% Exceedance			*27.3%*	*9.1%*	*0%*	*18.2%*
% Confidence			*91.0%*	*31.4%*	*N/A*	*69.7%*

CPF055E						
	TP	TN	Chl*a*	Turbidity	DO	pH
n	11	11	11	11	11	11
Mean	0.06	1.02	31.2	8.87	9.50	8.02
Min	0.04	0.67	6.7	3.00	6.40	7.00
Max	0.10	1.34	55.0	23.00	11.40	9.20
n>Standard			*2*	*0*	*0*	*2*
% Exceedance			*18.2%*	*0.0%*	*0%*	*18.2%*
% Confidence			*69.7%*	*N/A*	*N/A*	*69.7%*

Figure 4. *Haw River Arm of Jordan Lake*

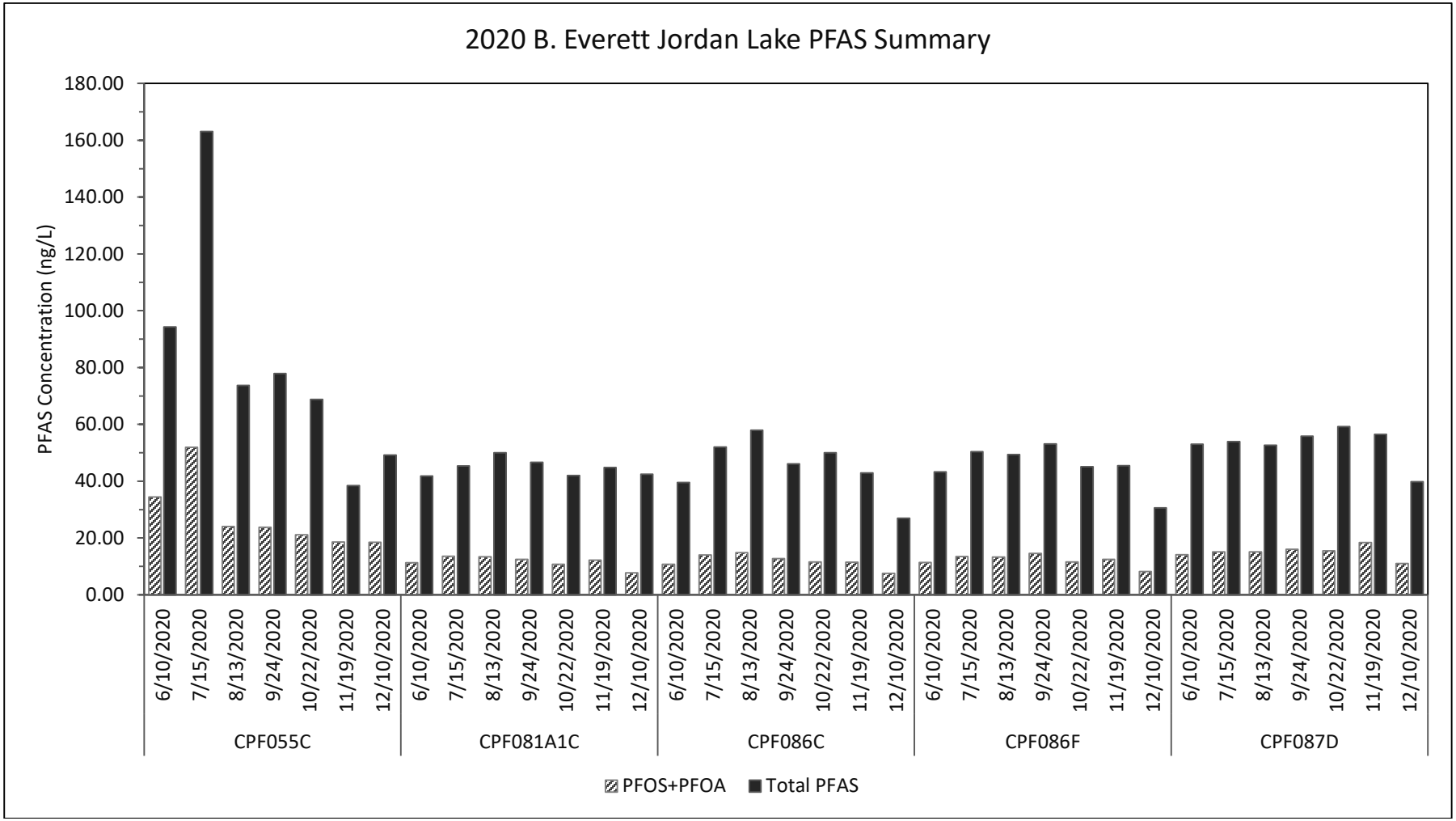


Figure 5. *Per- and poly-fluorinated alkyl concentrations at B. Everett Jordan Lake monitoring stations. Only values greater than the PQL (2 ng/L) are presented.*

References

[1]Intensive Survey Unit. 2019. *Identification of Select Emerging Compounds in Public Water Supply Reservoirs in the Cape Fear, New, and Watauga River Basins*. https://files.nc.gov/ncdeq/Water%20Resources/files/ec/Identification-of-Select-Emerging-Compounds-in-Public-Water-Supply-Reservoirs-in-the-Cape-Fear-New-and-Watauga-River-Basins-FINAL.pdf

[2]DWR-WSS. 2013. *Intensive Survey Branch Standard Operating Procedures Manual: Physical and Chemical Monitoring.* Raleigh: State of North Carolina. https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/ISU/ISB%20SOP%20Version2.1%20%20FINAL.pdf

[3]NCDWR. 2017. *NC Surface Water Quality Standards Table.* https://deq.nc.gov/about/divisions/water-resources/planning/classification-standards/surface-water-standards#TriennialReviewInfo

[4]USEPA. 2016. *Fact Sheet: PFOA & PFOS Drinking Water Health Advisories.* https://www.epa.gov/ground-water-and-drinking-water/supporting-documents-drinking-water-health-advisories-pfoa-and-pfos