

Quality Assessment Report for Water Quality Monitoring

October – December 2021



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INTRODUCTION

This report is an assessment of the South Florida Water Management District (SFWMD) laboratory analysis and field sampling for total phosphorus (TP), primarily for the following projects and their associated stations from October 1, 2021, through December 31, 2021. The analysis contained in this document reflects the status of the data at the time of download and does not account for changes made to the data after March 2, 2022. The projects and associated stations at which data are collected are as follows:

- Everglades National Park Inflows North (PIN): S12A, S12B, S12C, S12D, S333, S333N, S355A, S355B, and S356-334
- Everglades National Park Inflow East (PIE): G737, S332DX, S18C, S328, and BERMB3
- Everglades Protection Area (EVPA): LOX3 through LOX16

The Water Quality Monitoring Section (WQM) *Field Quality Manual* (SFWMD-FIELD-QM-001) and *Field Sampling Manual* (SFWMD-FIELD-FSM-001) provided the quality system requirements and the field sampling procedures followed in field sample collection, respectively, from October 1 to December 31, 2021. The Analytical Services Section's *Chemistry Laboratory Quality Manual* (SFWMD-LAB-QM-001) provides the requirements for preparing and analyzing laboratory samples, as well as data verification and validation. The *Field Sampling Quality Assessment* and *Laboratory Analysis Quality Assessment* sections in this report provide a comprehensive evaluation and validation of the TP results for samples collected from the locations and timeframe described above.

For the purpose of preparing this report, a Microsoft Excel workbook named "qa_report_oct_dec_2021_data.xlsx" was created and contains all TP results obtained from DBHYDRO, SFWMD's corporate environmental database, for all sampling events that include grab samples collected for the project/stations listed above during the period specified in this report. This Excel workbook is available for reference on the Everglades Technical Oversight Committee (TOC) website (<https://www.sfwmd.gov/our-work/toc>) along with this report and will be referred to as the Reference Data Set (RDS) in this report. All sample analyses for TP were completed at the SFWMD Analytical Services Chemistry Laboratory (Department of Health Identification E46077).

If available, this report will also include TP sample results for biannual laboratory proficiency testing as required for the National Environmental Laboratory Accreditation Program (NELAP) or results from other laboratory performance evaluation studies that were completed during the period specified in this report.

FIELD SAMPLING QUALITY ASSESSMENT

SAMPLE COLLECTION

All samples were collected by WQM staff. A total of 39 sampling events were conducted that included collection of samples for the projects/locations and timeframe described in the *Introduction* to this report. A complete list of the laboratory work orders obtained from the Laboratory Information Management System (LIMS) for these sampling events is shown in **Table 1**. The table details the work identifiers, work order numbers, project codes, and dates the samples were collected.

During the 39 sampling events described in **Table 1**, a total of 37 grab sample records for the projects/locations described in the *Introduction* to this report indicate that a sample was not collected, typically because of no flow, water being too shallow, platform being unsafe, or area overgrown by vegetation to collect a sample. The grab sample identifiers and reasons these samples were not collected are shown in **Table 2**.

Table 1. Sampling events for the reporting period.

Work Identifier	Work Order	Project ^a	Date Collected
P126814	80527	PIN	10/04/2021
P125773	80001	EVPA	10/05/2021
P127925	81038	PIE	10/05/2021
P127913	81044	PIE	10/05/2021
P125781	80005	EVPA	10/06/2021
P129030	81567	PIN	10/11/2021
P127900	81032	PIE	10/12/2021
P129032	81568	PIN	10/18/2021
P129538	81644	PIE	10/19/2021
P129536	81643	PIE	10/20/2021
P126796	80515	PIN	10/25/2021
P129529	81637	PIE	10/26/2021
P129407	81573	PIN	11/01/2021
P130459	82082	EVPA	11/02/2021
P129559	81652	PIE	11/02/2021
P129571	81658	PIE	11/02/2021
P130467	82086	EVPA	11/03/2021
P126802	80521	PIN	11/08/2021
P129530	81638	PIE	11/10/2021
P129408	81574	PIN	11/15/2021
P129560	81653	PIE	11/16/2021
P129572	81659	PIE	11/16/2021
P129417	81579	PIN	11/23/2021
P129531	81639	PIE	11/23/2021
P129409	81575	PIN	11/29/2021
P129573	81660	PIE	11/30/2021
P129561	81654	PIE	11/30/2021
P130498	82096	EVPA	12/01/2021
P130500	82097	EVPA	12/02/2021
P129418	81580	PIN	12/06/2021
P129532	81640	PIE	12/07/2021
P129410	81576	PIN	12/13/2021
P129562	81655	PIE	12/14/2021
P129574	81661	PIE	12/14/2021
P129419	81581	PIN	12/20/2021
P129533	81641	PIE	12/21/2021
P129411	81577	PIN	12/27/2021
P129575	81662	PIE	12/28/2021
P129563	81656	PIE	12/28/2021

