

Rookery Bay National Estuarine Research Reserve (RKBNERR)
NERR Nutrient Metadata
January – December 2021
Latest update: May 20, 2022

Note: This is a provisional metadata document; it has not been authenticated as of its download date. Contents of this document are subject to change throughout the QAQC process and it should not be considered a final record of data documentation until that process is complete. Contact the CDMO (cdmosupport@baruch.sc.edu) or reserve with any additional questions.

I. Data Set and Research Descriptors

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2) Research objectives:

The System-wide Monitoring Program water quality initiative began at the RKBNERR in 1996. Currently, there are four primary SWMP stations and one secondary SWMP station that are in estuaries affected by watersheds demonstrating different patterns of land use. Their placement addresses priority resource management issues that are identified in the Reserve's management plan. Specifically, the data from these stations provide valuable information concerning the effects of land-use activities on the quantity, quality, and timing of freshwater inflow into the reserve. Each bay studied exhibits a pattern of altered freshwater inflow.

- a) **Monthly Grab Sampling Program:** The principal objective of the monthly grab sampling is to determine spatial and temporal differences in water quality between sites representing different land-use patterns.
- b) **Diel Sampling Program:** The principal objective of the diel sampling is to quantify temporal variability over a lunar tidal cycle and to determine the impact of tidal water exchange within Henderson Creek (a source of freshwater into the Rookery Bay proper waterbody).

3) Research methods:

a) Monthly Grab Sampling Program

Monthly grab samples were collected at all four primary SWMP water quality stations: Henderson Creek, Middle Blackwater River, Faka Union Bay, and Fakahatchee Bay. Beginning in October 2012, grab samples were also collected at Pumpkin Bay which was designated a Secondary SWMP Station by the CDMO in October of 2016. Duplicate grab samples were taken every month at each of the water quality stations following the National Estuarine Research Reserve System Nutrient and Chlorophyll Monitoring Program and Database Design SOP v1.8. Slack low tide was generally not considered for the grab sampling events due to the travel time between sites and the time constraints with the contracted laboratory. Rainfall conditions prior to grab sampling were generally not considered due to constraints with the contracted laboratory.

Sample bottles were pre-cleaned by the contracted laboratory following their Quality Assurance Management Plan (available by request). The bottle kits for each station were labeled with a unique sample identification number and chain of custody sheets were completed for tracking the samples during laboratory analysis and in the laboratory database. Tubing for the water sampling device (peristaltic pump), carboys (for deionized water), and filter holders were pre-cleaned using a Florida Department of Environmental Protection (FLDEP) decontamination procedure (FLDEP SOP FC1000/DEP-QAA-01/001) which involved: cleaning with phosphate-free soap, rinsing three times with tap water, soaking from 4 - 24 hours in a 10% hydrochloric acid bath, rinsing three times with deionized water, and drying for 24 hours. One to two days prior to field sampling, the filter holders were assembled with in-line filters (0.7 µm glass microfiber filters and 0.45 µm membrane filters).

At each water quality station, grab samples for dissolved nutrients were collected 0.5 meter below the surface (near surface grab) using a peristaltic pump. A filter holder attached to the peristaltic

pump tubing was used to filter for dissolved nutrients in the field. Nitrile gloves were worn through the entire process of sample collection and filtering. Unfiltered parameters included chlorophyll *a*, phaeophytin *a*, total phosphorous (TP), total Kjeldahl nitrogen (TKN), and total suspended solids (TSS). Filtered parameters included ammonium (NH₄), nitrite + nitrate (NO₂+NO₃), nitrite (NO₂), and orthophosphate (PO₄). Chlorophyll *a*/ phaeophytin *a* and TSS sample bottles were rinsed three times with the sample water then filled to the shoulder, capped, and immediately stored in a cooler with ice. The nitrite/ orthophosphate bottle was rinsed three times with filtered water and then filled with the filtrate, capped, and immediately stored in a cooler with ice. The sample bottles for ammonia, nitrite + nitrate, total Kjeldahl nitrogen, and total phosphorus contained sulfuric acid for preservation and therefore were not rinsed before adding the sample. All sample bottles were made of translucent high-density polyethylene (HDPE) with the exception of the chlorophyll *a*/ phaeophytin *a* bottle which was an opaque amber HDPE bottle. To avoid cross contamination, the peristaltic pump tubing was rinsed thoroughly with deionized water after each sampling and then rinsed thoroughly with sample water before sampling at each new station. New gloves and filters were used at each site. Additionally, an equipment blank using deionized water was performed at the end of each sampling event following all the same procedures. Samples were shipped overnight to the FLDEP lab in Tallahassee, FL.

Starting in January 2018, additional Chlorophyll *a* grab samples were collected at each site, using the same collection methods, in a different opaque amber HDPE bottles to compare the fluorometric and spectrophotometer method of analysis. The FLDEP lab reported the results for comparison purposes and the fluorometric data are available by request. The method comparisons were concluded July 2020 and the original spectrophotometer method was continued.

At each site physical/chemical water quality parameters were measured at the same depth as the nutrient samples were collected. A YSI EXO1 datasonde with hand held display were used to record the measurements. Recorded parameters included salinity (ppt), specific conductivity (mS/cm), temperature (°C), dissolved oxygen (% and mg/L), pH, and turbidity (NTU). Equipment calibration was done according to NERRS SWMP EXO SOP v2.0 and FLDEP SOP 001/01.

b) Diel Sampling Program

Monthly diel samples were collected at the depth of the water quality datasonde (0.25 meters above the bottom) every 2.5 hours over a lunar day (24hr:48 min) using an ISCO refrigerated auto-sampler (model 6712FR). The sampler was stationed approximately 100 meters from the Lower Henderson water quality site, on the RKBNERR Shell Island Road dock. Prior to sampling, the polyethylene bottles used in the auto-sampler were washed following the same FLDEP decontamination procedure as described above in the grab sampling methods. A day before the sampling was to begin, the ISCO auto-sampler was set up and programmed. The siphon hose was rinsed with 900 ml ambient water prior to programming the auto-sampler. Sample bottles for the laboratory analysis were pre-cleaned by the contracted laboratory following their Quality Assurance Management Plan (available by request). Bottle kits for each sample interval (11) were labeled with a unique sample identification number and chain of custody sheets were completed for tracking the samples during laboratory analysis and in the laboratory database.

Sample filtration: Nitrile gloves were worn during sample processing. At Rookery Bay's laboratory, each polyethylene bottle containing 1000 ml of sample water was shaken to homogenize the sample. A peristaltic pump with a filter holder attached to the sampling tube was used to filter for dissolved nutrients. For dissolved phosphorus and nitrite, HDPE sample bottles were filled with the filtrate, capped, and immediately stored in a cooler with ice. For ammonium and nitrite + nitrate, the HDPE sample bottles contained sulfuric acid for preservation and therefore were not rinsed before adding the filtrate, capped, and immediately stored in a cooler with ice. New filters were used for each sample. For the chlorophyll *a* samples, HDPE amber

sample bottles were filled with at least 500 ml of unfiltered sample, capped, and immediately stored in a cooler with ice. Samples were shipped overnight to the FLDEP lab in Tallahassee, FL.

c) All Samples

Samples are placed on ice immediately after collection and kept on ice while shipped overnight to the FLDEP lab in Tallahassee, FL. Once at the lab, they are inventoried and placed in the appropriate refrigerator/freezer. Refrigerators range from 0 to 6.0°C and freezers from -30.0 to -5.0°C.

4) Site location and character:

The RKBNER spans approximately 110,000 acres (445.2 km²) of public lands on Florida's Gulf coast south of Naples. Approximately 5 percent (6,000 acres) are uplands and 95 percent (104,000 acres) are submerged lands. Within the submerged lands, 68,000 acres are open water and 36,000 acres are mangroves. The Reserve covers approximately 40 percent of the Collier County coastline, from Gordon Pass in Naples southward to the northwestern boundary of Everglades National Park. Major habitats of the Reserve include extensive pristine subtropical mangrove-forested wetlands, undeveloped barrier islands, and some of the last remaining intact tropical hardwood hammocks and coastal scrub habitats in southwest Florida. The coastal ecosystem within the Reserve has national and international significance as the western edge of the Everglades ecosystem, yet it is located adjacent to one of the fastest developing coastal areas in the United States. DEP has designated all tidally connected waters within the boundaries of the Reserve as Class II and Outstanding Florida Waters (OFW).

Natural drainage patterns within Collier County have been significantly altered by the construction of canal systems designed to lower annual peak water levels during the wet season to prevent flooding. Such canals include the Henderson Creek Canal, Lely Canal, Faka Union Canal, and borrow canals used for constructing U.S. 41 (Tamiami Trail), State Road 951 (Collier Boulevard), and County Road 92. A combination of fixed weirs and gates control canal flow, preventing excessive freshwater drainage and saltwater encroachment. The primary basins that feed the Rookery Bay Reserve watershed are Lely (SFWMD No. 6), Henderson Creek, and Picayune Strand. These basins are sub-units of SFWMD.

The climate for southwest Florida is classified as Tropical Rainy. The average annual rainfall is approximately 54 inches (137 cm) per year, with the wet season extending from the end of May through the beginning of October. The average annual air temperature in the Reserve as recorded at the RKBNER SWMP weather station was 24.8°C (76.6°F) for 2020. Seasonal variation in temperature within the Reserve follows that of rainfall with a summer period of high temperatures between May and October and a cooler period extending from December through March. Southwestern Florida lies in the seasonal tropical weather belt that channels hurricanes toward or along the coast. One of the most common extreme weather impacts to the Reserve area is from tropical cyclones such as tropical depressions, tropical storms, and hurricanes. On average, Naples is affected once every 2.67 years by tropical cyclones, every 6.68 years by hurricanes, and every 10.5 years by major hurricanes. The last major hurricane that affected this area was Hurricane Irma on September 10, 2017, which made landfall on Marco Island with sustained winds of 115 mph.

