Documentation in Support of Category 4e

Waterbody/Watershed Identification

Organization	Orange County
Point of Contact	Rob Renk 3165 McCrory Place, Suite 200 Orlando, Florida 32803 Robert.Renk@ocfl.net 406-836-1488
Waterbody(s)	Waterbody Identification (WBID) #3169A3 Lake Buchanan
No. Waterbody / Pollutant Combinations	Lake Buchanan is currently on the FDEP Verified List of impaired waters for nutrients (chlorophyll-a, Total Nitrogen, Total Phosphorus), dissolved oxygen (percent saturation), and biology based on the 2022-2024 Biennial Assessment. The Chlorophyll-a (Chl-a), Total Nitrogen (TN), and Total Phosphorus (TP) annual geometric means (AGMs) exceeded the numeric nutrient criteria (NNC) for a clear, alkaline lake more than once in a three-year period. The 2022-2024 Biennial Assessment indicates that Lake Buchanan is impaired for biology based on failed bioassessments and is impaired for dissolved oxygen (DO) based on the number of exceedances. Nutrients have been determined to be the causative pollutant of biological and DO impairments. Lake Buchanan is located within the Okeechobee BMAP area.
EPA Completed TMDL	The Environmental Protection Agency (EPA) has not completed a Total Maximum Daily Load (TMDL) for the impaired waterbody segment listed in this document.

Description of Baseline Conditions

Watershed(s)	Shingle Creek Drainage Basin / Upper Kissimmee River Watershed
Baseline Data	**<u>Nutrients</u>** • Parameter: Nutrients (Chl-a) Criterion Concentration or Threshold not met: ≤ 20 µg/L. Annual geometric mean chlorophyll-a values exceeded the criterion in 2016, 2017, 2019, 2020, 2021, 2022, and 2023 with values of 29 µg/L, 33 µg/L, 35 µg/L, 39 µg/L, 30 µg /L, 31 µg /L, and 22 µg /L, respectively. (Source: Orange County Environmental Protection Division, Station SC3) • Parameter: Nutrients (TN) Criterion Concentration or Threshold not met: ≤1.05 mg/L. Annual geometric mean total nitrogen values exceeded the criterion in 2016, 2017, 2019, 2020, 2021, 2022, and 2023 with values of 1.36 mg/L, 1.48 mg/L, 1.58 mg/L, 1.50 mg/L, 1.49 mg/L, 1.63 mg/L, and

1.28 mg/L, respectively. (Source: Orange County Environmental Protection Division, Station SC3)

- Parameter: Nutrients (TP) Criterion Concentration or Threshold not met: ≤ 0.03 mg/L. Annual geometric mean total phosphorus values exceeded the criterion in 2016, 2017, 2019, 2020, 2021, 2022, and 2023 with values of 0.07 mg/L, 0.08 mg/L, 0.21 mg/L, 0.13 mg/L, 0.06 mg/L, 0.10 mg/L, and 0.07 mg/L, respectively. (Source: Orange County Environmental Protection Division, Station SC3)

Table 1 lists the annual geometric means from 2015-2023 for Chl-a, TN, and TP calculated by Orange County. Buchanan has a long-term color geomean of 22 PCU and a long-term alkalinity of 45 mg/L CaCO3.

Table 1 *- Nutrient AGMs – Assessment Data*

Year	Chl-A	TN (mg/L)	TN Criteria (mg/L)	TP	TP Criteria (mg/L)
2016	29.4	1.36	1.05	0.07	0.03
2017	33.4	1.48	1.05	0.08	0.03
2018	17.1	0.94	1.91	0.07	0.09
2019	35.8	1.58	1.05	0.21	0.03
2020	39.0	1.50	1.05	0.13	0.03
2021	30.0	1.49	1.05	0.06	0.03
2022	30.8	1.63	1.05	0.10	0.03
2023	21.9	1.28	1.05	0.07	0.03

Notes:
Data source: Orange County Environmental Protection Division, Station SC3.
Data highlighted in red indicates the NNC criterion threshold was exceeded.
Data highlighted in green indicates the NNC criterion threshold was not exceeded.
TN and TP Criteria is a range depending on Chl-a AGM values.

Table 2 lists the annual geometric means from 2017-2023 for Chl-a, TN, and TP from IWR Run 66.

Table 2 *- Nutrient AGMs – Assessment Data from IWR Run 66*

Year	Chl-A	TN (mg/L)	TN Criteria (mg/L)	TP	TP Criteria (mg/L)
2017	33	1.48	1.05	0.08	0.03
2018	9	0.87	1.91	0.06	0.09
2019	25	1.66	1.05	0.19	0.03
2020	39	1.50	1.05	0.13	0.03
2021	-	-	-	-	-

2022	31	1.63	1.05	0.10	0.03
2023	17	-	1.91	-	0.09

Notes:
Data source: IWR Run 66.
Data highlighted in red indicates the NNC criterion threshold was exceeded.
Data highlighted in green indicates the NNC criterion threshold was not exceeded.
A dash (-) indicates not enough samples collected to calculate a geometric mean.
TN and TP Criteria is a range depending on Chl-a AGM values.

Biology:

Parameter: Biology
Criterion Concentration or Threshold not met: Average score of at least two temporally independent LVI scores ≥ 43; or if there are only two LVI scores and there is less than or equal to a 20-point difference. Buchanan did not meet the LVI criterion in 2021 and 2022 with values of 23 and 28, respectively.

Table 3 lists all available biology (LVI) scores for Lake Buchanan. The average of at least two LVI scores should be greater than or equal to 43 for a lake to be considered biologically healthy.

***Table 3** – Biology (LVI) Assessment Scores*

Criteria: The average LVI score should be ≥ 43.

Year	LVI
2021	23
2022	28

Notes:
Data highlighted in red indicates the minimum criterion threshold of 43 was not met.

Dissolved Oxygen:

Parameter: Dissolved Oxygen (DO) (Percent Saturation)
Criterion Concentration or Threshold not met: ≥ 38 %
No more than 10 percent of the daily average percent dissolved oxygen (DO) saturation values should be below 38%. The 2022-2024 Biennial Assessment indicates that Buchanan is impaired for this parameter. In the IWR Run 66 results, Buchanan did not meet the dissolved oxygen percent saturation criteria in 7 out of 34 samples, indicating that 21% of samples did not meet the criteria. In Orange County sampling results, Buchanan did not meet the dissolved oxygen percent saturation criteria in 3 out of 37 samples since 2015, indicating that 8% of samples did not meet the criteria. Orange County dissolved oxygen results for SC3 do not suggest that Lake Buchanan is impaired for this parameter. Orange County station SC3 is detailed in the Critical Milestones/Monitoring section of this document.