a. EVPA – Everglades Protection Area; PIE – Everglades National Park Inflows East; and PIN – Everglades National Park Inflows North.

Table 2. Grab samples not collected during the reporting period.

Work Identifier	Project ^a	Sample Identifier	Station	Date	Reason Sample Was Not Collected
80527035	PIN	P126814-35	S12B	10/04/2021	Gates closed. No flow.
81567016	PIN	P129030-16	S355B	10/11/2021	Gates closed. No flow.
81567018	PIN	P129030-18	S355A	10/11/2021	Gates closed. No flow.
81567042	PIN	P129030-42	S12B	10/11/2021	Gates closed. No flow.
81568038	PIN	P129032-38	S12B	10/18/2021	Gates closed. No flow.
81643029	PIE	P129536-29	BERMB3	10/19/2021	Area overgrown by vegetation.
80515039	PIN	P126796-39	S12B	10/25/2021	No flow. Site not visited.
81573035	PIN	P129407-35	S12B	11/01/2021	Gates closed. No flow.
81652026	PIE	P129559-26	BERMB3	11/02/2021	Area overgrown by vegetation.
80521013	PIN	P126802-13	S355B	11/08/2021	Gates closed. No flow.
80521015	PIN	P126802-15	S355A	11/08/2021	Gates closed. No flow.
80521039	PIN	P126802-39	S12B	11/08/2021	Gates closed. No flow.
81574035	PIN	P129408-35	S12B	11/15/2021	Gates closed. No flow.
81574036	PIN	P129408-36	S12A	11/15/2021	Gates closed. No flow.
81653026	PIE	P129560-26	BERMB3	11/16/2021	Area overgrown by vegetation.
81579039	PIN	P129417-39	S12B	11/22/2021	Gates closed. No flow.
81575034	PIN	P129409-34	S12C	11/29/2021	No flow. Site not visited.
81575035	PIN	P129409-35	S12B	11/29/2021	No flow. Site not visited.
81660004	PIE	P129573-4	G737	11/30/2021	Too shallow to sample.
81580027	PIN	P129418-27	S333	12/06/2021	Platform unsafe to sample.
81580038	PIN	P129418-38	S12C	12/06/2021	Gates closed. No flow.
81580039	PIN	P129418-39	S12B	12/06/2021	Gates closed. No flow.
81640026	PIE	P129532-26	G737	12/07/2021	Too shallow to sample.
81576023	PIN	P129410-23	S333	12/13/2021	Platform unsafe to sample.
81576034	PIN	P129410-34	S12C	12/13/2021	Gates closed. No flow.
81576035	PIN	P129410-35	S12B	12/13/2021	Gates closed. No flow.
81661004	PIE	P129574-4	G737	12/14/2021	Too shallow to sample.
81581013	PIN	P129419-13	S355B	12/20/2021	Gates closed. No flow.
81581015	PIN	P129419-15	S355A	12/20/2021	Gates closed. No flow.
81581027	PIN	P129419-27	S333	12/20/2021	Platform unsafe to sample.
81581038	PIN	P129419-38	S12C	12/20/2021	Gates closed. No flow.
81581039	PIN	P129419-39	S12B	12/20/2021	Gates closed. No flow.
81641026	PIE	P129533-26	G737	12/21/2021	Too shallow to sample.
81577023	PIN	P129411-23	S333	12/27/2021	Platform unsafe to sample.
81577034	PIN	P129411-34	S12C	12/27/2021	Gates closed. No flow.
81577035	PIN	P129411-35	S12B	12/27/2021	Gates closed. No flow.
81662004	PIE	P129575-4	G737	12/28/2021	No flow. Site not visited.

a. PIE – Everglades National Park Inflows East; and PIN – Everglades National Park Inflows North.

