## Field Measurement of Turbidity and Total Suspended Solids (TSS)

##### Use in conjunction with:

###### FT 1000 General Field Testing and Measurement

###### FS 1000 General Sampling Procedures

###### FD 1000 Documentation Procedures

##### Introduction: The clarity of water is an important component of water quality used to monitor water treatment processes as well as the condition and productivity of natural water bodies. Two measures of water clarity, turbidity and total suspended solids (TSS), are presented in this SOP.

##### Turbidity measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms cause turbidity in water. The measurement of turbidity depends on the technology of the instrumentation used. While turbidity can be comparable between different technologies when measuring a common standard in a laboratory setting, data may not be comparable when measuring a common environmental sample. Since data from environmental turbidity samples measured using different technologies may not be comparable, it is important to consider the design of the project, including expected turbidity concentration, interferences and sample matrix, as well as the intended use of the data when choosing turbidity methods.

##### The traditional nephelometric measurement of turbidity requires an instrument that uses a white light source and meets the specifications outlined in FT 1610 section 2.1. The instrument measures a discrete sample collected into a cuvette and results are reported in Nephelometric Turbidity Units (NTU).

##### Method FT 1620 covers in situ turbidimeter probes that use an infrared light source. Results are reported in Formazin Nephelometric Units (FNU). In situ probes with turbidity sensors can be used for screening purposes, such as monitoring groundwater purge stabilization parameters, or for continuous monitoring of surface water. Follow the instructions in FT 1920 for instruments that will be deployed for continuous monitoring for ambient in situ monitoring. FT 1620 shall be used for the continuous monitoring of turbidity of wastewater matrices as reclaimed water at domestic wastewater treatment facilities as required by Rule 62-610.320, F.A.C. FT 1620 shall not be used when collecting samples for NPDES permit compliance or regulatory compliance sampling defined in Rules or permits. Method FT 1620 may be proposed for use in studies that entail comparison measurements (dredge and fill) or unattended deployment for continuous monitoring purposes, with specific Department approval. **Do not report turbidity results measured using FT 1620 for regulatory purposes such as permit compliance unless the Department has approved the use for the specific project or for compliance with Rule 62-610.320, F.A.C.** All turbidity probes must be calibrated and verified according to the requirements in FT 1620.

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##### The measurement of total suspended solids (TSS) is covered in FT 1630. This SOP describes the continuous measurement of TSS in mg/L (ppm) with installed, in-line (on-line) sensors meeting the specifications outlined in FT 1630, Section 2. It is intended to be used for the continuous in-line monitoring of TSS of wastewater matrices as reclaimed water at domestic wastewater treatment facilities as required by Rule 62-610.320, F.A.C.

### Measurement of Turbidity by Nephelometry (NTU)

Use in conjunction with:

* FT 1000 General Field Testing and Measurement
* FT 1900 Continuous Monitoring Meters
* FS 1000 General Sampling Procedures
* FS 2000 General Aqueous Sampling
* FD 1000 Documentation Procedures
* FC 1000 Cleaning/Decontamination Procedures
* FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs

##### 1. Introduction:  The traditional nephelometric measurement of turbidity requires an instrument that uses a white light source and meets the specifications outlined in section 2.1, below. The instrument measures a discrete sample collected into a cuvette and results are reported in Nephelometric Turbidity Units (NTU).

##### Equipment and Supplies

##### Field Instrument: Use a turbidimeter (nephelometer) or a spectrophotometer consisting of a light source and one or more photoelectric detectors with a readout device to indicate the intensity of light. The instrument must meet these specifications:

##### The light source must have a tungsten-filament lamp operated at a color temperature between 2200 and 3000K.

##### The distance traversed by the incident light and scattered light within the sample tube must not exceed 10 cm.

##### The light detector, positioned at 90o to the incident light, must have an acceptance angle that does not exceed + 30o from 90o.

##### The detector and any filter system must have a spectral peak response between 400 and 600 nanometers.

##### The instrument sensitivity must permit detection of a turbidity difference of 0.02 NTU at the 0 – 1.0 NTU scale.

##### Note: using the appropriate equipment and following the procedures in this SOP, the field accuracy of this measurement is close to %R = 100 + 10% for turbidities in the range of 1 to 100 NTU.

##### Sample Cells (cuvettes): Use sample cells or tubes of clear, colorless glass or plastic.

##### Keep cells clean, both inside and out, and discard if scratched or etched.

##### Never handle them where the light beam strikes the sample.

##### Clean sample cells by thorough washing with laboratory soap (inside and out) followed by multiple rinses with distilled or de-ionized water, and let air-dry.

##### Use a very thin layer of silicone oil on the outside surfaces to mask minor imperfections or scratches in the cells.

##### Use silicone oil with the same refractive index of the glass; making sure the cell appears to be nearly dry with little or no visible signs of oil.

##### Because small differences between cells significantly impact measurement, use either matched pairs or the same cell for standardization and sample measurement.

##### Standards:

##### Primary standards: Use these standards for initial calibration.

##### Formazin standards can be either obtained commercially, as commercial stock formazin polymer microsphere suspensions, or prepared according to method 2130B (2011), section 3. in Standard Methods for the Examination of Water and Wastewater (see Standard Methods Online, http://www.standardmethods.org/Buy/). Commercially prepared formazin polymer suspensions are used as prepared from the manufacturer and may not be diluted.

##### Some instruments may require the use of styrene divinylbenzene (SDVB) standards for calibration.

##### Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards must only be used for continuing calibration verifications according to the procedures in section 3.4 below. Determine or verify the values of secondary standards according to the procedure in section 3.3 below.

##### Turbidity-free water: Use filtered, laboratory reagent water demonstrated to be free of measurable turbidity (<0.01 NTU) or purchase commercially prepared turbidity-free water. Turbidity-free water may only be used for rinsing and to set the zero point according to the instrument manufacturer’s manual.

##### Calibration and Use

##### General Concerns

##### Light absorption by dissolved and suspended matter may cause a negative bias on the turbidity measurement. When present in significant concentrations, particles of light-absorbing materials such as activated carbon will cause a negative interference. Likewise, the presence of dissolved, color-causing substances that absorb light may also cause a negative interference. Some commercial instruments may have the capability of either correcting for slight color interference or optically blanking out the color effect.

##### Handle samples with natural effervescence as described in 3.5.7.1 below.

##### Calibration and Initial Calibration Verification

##### Follow the calibration activities in FT 1000, section 2.2, including requirements for chronological and quantitative bracketing.

##### Perform an initial calibration using at least two primary standards.

##### If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard per 3.2.3 below.

##### For measurement of samples of very low turbidity, select the lowest standard commercially available (typically 1 to 20 NTU) for bracketing the lower end of the anticipated sample turbidity range or dilute higher turbidity standards with turbidity-free water. While it is important to choose calibration standards as close as possible to the expected range of environmental measurements, the quantitative bracket may be achieved using a combination of calibration and verification points if a low enough standard is not available for the lowest end of the calibration.

##### Do not use a standard less than 0.1 NTU or turbidity-free water as a calibration standard.

##### Perform an initial calibration verification by reading at least one primary standard as a sample in “read” or “run” mode. The acceptance criterion for the initial calibration verification depends on the range of turbidity of the standard value:

##### Standard Value < 0.1 NTU: For verification uses only, standards less than 0.1 NTU do not have to meet the acceptance requirement of ± 10%, but must meet the vendor’s stated value (typically < 0.1 NTU) or be less than the reporting limit.

##### Standard Value = 0.1-10 NTU: the response must be within 10% of the standard except specified in 3.2.3.1 below;

##### Standard Value = 11-40 NTU: the response must be within 8% of the standard;

##### Standard Value = 41-100 NTU: the response must be within 6.5% of the standard; and

##### Standard Value > 100 NTU: the response must be within 5% of the standard.

##### Do not use turbidity-free water as a calibration verification standard.

##### Determining the Values of Secondary Standards

##### Use only those standards certified by the manufacturer for a specific instrument.

##### Use verified secondary standards only for continuing calibration verifications.

##### Determining the initial value(s) of secondary standard(s):

##### Calibrate or verify the instrument with primary standards. Select primary standards that bracket the range of the secondary standards.

##### Immediately after an initial calibration with primary standards or verification with a primary standard, read each secondary standard as a sample in “read” or “run” mode, using the reading from the instrument as the first assigned value.

##### Verifying Secondary Standards

##### At least once per quarter or at other documented intervals (see 3.3.5 below), determine or verify the values of secondary standards immediately after the instrument has been calibrated or verified with primary standards.

##### Read each secondary standard as a sample in “read” or “run” mode. This reading must be within the manufacturer’s stated tolerance range and within the acceptance ranges of the assigned standard value as listed in 3.2.3., above. If the criteria in section 3.2.3., above are not met, assign this reading as the value of the standard. If the reading is outside the manufacturer’s stated tolerance range, discard the secondary standard.

##### **More frequent calibration verifications may be required for discharge permit compliance measurements or other regulatory requirements.**

##### Continuing Calibration Verification

##### Determine the maximum time between continuing calibration verifications for the specific turbidity measurement device based on instrument stability at demonstrated intervals as in FT 1000, sections 2.2.5.1 and 2.2.5.2. Sample readings must be chronologically and quantitatively bracketed per requirements in FT 1000, section 2.2.

#####  Perform a continuing calibration verification using at least one primary or secondary standard by reading the standard as a sample in “read” or “run” mode.

##### The calibration acceptance criteria are the same as those listed in section 3.2.3 above.

##### Measuring Turbidity in Samples

##### Double-rinse the sample cell or cuvette with a small amount of the sample.

##### Discard, and pour an aliquot into the sample cell or cuvette.

##### Gently agitate the sample and wait until air bubbles disappear.

##### Gently dry out its external surface with lint-free paper.

##### Insert the cell in the instrument and read the turbidity directly from the meter display.

##### Process and measure the sample as above and record the instrument reading within 15 minutes of sample collection.

##### Do not use vacuum degassing, ultrasonic bath or other devices to remove bubbles from the sample. If the sample contains visible bubbles or if it effervesces (as in groundwater, with changes in pressure and temperature), make a note of this in the field records and collect a sample for laboratory measurement.

##### If effervescing samples are collected for laboratory analysis collect the sample without leaving headspace in the container and ship it as soon as possible to the laboratory (the holding time for this measurement is only 48 hrs).

##### Ship this sample in wet ice at ≤6oC.

##### Pour out the sample, double-rinse the cuvette with de-ionized water in preparation for the next sample.

##### Preventive Maintenance: Refer to FT 1000, section 3.

##### Documentation

##### Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

##### Note the date of receipt, the expiration date and the date of first use for all standards and reagents. Document acceptable verification of any standard used after its expiration date.

##### Record the concentration or other value for the standard in the appropriate measurement units.

##### Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

##### Retain vendor assay specifications for standards as part of the calibration record.

##### Record the grade of standard or reagent used.

##### When formulated in-house, document all calculations used to formulate calibration standards. Record the date of preparation for all in-house formulations.

##### Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

##### Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

##### Retain vendor certifications of all factory-calibrated instrumentation.

##### Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used. Record manufacturer name, model number, and identifying number (such as a serial number) for each instrument unit.

##### Record the time and date of all initial calibrations and all calibration verifications.

##### For all calibration verifications, record the instrument reading (value) in appropriate measurement units to the resolution stated by the instrument manufacturer for the measurement range.

##### Record the name of the analyst(s) performing the calibration.

##### Document the specific standards used to calibrate or verify the instrument or field test with the following information:

##### Type of standard or standard name (e.g., formazin)

##### Value of standard, including correct units (e.g., 20 NTU)

##### Link to information recorded according to section 5.1 above

##### Retain manufacturers’ instrument specifications.

##### Document whether successful initial calibration occurred.

##### Document whether each calibration verification passed or failed.

##### Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

##### Document date and time of any corrective action.

##### Note any incidence of discontinuation of use of the instrument due to calibration failure.

##### Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

##### Record all field-testing measurement data, to include the following:

###### Project name

###### Date and time of measurement or test (including time zone, if applicable)

###### Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)

* + Latitude and longitude of sampling source location (if required)
	+ Analyte or parameter measured
	+ Measurement or test sample value, recorded to the resolution stated by the instrument manufacturer for the measurement range
	+ Reporting units
	+ “J” data qualifier code and explanatory comment if the sample measurement is not chronologically and quantitatively bracketed by acceptable calibrations and verifications per requirements in FT 1000, section 2.2
	+ Initials or name of analyst performing the measurement
	+ Unique identification of the specific instrument unit(s) used for the test(s)

### In situ Measurement of Turbidity by Formazin Nephelometric Units (FNU)

Use in conjunction with:

* FT 1000 General Field Testing and Measurement
* FT 1900 Continuous Monitoring Meters
* FS 1000 General Sampling Procedures
* FS 2000 General Aqueous Sampling
* FD 1000 Documentation Procedures
* FC 1000 Cleaning/Decontamination Procedures
* FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs

##### Introduction: Turbidity measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms cause turbidity in water. This SOP describes use of turbidimeters designed for in situ measurements. This method is applicable to turbidity measurements ranging from 1-10,000 FNU.

##### Method FT 1620 covers in situ turbidimeter probes that use an infrared light source. Results are reported in Formazin Nephelometric Units (FNU). In situ probes with turbidity sensors can be used for screening purposes such as monitoring groundwater purge stabilization parameters, or for monitoring of surface water. Follow the instructions in FT 1920 for instruments that will be deployed for continuous monitoring for ambient in situ monitoring. FT 1620 shall be used for the continuous monitoring of turbidity of wastewater matrices as reclaimed water at domestic wastewater treatment facilities as required by Rule 62-610.320, F.A.C. FT 1620 shall not be used when collecting samples for NPDES permit compliance or regulatory compliance sampling defined in rules or permits. Method FT 1620 may be proposed for use in studies that entail comparison measurements (dredge and fill) or unattended deployment for continuous monitoring purposes, with specific Department approval. **Do not report turbidity results measured using FT 1620 for regulatory purposes such as permit compliance unless the Department has approved the use for the specific project or for compliance with Rule 62-610.320, F.A.C.** All turbidity probes must be calibrated and verified according to the requirements in FT 1620.

##### Equipment and Supplies

##### Field Instrument: Use a nephelometric, non-ratiometric, near-ifrared turbidimeter probe consisting of a monochromatic light source. This may be a submersible-sensor instrument consisting of a multiparameter probe with installed turbidity sensor. The turbidity sensor must meet these specifications:

##### Use a near-IR (780-900 nm) monochromatic light source coupled with a monitor detection device to achieve a constant output.

##### The distance traversed by the incident light and scattered light within the sample tube must not exceed 10 cm.

##### The light detector, centered at 90o to the incident light, must have an acceptance angle that does not exceed + 10o from 90o.

##### The detector and any filter system must have a spectral peak response between 780 and 900 nanometers.

##### Instrument sensitivity and accuracy must be sufficient for project objectives.

##### Standards:

##### Use these standards for calibration and verifications. Check the manufacturer for instrument-specific standard requirements.

##### Formazin standards can be either obtained commercially, as commercial stock formazin polymer microsphere suspensions, or prepared according to method 2130B (2011), section 3. in Standard Methods for the Examination of Water and Wastewater (see Standard Methods Online, http://www.standardmethods.org/Buy/). Commercially prepared formazin polymer suspensions are used as prepared from the manufacturer and may not be diluted.

##### Some instruments may require the use of styrene divinylbenzene (SDVB) standards for calibration.

##### Turbidity standard concentrations labelled NTU are considered equivalent to FNU.

##### Turbidity-free water: Use filtered, laboratory reagent water demonstrated to be free of measurable turbidity (<0.01 NTU) or purchase commercially prepared turbidity-free water. Allowable uses for turbidity-free water include probe rinsing, verification (as in sections 3.2 and 3.3 below), or as specifically allowed by the instrument manufacturer for sensor calibration.

##### Calibration and Use

##### General Concerns

**Follow the instrument manufacturer's instructions for the details of operating the instrument.**

Ensure stable sample and sensor readings before calibrating or taking sample readings.

##### Water color may cause a negative interference with the turbidity reading when significant amounts of light absorbing particles are present to absorb the wavelengths of incident light. The effect of color interference is less with the near-infrared meter design and some instruments or methods may have the capability of reducing or eliminating the color effect. Differences in particle size as well as flow disruption around the probe itself can create a positive or negative interference. Large, abrupt temperature fluctuations can result in measurement errors and should be considered when measuring thermal plumes or temperature stratifications.

##### Bubbles may cause a positive interference. Agitate the submersed sensor repeatedly or employ the mechanical wiper, if installed, to remove bubbles.

##### Thoroughly rinse the turbidity sensor with deionized water between standards when calibrating or verifying the calibration. Ensure adequate flushing of the sensor with fresh sample water prior to taking measurements. Any residual standard, sample or deionized water remaining on the sensor may affect the measurement of the subsequent standard or sample.

##### Calibration and Initial Calibration Verification

##### **Follow manufacturer’s instructions for cleaning and calibration requirements specific to the instrument.**

##### Follow the calibration activities in FT 1000, section 2.2, including requirements for chronological and quantitative bracketing.

##### Thoroughly clean the sensor and calibration cup, ensure the optical surface of the sensor is free of bubbles and perform an initial calibration using at least two standards. If the instrument can accept a three point calibration, choose additional calibration standards within the range of expected sample values.

##### Calibrate with standards in increasing order, using the lowest standard first. If the manufacturer requires calibration with a zero standard, calibrate starting with this standard first.

##### For measurement of samples of very low turbidity, ensure quantitative bracketing is met by either a passing manufacturer-required calibration with a zero standard or passing verification of a <0.1 FNU turbidity standard.

##### Perform an initial calibration verification by reading at least one standard as a sample in “read” or “run” mode. The acceptance criterion for the initial calibration verification depends on the range of turbidity of the standard value:

##### Standard Value < 0.1 FNU: Standards less than 0.1 FNU and turbidity-free water do not have to meet the acceptance requirement of ± 10% but must meet the vendor’s stated value (typically < 0.1 FNU) or be less than the reporting limit.

##### Standard Value = 0.1-10 FNU: the response must be within 10% of the standard;

##### Standard Value = 11-40 FNU: the response must be within 8% of the standard;

##### Standard Value = 41-100 FNU: the response must be within 6.5% of the standard; and

##### Standard Value > 100 FNU: the response must be within 5% of the standard.

##### Continuing Calibration Verification

##### Determine the maximum time between continuing calibration verifications for the specific turbidity measurement device based on instrument stability at demonstrated intervals as in FT 1000, sections 2.2.5.1 and 2.2.5.2. Sample readings must be chronologically and quantitatively bracketed per requirements in FT 1000, section 2.2.

#####  Perform a continuing calibration verification using at least one standard and turbidity-free water by reading each as a sample in “read” or “run” mode.

##### The verification acceptance criteria are the same as those listed in section 3.2.4 above.

##### Measuring Turbidity in Samples

##### Immerse or place the probe at a measuring location representative of the sampling source.

##### If the turbidity instrument has selectable settings to measure the full range of potential sample turbidities, select the correct range in order to take a reading.

##### Allow the turbidity instrument reading to stabilize for at least 60 seconds.

##### Record the sample turbidity measurement after all applicable meter adjustments have been made and the instrument reading has stabilized.

##### For in situ measurements of turbidity at depth in surface water or wastewater, immerse the probe at the desired depth and wait for stabilization of the reading and record its value, as above.

##### For sites that are not well-mixed or during rapidly changing conditions, it may be necessary to take measurements at multiple points to represent the sample loation.

##### Measure groundwater sample turbidity in situ with a downhole probe or in a flow-through container or other applicable measurement configuration.

##### Post-Deployment Verification for Data Corrections or Other Uses: Refer to FT 1920, section 4 if data are to be corrected for instrument drift or fouling.

##### Preventive Maintenance: Refer to FT 1000, section 3 and FT 1920, section 5.

##### Data Evaluation: Refer to FT 1920, section 6.

##### Documentation

##### Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

##### Note the date of receipt, the expiration date and the date of first use for all standards and reagents. Document acceptable verification of any standard used after its expiration date.

##### Record the concentration or other value for the standard in the appropriate measurement units.

##### Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

##### Retain vendor assay specifications for standards as part of the calibration record.

##### Record the grade of standard or reagent used.

##### When formulated in-house, document all calculations used to formulate calibration standards. Record the date of preparation for all in-house formulations.

##### Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

##### Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

##### Retain vendor certifications of all factory-calibrated instrumentation.

##### Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used. Record manufacturer name, model number, and identifying number (such as a serial number) for each instrument unit.

##### Record the time and date of all initial calibrations and all calibration verifications.

##### For all calibration verifications, record the instrument reading (value) in appropriate measurement units to the resolution stated by the instrument manufacturer for the measurement range.

##### Record the name of the analyst(s) performing the calibration.

##### Document the specific standards used to calibrate or verify the instrument or field test with the following information:

##### Type of standard or standard name (e.g., formazin)

##### Value of standard, including correct units (e.g., 20 FNU)

##### Link to information recorded according to section 7.1 above

##### Retain manufacturers’ instrument specifications.

##### Document whether successful initial calibration occurred.

##### Document whether each calibration verification passed or failed.

##### Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

##### Document date and time of any corrective action.

##### Note any incidence of discontinuation of use of the instrument due to calibration failure.

##### Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

##### Record all field-testing measurement data, to include the following:

###### Project name

###### Date and time of measurement or test (including time zone, if applicable)

###### Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)

* + Latitude and longitude of sampling source location (if required)
	+ Analyte or parameter measured
	+ Measurement or test sample value, recorded to the resolution stated by the instrument manufacturer for the measurement range
	+ Reporting units
	+ “J” data qualifier code and explanatory comment if the sample measurement is not chronologically and quantitatively bracketed by acceptable calibrations and verifications per requirements in FT 1000, section 2.2
	+ Initials or name of analyst performing the measurement
	+ Unique identification of the specific instrument unit(s) used for the test(s)

### Continuous Measurement of Total Suspended Solids (TSS) by In-line Meter

Use in conjunction with:

FT 1000 General Field Testing and Measurement

FT 1900 Continuous Monitoring Meters

FS 1000 General Sampling Procedures

FS 2000 General Aqueous Sampling

FS 2400 Wastewater Sampling

FD 1000 Documentation Procedures

FC 1000 Cleaning/Decontamination Procedures

FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs

##### Introduction

##### Scope and applicability: A total suspended solids (TSS) sensor measures the scattering/backscattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered/backscattered light), the higher the TSS value. Suspended and colloidal matter consist of, but are not limited to clay, gravel, silt, sand, finely divided organic and inorganic matter, plankton, and other microscopic organisms.

##### This SOP describes the continuous measurement of TSS in mg/L (ppm) with installed, in-line sensors meeting the specifications outlined in Section 2. It is intended to be used for the continuous in-line monitoring of TSS of wastewater matrices as reclaimed water at domestic wastewater treatment facilities as required by Rule 62-610.320, F.A.C.

##### Equipment

Continuous Monitoring Instrument: Use a total suspended solids sensor consisting of a light source and one or more photoelectric detectors with a readout device to indicate the intensity of light. The instrument must meet these specifications:

The light source must have a light-emitting diode (LED) operating in the Infrared (IR) spectrum, a wavelength from 780 nm to 1000 nanometers. Near Infrared (NIR) is within this range.

The detector and any filter system must have a spectral peak response between 780 and 1000 nanometers.

The instrument accuracy must permit detection of TSS difference of ± 0.50 mg/L at the 1 – 5 mg/L scale.

The sensor must have automatic cleaning capabilities (e.g., wipers, high pressure jets, ultrasonication) to minimize the effects of data drift and fouling.

##### Calibration, Initial demonstration of capability, verification, and Use

General Concerns:

Light-absorbing dissolved and suspended matter, color, particle size, air bubbles, and water density may interfere with TSS measurement. When present in significant concentrations, particles of light-absorbing materials (e.g., activated carbon) and dissolved, color-causing substances that absorb light may also cause an interference. Characteristics such as color, particle size, and water density may change over time (e.g., seasons) along with conditions of the measuring environment.

In flowing waters, the direction of the sensor and distance from the ground or wall when installed can also affect TSS measurement. Follow manufacturer’s instructions on installation of the sensor.

Some commercial instruments may have the capability of either correcting for slight color interference or optically blanking out the color effect.

Calibration:

Follow the calibration requirements in Section 1.1 of FT 1910.

Prior to installation, check the zero point of the sensor by measuring analyte-free water according to the manufacturer’s manual. A zero-point calibration is typically performed by the factory. If it is determined that a zero-point recalibration is needed (e.g., deviations in measured values compared to manufacturer’s acceptance criteria), refer to the manufacturer’s instructions. Retain records of factory recalibration and maintenance.

A one-point calibration of the sensor is required upon initial installation, when verifications do not meet acceptance criteria, and when the sensor is taken offline. Install the sensor per the manufacturer’s instructions, and perform a one-point calibration. For the calibration, take a grab sample for analysis by a certified lab per the method required in the permit, at or as near as possible to the same location as the in-line sensor. Grab samples are taken per FS 2430, FS 2460, and FS 2470. Use the certified lab result for the grab sample to adjust the displayed sensor value in calibration mode either by entering the certified lab result (for automated calculation of the correction factor) or the correction factor, manually calculated by the following equation:

$$CF=\frac{Certified Lab TSS Result}{Sensor TSS Result}$$

Initial Demonstration of Capability: Before reporting data from the TSS sensor, a wastewater treatment facility must collect comparison data and document information related to initial demonstration of capability (IDOC), as detailed below. Documentation shall be provided to the Department upon request.

Sensor readings must be within ± 1.0 mg/L of the grab sample measurements per Section 3.4 below. If the criterion is not met, staff should determine the source of the problem, take corrective action, and continue collecting daily grab samples. After 14 consecutive sampling days (sample pairs may not be omitted from the demonstration dataset), the sensor can be put into service for compliance monitoring.

Historical data can be used for the IDOC and must show that the sensor remains in agreement with the grab sample measurements over 14 consecutive sampling days without sensor maintenance or calibration adjustment.

If historical data are not available, the facility must conduct an IDOC by comparing the concentration determined by the TSS sensor with grab sample analysis collected at least daily for 14 days, or 14 consecutive sampling days. Data pairs collected during the 14-day period should be representative of the range of concentrations expected at the facility.

Verifications:

For verification requirements, see Sections 1.2 - 1.6 of FT 1910. At documented intervals, compare the displayed sensor reading with the certified lab result of the grab sample. Base the selected time interval on the shortest interval that the instrument maintains stability. For these comparisons, the calibrated instrument reading must be no greater than 1.0 mg/L different from the certified lab result, per Section 1.3 of FT 1910.

If the sensor fails to meet the acceptance criteria (no greater than 1.0 mg/L), qualify affected sensor measurements, conduct a one-point calibration per Subsection 3.2.3 above and repeat verifications.

Refer to Section 2 of FT 1910 for extended verification intervals.

If the sensor is removed from service (e.g., cleaning, failure), perform a zero-point check, calibration, and verification prior to continued use.

Continuous Measurement of TSS: Conduct measurements with installed sensors according to the manufacturer’s instructions.

If the sensor controller has selectable settings to measure the full range of potential sample TSS concentrations, select the appropriate range to take a reading.

##### A secondary TSS instrument may be used in place of the primary installed TSS sensor. Secondary devices must meet equipment and calibration requirements within this SOP.

##### Preventive Maintenance: Refer to the manufacturer’s recommendations for manual cleaning of the instrument.

##### Documentation: Refer to the documentation requirements in Section 4 of FT 1910 and FD 4100.

Initial Demonstration of Capability Documentation: Document and retain successful IDOC conducted per Section 3.3 above. Retain lab certification information and lab reports. For both the sensor and the comparison measurements, include the following:

* Date and time of measurement or test (including time zone, if applicable)
* Source and location of the measurement or test sample (e.g., outfall number)
* Latitude and longitude of sampling source location (if required)
* