Surface Water Trend Monitoring Network Results
(1998 to 2022)

Division of Environmental Assessment and Restoration
Watershed Monitoring Section
Florida Department of Environmental Protection
Report Prepared July 2025

Goal of the Surface water Trend Monitoring Network

The purpose of the Surface Water Trend Monitoring Network is to examine water quality changes in flowing surface water systems over time. The Trend Monitoring Network consists of fixed monitoring stations across the state. The Trend Network provides long-term spatial and temporal information about water resources and potential changes from anthropogenic or natural influences, including extreme events (e.g., droughts and hurricanes).

Monitoring Design

The Surface Water Trend Monitoring Network consists of 78 fixed stations (Figure 1) used to quantify water quality trends in flowing surface water resources by obtaining chemistry and field data from rivers, streams, and canals. WMS chose station locations based on Florida's 52 United States Geological Survey (USGS) 8-digit drainage basins. Many stations are located at or near existing USGS, South Florida Water Management District (SFWMD) or St. Johns River Water Management District (SJRWMD) gauging stations, and often are situated at the lower end of a watershed, enabling the department to obtain biology, chemistry, and loading data at a point that reflects multiple land use activities within the watershed. Some stations are located at or near the Florida boundary with Alabama and Georgia to obtain chemistry and loading data for major streams entering Florida. Staff collect monthly water samples and field measurements at all stations in the Surface Water Trend Network. Please see the *Design Document* (Florida Department of Environmental Protection 2022) for more information on the Trend Network design.

Water Quality Trend Detection

DEP uses the Seasonal Kendall (SK) test for individual station water quality indicator trend detection. The Trend analysis protocols are provided in the document Status and Trend Monitoring Networks Trend Data Analysis Protocols (Florida Department of Environmental Protection 2024). For all trend analyses run, statistical significance is defined as when the probability of rejecting the null hypothesis of no change (probability value [p-value]) is < 5%.

When testing for trends using time series data, variations added by regularly spaced cycles make it more difficult to detect trends if they exist (Gilbert 1987). Regarding environmental data, Gilbert states that major cycles often are referred to as seasonality. To address this issue, Hirsch and Slack (1984) developed the SK test, which significantly reduces or removes the effect of seasonal cycles. DEP used the SK test to look for trends for each indicator at each surface water trend site, performing the analyses with R software (R Core Team 2022) version 4.1.3 and the kendallSeasonalTrendTest function in the EnvStats R package (Millard 2013).

As with seasonal cyclicity, in flowing surface waters, highly variable flow rates make it more difficult to detect trends. Where available, flow rate data from associated USGS, SJRWMD, and SFWMD gauging stations were collected at the same time as surface water samples. DEP adjusted surface water quality data for flow before conducting the SK trend analyses.

The SK test uses the median difference among all observations over the time series to calculate a Sen Slope (SS) and corresponding p-value (along with other statistics). The SS estimates the magnitude of change for a water quality indicator over the period of record. Reporting a trend as increasing or decreasing indicates the direction of the slope and does not necessarily indicate impairment or improvement in the analyte being measured. The *Design Document* (Florida Department of Environmental Protection 2022) contains a detailed explanation of the information goals for the Trend Monitoring Network, including data sufficiency and analytical methods.

Results

As of August 2023, 47 surface water stations have co-located USGS, SJRWMD, or SFWMD gauge stations allowing for flow adjustments. Of the 78 fixed Surface Water Trend Network stations, 47 have sufficient data for flow-adjusted SK analyses and 78 have sufficient data for nonflow-adjusted

SK analyses. DEP conducts surface water trend analyses using the SK test every 4 years for each station.

The latest analyses included data collected from October 1998 through December 2022. DEP's laboratory conducted the surface water analyses on total rather than dissolved constituents. Water quality indicators examined included total alkalinity (ALK), total ammonia nitrogen (TAN), total calcium (CAL), total organic carbon (TOC), total chloride (CL), total magnesium (Mg), total nitrate+nitrite (NOx), total Kjeldahl nitrogen (TKN), total nitrogen (TN), total phosphorous (TP), total potassium (K), total sodium (Na), specific conductance (SC), total suspended solids (TSS), total sulfate (SO4), temperature (Temp), chlorophyll a (CHL), *Escherichia coli* (E.coli), turbidity (Turb), potential of hydrogen (pH), and dissolved oxygen (DO). Appendix B provides additional information about water quality indicators.

Flow-adjusted and nonflow-adjusted surface water trend analysis outcomes for the 47 stations co-located with a gauging station and for all 78 surface water stations are provided for each indicator tested in Table 1 and Table 2. Statewide summaries of these outcomes follow in Table 3 and Table 4. Flow stations IDs used for Surface Water flow-adjusted SK analysis are found in Appendix A.