FIELD QUALITY CONTROL

To assess the quality of the sample collection process as required by the *Field Sampling Manual*, field quality control samples are collected at sampling locations during each sampling event. The results from these quality control samples are associated with all samples collected during the sampling trip (day) and if a specific field quality control sample fails to meet the requirements set forth in the Florida Department of Environmental Protection (FDEP) *Quality Assurance Rule* (Chapter 62-160, Florida Administrative Code [F.A.C.]), qualifiers will be added to the appropriate sample results. The types of field quality control samples that are collected may include replicate samples (RSs), and field quality control blanks, which include field generated equipment blanks (EBs), field-cleaned equipment blanks (FCEBs), and field blanks (FBs). The sampling events listed in **Table 1** may include field quality control samples collected at locations other than those listed in the *Introduction* to this report.

For the 39 sampling events described above, a total of 28 field quality control blanks and four RSs were collected. Only one of the field quality control blanks had a concentration equal to or greater than the TP method detection limit (MDL) of 0.002 milligrams per liter (mg/L). Project managers responsible for directing the sampling activities may also place qualifiers and/or remark codes on sample results based on project specific requirements, historical results for a given location, issues related to site conditions, and/or problems encountered by technicians when the samples were collected. Remark codes include a project manager remark (PMR), which is a SFWMD-derived and -applied remark code indicating a potential quality issue not otherwise defined by the qualifiers in the FDEP *Quality Assurance Rule* (Chapter 62-160, F.A.C.).

For grab samples collected at locations described in the *Introduction*, no PMR was assigned by project managers and nine G qualifiers were assigned as per the FDEP *Quality Assurance Rule* (Chapter 62-160, F.A.C.). These quality assurance process-related qualifiers are detailed in **Table 3**.

Table 3. Results with qualifiers and remark codes during the reporting period.

Work Identifier	Project ^a	Sample Identifier	Station	Collection Date	Qualifier or Remark Code/Reason
81574013	PIN	P129408-13	S333N	11/15/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81574023	PIN	P129408-23	S333	11/15/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81574003	PIN	P129408-3	S356-334	11/15/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81574033	PIN	P129408-33	S12D	11/15/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81574034	PIN	P129408-34	S12C	11/15/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81574037	PIN	P129408-37	S12A	11/15/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81639014	PIE	P129531-14	S332D X	11/23/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81639026	PIE	P129531-26	G737	11/23/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.
81639030	PIE	P129531-30	S18C	11/23/2021	G: Analyte was detected at or above the method detection limit in both the sample and the associated field blank, equipment blank, or trip blank, and the blank value was greater than 10% of the associated sample value.

a. PIE – Everglades National Park Inflows East and PIN – Everglades National Park Inflows North.

FIELD AUDITS

SFWMD did not conduct any field audits on TOC-related projects during the fourth quarter of 2021.

FIELD PROCEDURE UPDATES

No major procedural updates related to TP sample collection were made during the period specified in this report.

LABORATORY ANALYSIS QUALITY ASSESSMENT

SAMPLE ANALYSES

SFWMD Analytical Services Chemistry Laboratory staff conducted a total of 331 TP analyses for the grab samples collected during the 39 sampling events listed in **Table 1**. Of those 331 TP results, 162 were for grab samples collected from projects/locations listed in the *Introduction* (excluding field quality control samples). For reference, a complete set of all 331 grab TP results can be found in the RDS described in the *Introduction* to this report along with the sample identifiers, sampling locations, collection dates, etc.

LABORATORY QUALITY CONTROL

TP analyses are routinely conducted in the SFWMD Analytical Services Chemistry Laboratory in analytical batches of approximately 100 samples. To assess the quality of the sample results produced during the analyses of these batches, various types of laboratory control samples are included according to the requirements described in the *Chemistry Laboratory Quality Manual*. The results of these laboratory quality control samples are associated with all of the analyses conducted in a given batch and qualifiers are added to the data as required by the *Quality Assurance Rule* (Chapter 62-160, F.A.C.) based on the specifications found in the *Chemistry Laboratory Quality Manual*. The types of laboratory quality control samples typically run in a batch include samples with certified concentrations (laboratory control samples), matrix spikes, precision checks (duplicates or matrix spike duplicates), and method blanks. For the 162 TP results from samples collected from projects/locations listed in the *Introduction*, no qualifiers were added as a result of laboratory quality control failures.

METHOD DETECTION LIMIT AND PRACTICAL QUANTITATION LIMIT

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined by the laboratory on an annual basis using the procedure described in the Code of Federal Regulations (CFR), 40 CFR 136, Appendix B. The practical quantitation limit (PQL) is the minimum concentration of an analyte that can be measured with a high degree of confidence that the analyte is present at or above that concentration. However, there is not any universally accepted (or required) method for determination of the PQL. In the case of TP analyses, the SFWMD Analytical Services Chemistry Laboratory PQL (0.004 mg/L) is set to the concentration of the lowest standard used for calibration, which is a typical approach among analytical laboratories. Any TP results that are below the MDL (0.002 mg/L) are assigned a “U” qualifier indicating that there is high confidence that the analyte is not present. The reported TP values between the MDL (0.002 mg/L) and the PQL (0.004 mg/L) are assigned an “I” qualifier, indicating that the results are at concentrations that cannot be accurately quantified. Of the 162 TP results reported, no results were below the MDL and 12 samples had concentrations between the MDL and the PQL.

ESTIMATION OF ANALYTICAL MEASUREMENT UNCERTAINTY

All measurements are subject to uncertainty and a measured value is only complete if it is accompanied by a statement of the associated uncertainty. The definition of uncertainty (of measurement) can be found in the *International Vocabulary of Basic and General Standard Terms in Metrology*: “A parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand” (JCGM 1993). The uncertainty has a probabilistic basis and reflects incomplete knowledge of the quantity. The SFWMD Analytical Services Chemistry Laboratory provides uncertainty estimates using the nested hierarchical methodology by Ingersoll (2001) in combination with a mathematical model found in Eurachem/CITAC (2012). This quality control-based nested approach uses the statistical quality control data attributed to laboratory measurement activities and does not include uncertainty attributed to field sampling activities. The estimated uncertainty is calculated using the following equation:

$$U(x) = \sqrt{S_0^2 + (S_1 x)^2}$$

where:

$U(x)$ is the combined standard uncertainty in the result x at the 95% confidence interval (CI).

S_0 is a constant contribution to the overall uncertainty derived from the procedure to determine the MDL.

S_1 is a proportionality constant derived from nested hierarchical methodology by Ingersoll (2001).

During this reporting period, the uncertainty constants are $S_0 = 0.002$ and $S_1 = 0.068$. Estimated uncertainties are calculated automatically by LIMS using the equation and constants shown above and are provided with all TP results. **Figure 1** presents estimated uncertainties at the 95% and 99% CIs relative to the MDL and PQL of the TP measurement process.

Uncertainty of Measurement Close to the Detection Limit

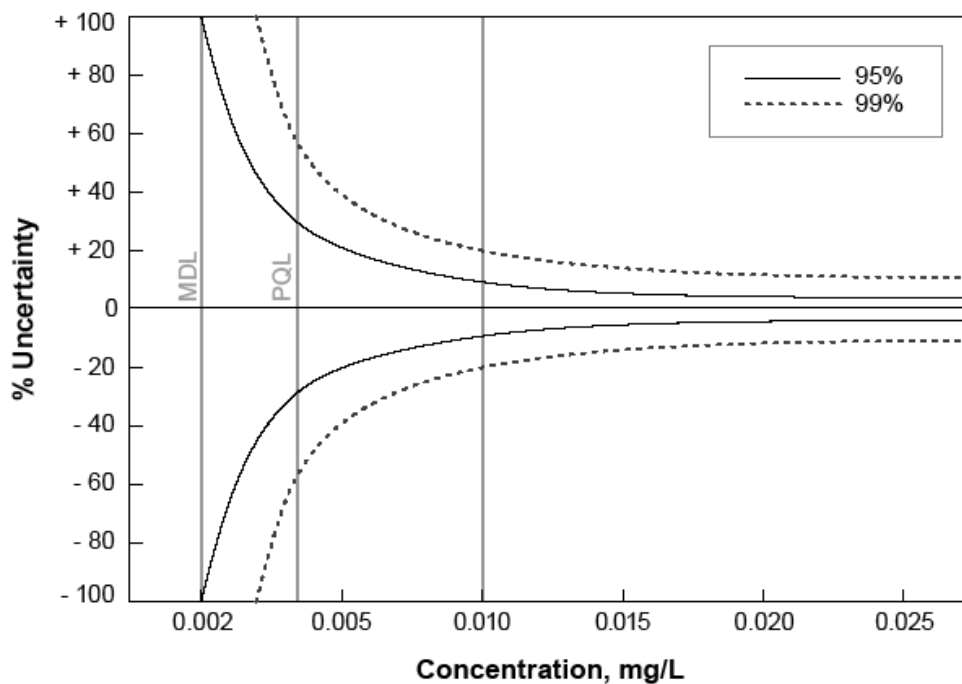


Figure 1. Estimated uncertainties at the 95% and 99% CIs relative to the MDL and PQL of the TP measurement process.

As can be seen from **Figure 1**, the percent measurement uncertainty (95% CI) is 100% at the MDL, nearly 30% at the PQL, and remains relatively constant at higher concentrations.

PROFICIENCY TESTING AND PERFORMANCE EVALUATION

The SFWMD Analytical Services Chemistry Laboratory participates in a variety of studies to evaluate the proficiency of the laboratory's quality system. During the fourth quarter of 2021, the laboratory received results from the QUASIMEME saline/brackish waters performance evaluation study. All seven reported results were identified as "acceptable" with no Z-score exceeding ± 0.3 .

LABORATORY AUDITS

During this reporting period no quality system laboratory audits were conducted.

PROCEDURE UPDATES

The TP analytical procedure (Standard Methods 4500 P-F, Automated Ascorbic Acid Reduction Method) did not change during this reporting period.

REFERENCES

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GLOSSARY

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations.

Confidence Interval (CI): A range of values so defined that there is a specified probability that the value of a parameter lies within it.

Equipment Blank (EB): Field quality control sample prepared using sampling equipment that has been brought to the site or processing area precleaned and is collected before the equipment has been used. The results of these blanks are used to monitor the on-site sampling environment, sampling equipment decontamination, sample container cleaning, suitability of sample preservatives and analyte-free water, sample transport and storage conditions, and laboratory process.

Field Blank (FB): FBs are collected by pouring analyte-free water directly into the sample container, preserved, and kept open for the same approximate time and interval as required for collection and/or processing of the routine sample. The results of this blank are used to monitor the on-site sampling environment, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions, and laboratory process.

Field Cleaned Equipment Blank (FCEB): Field quality control sample prepared using sampling equipment that has been cleaned in the field or at the processing area. The results of this blank are used to monitor the on-site sampling environment, sampling equipment field decontamination, sample container cleaning, suitability of sample preservatives and analyte-free water, sample transport and storage conditions, and laboratory process.

Measurand: Particular quantity subject to measurement.

Method Detection Limit (MDL): The smallest concentration of an analyte of interest that can be measured and reported with 99% confidence that the concentration is greater than zero. The MDLs are determined from the analysis of a sample in a given matrix, using accepted sampling and analytical preparation procedures, containing the analyte at a specified level. The MDL is determined by the protocol defined in the Code of Federal Regulations (CFR) Section 40 CFR, Part 136, Appendix B, as established by the United States Environmental Protection Agency.

Practical Quantitation Limit (PQL): The smallest concentration of an analyte of interest that can be quantitatively reported with a specific degree of confidence. The PQL is verified for each matrix, technology, and analyte. The validity of the PQL is verified by analysis of a quality control sample containing the analyte of concern.

Precision: The agreement or closeness between two or more results and is an indication that the measurement system is operating consistently and is a quantifiable indication of variations introduced by the analytical systems over a given time and field sampling period.

Replicate Sample (RS): An RS is collected by repeating (simultaneously or in rapid succession) the entire sample acquisition technique that was used to obtain the routine sample. A single RS set (e.g., one sample and two RSs) is collected per quarter, per project, at the same station, for the longest parameter list. RS data are compared to routine sample data to evaluate sampling precision.

Uncertainty: The range of values within which the true value is estimated to lie. It is a best estimate of possible inaccuracy due to both random and systematic error.

Z-Score: A measure of the deviation of the result (X_i) from the assigned value (X) for that determinant (calculated as $z = (X_i - X)/\sigma$, where σ is a standard deviation) (Eurachem/CITAC 2012).