Table 4 lists dissolved oxygen (DO) percent saturation data for Lake Buchanan since 2015. The DO percent saturation criteria indicates that no more than 10% of the daily average percent dissolved oxygen (DO) saturation values shall be below 38%. From July 2015 to April 2024, Orange County data shows that 3 out of 37 (8% of samples) fell below 38%. Orange County data does not suggest an impairment for dissolved oxygen saturation.

Table 4 *– Dissolved Oxygen (DO) Percent Saturation*		
Criteria: No more than 10% of the daily average percent dissolved oxygen (DO) saturation values shall be below 38%.		
Date	**Results**	**Units**
28-Jul-15	62.3	%
18-Nov-15	50.4	%
30-Mar-16	83.9	%
31-Mar-16	86.8	%
23-Jun-16	103.3	%
30-Aug-16	62.2	%
03-Nov-16	87.4	%
07-Feb-17	157.1	%
25-May-17	82.3	%
31-Aug-17	111.2	%
29-Nov-17	84.9	%
23-Jan-18	129.7	%
11-Jun-18	45	%
14-Aug-18	32	%
13-Nov-18	46	%
27-Feb-19	105.5	%
07-May-19	130.9	%
05-Sep-19	54.8	%
12-Nov-19	19.5	%
25-Feb-20	113.8	%
05-May-20	174.7	%
04-Aug-20	138.2	%
27-Oct-20	67.8	%
12-Jan-21	114.1	%
04-May-21	80.8	%
20-Oct-21	36	%
11-Jan-22	80.4	%
11-May-22	132.8	%
03-May-22	132.8	%
26-Jul-22	86.2	%
15-Nov-22	60.7	%
10-Jan-23	127.7	%
19-Apr-23	149	%
20-Jul-23	97.6	%

02-Oct-23	58.1	%
29-Jan-24	117.7	%
29-Apr-24	123.4	%

Notes:
Source: Orange County Environmental Protection Division, Station SC3.
Data highlighted in red indicates the minimum criterion of 38% was not met.

Stations used in the Chl-a, TN, TP and DO assessments:
21FLORANSC3 (28.496624, -81.405526)
This station is discussed and illustrated in the Critical Milestones/Monitoring section of this document.

Map

Figure 1 provides a Lake Buchanan Vicinity Map that includes the watershed and nearby jurisdictional boundaries. The Lake Buchanan watershed is located fully within unincorporated Orange County.

Figure 2 provides the WBID boundary and monitoring stations that fall within the WBID.