Station Descriptions:

Lower Henderson Creek (rkblhwq):

Lat/Long (Decimal Degrees): 26.02749 N, -81.73361 W

The Lower Henderson Creek station is affixed to a piling with a manatee caution sign located approximately 100 meters across the Reserve's Shell Island Road boat dock. The monitoring site is approximately 5 km downstream of a four-lane highway (SR 951) that crosses Henderson Creek. The creek is 5.8 km long (mainstream linear dimension), has an average mid-channel depth of approximately 2 meters at MHW, and an average width of 239 meters. At the sampling site, the depth is 2 meters at MHW and the width is 600 meters. Tides at Lower Henderson Creek are mixed and range from 0.23 m to 1.50 m (average 0.84 m). Salinity at this site ranged from 11.0 to 38.0 ppt during 2021. Creek bottom habitats are predominantly fine sand and there is no bottom vegetation. The dominant marsh vegetation near the sampling site is red mangrove. The dominant natural vegetation of the watershed is hydric pine and cypress.

The Lower Henderson Creek station receives most of its freshwater from a canal system that drains a watershed area with approximately 55% developed versus natural landscape. Land-use in the developed area is divided equally between residential and agricultural activities. Residential areas include developments with septic systems. A weir controls most of the freshwater flowing into Henderson Creek. The amount of water released from this weir can sometimes mask natural tidal salinity patterns. The historic Henderson Creek watershed was approximately 50% under State ownership and much of this protected area had intact cypress sloughs and other wetland vegetation. Canals and water use for agriculture and human consumption have altered the hydroperiod of this watershed. Consequently, the Henderson creek watershed may receive non-point source pollution runoff from a variety of sources.

Middle Blackwater River (rkbmbwq):

Lat/Long (Decimal Degrees): 25.9343 N, -81.5946 W

The Middle Blackwater River station is affixed to navigational marker 17 within the river channel. The average depth at this marker is approximately 2 meters at MHW. The tidal range for the station varies between 0.05 and 1.90 meters (average 0.95 m). Salinity at this site ranged from 3.4 to 39.1 ppt during 2021. Salinities fluctuate with the tides and watershed rainfall. The substrate within the channel is a mixture of sand and silt with oyster shell with some organic matter mixed in. Mature red mangrove forests dominate the banks of the river.

The Middle Blackwater River station has a watershed that is 75% natural landscape. Agriculture dominates the land-use activities within the developed area of the watershed, but residential development of the watershed has been increasing. Upstream influences consist of the Collier-Seminole State Park boat basin and upstream agricultural fields adjacent to Blackwater River's main feeder canal (SR 41 canal). Nonpoint source pollution from agricultural operations and golf courses may affect this site. In addition, canals and roads built during the 1960's (Picayune Strand, formerly Southern Golden Gate Estates) may have caused significant disruptions to overland sheet-flow reducing the amounts of freshwater flowing to this estuary. Despite these alterations, the salinity fluctuations of this site suggest that seasonal fluctuations in salinity are more closely correlated to watershed rainfall patterns than salinities of estuaries with water control structures, such as Henderson Creek. Based on modeling of historic flow-way patterns, the watershed draining into Blackwater River has been significantly reduced possibly resulting in higher than historical salinity values.

Faka Union Bay (rkbfuwq):

Lat/Long (Decimal Degrees): 25.9005 N, -81.5159 W

The Faka Union Bay station is located at the mouth of the Faka Union Canal on a manatee speed zone sign next to the main channel. The average depth at this site is approximately 2 meters at MHW. The tidal range for Faka Union Bay varies between 0.06 and 1.68 meters (average 0.79 m). Salinity at this site ranged from 0.4 to 38.0 ppt during 2021. Salinities fluctuate daily with tides, seasonal rainfall,

and management of upstream water control structures. The substrate within the channel is a mixture of sand and silt with some organic matter. Mature red mangrove forests and spoil islands dominate the banks of the canal.

The Faka Union Bay station is located immediately downstream of Port of the Isles community and the failed housing development and current PSRP. Four canals constructed for the original project converge into one canal (Faka Union Canal) which drains into Faka Union Bay. Consequently, this station represents the most extreme state of altered freshwater inflow of the four monitoring sites in the Ten Thousand Islands. Faka Union Bay experiences lower than historical salinity values and extreme fluctuations in salinity during the wet season.

Fakahatchee Bay (rkbfwbq):

Lat/Long (Decimal Degrees): 25.8922 N, -81.4770 W

The Fakahatchee Bay station is located at the mouth of two rivers, Fakahatchee River and East River, secured to a 6-inch PVC pipe hydro-jetted into the substrate. The average depth at MHW is approximately 1.5 meters. The tide range varies between 0.00 and 1.84 meters (average 0.80 m). Salinity at the station ranged from 3.3 to 39.2 ppt during 2021. Salinities fluctuate daily with the tides and seasonal rainfall. The substrate within the channel is a mixture of sand, silt and some organic matter. Mature red mangrove forests dominate the banks of the rivers.

The Fakahatchee Bay station is the least disturbed system relative to the other sites in the Ten Thousand Islands. The Fakahatchee Bay watershed is primarily under Preserve status and has been relatively undisturbed by the hydrologic alteration of the Southern Golden Gate Estates canal system. Upstream there are minimal influences from the Picayune Strand State Forest with non-point source pollutants possible from the culverts under I-75 and US 41. Fakahatchee Strand State Preserve and Big Cypress National Park manage the headwaters of Fakahatchee Bay. Because Fakahatchee Bay's watershed is considered the least altered, the water quality data collected from this station serves as a reference for assessing the effectiveness of the PSRP.

Pumpkin Bay (rkbpbwq):

Lat/Long (Decimal Degrees): 25.9141 N, -81.5404 W

The Pumpkin Bay station is located at the mouth of the Pumpkin River secured to a 6-inch PVC pipe hydro-jetted into the substrate. The tide range for Pumpkin Bay varies between 0.00 and 1.64 meters (average 0.64 m). Salinity at this site ranged from 14.9 to 39.1 ppt during 2021. The bottom habitat is predominantly fine sand and there is no bottom vegetation. Mature red mangrove forests dominate the Pumpkin River and the bay. Upland land use is minimal with the main influences being US 41 and the Picayune Strand canal system, which has diverted freshwater to Faka Union Bay. Like Blackwater River, the modeling of historic flow-way patterns, show the watershed draining into Pumpkin Bay has been significantly reduced resulting in higher than historical salinity values.

Station Code	SWMP Status	Station Name	Location	Active Dates	Reason Decommissioned	Notes
rkbfbnut	Primary	Fakahatchee Bay	25.8922 -81.477	01/01/2002 – current	NA	NA
rkbfunut	Primary	Faka Union Bay	25.9005 -81.5159	01/01/2002 – current	NA	NA

rkbllhnut	Primary	Lower Henderson Creek	26.0257 -81.7332	01/01/2001 – current	NA	NA
rkbmbnut	Primary	Middle Blackwater River	25.9343 -81.5946	01/01/2000 – current	NA	NA
rkbpbnut	Secondary	Pumpkin Bay	25.9141 -81.5404	07/06/2016 – current	NA	NA

5) Coded variable definitions:

Station Codes:

rkbllhnut = Rookery Bay Lower Henderson nutrients (monthly grabs and diel sampling)

rkbmbnut = Rookery Bay Middle Blackwater nutrients (monthly grabs)

rkbfunut = Rookery Bay Faka Union nutrients (monthly grabs)

rkbfbnut = Rookery Bay Fakahatchee Bay nutrients (monthly grabs)

rkbpbnut = Rookery Bay Pumpkin Bay nutrients (monthly grabs, Secondary SWMP station)

Monitoring Codes:

monthly grab sample program = 1

monthly diel sample program = 2

Replicate grab samples were denoted as 1 for the first sample and 2 for the second sample at each station in the “Rep” column. Since 1 diel sample was collected every 2.5 hrs., the replicate number was always denoted as 1 in the “Rep” column.

6) Data collection period:

The RKBNERR monthly grab sampling began in January 2002 at all the primary SWMP sampling stations. Grab sampling began in October 2012 at the Secondary SWMP station, rkbpbnut. Diel sampling began at the Lower Henderson Creek site in February 2002. Start times and end times have been modified to report in Eastern Standard Time (EST).