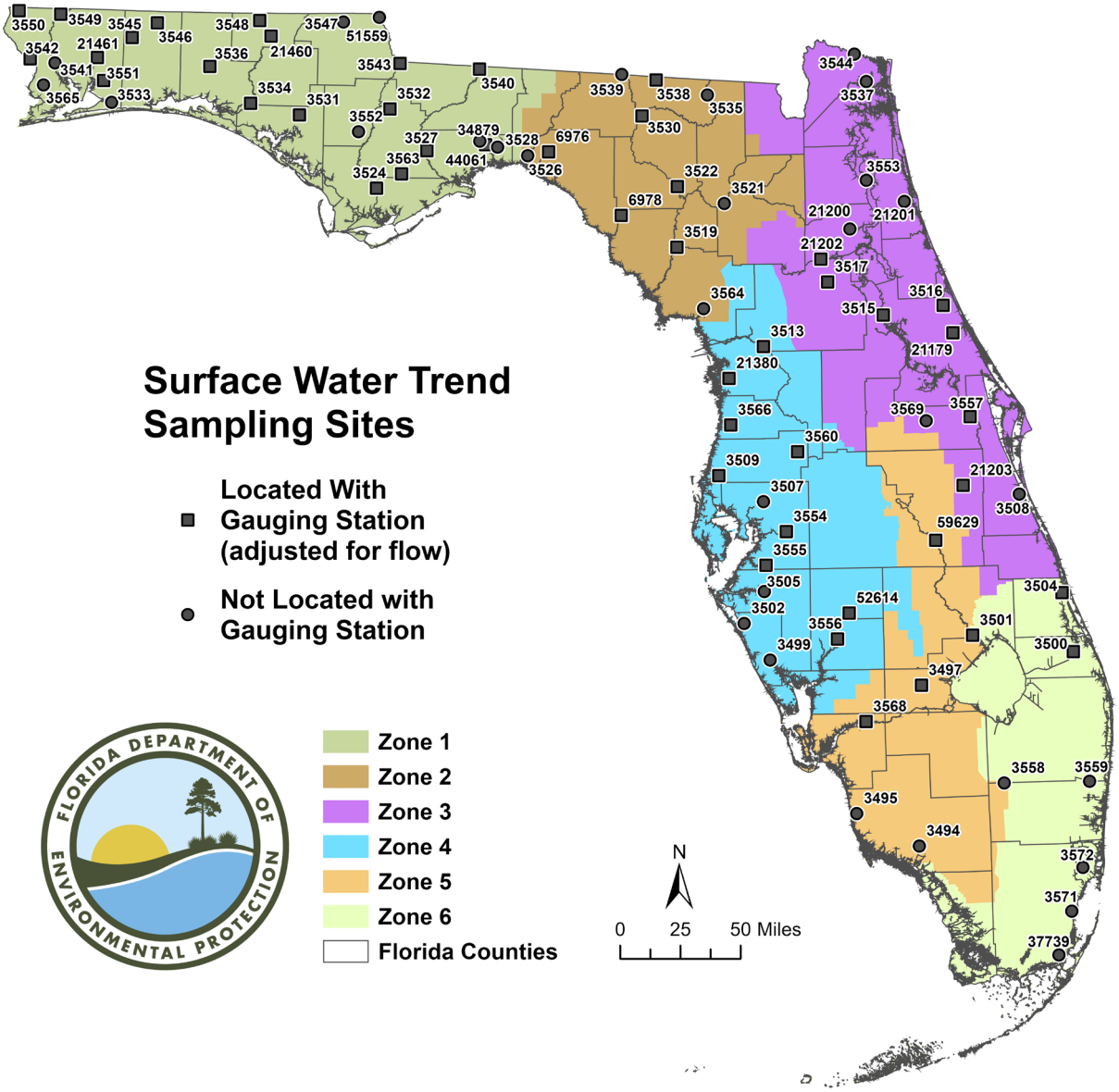

Figure 1. Surface Water Trend Network sampling sites

Table 1. Trends for specified analytes for 47 stations from the Surface Water Trend Monitoring Network associated with a USGS, SJRWMD or SFWMD gauging station and adjusted for water flow.

Note: A positive trend is indicated with a plus sign (+), a negative trend is indicated with a minus sign (-), insufficient evidence to determine a trend is indicated by a lower-case letter "o", and insufficient data to determine a trend is indicated by (ISD). Analyses are based on data collected between October 1998 and December 2022, with the following exceptions:

[1]For all stations, the period of record for *Escherichia coli* reporting begins in October 2013.
[2]For station 3506/59629, the period of record begins in February 1999.
[3]For stations 3501 and 3504, the period of record begins in March 1999.
[4]For stations 3497 and 3568, the period of record begins in April 1999.
[5]For stations 6976 and 6978, the period of record begins in October 1999.
[6]For station 3551, the period of record begins in October 2001.
[7]For stations 21179, 21202, 21380, 21460 and 21461, the period of record begins in October 2004.
[8]For station 3538, the period of record begins in October 2006.
[9]For station 34879, the period of record begins in October 2008.
[10]For station 21203, the period of record begins in October 2010.
[11]For station 3500, the period of record begins in August 2017.

Station	Waterbody Name	ALK	CAL	CL	CHL	DO	E.coli[1]	K	Mg	Na	NOx	pH	SC	SO4	TAN	Temp	TKN	TN	TOC	TP	TSS	Turb
3497[4]	Fisheating Creek	+	o	-	+	+	o	-	-	-	o	+	-	-	-	o	-	-	o	o	-	+
3500[11]	St. Lucie River	o	o	o	o	o	o	o	o	o	o	o	o	-	o	o	o	o	o	o	o	o
3501[3]	Kissimmee River	-	-	o	+	o	-	o	o	o	o	o	o	-	o	+	o	o	-	o	o	+
3504[3]	Belcher Canal	+	o	+	+	o	o	+	+	+	o	o	+	o	-	o	-	-	o	o	-	+
3509	Anclote River	o	o	o	-	+	o	-	-	o	-	o	o	-	-	o	-	-	-	-	-	o
3513	Withlacoochee River	+	o	+	+	o	o	o	+	+	+	o	o	-	-	o	o	o	o	-	-	o
3515	St. Johns River	o	o	o	o	o	o	-	o	o	o	o	o	-	-	+	-	-	o	o	-	-
3516	Tomoka River	+	+	+	o	o	o	o	+	+	+	+	+	-	-	+	o	o	o	o	-	+
3517	Oklawaha River	+	+	o	+	o	o	o	+	+	+	+	+	-	-	+	o	+	o	o	o	+
3519	Suwannee River	+	+	+	+	o	o	+	+	+	+	+	+	+	-	+	o	+	-	-	-	-
3522	Suwannee River	+	+	+	+	+	o	+	+	+	+	+	+	+	-	+	o	+	o	-	-	-
3524	Apalachicola River	+	+	o	+	o	o	o	+	-	+	o	o	-	-	+	o	+	-	-	-	o
3527	Ochlockonee River	o	+	-	+	o	o	o	+	-	+	-	o	-	-	o	o	+	o	o	-	o
3530	Suwannee River	+	+	o	+	o	o	+	+	+	+	+	+	+	-	+	o	+	o	o	-	-
3531	Econfina Creek	+	+	o	-	o	-	+	+	+	+	+	+	o	-	o	o	+	-	-	-	o
3532	Telogia Creek	+	+	o	-	o	o	o	+	o	+	o	o	-	-	+	o	+	o	o	o	+
3534	Choctawhatchee River	+	+	+	+	o	+	+	+	+	+	-	+	-	-	+	o	+	-	o	o	o
3536	Alaqua Creek	+	+	o	-	o	o	+	o	o	-	-	o	o	-	+	o	-	o	-	-	-
3538[8]	Alapaha River	o	o	-	o	o	+	o	o	-	o	+	-	o	-	o	-	-	-	o	-	o
3540	Ochlockonee River	o	+	-	+	o	o	o	+	-	o	-	o	-	-	o	o	o	o	-	o	+
3542	Perdido River	+	+	+	-	o	o	o	+	-	o	-	-	-	-	+	o	-	o	-	-	o

Station	Waterbody Name	ALK	CAL	CL	CHL	DO	E.coli[1]	K	Mg	Na	NOx	pH	SC	SO4	TAN	Temp	TKN	TN	TOC	TP	TSS	Turb
3543	Apalachicola River	+	+	o	+	o	o	o	+	-	+	o	o	-	-	+	o	+	o	-	-	-
3545	Blackwater River	o	o	o	-	o	o	+	o	+	+	-	-	-	-	o	o	o	o	-	-	o
3546	Yellow River	+	+	o	+	o	o	o	+	o	+	-	+	-	-	o	o	+	-	o	o	o
3548	Choctawhatchee River	+	+	+	o	o	o	+	+	+	+	-	+	-	-	+	o	+	-	o	-	o
3549	Escambia River	+	+	-	+	o	o	o	+	+	+	-	+	o	+	o	+	+	o	+	+	+
3550	Brushy Creek	o	+	-	-	+	o	o	+	-	-	-	-	-	-	+	-	-	-	-	o	+
3551[6]	Yellow River	+	+	o	o	o	ISD	o	+	+	+	-	+	o	-	o	-	o	-	-	o	o
3554	Alafia River	+	o	o	+	+	o	o	+	o	-	+	+	o	-	+	o	-	o	-	-	-
3555	Little Manatee River	+	o	o	o	o	o	o	o	+	-	o	o	o	-	+	o	-	+	-	-	+
3556	Peace River	+	o	-	o	o	o	o	o	o	o	o	o	-	-	o	o	o	o	-	o	+
3557	St. Johns River	+	o	o	+	o	o	o	o	o	o	o	o	-	-	+	-	-	o	o	o	+
3560	Withlacoochee River	+	o	o	o	+	o	-	o	+	o	+	o	-	-	o	-	-	-	o	-	-
3563	New River	o	o	o	+	o	o	+	+	o	o	o	o	-	o	o	+	+	+	o	o	+
3566	Weeki Wachee River	+	+	+	o	o	+	+	+	+	+	-	+	+	-	o	+	+	-	-	-	o
3568[4]	Caloosahatchee River	o	o	-	o	+	o	o	-	-	-	o	-	-	-	o	o	-	o	-	o	+
6976[5]	Econfina River	o	+	o	o	o	o	+	+	o	+	+	+	o	-	+	-	o	-	o	-	+
6978[5]	Steinhatchee River	o	o	-	o	o	+	+	o	-	+	+	o	-	-	+	o	o	o	o	-	+
21179[7]	Spruce Creek	o	o	+	o	-	-	o	o	+	+	o	o	o	-	+	o	o	o	-	-	o
21202[7]	Orange Creek	+	o	o	+	o	o	o	+	o	+	+	o	o	-	+	-	-	-	-	-	o
21203[10]	Crabgrass Creek	o	o	o	ISD	o	ISD	o	o	+	+	+	o	o	o	o	+	+	+	+	-	o
21380[7]	Homosassa Spring Run	+	o	-	o	+	o	-	-	-	+	o	-	-	-	o	-	+	-	o	-	+
21460[7]	Wrights Creek	o	o	-	o	-	+	o	+	o	o	-	o	-	-	+	o	o	o	o	-	o
21461[7]	Big Coldwater Creek	o	+	+	o	-	o	+	+	o	+	-	+	-	-	o	o	+	o	-	-	o
34879[9]	Wakulla River	+	+	o	+	-	+	o	o	o	-	-	o	o	-	o	-	-	o	o	-	+
3506 / 59629[2]	Kissimmee River	+	+	+	o	-	o	o	o	+	o	-	o	-	-	+	o	o	-	o	-	o
3561 / 52614	Charlie Creek	+	o	-	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	-	+