Figure 1 *– Lake Buchanan Vicinity Map*

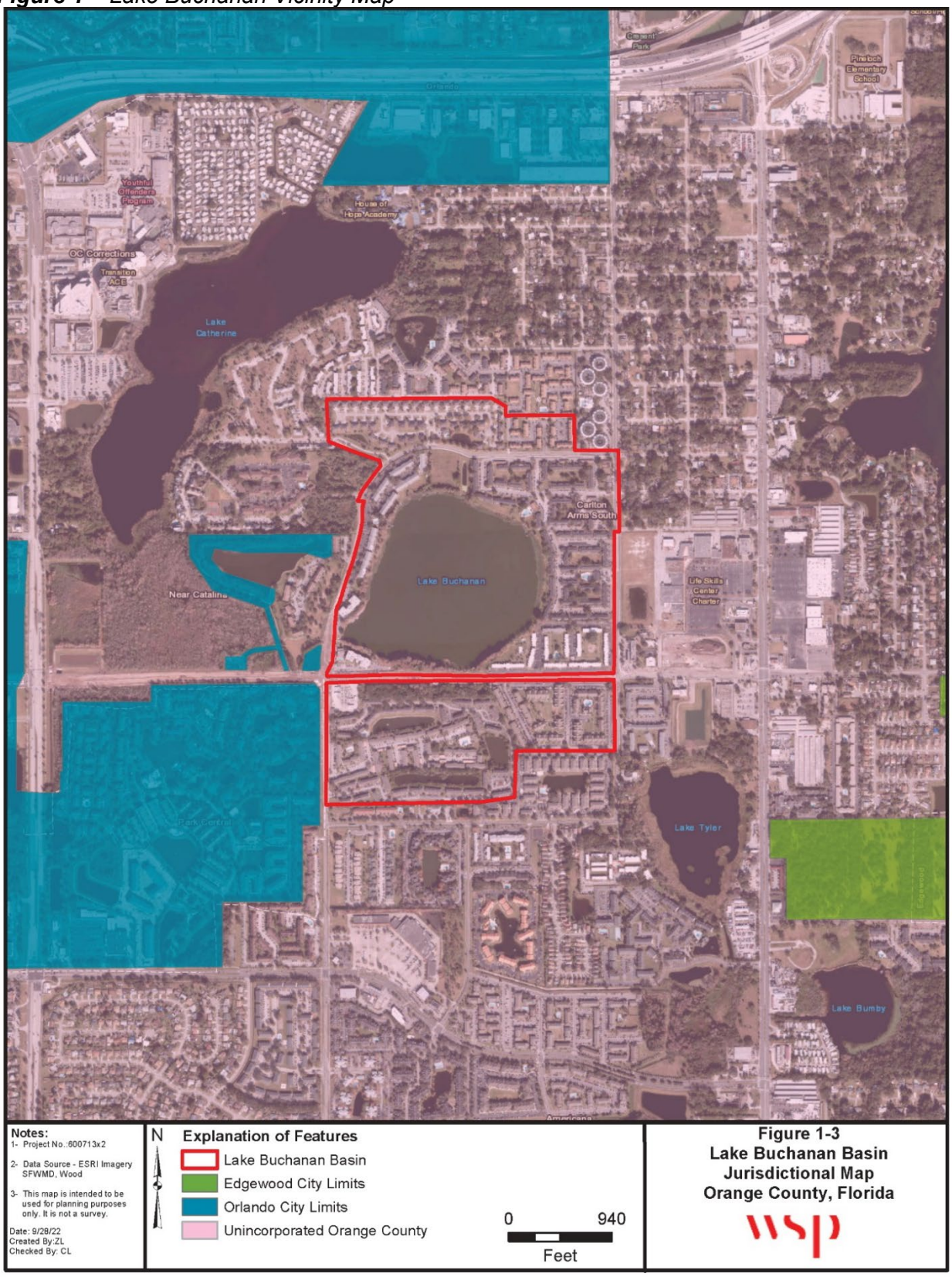


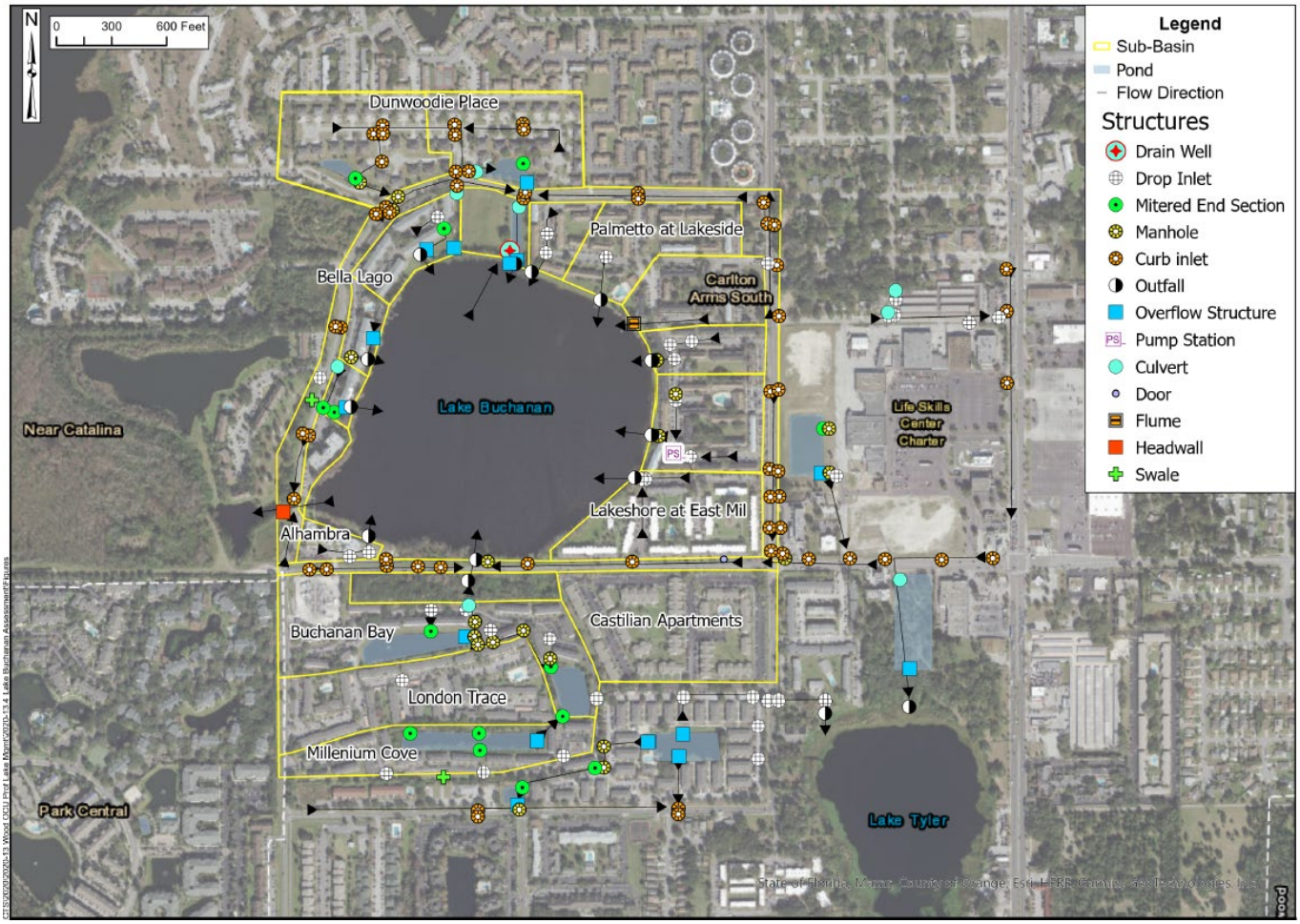
Figure 2 *– Lake Buchanan (WBID 3169A3) boundary and monitoring stations.*

Evidence of Watershed Approach

Area of Effort	**Figure 3** shows an aerial image of Lake Buchanan's watershed and 22 sub-basins. Lake Buchanan is a 47.3-acre lake with a contributing basin of approximately 144.7 acres. The lake is located within the Shingle Creek drainage basin in the Upper Kissimmee planning unit. The Lake Buchanan watershed is fully within unincorporated Orange County. **Figure 4** shows an aerial image of Lake Buchanan's stormwater structures and hydrologic flow directions.
Key Stakeholders Involved and Their Roles	Key Stakeholders: • Orange County Additional Stakeholders: • South Florida Water Management District (SFWMD)

Figure 3 *– Lake Buchanan Watershed and Sub-basins*

Figure 4 *– Lake Buchanan Stormwater Structures*



Watershed Plan & Other Supporting Documentation	The area includes the watershed drainage area to WBID # 3169A3 Lake Buchanan. This WBID is impaired for Biology, Nutrients (Chl-a, TN, TP), and DO (percent saturation) based on the number of exceedances for the sample size. The objectives outlined by this 4e Alternative Restoration Plan and the *Lake Buchanan Assessment Nutrient Loading Study and Lake Management Plan* (Lake Management Plan) address these impairments. Orange County has taken a proactive approach to addressing Lake Buchanan water quality issues and contracted the Lake Management Plan in 2023 to identify pollutant load sources contributing to the water quality impairments. The Lake Management Plan provides a list of project alternatives, ranked by nutrient reduction efficiency, to address the impairments and attain surface water quality standards. The report is available on the Orange County Water Atlas (https://orange.wateratlas.usf.edu/). The WBID drainage area includes existing key project(s) that Orange County has already completed or budgeted, as follows: • Lake Management Plan • Lake Buchanan Pond 6244 Downflow-Filter (DFF) Feasibility Study