Monthly Grab Sampling Collection Period: January – December 2021

Station Code	Date Time Stamp (rep 1)	Date Time Stamp (rep 2)
rkbllhnut	01/06/2021 13:10	01/06/2021 13:16
rkbllhnut	02/03/2021 13:12	02/03/2021 13:16
rkbllhnut	03/03/2021 12:38	03/03/2021 12:55
rkbllhnut	04/07/2021 06:48	04/07/2021 06:56
rkbllhnut	05/05/2021 06:22	05/05/2021 06:29
rkbllhnut	06/02/2021 06:27	06/02/2021 06:32
rkbllhnut	07/15/2021 11:11	07/15/2021 11:16
rkbllhnut	08/11/2021 10:37	08/11/2021 10:44
rkbllhnut	09/08/2021 10:32	09/08/2021 10:39
rkbllhnut	10/06/2021 10:16	10/06/2021 10:20
rkbllhnut	11/09/2021 12:00	11/09/2021 12:05
rkbllhnut	12/01/2021 07:53	12/01/2021 07:59

rkbmbnut	01/06/2021 11:09	01/06/2021 11:16
rkbmbnut	02/03/2021 08:46	02/03/2021 08:51
rkbmbnut	03/03/2021 08:13	03/03/2021 08:18
rkbmbnut	04/07/2021 11:16	04/07/2021 11:22
rkbmbnut	05/05/2021 10:41	05/05/2021 10:47
rkbmbnut	06/02/2021 08:16	06/02/2021 08:21
rkbmbnut	07/15/2021 06:41	07/15/2021 06:47
rkbmbnut	08/11/2021 06:34	08/11/2021 06:40
rkbmbnut	09/08/2021 08:38	09/08/2021 08:44
rkbmbnut	10/06/2021 08:28	10/06/2021 08:32
rkbmbnut	11/09/2021 10:06	11/09/2021 10:11
rkbmbnut	12/01/2021 11:51	12/01/2021 11:56
rkbfunut	01/06/2021 09:38	01/06/2021 09:46
rkbfunut	02/03/2021 10:12	02/03/2021 10:16
rkbfunut	03/03/2021 09:32	03/03/2021 09:39
rkbfunut	04/07/2021 09:52	04/07/2021 09:58
rkbfunut	05/05/2021 09:17	05/05/2021 09:23
rkbfunut	06/02/2021 09:34	06/02/2021 09:40
rkbfunut	07/15/2021 08:00	07/15/2021 08:06
rkbfunut	08/11/2021 08:41	08/11/2021 08:46
rkbfunut	09/08/2021 07:15	09/08/2021 07:22
rkbfunut	10/06/2021 07:22	10/06/2021 07:26
rkbfunut	11/09/2021 08:45	11/09/2021 08:51
rkbfunut	12/01/2021 10:24	12/01/2021 10:29
rkbfbnut	01/06/2021 10:11	01/06/2021 10:17
rkbfbnut	02/03/2021 10:45	02/03/2021 10:49
rkbfbnut	03/03/2021 10:06	03/03/2021 10:12
rkbfbnut	04/07/2021 09:16	04/07/2021 09:24
rkbfbnut	05/05/2021 08:43	05/05/2021 08:49
rkbfbnut	06/02/2021 10:04	06/02/2021 10:09
rkbfbnut	07/15/2021 08:30	07/15/2021 08:36
rkbfbnut	08/11/2021 07:58	08/11/2021 08:04
rkbfbnut	09/08/2021 07:44	09/08/2021 07:52
rkbfbnut	10/06/2021 06:58	10/06/2021 07:02
rkbfbnut	11/09/2021 08:15	11/09/2021 08:20
rkbfbnut	12/01/2021 10:54	12/01/2021 10:59
rkbpbnut	01/06/2021 09:06	01/06/2021 09:12
rkbpbnut	02/03/2021 09:37	02/03/2021 09:45
rkbpbnut	03/03/2021 09:00	03/03/2021 09:06
rkbpbnut	04/07/2021 10:26	04/07/2021 10:32
rkbpbnut	05/05/2021 09:51	05/05/2021 09:57

rkbpbnut	06/02/2021 09:05	06/02/2021 09:10
rkbpbnut	07/15/2021 07:30	07/15/2021 07:36
rkbpbnut	08/11/2021 07:19	08/11/2021 07:24
rkbpbnut	09/08/2021 06:42	09/08/2021 06:49
rkbpbnut	10/06/2021 06:26	10/06/2021 06:30
rkbpbnut	11/09/2021 09:19	11/09/2021 09:25
rkbpbnut	12/01/2021 09:52	12/01/2021 09:57

Monthly Diel Sampling Collection Period: January – December 2021

Station Code	Date Time stamp (begin)	Date Time stamp (end)
rklblhnut	01/12/2021 07:30	01/13/2021 08:30
rklblhnut	02/09/2021 06:30	02/10/2021 07:30
rklblhnut	03/16/2021 10:00	03/17/2021 11:00
rklblhnut	04/20/2021 02:30	04/21/2021 03:30
rklblhnut	05/11/2021 07:30	05/12/2021 08:30
rklblhnut	06/08/2021 06:30	06/09/2021 07:30
rklblhnut	07/20/2021 04:00	07/21/2021 05:00
rklblhnut	08/17/2021 02:30	08/18/2021 03:30
rklblhnut	09/22/2021 08:30	09/23/2021 09:30
rklblhnut	10/13/2021 01:00	10/14/2021 02:00
rklblhnut	11/16/2021 06:00	11/17/2021 07:00
rklblhnut	12/14/2021 05:00	12/15/2021 06:00

7) Associated researchers and projects:

Both water quality and nutrient data generated by RKBNERR have been used by the USACOE, USFWS, SFWMD and Florida DEP to analyze restoration targets established for the PSRP, which is a portion of the CERP.

In 2021, Florida DEP started using water quality and nutrient data to create an internal departmental data analysis dash board to analyze the duration of hypoxia, trends and comparisons relating to dissolved oxygen (DO) and other analytes available for the continuous monitoring stations, change and patterns at those stations, including how the stations may relate to external factors. Florida DEP is also using SWMP data for the Statewide Ecosystem Assessment of Coastal and Aquatic Resources (SEACAR) project. The project will provide status and trends reporting through web-based access to data and assessments and a tiered reporting format for a variety of audiences.

Other significant water quality research and monitoring initiatives within the RKBNERR include regular monitoring by Florida Department of Environmental Protection's Division of Environmental Assessment and Restoration (<https://floridadep.gov/DEAR>) water quality assessment program, oyster reef/benthic crab survey (1999 – 2008), long-term fisheries survey (July 1998 - June 2013 and October 2015 - present), shark demographics survey (May 2000 - present) and shorebird mortality MST water quality study (July 2021 – present). The fisheries data are obtained through monthly trawls in the bays corresponding with the SWMP water quality sites to document the population dynamics in a variety of fish species, as well as commercially important invertebrates such as stone crabs, blue crabs and pink shrimp. Shark demographic data are also collected monthly from the reference bays downstream of the PSRP through long-line and gillnet 'tag, measure and release' surveys. Benthic

crabs were collected from oyster reefs using Hester-Dendy collection substrates at the four SWMP water quality stations. In October 2021, NOAA submitted the paper "Canals reroute freshwater to the Ten Thousand Islands, Florida USA: Too much freshwater vs not enough and how much does it matter to estuarine fish?", to *Estuaries and Coasts*.

The water quality and nutrient data are also used by visiting investigators/ researchers to support the research conducted within the Reserve.

As part of the SWMP long-term monitoring program, RKBNERR also monitors 15-minute meteorological and water quality data which may be correlated with this nutrient/pigment dataset. These data are available at www.nerrsdata.org.

8) Distribution:

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: www.nerrsdata.org; accessed 12 October 2021.

NERR nutrient data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in comma separated version format.

II. Physical Structure Descriptors

9) Entry verification:

The analytical results (electronic files) were provided monthly from the contracted laboratory to Julie Drevenkar, SWMP Manager. Upon receiving the results, the SWMP Manager reviewed the data for errors. The SWMP Manager was responsible for compilation and QA/QC of the final data set according to chapter 10 of the Centralized Data Management Office (CDMO) NERR SWMP Data Management Manual v 6.6. The data reported from the lab were in the required units making it unnecessary to convert the data prior to entering it into Microsoft Excel.

Nutrient data are entered into a Microsoft Excel worksheet and processed using the NutrientQAQC Excel macro. The NutrientQAQC macro sets up the data worksheet, metadata worksheets, and MDL worksheet; adds chosen parameters and facilitates data entry; allows the user to set the number of significant figures to be reported for each parameter and rounds using banker's rounding rules; allows the user to input MDL values and then automatically flags/codes measured values below MDL and inserts the MDL; calculates parameters chosen by the user and automatically flags/codes for

component values below MDL, negative calculated values, and missing data; allows the user to apply QAQC flags and codes to the data; produces summary statistics; graphs selected parameters for review; and exports the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO's authoritative online database.

10) Parameter titles and variable names by category:

Required NOAA NERRS System-wide Monitoring Program nutrient parameters are denoted by an asterisk “*”.

Data Category	Parameter	Variable Name	Units of Measure
Phosphorus			
	Orthophosphate, Filtered*	PO4F	mg/L as P
	Total Phosphorus	TP	mg/L as P
Nitrogen			
	Nitrite + Nitrate, Filtered*	NO23F	mg/L as N
	Nitrite, Filtered*	NO2F	mg/L as N
	Nitrate, Filtered*	NO3F	mg/L as N
	Ammonium, Filtered*	NH4F	mg/L as N
	Total Kjeldahl Nitrogen	TKN	mg/L as N
	Total Organic Nitrogen	TON	mg/L as N
Plant Pigments			
	Chlorophyll <i>a</i> *	CHLA_N	µg/L
	Phaeophytin	PHEA	µg/L
Other Lab Parameters			
	Total Suspended Solids	TSS	mg/L
Field Parameters			
	Water Temperature	WTEM_N	degrees Celsius
	Specific Conductance	SCON_N	mS/cm
	Salinity	SALT_N	ppt
	Dissolved Oxygen	DO_N	mg/L
	Dissolved Oxygen Saturation	DO_S_N	percent
	pH	PH_N	standard units
	Turbidity	TURB_N	NTU/FNU

Notes:

1. Time is coded based on a 2400 clock and is referenced to Standard Time.
2. Reserves have the option of measuring either NO2 and NO3 or they may substitute NO23 for individual analyses if they can show that NO2 is a minor component relative to NO3.

11) Measured or calculated laboratory parameters:

a) Parameters measured directly

Phosphorus species:	PO ₄ F, TP
Nitrogen species:	NH ₄ F, NO ₂ F, NO ₃ F, TKN
Plant Pigments:	CHLA_N, PHEA
Other:	TSS

b) Calculated parameters

NO ₃	$(\text{NO}_{23}\text{F} \cdot \text{Df}) - (\text{NO}_{2}\text{F} \cdot \text{Df})$
	Df=Dilution factor
DIN	NO ₃ F + NH ₄ F
TON	TKN – NH ₄ F
TN	TKN + NO ₃ F

12) Limits of detection:

Method Detection Limits (MDL), the lowest concentration of a parameter that an analytical procedure can reliably detect, were established by the Florida Department of Environmental Protection (FLDEP) Laboratory. MDLs were determined using the U.S. Environmental Protection Agency MDL procedure found in Title 40 Code of Federal Regulations Part 136 (40 CFR 136, Appendix B, revision 2.0). Once the MDL was established using this method, verification was done prior to use. Verification included analyzing a known standard at 2-3 times the calculated MDL. Additionally, various checks and balances were used to ensure suitability of the MDL. Every quarter the labs employed verification checks on all MDLs. If the verification checks met the lab's acceptance criteria, then the MDL remained unchanged. The MDL for all parameters were determined by the FLDEP Laboratory.

FLDEP laboratory MDL determination:

The FLDEP Laboratory defines the MDL as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from the method blank result. MDLs are determined using the method specified in the Federal Register, 40 CFR Part 136 Appendix B Revision 2, using LCSs prepared near the estimated detection limit as surrogates to estimate methodological noise for actual method blanks to directly measure methodological noise. If none of the method blanks give numerical results for an individual analyte, method blanks are not required for the determination of the MDL. Where the possibility exists for significant systematic bias from sample preparation and handling or from the analytical determinative step (typically inorganic analyses), bias is taken into account when calculating detection limits. Published MDLs may be set higher than experimentally determined MDLs to (1) avoid observed positive interferences from matrix effects or common reagent contaminants or (2) for reporting convenience (i.e., to group common compounds with similar but slightly different experimentally determined MDLs). MDLs are determined in a suitable analyte-free matrix when possible. For certain analytes and matrices, no suitable, analyte-free matrix may be available. In those cases, MDLs are determined in the absence of any matrix, but in the presence of all preparatory reagents carried through the full preparatory and determinative steps. LOD verification procedures may be found in SOP LB-031, Limit of Detection Verification. (From page 43 of FLDEP Laboratory Quality Manual 2021 located at: [Florida DEP Laboratory Quality Manual \(state.fl.us\)](https://www.fl.gov/dep/laboratory-quality-manual))

2021 MDLs

Parameter	Variable	MDL	Approved
Orthophosphate	PO4F	0.004 mg/L	12/26/19-12/31/21
Total Phosphorus	TP	0.002 mg/L	12/26/20-12/31/21
Ammonium	NH4F	0.002 mg/L	12/30/19-12/31/21
Nitrite	NO2F	0.002 mg/L	12/30/19-12/31/21
Nitrite +Nitrate	NO23F	0.004 mg/L	05/10/19-12/31/21
Kjeldahl Nitrogen	TKN	0.08 mg/L	12/30/19-12/31/21
Chlorophyll <i>a</i>	CHLA	0.82 µg/L	01/01/20-12/31/21
Phaeophytin	PHEA	0.90 µg/L	01/01/20-12/31/21
Total Suspended Solids*	TSS	2 mg/L	12/17/19-12/31/21

*MDL for Total Suspended Solids is 3 when conductivity is > 15,000 µmhos/cm.

FLDEP MDLs for the chlorophyll suite of components may change by station and month based on the need to dilute samples during processing. The base MDL listed in the FLDEP SOP is based on the maximum filtration volume and minimum extract volume and will therefore be the lowest MDL. This MDL was last verified by the FLDEP laboratory 1/27/2020 (as presented in version BB-029-2.7 of the FLDEP SOP for *Spectrophotometric Determination of Corrected and Uncorrected Chlorophyll a and Phaeophytin*, available here:

<https://fldeploc.dep.state.fl.us/sop/sop3.asp?sect=BIOLOGY&cat=CHLOROPHYLL-BOD-SEDIMENT+GRAIN+SIZE&A1=Submit>).

The sample MDL is calculated based on the number of times a sample must be diluted. For example, if a CHLA_A sample must be diluted to twice its volume, the base MDL of 0.55 ug/L is multiplied by a dilution factor of two (0.55 ug/L x 2) thus resulting in an MDL of 1.10 ug/L. For samples that fall below the MDL and their MDL is greater than the base MDL, individual sample MDLs are listed in the table below. These data have been flagged and coded as -4 SBL in the dataset. A table of these instances can be found in the “Other Remarks/Notes” section of this metadata document.

Monthly MDL Changes: Due to the need for sample dilution by the lab for the sample to be analyzed, chlorophyll *a*, pheaphytin *a*, nitrite+nitrate, and TSS MDLs may be elevated. Some values are flagged as below sensor limits <-4> [SBL] while the value reported is higher than the normal MDL. These samples are as follows:

Parameter	Date Time Stamp	Station Code	MDL	Units
CHLA_N	04/07/2021 06:48	rkblhnut	1.60	ug/L
CHLA_N	04/07/2021 06:56	rkblhnut	1.40	ug/L
CHLA_N	06/09/2021 02:30	rkblhnut	5.10	ug/L
PHEA	01/06/2021 13:10	rkblhnut	1.30	ug/L
PHEA	01/12/2021 07:30	rkblhnut	1.80	ug/L
PHEA	01/12/2021 10:00	rkblhnut	1.10	ug/L
PHEA	01/12/2021 12:30	rkblhnut	1.10	ug/L
PHEA	01/12/2021 15:00	rkblhnut	2.20	ug/L

PHEA	01/12/2021 17:30	rkblhnut	1.10	ug/L
PHEA	01/12/2021 20:00	rkblhnut	1.10	ug/L
PHEA	01/12/2021 22:30	rkblhnut	1.10	ug/L
PHEA	01/13/2021 03:30	rkblhnut	1.00	ug/L
PHEA	01/13/2021 06:00	rkblhnut	1.00	ug/L
PHEA	02/03/2021 13:12	rkblhnut	1.40	ug/L
PHEA	02/09/2021 06:30	rkblhnut	1.10	ug/L
PHEA	03/16/2021 12:30	rkblhnut	1.00	ug/L
PHEA	03/17/2021 03:30	rkblhnut	0.95	ug/L
PHEA	03/17/2021 08:30	rkblhnut	0.95	ug/L
PHEA	04/07/2021 06:48	rkblhnut	1.80	ug/L
PHEA	04/07/2021 06:56	rkblhnut	1.50	ug/L
PHEA	04/07/2021 09:52	rkbfunut	1.80	ug/L
PHEA	04/07/2021 09:58	rkbfunut	1.80	ug/L
PHEA	04/07/2021 11:16	rkbmbnut	1.80	ug/L
PHEA	04/07/2021 11:22	rkbmbnut	1.80	ug/L
PHEA	04/20/2021 02:30	rkblhnut	1.80	ug/L
PHEA	04/20/2021 05:00	rkblhnut	2.20	ug/L
PHEA	04/20/2021 07:30	rkblhnut	2.20	ug/L
PHEA	04/20/2021 10:00	rkblhnut	2.20	ug/L
PHEA	04/20/2021 12:30	rkblhnut	2.20	ug/L
PHEA	04/20/2021 15:00	rkblhnut	2.60	ug/L
PHEA	04/20/2021 17:30	rkblhnut	1.80	ug/L
PHEA	04/20/2021 20:00	rkblhnut	1.80	ug/L
PHEA	04/20/2021 22:30	rkblhnut	1.80	ug/L
PHEA	04/21/2021 01:00	rkblhnut	1.80	ug/L
PHEA	04/21/2021 03:30	rkblhnut	1.80	ug/L
PHEA	05/05/2021 08:43	rkbfbnut	1.50	ug/L
PHEA	05/05/2021 08:49	rkbfbnut	1.20	ug/L
PHEA	05/05/2021 09:51	rkbpbnut	1.80	ug/L

PHEA	05/05/2021 10:47	rkbmbnut	1.20	ug/L
PHEA	06/02/2021 06:27	rkbblhnut	1.80	ug/L
PHEA	06/02/2021 06:32	rkbblhnut	1.80	ug/L
PHEA	06/02/2021 08:16	rkbmbnut	1.80	ug/L
PHEA	06/02/2021 10:09	rkbfbnut	1.80	ug/L
PHEA	06/08/2021 09:00	rkbblhnut	2.10	ug/L
PHEA	06/08/2021 14:00	rkbblhnut	1.30	ug/L
PHEA	06/08/2021 16:30	rkbblhnut	1.30	ug/L
PHEA	06/08/2021 21:30	rkbblhnut	2.60	ug/L
PHEA	06/09/2021 00:00	rkbblhnut	2.60	ug/L
PHEA	06/09/2021 02:30	rkbblhnut	5.50	ug/L
PHEA	06/09/2021 05:00	rkbblhnut	2.60	ug/L
PHEA	06/09/2021 07:30	rkbblhnut	2.10	ug/L
PHEA	07/15/2021 06:41	rkbmbnut	2.60	ug/L
PHEA	07/15/2021 08:00	rkbfunut	2.20	ug/L
PHEA	07/15/2021 08:06	rkbfunut	1.80	ug/L
PHEA	07/15/2021 08:36	rkbfbnut	1.80	ug/L
PHEA	07/15/2021 11:16	rkbblhnut	2.60	ug/L
PHEA	07/20/2021 04:00	rkbblhnut	3.00	ug/L
PHEA	07/20/2021 06:30	rkbblhnut	3.00	ug/L
PHEA	07/20/2021 09:00	rkbblhnut	2.40	ug/L
PHEA	07/20/2021 11:30	rkbblhnut	2.40	ug/L
PHEA	07/21/2021 02:30	rkbblhnut	1.80	ug/L
PHEA	07/21/2021 05:00	rkbblhnut	2.20	ug/L
PHEA	08/11/2021 08:46	rkbfunut	1.80	ug/L
PHEA	08/17/2021 15:00	rkbblhnut	2.20	ug/L
PHEA	08/17/2021 17:30	rkbblhnut	2.60	ug/L
PHEA	08/18/2021 01:00	rkbblhnut	3.00	ug/L
PHEA	09/08/2021 07:44	rkbfbnut	1.80	ug/L
PHEA	09/22/2021 08:30	rkbblhnut	3.00	ug/L

PHEA	10/06/2021 07:22	rkbfunut	1.80	ug/L
PHEA	10/06/2021 08:28	rkbmbnut	2.00	ug/L
PHEA	10/13/2021 01:00	rkbhlhnut	2.00	ug/L
PHEA	10/13/2021 18:30	rkbhlhnut	1.50	ug/L
PHEA	10/13/2021 23:30	rkbhlhnut	1.80	ug/L
PHEA	11/09/2021 08:51	rkbfunut	1.80	ug/L
PHEA	11/09/2021 12:05	rkbhlhnut	1.50	ug/L
PHEA	11/16/2021 08:30	rkbhlhnut	2.20	ug/L
PHEA	11/16/2021 11:00	rkbhlhnut	1.80	ug/L
PHEA	11/16/2021 13:30	rkbhlhnut	1.80	ug/L
PHEA	11/16/2021 18:30	rkbhlhnut	1.30	ug/L
PHEA	11/16/2021 23:30	rkbhlhnut	1.30	ug/L
PHEA	11/17/2021 02:00	rkbhlhnut	1.30	ug/L
PHEA	11/17/2021 04:30	rkbhlhnut	1.10	ug/L
PHEA	12/01/2021 10:54	rkbfbnut	1.30	ug/L
PHEA	12/14/2021 07:30	rkbhlhnut	2.20	ug/L
PHEA	12/14/2021 12:30	rkbhlhnut	1.10	ug/L
PHEA	12/14/2021 15:00	rkbhlhnut	2.00	ug/L
PHEA	12/14/2021 17:30	rkbhlhnut	1.80	ug/L
PHEA	12/14/2021 20:00	rkbhlhnut	2.00	ug/L
PHEA	12/15/2021 01:00	rkbhlhnut	1.50	ug/L
TSS	10/06/2021 08:28	rkbmbnut	15	mg/L
TSS	12/01/2021 10:29	rkbfunut	4	mg/L

13) Laboratory methods:

Chemical and biological analysis was performed by Florida Department of Environmental Protection Laboratory. FLDEP SOP hold times are as follows:

NH ₄ F, Ammonia	Cool, ≤6 °C, H ₂ SO ₄ to pH<2	28 days
NO ₂ F, Nitrite	Cool, ≤6 °C	48 hours
NO ₃ F, Nitrate-Nitrite	Cool, ≤6 °C, H ₂ SO ₄ to pH<2	28 days
TP, Total Phosphorous	Cool, ≤6 °C, H ₂ SO ₄ to pH<2	28 days
TKN, Total Kjeldahl Nitrogen	Cool, ≤6 °C, H ₂ SO ₄ to pH<2	28 days
TON, Total Organic Nitrogen	Cool, ≤6 °C, H ₂ SO ₄ to pH<2	28 days

PO4F, Orthophosphate	Cool, to $\leq 6^{\circ}\text{C}$	Filter w/in 15 minutes; Analyze w/in 48 hours
TSS, Total Suspended Solids	Cool, to $\leq 6^{\circ}\text{C}$	7 days

*Note that FDEP lab hold times INCLUDE time spent in transport and held at the laboratory.

a) Parameter: PO4F

FDEP SOP: PO4_NU_070-1.20, PO4_NU-070-1.21

Reference Method: EPA 365.1 Revision 2.0

Method Reference: U.S. Environmental Protection Agency (EPA), 1993. Determination of Phosphorus by Semi-Automated Colorimetry, EPA Method 365.1 Revision 2.0. Cincinnati, OH and Bran+Lubbe method G-146-95 Rev. 3.

Method Description: Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phosphomolybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration and is measured with a rapid flow autoanalyzer.

Preservation Method: Samples are filtered through $0.7\ \mu\text{m}$ glass microfiber filters and $0.45\ \mu\text{m}$ membrane filters in the field, stored in ice and shipped. Samples stored in the laboratory at 4°C and are analyzed within 28 days of collection.

b) Parameter: TP

FDEP SOP: TP_NU-082-1.15, TP_NU-082-1.16

Reference Method: EPA 365.1 Revision 2.0

Method Reference U.S. Environmental Protection Agency (EPA), 1993. Determination of Phosphorus by Semi-Automated Colorimetry, EPA Method 365.1 Revision 2.0. Cincinnati, OH.

Method Description: Ammonium molybdate and antimony potassium tartrate react in an acidmedium with dilute solutions of phosphorus to form an antimony-phosphomolybdate complex. All the phosphorus present in the sample regardless of forms is measured by the persulfate digestion procedure.

Preservation Method: Samples were preserved with H_2SO_4 to a $\text{pH} \leq 2$, stored on ice and shipped. Samples stored in the laboratory at 4°C and are analyzed within 28 days of collection.

c) Parameter: NH4F

There was a change in instrumentation used to analyze ammonia. Prior to 02/15/2021 an OI Analytical Gas Diffusion Segmented Flow Analyzer was used. That instrument was phased out and the newer Seal Bran+Luebbe AA3 Gas Diffusion Segmented Flow Analyzer is now being used. The method remains unchanged.

FDEP SOP: NH4_NU-104-1.1, NH4_NU-104-1.2

Reference Method: EPA 350.1 Revision. 2.0 (no distillation)

Method Reference: U.S. Environmental Protection Agency (EPA), 1993, Determination of Ammonia Nitrogen by Semi-Automated Colorimetry, EPA Method 350.1 Revision 2.0. Cincinnati, OH and OI Analytical Method 327152 utilizing gas diffusion.

Method Description: Alkaline phenol and hypochlorite react with ammonia to form indophenol blue that is proportional to the ammonia concentration. The blue color formed is intensified with sodium nitroprusside. The color's absorbance is directly proportional to analyte concentration and is measured with a rapid flow autoanalyzer.

Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field and preserved with H₂SO₄ to a pH ≤ 2, stored in ice and shipped. Samples are analyzed within 28 days of collection.

NOTE: This method measures total ammonia, NH₃ is considered negligible.

d) Parameter: NO₂F

FDEP SOP: Nitrite NO₂_NU-087-1.13, NO₂_NU-087-1.14

Reference Method: EPA 353.2 Revision 2.0

Method Reference: This method is based upon EPA method 353.2, Rev. 2.0 (1993) and Seal Analytical AQ2 method EPA-137-A Rev.1.

Method Description: The diazonium compound, formed by diazotation of sulfanilamide by nitrite in water under acid conditions, is coupled with N-(1-naphthyl)-ethylenediamine dihydrochloride (NED) to produce a reddish-purple azo dye, which is measured colorimetrically at a wavelength of 520 nm.

Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field and preserved with H₂SO₄ to a pH ≤ 2, stored in ice, shipped, and analyzed within 48 hours.

e) Parameter: NO₃F

FDEP SOP: Nitrate_Nitrite_NU-066-1.23, Nitrate_Nitrite_NU-066-1.24

Reference Method: EPA 353.2 Revision 2.0

Method Reference: U.S. Environmental Protection Agency (EPA), 1993. Nitrogen, Nitrate-Nitrite (Colorimetric, Automated, Cadmium Reduction), EPA Method 353.2 Revision 2.0. Cincinnati, OH and Seal Analytical AQ2 method EPA-137-A Rev. 1.

Method Description: A filtered sample is passed through a column containing granulated copper-cadmium to reduce nitrate to nitrite. The nitrite (that was originally present plus reduced nitrate) is determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye, which is measured colorimetrically with a rapid flow autoanalyzer.

Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field and preserved with H₂SO₄ to a pH ≤ 2, stored in ice and shipped. Samples are analyzed within 28 days of collection.

f) Parameter: TKN

FDEP SOP: TKN_NU-092-1.11, TKN_NU-092-1.12

Reference Method: EPA 351.2 Revision 2.0

Method Reference: U.S. Environmental Protection Agency (EPA), 1993. Determination of Total Kjeldahl nitrogen by Semi-Automated Colorimetry, EPA Method 351.2 Revision 2.0. Cincinnati, OH and AQ2 method No: EPA-111-A Rev.4.

Method Description: The sample is heated in the presence of sulfuric acid, H₂SO₄ for two- and one-half hours. The residue is cooled, diluted to 25 mL and analyzed for ammonia. This digested sample may also be used for phosphorus determination. Total Kjeldahl nitrogen is the sum of free-ammonia and organic nitrogen compounds which are converted to ammonium sulfate (NH₄)₂SO₄, under the conditions of digestion described. Organic Kjeldahl nitrogen is the difference obtained by subtracting the free ammonia value from the total Kjeldahl nitrogen value. Reduced volume versions of this method that use the same reagents and molar ratios are acceptable provided they meet the quality control and performance requirements stated in the method.

Preservation Method: Samples were preserved with H₂SO₄ and stored at 4 °C until analysis.

g) Parameter: TSS

FDEP SOP: TSS_NU-051-3.23, TSS_NU-051-3.24

Reference Method: Standard Methods 2540 D-97

Method Description: A well-mixed sample is filtered through a pre-weighed glass fiber filter. The filter and any residue are then dried to a constant weight at 103-105 °C. The filter is cooled in a desiccator, weighed and the result used to compute the TSS of the sample.

Preservation Method: Samples are collected as whole water samples, stored in ice and shipped. Samples are stored at 4°C in the laboratory and filtration is performed within 48 hours of collection.

h) Parameter: CHLA and PHEA

FDEP SOP: Spectrophotometric CHLA and PHEA BB-029-2.8, Spectrophotometric CHLA and PHEA BB-029-2.9

Reference Method: SM 10200 H and EPA 446.0 Revision 1.2

Method Reference APHA (American Public Health Association), 2001. Standard Methods for the Examination of Water and Wastewater, (SM 10200H). 20th Edition, Baltimore, Maryland: United Book Press, Inc. and U.S. Environmental Protection Agency (EPA), 1993. In Vitro Determination of Chlorophylls a, b, c1+c2 and Pheopigments in Marine and Freshwater Algae by Visible Spectrophotometry, EPA Method 446.0 Revision 1.2. Cincinnati, OH.

Method Description: An extractive spectrophotometric technique was used to determine chlorophyll *a* concentrations. Samples were filtered immediately at the laboratory. Filters were placed in a tissue grinder with 2-3 ml of 90% aqueous acetone. Extracts steeped for at least 2 hours at 4 °C in the dark. Extracts were analyzed using a UV/VIS Spectrophotometer.

Preservation Method: Samples are collected as whole water samples in a dark sampling bottle and stored at 4 °C and filtered at the lab upon arrival.

14) Field and Laboratory QAQC programs:

The FDEP laboratory has an established quality control program for monitoring the performance of test methods. The laboratory QA/QC procedures for the State of Florida Department of Environmental Protection Bureau of Laboratories FDOH Certification Number E31780 are as prescribed in the Quality Manual (<https://floridadep.gov/dear/florida-dep-laboratory/content/dep-laboratory-quality-assurance-manual-and-sops>) and test [SOPs](#).

a) Precision

- i. Field variability** - In the field each month, two successive grab samples are collected at each site. Replicate (N=2) samples are collected using a pole sampler lowered to the approximate depth of the data sonde probes in closed position and then opened to draw water from the specified depth. One field blank is included in each monthly collection.
- ii. Laboratory variability** - Method blanks and duplicate samples are run with every sample batch. A batch of samples consists of 20 or fewer samples (with the exception of microbiology) that are prepared and/or analyzed in a single run. Microbiology samples are batched by day, so that all samples received and processed on a given day are in the same prep and analysis batch. Saline matrices are batched separately where the test is impacted by high conductivity samples.

Replicate analyses are used to evaluate precision (with the exception of microbiology). Precision is expressed by the relative percent difference (RPD) to compare duplicate samples/spikes A and B and is based on the formula:

$$\text{RPD (\%)} = |A-B| / (A+B) \times 200$$

Precision may be determined from duplicate authentic samples, from duplicate Laboratory Control Samples (LCS), or from matrix spike duplicates. Where RPDs are calculated based on matrix spike duplicates, A and B represent the raw results of the spiked sample (spike plus the background). Microbiology precision is evaluated according to Standard Methods 9020, in which the precision criteria (calculated by multiplying the mean range of the last fifteen points by 3.27) is compared to the log value range between duplicates.

iii. **Inter-organizational splits** – None

b) **Accuracy**

- i. **Sample spikes** – Sample spikes are performed with each sample batch. The acceptance limits for sample or spike duplicates is a RPD of less than 20% if both results are above the PQL. Laboratory fortified blanks are run with each sample batch, acceptance limits for recovery are 85-115%.
- ii. **Standard Reference Material Analysis** – Check standards are included in each batch and at the beginning and end of each run. Check standard acceptance limits for recovery are 85-115%.
- iii. **Cross Calibration Exercises** – FDEP laboratory participated in two rounds of performance testing (PT) in 2020. The studies are performed by many labs around the nation to and are required to maintain the lab's TNI certification. In addition to the PT studies the lab also participated in a round robin organized by North Carolina DEQ for chlorophyll analysis. In 2020, the round robin occurred at the end of July/beginning of August and the lab analyzed 8 split samples.

15) **QAQC flag definitions:**

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by an F_). QAQC flags are applied to the nutrient data during secondary QAQC to indicate data that are out of sensor range low (-4), rejected due to QAQC checks (-3), missing (-2), optional and were not collected (-1), suspect (1), and that have been corrected (5). All remaining data are flagged as having passed initial QAQC checks (0) when the data are uploaded and assimilated into the CDMO ODIS as provisional plus data. The historical data flag (4) is used to indicate data that were submitted to the CDMO prior to the initiation of secondary QAQC flags and codes (and the use of the automated primary QAQC system for WQ and MET data). This flag is only present in historical data that are exported from the CDMO ODIS.

-4	Outside Low Sensor Range
-3	Data Rejected due to QAQC
-2	Missing Data
-1	Optional SWMP Supported Parameter
0	Data Passed Initial QAQC Checks
1	Suspect Data
4	Historical Data: Pre-Auto QAQC
5	Corrected Data

16) **QAQC code definitions:**

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the sample or sample collection, sensor errors document common sensor or parameter specific problems, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point. However, a record flag column (F_Record) in the nutrient data allows multiple comment codes to be applied to the entire data record.

General errors

GCM	Calculated value could not be determined due to missing data
GCR	Calculated value could not be determined due to rejected data
GDM	Data missing or sample never collected
GQD	Data rejected due to QA/QC checks
GQS	Data suspect due to QA/QC checks
GSM	See metadata

Sensor errors

SBL	Value below minimum limit of method detection
SCB	Calculated value could not be determined due to a below MDL component
SCC	Calculation with this component resulted in a negative value
SNV	Calculated value is negative
SRD	Replicate values differ substantially
SUL	Value above upper limit of method detection

Parameter comments

CAB	Algal bloom
CDR	Sample diluted and rerun
CHB	Sample held beyond specified holding time
CIP	Ice present in sample vicinity
CIF	Flotsam present in sample vicinity
CLE	Sample collected later/earlier than scheduled
CRE	Significant rain event
CSM	See metadata
CUS	Lab analysis from unpreserved sample

Record comments

CAB	Algal bloom
CHB	Sample held beyond specified holding time
CIP	Ice present in sample vicinity
CIF	Flotsam present in sample vicinity
CLE	Sample collected later/earlier than scheduled
CRE	Significant rain event
CSM	See metadata
CUS	Lab analysis from unpreserved sample

Cloud cover

CCL	clear (0-10%)
CSP	scattered to partly cloudy (10-50%)
CPB	partly to broken (50-90%)
COC	overcast (>90%)
CFY	foggy
CHY	hazy
CCC	cloud (no percentage)

Precipitation

PNP	none
PDR	drizzle
PLR	light rain
PHR	heavy rain
PSQ	squally
PFQ	frozen precipitation (sleet/snow/freezing rain)
PSR	mixed rain and snow
<i>Tide stage</i>	
TSE	ebb tide
TSF	flood tide
TSH	high tide
TSL	low tide
<i>Wave height</i>	
WH0	0 to <0.1 meters
WH1	0.1 to 0.3 meters
WH2	0.3 to 0.6 meters
WH3	0.6 to > 1.0 meters
WH4	1.0 to 1.3 meters
WH5	1.3 or greater meters
<i>Wind direction</i>	
N	from the north
NNE	from the north northeast
NE	from the northeast
ENE	from the east northeast
E	from the east
ESE	from the east southeast
SE	from the southeast
SSE	from the south southeast
S	from the south
SSW	from the south southwest
SW	from the southwest
WSW	from the west southwest
W	from the west
WNW	from the west northwest
NW	from the northwest
NNW	from the north northwest
<i>Wind speed</i>	
WS0	0 to 1 knot
WS1	> 1 to 10 knots
WS2	> 10 to 20 knots
WS3	> 20 to 30 knots
WS4	> 30 to 40 knots
WS5	> 40 knots

17) Other remarks/notes:

Data may be missing due to problems with sample collection or processing. Laboratories in the NERRS System submit data that are censored at a lower detection rate limit, called the Method Detection Limit or MDL. MDLs for specific parameters are listed in the Laboratory Methods and Detection Limits Section (Section II, Part 12) of this document. Concentrations that are less than this limit are censored with the use of a QAQC flag and code, and the reported value is the method detection limit itself rather than a measured value. For example, if the measured concentration of NO₂3F was 0.0005 mg/l as N (MDL=0.0008), the reported value would be 0.0008 and would be flagged as out of sensor range low (-4) and coded SBL. In addition, if any of the components used to

calculate a variable are below the MDL, the calculated variable is removed and flagged/coded -4 SCB. If a calculated value is negative, it is rejected, and all measured components are marked suspect. If additional information on MDL's or missing, suspect, or rejected data is needed, contact the Research Coordinator at the reserve submitting the data.

Note: The way values below MDL are handled in the NERRS SWMP dataset was changed in November of 2011. Previously, below MDL data from 2007-2010 were also flagged/coded, but either reported as the measured value or a blank cell. Any 2007-2011 nutrient/pigment data downloaded from the CDMO prior to November of 2011 will reflect this difference.

Sample hold times for 2021: Samples are held at 4°C by the FDEP Laboratory. NERRS SOP allows nutrient samples to be held for up to 24 hours at 4°C or 28 days at 4°C with acidification, plus up to 5 days for collecting, processing, and shipping samples. Samples held beyond that time period are flagged suspect and coded CHB. The dates recorded in the table below are the longest hold date that the FLDEP Laboratory analyzed each parameter.

Sample Date	Program Type	Date Analyzed				
		PO4F	NH4	NO2	NO3	CHLA_N
01/06/2021	Grab	01/07/2021	01/13/2021	01/07/2021	01/12/2021	01/08/2021
01/12/2021 - 01/13/2021	Diel	01/14/2021	01/18/2021	01/14/2021	01/19/2021	01/18/2021
02/03/2021	Grab	02/04/2021	02/09/2021	02/04/2021	02/08/2021	02/10/2021
02/09/2021 - 02/10/2021	Diel	2/16/2021*	02/15/2021	2/17/2021*	02/16/2021	02/16/2021
03/03/2021	Grab	03/04/2021	03/07/2021	03/04/2021	03/09/2021	03/10/2021
03/16/2021 - 03/17/2021	Diel	03/18/2021	03/31/2021	03/18/2021	03/19/2021	03/25/2021
04/07/2021	Grab	04/08/2021	04/22/2021	04/08/2021	04/16/2021	04/14/2021
04/20/2021 - 04/21/2021	Diel	04/22/2021	05/01/2021	04/22/2021	04/23/2021	04/27/2021
05/05/2021	Grab	05/06/2021	05/17/2021	05/06/2021	05/11/2021	05/14/2021
05/11/2021 - 05/12/2021	Diel	05/13/2021	05/21/2021	05/13/2021	05/14/2021	05/20/2021
06/02/2021	Grab	06/03/2021	06/16/2021	06/03/2021	06/04/2021	06/11/2021
06/08/2021 - 06/09/2021	Diel	06/10/2021	06/23/2021	06/10/2021	06/11/2021	06/24/2021
07/15/2021	Grab	07/16/2021	08/02/2021	07/16/2021	07/21/2021	07/28/2021
07/20/2021 - 07/21/2021	Diel	07/22/2021	08/05/2021	07/22/2021	07/26/2021	08/03/2021
08/11/2021	Grab	08/12/2021	08/20/2021	08/12/2021	08/17/2021	08/26/2021
08/17/2021 - 08/18/2021	Diel	08/19/2021	08/24/2021	08/19/2021	08/24/2021	08/30/2021
09/08/2021	Grab	09/09/2021	09/13/2021	09/09/2021	09/30/2021	09/20/2021
09/22/2021 - 09/23/2021	Diel	09/24/2021	09/28/2021	09/24/2021	09/27/2021	10/04/2021
10/06/2021	Grab	10/07/2021	10/15/2021	10/07/2021	10/26/2021	10/15/2021
10/13/2021 - 10/14/2021	Diel	10/15/2021	10/18/2021	10/15/2021	10/19/2021	10/21/2021
11/09/2021	Grab	11/10/2021	11/18/2021	11/10/2021	11/15/2021	11/15/2021
11/16/2021 - 11/17/2021	Diel	11/18/2021	12/06/2021	11/18/2021	11/23/2021	11/23/2021
11/09/2021	Grab	12/03/2021	12/20/2021	12/03/2021	12/07/2021	12/06/2021
11/16/2021 - 11/17/2021	Diel	12/16/2021	01/03/2022	12/16/2021	12/28/2021	12/21/2021

*Sample held longer than allowed by NERRS protocols

Monthly QAQC Code explanations:

January

The Total Kjeldahl Nitrogen (TKN) grab sample for rkbfbnut taken at 01/06/2021 09:46 was J-qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

The Total Suspended Solids (TSS) grab sample for rkblhnut taken at 01/06/2021 13:16 was A-qualified, "Value reported is the mean of two or more determinations."

February

For the diel samples from 02/09/2021 14:00 through 02/10/2021, PO4 and NO2 were Q-qualified, "sample held beyond normal holding time" by the lab and rejected due to the samples arriving 4 days late. The CHLA and PHEA samples were not analyzed.

March

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The Total Suspended Solids (TSS) grab sample for rkbmbnut taken at 03/03/2021 08:18 was A-qualified, "Value reported is the mean of two or more determinations."

The Phaeophytin diel sample taken at 03/17/2021 06:00 was A-qualified, "Value reported is the mean of two or more determinations."

April

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

Grab samples for rkbpbnut on 04/07/2021 were rejected for TKN due to the lab reanalyzed the sample out of holding time because of an incorrect field conductivity. The result was confirmed on 05/05/2021.

May

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

June

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

July

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The Total Suspended Solids (TSS) grab sample for rkbfbnut taken at 07/15/2021 08:36 was A-qualified, "Value reported is the mean of two or more determinations."

The Total Kjeldahl Nitrogen (TKN) grab sample for rkblhnut taken at 07/15/2021 11:11 was J-qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

August

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The Nitrite (NO2) grab sample for rkbmbnut taken at 08/11/2021 06:34 was J-qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

The Total Suspended Solids (TSS) grab sample for rkblhnut taken at 08/11/2021 10:44 was A-qualified, "Value reported is the mean of two or more determinations."

September

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

October

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

For the 10/13/2021 11:00 diel sample, the PO₄, CHLA and PHEA were Q-qualified, “sample held beyond normal holding time” by the lab due to the “sample expired upon receipt”, but the samples were within the CDMO’s hold time criteria.

The Chlorophyll *a* (CHLA) diel sample taken at 10/13/2021 23:30 was A-qualified, “Value reported is the mean of two or more determinations.”

November

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The Total Kjeldahl Nitrogen (TKN) grab sample for rkbpbnut taken on 11/09/2021 at 09:19 was J-qualified, “Estimated value and/or the analysis did not meet established quality control criteria.”

The Total Suspended Solids (TSS) grab sample for rkblhnut taken on 11/09/2021 at 12:00 was A-qualified, “Value reported is the mean of two or more determinations” and J-qualified, “Estimated value and/or the analysis did not meet established quality control criteria.”

The Total Suspended Solids (TSS) grab sample for rkblhnut taken on 11/09/2021 at 12:05 was J-qualified, “Estimated value and/or the analysis did not meet established quality control criteria.”

December

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The 12/01/2021 grab samples for rkblhnut and rkbpbnut sample 09:52, PO₄, NO₂, CHLA and PHEA were Q-qualified, “sample held beyond normal holding time” by the lab due to the “sample expired upon receipt”, but the samples were within the CDMO’s hold time criteria.

The Total Suspended Solids (TSS) grab sample for rkbfunut taken on 12/01/2021 at 10:24 was A-qualified, “Value reported is the mean of two or more determinations.”

2020 - 2021 weather conditions based on Big Cypress Basin (BCB) Hydrologic Reports:

December 2020: A typical dry season pattern remained in place over the Basin during December. A series of cold fronts that made their way through the region brought little rainfall except for one stronger front that moved through the first few days of the month. The early month front brought almost all of the month’s above average rainfall in a couple days. That beneficial rain event once again topped off surface and groundwater levels throughout the region. As the year ended, water levels throughout the region remain well above normal for this time of year and are in an excellent position to weather the expected drier periods of the winter and spring. Rainfall totals for 2020 came in at 56.1 inches which is 99% of average. The wetter than average September through December offset the deficit the region had from the spring drought. Rainfall in December was above normal due a strong early December cold front. The basin-wide monthly average was **3.23 inches (193% of normal)**, which is above the average 1.67 inches typically collected.

January: A drier than normal winter season pattern remained in place over the Basin during January. A series of cold fronts made their way through the region but brought little rainfall. As the month ended, water levels throughout the region still remain well above normal for this time of year and are in an excellent position to weather the expected drier periods of the winter and spring. Rainfall in January was well below normal due to continue La Nina conditions in the Pacific Ocean, which usually suggest warmer and drier than average conditions for south Florida during the winter. The basin-wide monthly average was **0.5 inches (21% of normal)**, which is well below the average 2.4 inches typically collected.

February: A drier than average winter season pattern remained in place over the Basin during February. A series of cold fronts made their way through the region but brought little rainfall. As the month ended, water levels throughout the region still remain well above normal for this time of year and are in a good position to weather the height of the dry season. Rainfall in February was below normal partially due to the continued La Nina conditions in the Pacific Ocean, which usually suggest warmer and drier than average conditions for south Florida during the winter and spring. The basin-wide monthly average was **1.42 inches (76% of normal)**, which is below the average 1.85 inches typically collected.

March: The below normal rainfall trend continued in March. While this last month was not nearly as dry as the record dry March in 2020, the Basin still was well below normal. Every month so far this year has been below average which assists with accelerating the normal recession of groundwater and surface water in the region. While surface water levels are still above normal for this time of year, some groundwater levels are lower than normal entering April, which is also Water Conservation Month. Individual voluntary water conservation initiatives can help reduce water demand and slow the recession of groundwater levels. Fortunately, so far groundwater levels are higher than they were in Spring 2020 when there were widespread severe drought conditions. As the system continues to dry out, portions of south Florida are now in a moderate drought. Any additional rainfall the Basin receives during the last few months of dry season will be beneficial and will be retained within the surface water system to promote groundwater recharge. The weather pattern in March was once again mostly hot and dry continuing with the patterns from February and January. The basin-wide monthly average was **0.93 inches (49% of normal)**, which is below the average 1.88 inches typically collected.

April: The below normal rainfall trend finally stopped in April but did not reduce the 2021 rainfall deficit. Even with the rainfall deficit, surface water levels throughout the Basin remain above normal for the end of April and are in an excellent position to enter the transition to wet season which typically occurs the second half of May. The weather pattern in April was once again mostly hot and dry continuing with the patterns from January through March. A couple cold fronts brought widespread rainfall coverage to the area, but rainfall totals were not enough to erase the rainfall deficit. The basin-wide monthly average was **2.39 inches (103% of normal)**, which is just above the average 2.31 inches typically collected.

May: The disappointing May rainfall totals only added to the growing 2021 rain deficit. As the month came to a close, the 2021 deficit grew to about six (6) inches or about 50% of average. With the continued lack of significant rainfall, the entire Basin started June in moderate drought conditions. As May came to a close, the weather pattern did finally transition on 28th to a typical wet season pattern of daily afternoon thunderstorms. Canal and surface water levels have reached their lowest levels as the wet season started. Most canals ended their recession between the 25th and 50th percentiles for May, which is higher than normal considering the Basin has only received 50% of normal rainfall. Early May brought a couple of days for wet season style weather but was interrupted by a couple late season cold fronts. The wet season finally got started on May 28th where there is daily thunderstorm activity in the Basin. The basin-wide monthly average was **0.87 inches (22% of normal)**, which is way below the average 4.03 inches typically collected.

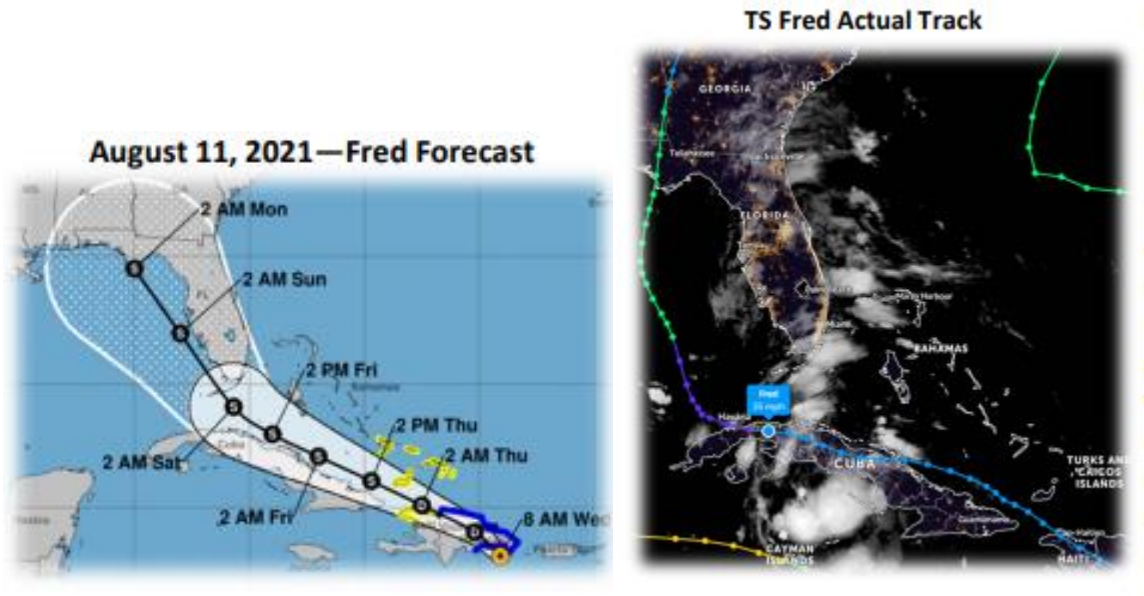
June: As usual the rainy season ramped up in June with daily afternoon thunderstorms occurring over the region. While the month did not bring enough rain to overcome the May deficit, June did finish with above normal rainfall (approximately 113% of normal). The rainfall was enough to eliminate the drought conditions that had covered the Basin during April and May. Surface and ground water levels have all increased throughout the region in response to the rainfall. As the month came to a close, all water levels are near normal for late June. The basin-wide monthly average was **11.12 inches (113% of normal)**, which just above the average 9.8 inches typically collected

July: As July started Tropical Storm/Hurricane Elsa formed and threatened the Basin. Elsa took a more traditional August storm track from the eastern Caribbean. As it took a turn to the north through Cuba, Elsa passed by the west coast of Florida offshore, but did bring heavy rainfall to portions of southwest Florida. Fortunately, the Basin did not receive the heaviest rainfall in southwest Florida. Western areas of the Basin received 3-5 inches, while eastern portions of the County only received 1-2 inches. This is in stark contrast to some of the totals that occurred in coastal Charlotte and Lee where some rainfall totals topped 10 inches. The routine summer pattern of daily thunderstorms was re-established after Elsa passed. Looking ahead, there is much uncertainty on how the rest of the wet season will play out. The Basin has equal chances for above, normal, or below average rainfall for the next three months. The basin-wide monthly average was **9.9 inches (115% of normal)**, which above the average 8.6 inches typically collected.



August: For most of August, a typical summer time pattern of daily thunderstorm activity was in place over the region. Near the middle of the month, Tropical Storm Fred formed and once again another storm threatened Florida. TS Fred was forecast to take a similar path as recent TS Elsa with

similar total rainfall forecast amounts of 4-6" average across the region. Fortunately for Florida, Fred interacted with the mountainous terrain of Hispaniola and Cuba hindering further development. Fred ultimately passed west of Florida and actual rainfall totals were much less than previous forecasts. The region received an average of 2-3" rainfall from TS Fred. The routine summer pattern of daily thunderstorms was re-established after Fred passed. Looking ahead, much uncertainty remains on how the rest of the wet season will play out. The Basin has equal chances for above, normal, or below average rainfall for the next three months. There are some signals that La Nina is potential forming again in the Pacific Ocean, which similarly to last year, may signal a drier than normal dry season. The basin-wide monthly average was **9.2 inches (92% of normal)**, which is just below the average 10.0 inches typically collected.



September and October: September was another typical summer month with a pattern of daily thunderstorm activity. The tropics remained very active, but fortunately all activity was well away from south Florida. In terms of rainfall, it was again nearly average with about 107% of normal. The summertime pattern remained in place well into October until the Basin had its first significant cold front near the middle of the month. The frontal passage on October 17th marked the end of the wet season and beginning of the dry season. As October ended, the near average rainfall trend continued with the Basin receiving about 106% of normal rainfall. Looking ahead to the rest of the dry season, La Nina has developed again over the Pacific Ocean which typically means Florida will have a warmer and drier than average winter. NWS Climate Prediction Center long term outlooks indicate Florida will likely have below average rainfall until April 2022. As measured by twenty-three (23) reporting, the basin-wide September monthly average was 9.5 inches (107% of normal), which is above the average 8.8 inches typically collected and the basin-wide October monthly average was **4.06 inches (107% of normal)**, which is above the average 3.8 inches typically collected.

November: The typical dry season pattern was in place over the Basin for November. The month was mostly dry with the exception of a few cold fronts that passed through the region. Most of the month's above average (210% of normal) rainfall fell from a weather system passing over the Basin towards the beginning of the month. Some very small and isolated locations in mostly natural areas in Fakahatchee and south of Immokalee received about 8" of rainfall from the early month system. The rainfall that fell during November was well timed which gave the Basin the last bit of water needed to top off the system heading into the peak of dry season. Looking forward to the rest of the dry season, a drier than normal period is expected due to the influence of La Nina in the Pacific Ocean. The basin-wide monthly average was **3.78 inches (210% of normal)**, which more than double the average 1.8 inches typically collected.

December: A warm and dry weather pattern remained in place over the Basin during December. The month was exceptionally dry with only six (6) of the last thirty-one (31) Decembers being drier than this year. Even with the extremely dry conditions, most surface and groundwater levels are at or above normal. Even with the very dry December, the rainfall total for the year was very close to average. The 2021 Basin rainfall was 54.1 inches which is 96% of average. June was the wettest month with 11.1 inches and December was the driest with 0.4 inches. The basin-wide monthly average **was 0.41 inches (23% of normal)**, which was not even a quarter of the 1.76 inches typically collected. Based on collected gauge and radar data, the rainfall distribution across the Basin was very uniform with most areas receiving totals very close to the 0.4 inch average.

Acknowledgement: The data included with this document were collected by the staff of the Florida Department of Environmental Protection at the Rookery Bay National Estuarine Research Reserve with funding through NOAA's Estuarine Research Division. Any products derived from these data should clearly acknowledge this source (please use the attached logos). This recognition is important for ensuring that this long-term monitoring program continues to receive the necessary political and financial support.