Table 2. Trends for specified analytes for 78 stations from the Surface Water Trend Monitoring Network, not adjusted for water flow.

Note: A positive trend is indicated with a plus sign (+), a negative trend is indicated with a minus sign (-), insufficient evidence to determine a trend is indicated by a lower-case letter "o", and insufficient data to determine a trend is indicated by (ISD). Analyses are based on data collected between October 1998 and December 2022, with the following exceptions:
[1]For all stations, the period of record for *Escherichia coli* reporting begins in October 2013.
[2]For station 3559, the period of record begins in November 1998.
[3]For Stations 3494 and 3495, the period of record begins in December 1998.
[4]For station 3506/59629, the period of record begins in February 1999.
[5]For stations 3500, 3501, 3504 and 3558, the period of record begins in March 1999.
[6]For stations 3497 and 3568, the period of record begins in April 1999.
[7]For stations 6976 and 6978, the period of record begins in October 1999.
[8]For stations 21179, 21200, 21201, 21202, 21380, 21460 and 21461, the period of record begins in October 2004.
[9]For station 34879, the period of record begins in October 2008.
[10]For station 21203, the period of record begins in October 2010.
[11]For station 44061, the period of record begins in October 2013.
[12]For station 51559, the period of record begins in October 2017.

Station	Waterbody Name	ALK	CAL	CL	CHL	DO	E.coli[1]	K	Mg	Na	NOx	pH	SC	SO4	TAN	Temp	TKN	TN	TOC	TP	TSS	Turb
3494[3]	Barron River	o	+	+	o	o	o	o	o	+	+	-	o	o	o	o	o	o	o	+	-	+
3495[3]	Golden Gate Canal	-	-	+	+	+	o	+	+	+	+	+	o	-	-	+	o	o	-	-	-	o
3497[6]	Fisheating Creek	o	-	-	+	+	o	-	-	-	+	+	-	-	-	o	-	-	+	o	o	+
3499	Myakka River	o	+	+	+	+	+	+	+	+	o	+	+	+	-	+	o	+	o	o	o	+
3500[5]	St. Lucie River	+	o	-	+	o	o	-	-	-	-	+	-	-	-	+	-	-	o	-	-	o
3501[5]	Kissimmee River	-	-	o	+	o	o	o	o	o	o	o	o	-	o	+	o	o	-	o	o	+
3502	Phillippe Creek	o	o	+	+	o	o	o	o	+	o	-	o	-	-	o	+	+	o	o	o	+
3504[5]	Belcher Canal	o	o	o	+	o	+	+	+	o	o	o	o	-	-	+	o	o	o	+	o	+
3505	Manatee River	o	o	o	+	+	o	+	o	+	o	+	o	o	-	+	+	+	+	o	o	o
3507	Hillsborough River	o	o	o	+	o	o	o	o	o	-	o	o	-	-	o	o	-	o	o	-	o
3508	Crane Creek	+	o	-	+	-	+	+	-	-	+	o	-	-	-	o	-	-	o	o	-	-
3509	Anclote River	-	-	o	o	+	o	-	-	o	-	o	-	-	-	o	o	-	o	-	o	o
3513	Withlacoochee River	+	o	+	o	-	o	o	-	+	+	-	-	-	-	o	+	+	+	+	o	+
3515	St. Johns River	o	-	-	o	-	o	-	-	-	o	-	-	-	-	+	-	-	o	o	-	-
3516	Tomoka River	o	o	+	o	o	o	+	o	+	+	o	o	-	-	+	o	o	o	o	o	+
3517	Oklawaha River	+	+	+	o	o	+	+	+	+	o	o	+	-	-	+	+	+	o	o	o	+
3519	Suwannee River	o	o	+	o	o	o	+	o	+	+	o	o	o	-	o	+	+	+	o	o	o
3521	Santa Fe River	o	o	-	-	o	+	o	-	-	+	o	o	-	-	o	o	+	o	o	-	o
3522	Suwannee River	o	o	+	-	o	o	+	o	o	+	o	o	o	-	o	+	+	+	-	o	+
3524	Apalachicola River	o	o	o	+	o	o	o	+	-	+	-	o	-	-	o	o	+	o	o	-	+
3526	Aucilla River	o	o	o	-	o	o	o	o	o	+	+	o	o	-	o	+	+	o	o	-	o

Station	Waterbody Name	ALK	CAL	CL	CHL	DO	E.coli[1]	K	Mg	Na	NOx	pH	SC	SO4	TAN	Temp	TKN	TN	TOC	TP	TSS	Turb
3527	Ochlockonee River	o	o	-	+	o	o	o	+	-	+	-	-	-	-	o	+	+	+	o	o	+
3528	St. Marks River	o	o	+	-	-	+	+	+	+	o	o	+	-	-	-	+	+	o	+	-	+
3530	Suwannee River	o	o	+	o	+	o	+	o	o	+	o	o	o	-	o	+	+	o	-	o	+
3531	Econfina Creek	+	+	o	-	-	-	+	+	+	+	o	+	-	-	+	+	+	+	o	o	+
3532	Telogia Creek	-	+	o	o	o	o	+	+	o	+	-	o	-	-	+	+	+	+	o	o	+
3533	East Bay River	o	o	o	-	o	o	o	o	o	-	-	o	o	-	o	-	-	o	-	-	o
3534	Choctawhatchee River	o	o	o	o	o	o	+	o	o	+	-	o	-	-	o	o	+	o	o	o	+
3535	Suwannee River	o	o	o	-	o	o	+	+	o	o	o	-	-	-	o	o	o	o	o	o	+
3536	Alaqua Creek	+	+	o	-	o	+	+	+	+	-	-	+	o	-	+	o	-	o	-	o	o
3537	Nassau River	o	o	o	+	-	o	o	o	o	o	o	o	o	-	+	-	-	o	o	-	o
3538	Alapaha River	-	o	-	+	o	o	+	o	-	-	o	-	-	-	o	o	-	o	-	o	+
3539	Withlacoochee River	o	o	+	+	o	+	+	o	+	o	o	o	-	-	o	o	o	o	-	o	o
3540	Ochlockonee River	o	o	-	+	o	+	o	o	-	o	-	o	-	-	o	o	-	o	-	o	+
3541	Escambia River	o	o	o	+	+	o	o	+	o	+	-	o	o	o	o	+	+	o	+	+	+
3542	Perdido River	o	+	o	-	o	+	+	o	-	-	-	-	-	-	+	o	-	+	-	o	+
3543	Apalachicola River	o	o	-	+	o	o	o	+	-	+	o	o	-	-	+	o	+	o	o	o	o
3544	St. Marys River	-	-	-	-	-	o	-	-	-	-	-	-	-	-	+	-	-	o	-	-	o
3545	Blackwater River	o	o	o	-	o	o	+	o	+	o	-	-	-	-	o	o	o	o	o	o	+
3546	Yellow River	o	o	o	+	o	o	o	o	o	+	-	o	-	-	o	o	+	o	o	o	o
3547	Cowarts Creek	+	+	+	o	o	o	+	+	+	+	o	+	o	o	+	+	+	o	+	o	+
3548	Choctawhatchee River	o	o	o	+	o	o	+	+	o	+	-	o	-	-	o	o	+	o	o	o	+
3549	Escambia River	o	o	-	+	o	o	o	+	o	+	-	o	-	+	o	+	+	o	+	+	+
3550	Brushy Creek	o	+	-	-	+	+	o	+	-	-	-	-	-	-	o	-	-	o	-	o	+
3551	Yellow River	o	+	+	o	o	o	+	+	+	+	-	+	-	-	o	o	o	o	o	o	+
3552	Chipola River	+	+	o	o	o	o	+	+	-	+	o	+	-	-	+	+	+	+	o	o	+
3553	St. Johns River	+	o	-	+	-	o	-	-	-	o	o	-	-	-	+	-	-	o	-	o	+
3554	Alafia River	+	o	-	+	o	o	o	+	o	-	+	o	-	-	+	o	-	o	-	-	o
3555	Little Manatee River	o	o	-	o	o	o	-	o	+	-	o	-	o	-	+	o	-	+	-	o	+
3556	Peace River	o	-	-	+	o	o	o	-	o	o	-	-	-	-	o	+	o	o	-	o	o
3557	St. Johns River	o	-	-	o	o	o	-	-	-	o	o	-	-	-	+	-	-	o	o	-	o
3558[5]	Miami Canal	-	-	o	o	o	o	o	o	o	-	o	-	-	o	+	-	-	-	-	-	-

Station	Waterbody Name	ALK	CAL	CL	CHL	DO	E.coli[1]	K	Mg	Na	NOx	pH	SC	SO4	TAN	Temp	TKN	TN	TOC	TP	TSS	Turb
3559[2]	Hillsboro Canal	o	o	o	+	+	+	o	-	o	o	+	o	o	o	+	-	-	-	o	-	o
3560	Withlacoochee River	o	o	o	-	+	o	-	o	o	o	+	-	-	-	o	-	-	-	o	-	-
3563	New River	o	o	-	o	o	o	+	+	o	o	o	o	-	o	o	+	+	+	o	o	+
3564	Waccasassa River	-	-	o	o	o	o	o	-	o	o	o	-	-	-	o	+	+	+	-	-	o
3565	Eleven Mile Creek	-	-	-	-	+	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o
3566	Weeki Wachee River	+	+	+	-	o	+	+	+	+	+	-	+	+	-	-	+	+	-	-	-	o
3568[6]	Caloosahatchee River	o	o	-	+	+	o	o	-	-	-	o	-	-	-	o	-	-	o	-	o	+
3569	Little Econlockhatchee River	o	o	o	+	o	+	-	o	+	o	+	o	-	o	+	-	o	o	-	-	-
3571	Black Creek Canal C-1	-	-	+	+	+	o	+	o	+	+	o	o	o	-	+	o	+	-	o	-	-
3572	Miami River	-	-	o	+	+	o	o	-	o	o	+	-	-	-	+	-	-	-	-	-	-
6976[7]	Econfina River	-	-	-	-	o	+	+	-	-	o	o	-	-	-	o	o	o	o	o	-	o
6978[7]	Steinhatchee River	-	-	-	-	o	+	+	-	-	o	o	-	-	o	o	+	+	+	+	o	+
21179[8]	Spruce Creek	o	o	o	o	o	o	o	o	o	+	-	o	-	-	+	o	o	+	-	-	o
21200[8]	Rice Creek	o	o	o	o	o	o	-	o	o	o	o	o	o	o	+	o	o	o	o	-	o
21201[8]	Moultrie Creek	+	+	o	+	o	+	-	o	o	+	+	+	o	-	+	o	o	o	o	o	+
21202[8]	Orange Creek	-	-	o	o	o	o	o	-	o	o	o	-	-	-	+	o	o	o	o	o	+
21203[10]	Crabgrass Creek	o	o	o	+	-	o	o	o	+	+	+	o	o	o	o	+	+	o	+	o	o
21380[8]	Homosassa Spring Run	+	-	-	o	+	o	-	-	-	+	o	-	-	-	o	-	+	-	o	-	+
21460[8]	Wrights Creek	-	-	-	o	-	+	+	o	o	o	-	-	-	-	o	+	o	+	+	o	+
21461[8]	Big Coldwater Creek	o	+	o	o	-	o	+	+	o	+	-	o	-	-	o	o	+	o	o	o	o
34879[9]	Wakulla River	o	+	+	+	-	+	o	o	+	-	-	+	o	-	o	-	-	o	o	-	+
44061[11]	Wakulla River	+	+	+	+	o	o	o	o	+	-	o	+	o	o	+	o	-	o	o	o	o
51559[12]	Chattahoochee River	o	o	-	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
3506 / 59629[4]	Kissimmee River	o	o	o	o	-	o	o	-	+	o	-	o	-	-	+	o	o	-	o	o	o
3561 / 52614	Charlie Creek	o	o	-	+	o	o	o	o	-	o	-	o	o	o	o	o	o	o	o	o	+
3570 / 37739	Aerojet Canal Number C-111	-	-	o	+	+	o	-	o	o	+	+	o	-	o	+	o	o	o	-	-	o

Table 3. Surface water trend summary by analyte for flow-adjusted stations (1998-2022)

Note: Percentages are calculated by number of trends (increasing, decreasing, or insufficient evidence of trend), divided by the total number of stations. Flow-adjusted site percentages were calculated based on a sample size of 47 stations that are associated with a USGS, SJRWMD, or SFWMD gauging station and adjusted for water flow. Percentages for *Escherichia coli* at flow adjusted sites were calculated based a sample size of 45 flow adjusted sites, as 2 stations had insufficient data for analysis. Percentages for chlorophyll a at flow adjusted sites were calculated based a sample size of 46 flow adjusted sites, as 1 station had insufficient data for analysis. For all sites, the period of record for *Escherichia coli* reporting begins in October 2013. Prior to October 2013, data collection frequency for *Escherichia coli* was insufficient for analysis.

Analyte	Decreasing Trend (%)	Increasing Trend (%)	Insufficient Evidence of Trend (%)
Alkalinity	2.1	63.8	34.0
Calcium	2.1	51.1	46.8
Chloride	25.5	25.5	48.9
Chlorophyll a	15.2	45.7	39.1
Dissolved Oxygen	38.5	61.5	0.0
Escherichia coli	6.7	13.3	80.0
Kjeldahl Nitrogen	27.7	8.5	63.8
Magnesium	8.5	57.4	34.0
Nitrate+Nitrite	21.9	78.1	0.0
pH	53.3	46.7	0.0
Potassium	10.6	29.8	59.6
Sodium	36.7	63.3	0.0
Specific Conductance	14.9	34.0	51.1
Sulfate	61.7	8.5	29.8
Total Ammonia Nitrogen	97.6	2.4	0.0
Total Nitrogen	31.9	38.3	29.8
Total Organic Carbon	36.2	6.4	57.4
Total Phosphorus	91.3	8.7	0.0
Total Suspended Solids	97.1	2.9	0.0
Turbidity	29.6	70.4	0.0
Water Temperature	0.0	51.1	48.9

Table 4. Surface water trend summary by analyte for nonflow-adjusted stations (1998-2022)

Note: Percentages are calculated by number of trends (increasing, decreasing, or insufficient evidence of trend), divided by the total number of stations. Nonflow-adjusted site percentages were calculated based on a sample size of 78 stations. For all sites, the period of record for *Escherichia coli* reporting begins in October 2013. Prior to October 2013, data collection frequency for *Escherichia coli* was insufficient for analysis.

Analyte	Decreasing Trend (%)	Increasing Trend (%)	Insufficient Evidence of Trend (%)
Alkalinity	20.5	17.9	61.5
Calcium	24.4	20.5	55.1
Chloride	33.3	23.1	43.6
Chlorophyll a	21.8	44.9	33.3
Dissolved Oxygen	44.8	55.2	0.0
Escherichia coli	5.0	95.0	0.0
Kjeldahl Nitrogen	24.4	29.5	46.2
Magnesium	26.9	29.5	43.6
Nitrate+Nitrite	20.5	41.0	38.5
pH	37.2	17.9	44.9
Potassium	19.2	39.7	41.0
Sodium	28.2	30.8	41.0
Specific Conductance	70.0	30.0	0.0
Sulfate	70.5	2.6	26.9
Total Ammonia Nitrogen	79.5	1.3	19.2
Total Nitrogen	33.3	39.7	26.9
Total Organic Carbon	14.1	20.5	65.4
Total Phosphorus	72.2	27.8	0.0
Total Suspended Solids	38.5	2.6	59.0
Turbidity	9.0	51.3	39.7
Water Temperature	3.8	43.6	52.6

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For more information, contact:

Florida Department of Environmental Protection
Watershed Monitoring Section, MS 3560
2600 Blair Stone Road
Tallahassee, FL 32399
850-245–8080
https://floridadep.gov/dear/watershed-monitoring-section

Appendix A. Gauging stations

Table A1. Gauging stations used for Surface Water Trend Monitoring Network trend analyses adjusted for water flow.

Water Quality Station	Waterbody Name	Flow Data Source	Flow Station
3497	Fisheating Creek	USGS	02256500
3500	St. Lucie River	USGS	02276998
3501	Kissimmee River	SFWMD	S65E_S
3504	Belcher Canal	SFWMD	S50_S
3509	Anclote River	USGS	02310000
3513	Withlacoochee River	USGS	02313000
3515	St. Johns River	USGS	02236125
3516	Tomoka River	USGS	02247510
3517	Oklawaha River	USGS	02240500
3519	Suwannee River	USGS	02323500
3522	Suwannee River	USGS	02320500
3524	Apalachicola River	USGS	02359170
3527	Ochlockonee River	USGS	02330150
3530	Suwannee River	USGS	02319500
3531	Econfina Creek	USGS	02359500
3532	Telogia Creek	USGS	02330100
3534	Choctawhatchee River	USGS	02366500
3536	Alaqua Creek	USGS	02366996
3538	Alapaha River	USGS	02317620
3540	Ochlockonee River	USGS	02328522
3542	Perdido River	USGS	02376500
3543	Apalachicola River	USGS	02358000
3545	Blackwater River	USGS	02370000
3546	Yellow River	USGS	02367900
3548	Choctawhatchee River	USGS	02365200
3549	Escambia River	USGS	02375500
3550	Brushy Creek	USGS	02376293
3551	Yellow River	USGS	02369600
3554	Alafia River	USGS	02301500
3555	Little Manatee River	USGS	02300500
3556	Peace River	USGS	02296750
3557	St. Johns River	USGS	02232500
3560	Withlacoochee River	USGS	02311500
3563	New River	USGS	02330400
3566	Weeki Wachee River	USGS	02310525
3568	Caloosahatchee River	USGS	02292900
6976	Econfina River	USGS	02326000
6978	Steinhatchee River	USGS	02324000
21179	Spruce Creek	USGS	02248000
21202	Orange Creek	USGS	02243000
21203	Crabgrass Creek	SJRWMD	02090218
21380	Homosassa Spring Run	USGS	02310678
21460	Wrights Creek	USGS	02365470

Water Quality Station	Waterbody Name	Flow Data Source	Flow Station
21461	Big Coldwater Creek	USGS	02370500
34879	Wakulla River	USGS	02327022
3506 / 59629	Kissimmee River	SFWMD	S65_S
3561 / 52614	Charlie Creek	USGS	02296500

Appendix B. Water Quality Indicators

Alkalinity is a measure of the buffering capacity of water to the addition of an acid. Anions form in surface water consisting of bicarbonates, carbonates, phosphates, sulfides, silicates and some organics. The primary anion is bicarbonate. The analysis of alkalinity is reported as milligrams per liter of $CaCO_3$ (calcium carbonate).

Calcium is a metal that occurs naturally in Florida's surface water through the solution of calcite and dolomite. The analysis of total calcium is reported as milligrams per liter.

Chloride: Two major sources of chloride are rainfall deposition of marine aerosols and saltwater encroachment. The analysis of chloride is reported as milligrams per liter (mg/L).

Chlorophyll *a*: Chlorophylls are green pigments in plants, algae, and some bacteria which utilize the sun's light energy during the process of photosynthesis to produce chemical energy. Chlorophyll *a* is the most predominant pigment found and therefore its presence can be used as a measured proxy for the amount of algae present in a surface waterbody. The threshold for chlorophyll *a* is less than or equal to 20 micrograms per liter (ug/L). It is listed in Rule 62-303.351 Florida Administrative Code (FAC) which describes the assessment of nutrients in streams.

Dissolved oxygen (DO) is a measure of the saturation of oxygen in water. Its concentration in water is dependent on both temperature and pressure. The analysis of DO is reported as percent saturation. Because of Florida's unique geology and temperature regimes, DO criteria are also dependent on the Bioregion. More information on DO criteria for surface waters can be found in F.A.C. 62-303.351.

Escherichia coli bacteria are found in the gut and intestinal tracts of both animals and humans. They enter waterways through direct discharge or via wastewater treatment systems. Sources include septic tank system discharges, wastewater treatment plant discharges, and sewage collection system overflows. Rain events may re-suspend fecal materials or wash them into nearby streams or canals. The threshold for *Escherichia coli* bacteria is 410 colony-forming units per 100 milliliters of water. More information on the bacteriological standards for *Escherichia coli* can be found in F.A.C. 62-302.530. The presence of the bacteria may indicate possible presence of pathogens.

Magnesium is a metal. Major sources of magnesium in Florida's waters are derived naturally from sea water and through the solution of dolomite and from the ionic exchange with magnesium rich clay minerals. Magnesium is reported as total magnesium in water as milligrams per liter.

The **potential of hydrogen** (pH) is measured in standard units (SU) and ranges between zero (very acidic) to 14 (very basic). For example, the pH of lemon juice is approximately two SU. Water with a pH of seven SU is considered neutral. The surface water criterion for pH is between 6 and 8.5 SU. The pH measurement is influenced by the geology present in the area of the surface water, the chemistry of the atmosphere, rainfall, and the biological inputs to the surface water. Concentrations of pH are also influenced by sources of water pollution such as runoff and wastewater discharge.

Total Kjeldahl Nitrogen (TKN) measures the sum of ammonia and organic nitrogen in water. The nitrogen compounds encourage growth of algae and eutrophication leading to anoxic conditions. TKN is one component of total nitrogen. Criteria for total nitrogen and other nutrients in surface water have been adopted into numeric nutrient standards for the State of Florida. Due to the complexity of nutrients and how they are evaluated, please visit the Numeric Nutrient Criteria website for more information.

Nitrate is composed of one nitrogen and three oxygen atoms (NO_3) and **nitrite** is composed of one nitrogen and two oxygen atoms (NO_2). These are typical chemical forms of nitrogen found in surface waters arising from storm water runoff of areas containing fertilizers or from animal and human wastes. The pH of the water influences which forms are more likely present. Another form, **ammonia** (NH_4) is also found in water and can be toxic to fish and other aquatic organisms. The EPA has set a drinking water standard for nitrate at ten parts per million (ppm) and a standard for nitrite at one ppm. Since the toxicity for nitrate and nitrite together is additive, the EPA set a standard for both at 10 ppm. The criteria for $NO_3 + NO_2$ in surface water have been adopted into numeric nutrient standards for the State of Florida. Due to the complexity of nutrients and how they are evaluated, please visit the Numeric Nutrient Criteria website for more information.

Total Nitrogen (TN) measures the sum of nitrate, nitrite, and Total Kjeldahl Nitrogen in water. The nitrogen compounds encourage growth of algae and eutrophication leading to anoxic conditions. The criteria for TN in surface water have been adopted into numeric nutrient standards for the State of Florida. Due to the complexity of nutrients and how they are evaluated, please visit the Numeric Nutrient Criteria website for more information.

Phosphorus is necessary for many life processes and is present in dissolved and mineral forms. Phosphorus can exist in many forms in surface water and can undergo biological and chemical transformation. The criteria for total phosphorus concentrations in surface water have been adopted into numeric nutrient standards for the State of Florida. Due to the complexity of nutrients and how they are evaluated, please visit the Numeric Nutrient Criteria website for more information.

Potassium is a metal. It is primarily derived from sea water and potassium rich clays.

Sodium is a metal. Sources of sodium include mixing with sea water or groundwater in the salt water interface zone, and industrial or wastewater discharges. Sodium is reported as total sodium in water in milligrams per liter (mg/L).

Specific conductance is a measurement of the electrical conductivity of water at 25 degrees Celsius. The specific conductance of water is measured in microsiemens (µS).

Sulfate is composed of one sulfur atom and four oxygen atoms (SO_4^{-2}). The dissolution of gypsum and anhydrite is a natural source of sulfur in Florida's waters. Sulfate is reported as SO_4^{-2} in milligrams per liter (mg/L).

Total suspended solids (TSS) is a measurement of particles larger than two micrometers that are suspended in water. Sediment and biological sources can contribute to TSS in surface waters. TSS is reported in milligrams per liter (mg/L).

Total organic carbon (TOC) is the measurement of organic carbon in water. TOC is typically derived from the subtraction of inorganic carbon from total carbon in a sample. TOC is reported in milligrams per liter (mg/L).

Temperature is a measure of the molecular activity within a solution measured against a reference scale. Temperature varies greatly with seasonal conditions and within climatic and microclimate zones. Temperature is typically measured in degrees Celsius.

Turbidity is a measurement of the clarity of a solution. High turbidity causes water to appear cloudy or opaque. Sources contributing to high turbidity include the presence of small particulates of clay, silt, or other materials. These particulates may serve as points of attachment for metals, bacteria, or other compounds.