- Lake Buchanan Alum Dosing and Application
- Street Sweeping

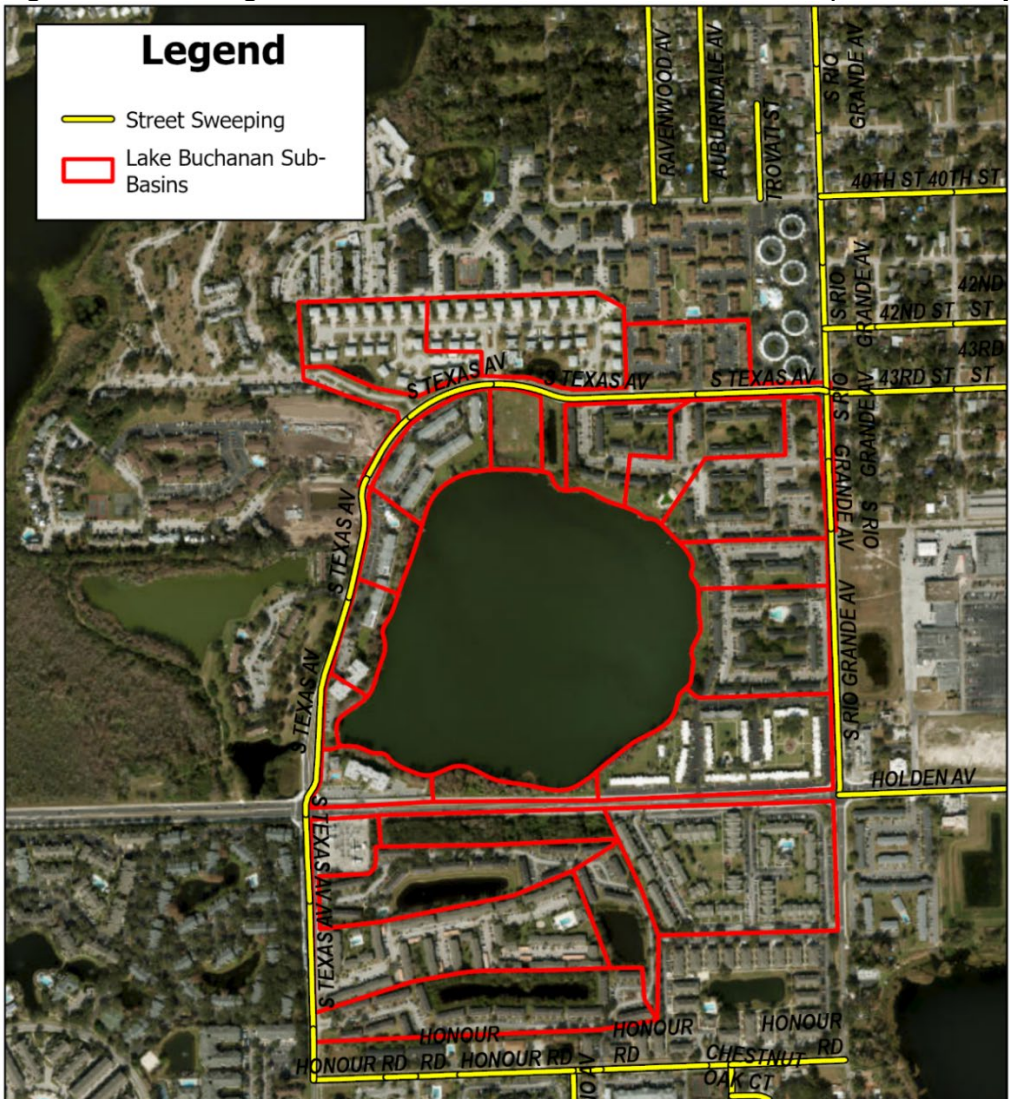
A map of street sweeping in the Lake Buchanan watershed is given in **Figure 5**.

The Lake Management Plan identified and ranked a list of additional structural projects and programmatic activities that can be undertaken to further reduce nutrient load to Lake Buchanan. Suggested alternatives are as follows, ranked from most to least recommended:

1. Mechanical harvesting
2. Sediment inactivation
3. Public education
4. Downflow-filter with BAM
5. Wet detention and downflow-filter with BAM
6. Bioretention

Construction of structural BMPs is contingent on project feasibility and budget.

Figure 5 – Existing BMPs in the Lake Buchanan Watershed (Street Sweeping)



Point Sources and Indirect Source Monitoring (Sites)

No point sources were identified in the Lake Buchanan drainage basin.

The Lake Buchanan drainage basin is regulated by Municipal Separate Storm Sewer (MS4) Permit FLS000011-004 for Orange County.

Nonpoint Sources

Table 5 *– Land Use within Lake Buchanan Basin*

Land Use	Approximate % of Watershed
Residential, High Density	0.20
Residential, Medium Density	89.93
Open Land	0.01
Upland Mixed Forests	3.71
Lakes	1.71
Reservoirs	3.08
Utilities	1.36
Total	100

Table 6 *– Hydrologic Soil Groups within Lake Buchanan Watershed*

Land Use	Approximate % of Watershed
A/D	65.4
A	15.3
B/D	8.9
Water/Urban	10.4
Total	100

Pollutant loading sources were evaluated in the Lake Management Plan.
The results indicated that sediment flux within Lake Buchanan is the largest source of pollutants contributing 592 lb./yr total phosphorus (71%) and 2,360 lb./yr total nitrogen (63%).

Surface runoff is the largest source of external loading at 219 lb./yr TP and 1,028 lb./yr TN. The Lake Buchanan watershed was divided into 22 sub-basins and each sub-basin was evaluated using land use cover and soil classification information to support water quantity and quality modeling.

Thirteen of the twenty sub-basins contribute less than 5% of the total runoff contribution. Sub-Basins LB-130 and LB-110 have no on-site stormwater treatment and generate the largest amount of stormwater runoff at 11.3% and 10.8%, respectively.

Seepage inputs contribute approximately 16 lb/yr total phosphorus and 309 lb/yr total nitrogen. Direct atmospheric loading was a relatively minor pollutant source.

Water Quality Criteria	Lake Buchanan is expected to meet Class III surface water quality standards as defined in Chapter 62-302 of the Florida Administrative Code upon successful completion of all projects.

Restoration Work	**EXISTING PROJECTS:**
	Existing projects are currently implemented and ongoing.
	
	Project 1: Lake Management Plan completed in February 2023.
	Orange County funded a hydrologic and nutrient loading study on Lake Buchanan (the Lake Management Plan) during 2021-2023. The study included significant field monitoring for a year and resulted in the identification of multiple projects for water quality improvement. The cost of this study was $148,372.36. The report is available on the Orange County Water Atlas (https://orange.wateratlas.usf.edu/)
	
	Project 2: Lake Buchanan Pond 6244 Downflow-Filter (DFF) North.
	From the Lake Management Plan, a BMP recommendation was made for a downflow linear Biosorption Activated Media (BAM) filter on the north side of the lake that would treat both stormwater from an adjacent wet retention pond and surface water from Lake Buchanan. A feasibility study for this project is currently underway and is expected to cost $119,449.
	
	Project 3: Lake Buchanan Alum Dosing and Application.
	To address internal sediment flux, which is the largest source of pollutants contributing to the nutrient load in Lake Buchanan, an alum treatment was budgeted for FY25. This project will scrub TP from the water column and sequester TP nutrient release from the benthic sediments. The dosing study for this project is underway and the alum treatment is expected to be completed in 2026. Alum dosing and treatment is estimated to cost $346,588.
	
	Project 4: Street Sweeping.
	Orange County Public Works operates a street sweeping program that includes approximately 1.5 curb miles in the Lake Buchanan watershed at a frequency of every six weeks. Locations of street sweeping are shown in Figure 5.
	
	Project 5: Education and Ordinances.
	• Orange County has Ordinances in place for
	  ○ Fertilizer, Chapter 15 Article XVII: https://library.municode.com/fl/orange_county/codes/code_of_ordinances?nodeId=PTIIORCOCO_CH15ENCO_ARTXVIIFEMAOR
	  ○ Pet Waste, Chapter 5 Article II: https://library.municode.com/fl/orange_county/codes/code_of_ordinances?nodeId=PTIIORCOCO_CH5AN_ARTIIANSE and
	  ○ Landscape and Irrigation, Chapter 24 Article I: https://library.municode.com/fl/orange_county/codes/code_of_ordinances?nodeId=PTIIORCOCO_CH24LABUOPSP_ARTIINGE.
	• Public Service Announcements are shown on Orange TV.
	• Orange County maintains its website as well as providing additional water quality, fertilizer, and NPDES information on the Orange County Water Atlas.
	• Brochures are provided to the public explaining the ordinances and encouraging nutrient-reducing activities in the watershed.

Critical Milestones/Monitoring

Anticipated Critical Milestone(s) and Completion Dates:	Orange County Projects: • Project 1: Lake Buchanan Watershed Assessment completed in February 2023. • Project 2: Lake Buchanan Downflow BAM North (Pond 6244) – A feasibility study is underway. • Project 3: Lake Buchanan Alum Dosing and Application (underway) – expected to be completed by 2026. • Project 4: Street Sweeping (ongoing) • Project 5: Education and Ordinances (ongoing)
Monitoring Component	***ORANGE COUNTY AMBIENT MONITORING PROGRAM - Ongoing*** The Orange County monitoring location SC3 is provided in **Figure 6** and coordinates are 28.496624, -81.405526. Trend graphs for TN, TP, Chl-a, and Dissolved Oxygen (Percent Saturation) are provided in **Attachment 1** for the period 2015 through 2023. Orange County will continue to monitor on a quarterly basis to review nutrient and dissolved oxygen trends. The monitoring station SC3 was established in 1971, and Orange County will evaluate all historical data from that location. Samples from the monitoring location, the center of Lake Buchanan (monitoring location ID FLORANSC3, aka SC3), will be analyzed for the following parameters: • Alkalinity • Chloride • Color • Chl-a • Sulfate • Turbidity • Metals (200.7 and 200.8) • *Escherichia coli* • Ammonia • Nitrite • Nitrate • Nitrate + Nitrite (NOx) • total Kjeldahl nitrogen (TKN) • Organic nitrogen • TN • Orthophosphate • TP • Dissolved phosphorus • Total suspended solids (TSS) • Total dissolved solids (TDS) • Total solids (TS) Water quality field parameters are also collected from the surface (0.5 meters) for pH,

specific conductance, temperature, and dissolved oxygen (% saturation and concentration).

Water quality data are and will continue to be uploaded to the Orange County Water Atlas and the FDEP Watershed Information Network (WIN).

ORANGE COUNTY BIOLOGY PROGRAM – *Ongoing*
Orange County periodically performs Lake Vegetation Index Surveys to monitor impaired lakes, record pre and post construction conditions, and record characteristics pre and post alum treatments. Orange County completed LVI Surveys on Lake Buchanan in 2021 and 2022. Orange County will continue to perform LVI Surveys as resources allow.

LAKE MANAGEMENT PLAN MONITORING PROGRAM - Completed
Orange County funded a hydrologic and nutrient loading study on Lake Buchanan during 2021-2023. The study included significant field monitoring for one year and resulted in the identification of multiple projects for water quality improvement.

Field monitoring included:

- Seepage Meter Monitoring (6 grab samples at 3 locations; bimonthly collection for a year):
    - Ammonia
    - Total Kjeldahl Nitrogen
    - NOx
    - Orthophosphate
    - TP

- Surface Water Monitoring (bimonthly grab samples, 6 at one location)
    - Ammonia
    - Total Kjeldahl Nitrogen
    - NOx
    - TN
    - Orthophosphate
    - TP
    - Alkalinity
    - Color
    - Chl-a
    - Turbidity
    - Total Suspended Solids

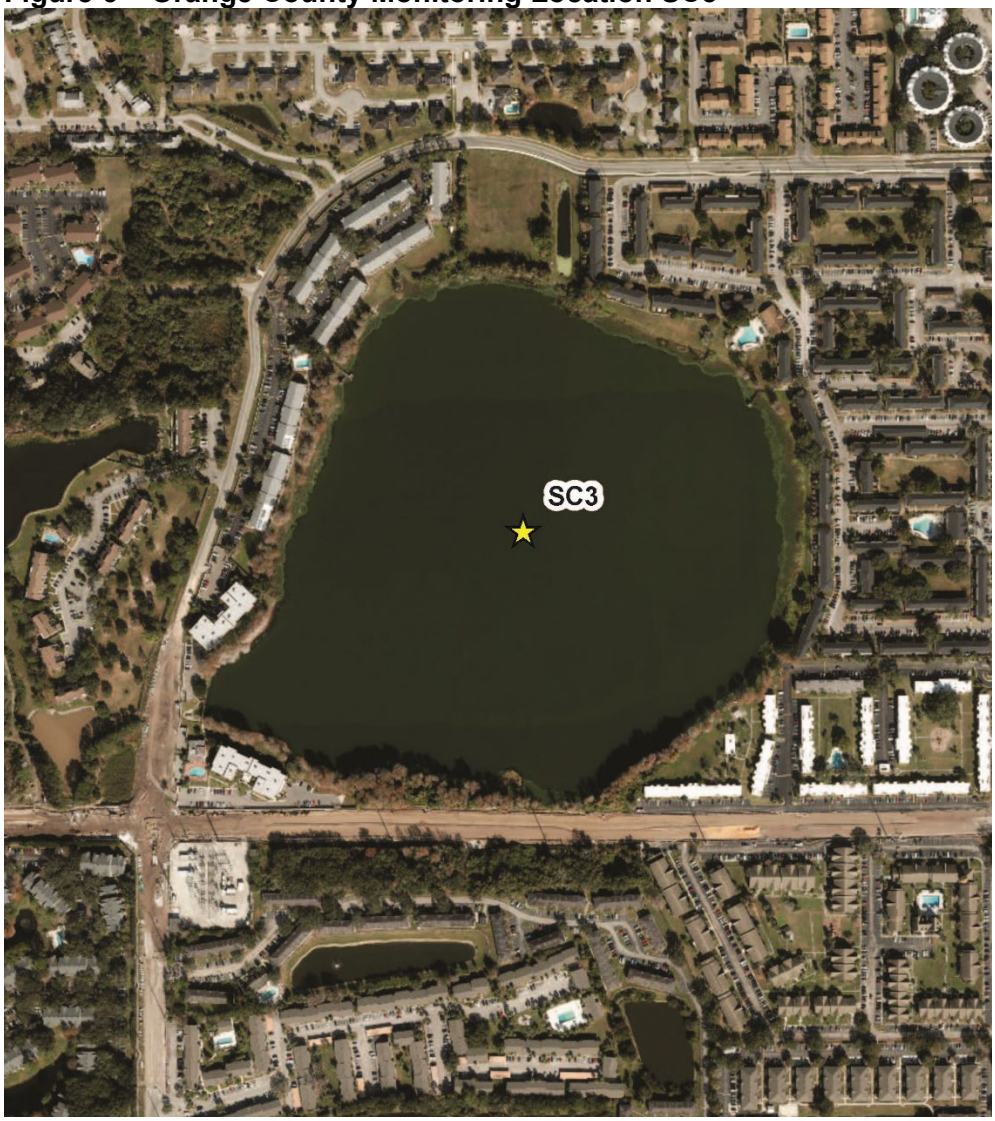
Water depth profiles were also collected from the surface and every 0.5 meters to total depth for pH, specific conductance, temperature, and dissolved oxygen (percent saturation and concentration).

- Stormwater monitoring (2 autosamplers: flow-weighted composite samples from 6 storm events, 0.2-inch or greater storm events)
    - NOx
    - Total Kjeldahl Nitrogen
    - TP
    - Orthophosphate
    - Alkalinity
    - Total Suspended Solids

- Turbidity
- Sediment phosphorus fractionation and flux (four cores for fractionation, four location (8 cores) for flux study)

Specific monitoring locations from the Lake Management Plan monitoring activities are included in the final report.

Figure 6 – Orange County Monitoring Location SC3



Other Key Dates

Estimated Date for Delisting from Verified List or Removal from Study List	WBID 3169A3 (Lake Buchanan) is in the Shingle Creek Watershed in the Upper Kissimmee Basin in the Lake Okeechobee BMAP area. The current review and assessment cycle (the next biennial assessment) is scheduled for completion in 2026. This waterbody is currently impaired for nutrients (TN, TP, chlorophyll-a, DO saturation, biology). Based on the 2024 biennial assessment lists, Lake Buchanan is on the 303(d) list of impaired waters for TN, TP, Chl-a, DO saturation, and biology. Lake Buchanan will remain in assessment category 4e for an additional biennial assessment cycle.

Financial Commitments

Estimated Implementation Cost	**Project 1: Lake Buchannan Assessment** The final cost to complete the year-long hydrologic and nutrient loading study was $148,372.36.

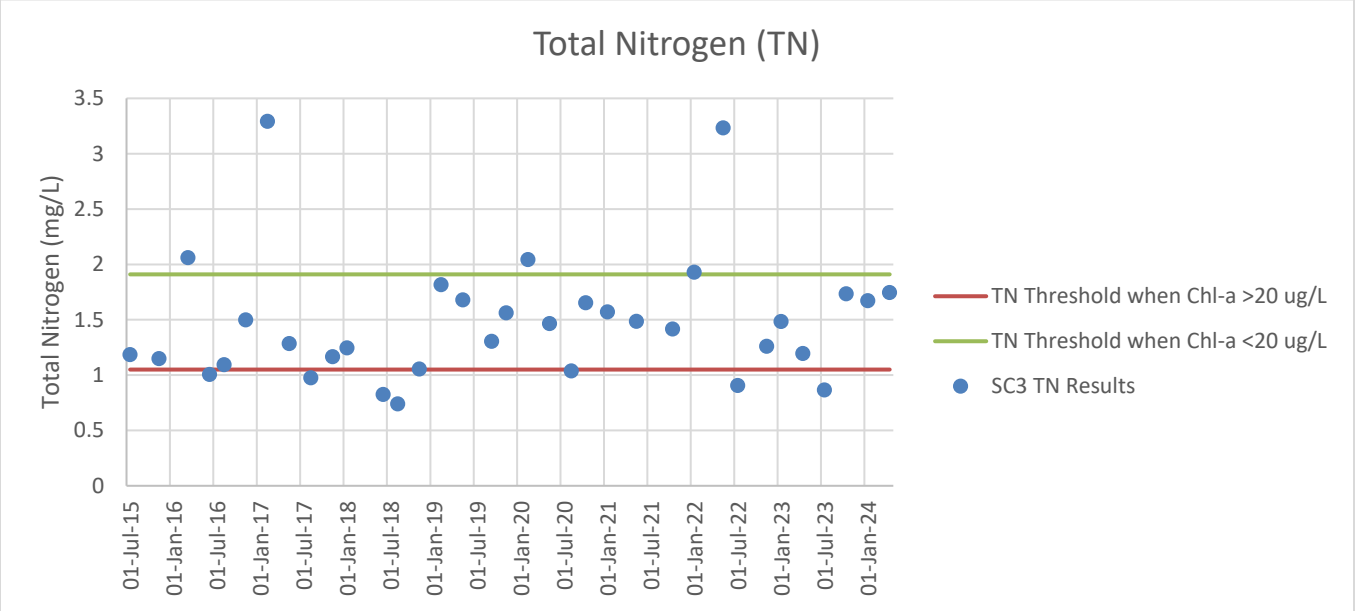
	Project 2: Lake Buchanan Pond 6244 Downflow-Filter (DFF) North. The cost of the feasibility study that is currently underway is estimated to be $119,449. **Project 3: Lake Buchanan Alum Dosing and Application.** The alum dosing and application is estimated to be $346,588. **Project 4: Street Sweeping** Orange County Public Works Department implements the current street sweeping program as part of its regional program. Streets are swept approximately every 6 weeks. **Project 5: Education and Ordinances.** Orange County has implemented several ordinances that positively affect water quality. Orange County provides educational outreach and educational materials and works with other local stakeholders to share resources.
Land Acquisition (if applicable)	**Funding Source (NA)** Total…….$ NA
Design and Construction (if applicable)	Primary Funding Source: Orange County With Potential Support From: SFWMD Total estimated future project costs are dependent on Feasibility Study results and County Prioritization and Budgeting procedures. Orange County has budgeted structural and non-structural water quality improvement projects identified during the Lake Management Plan. The feasibility study for the Lake Buchanan Pond 6244 was budgeted in FY24 for $150,000. The Lake Buchanan Alum Dosing and Application was budgeted in FY25 for $350,000. Implementation of future Design and Construction of Structural Projects will be included in the prioritization process for development of future Orange County EPD Water Quality CIP Projects.

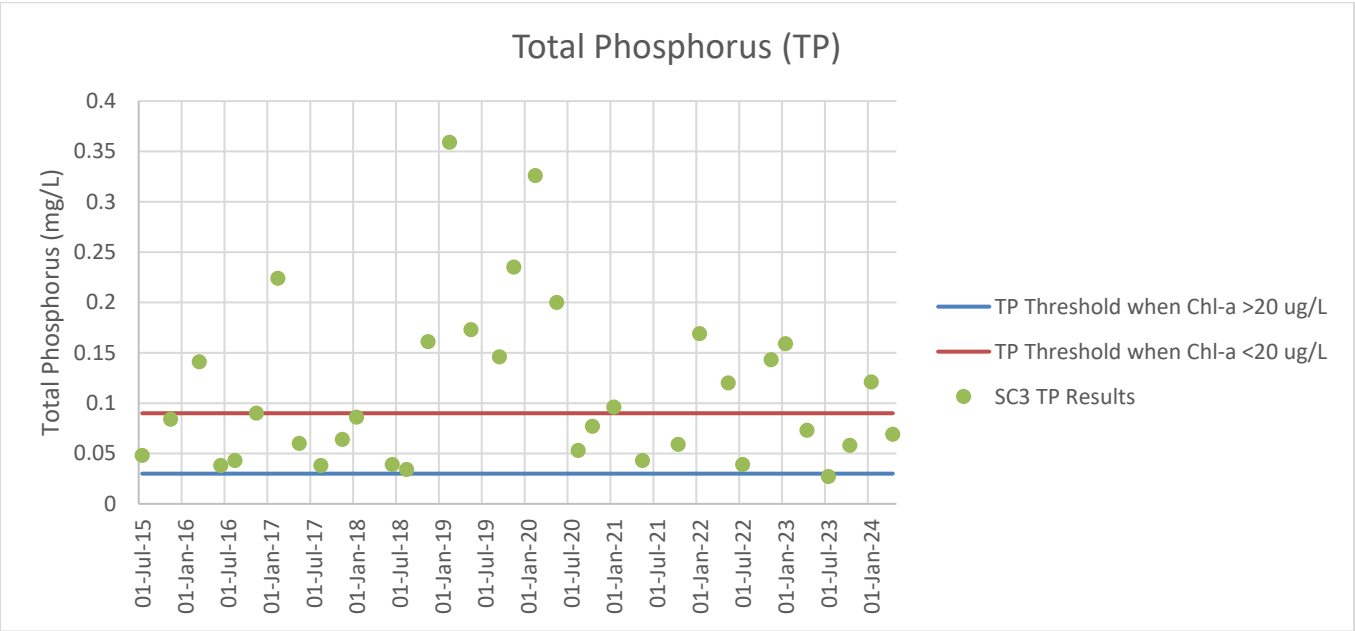
Figures:

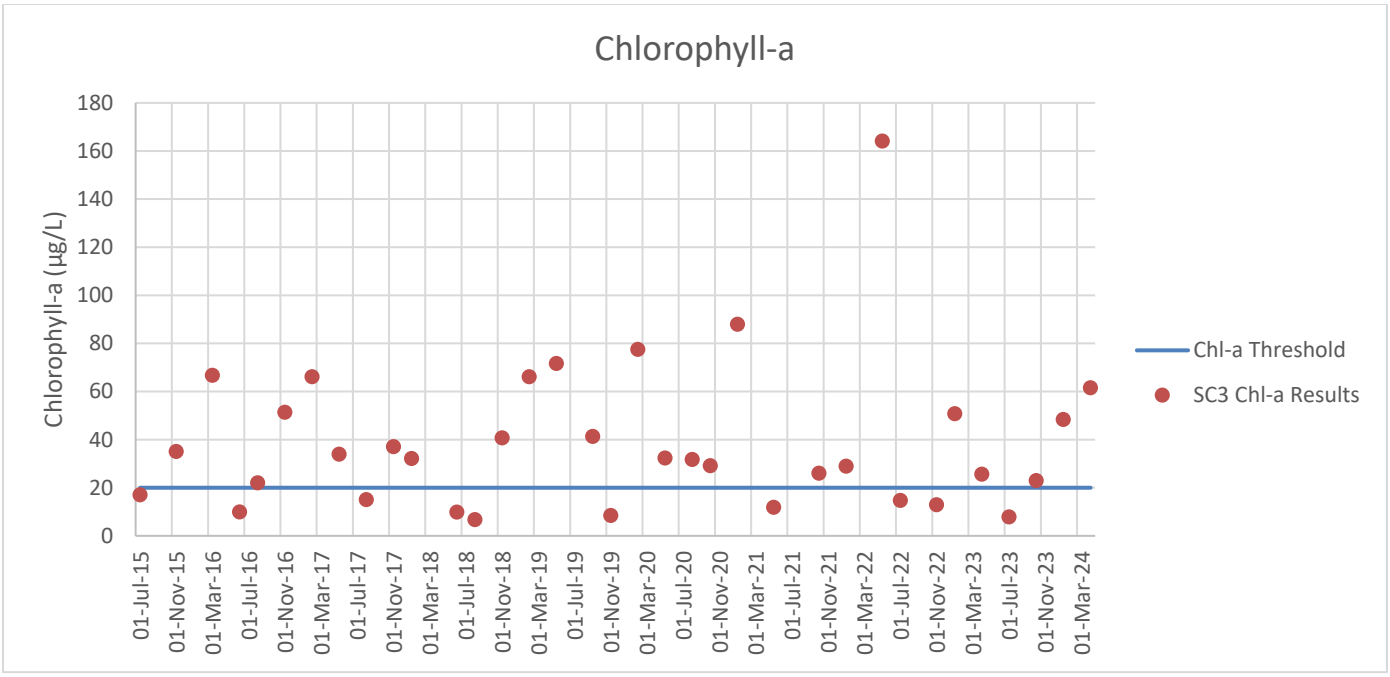
Figure 1: Lake Buchanan Vicinity Map
Figure 2: Lake Buchanan WBID Boundary and IWR Stations
Figure 3: Lake Buchanan Watershed Boundary with Sub-basins
Figure 4: Lake Buchanan Stormwater Structures and Drainage Map
Figure 5: Lake Buchanan Existing BMPs (Street Sweeping)
Figure 6: Orange County Monitoring Location SC3

Attachment 1: Trend Graphs (2015-2023)

Attachment 1: Trend Graphs






Chlorophyll-a
Chlorophyll-a (µg/L)
180
160
140
120
100
80
60
40
20
0
01-Jul-15
01-Nov-15
01-Mar-16
01-Jul-16
01-Nov-16
01-Mar-17
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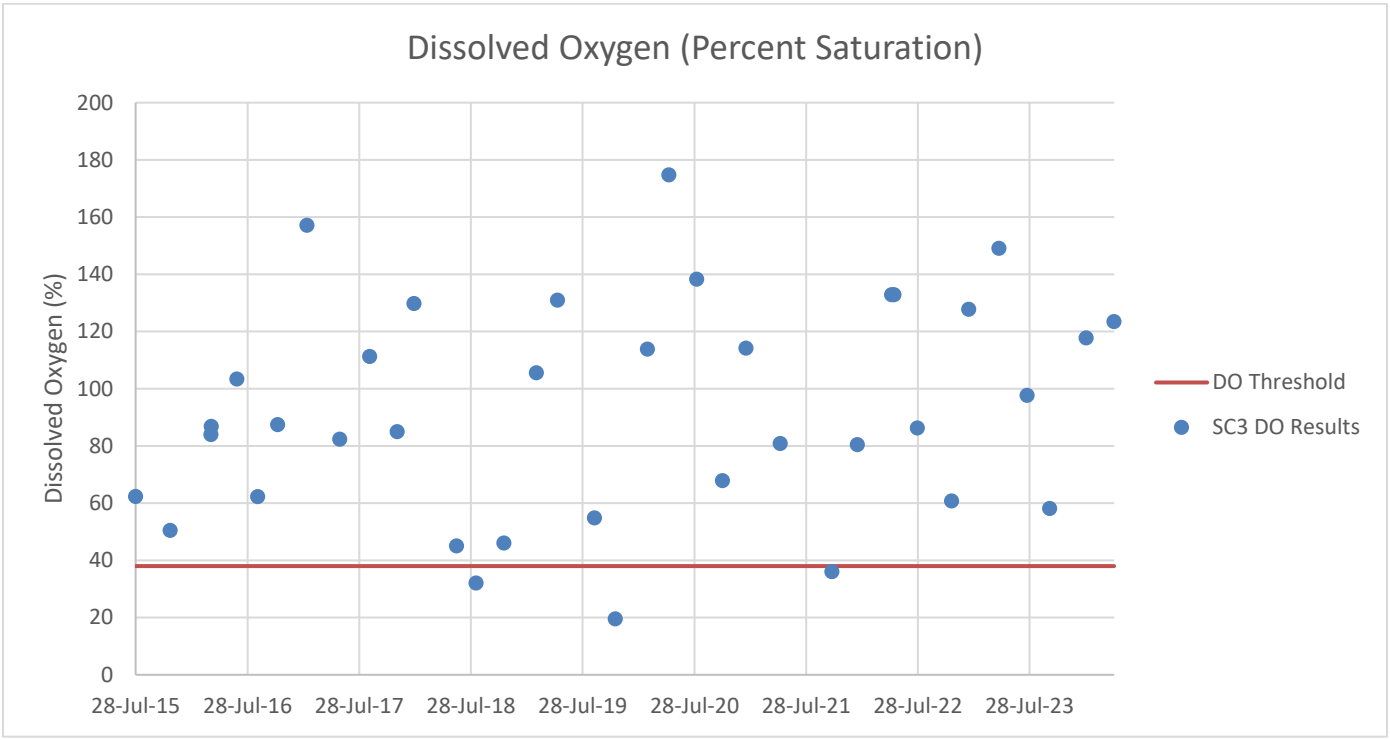
01-Nov-23
01-Mar-24
Chl-a Threshold
SC3 Chl-a Results


Dissolved Oxygen (Percent Saturation)
Dissolved Oxygen (%)
200
180
160
140
120
100
80
60
40
20
0
28-Jul-15
28-Jul-16
28-Jul-17
28-Jul-18
28-Jul-19
28-Jul-20
28-Jul-21
28-Jul-22
28-Jul-23
DO Threshold
SC3 DO Results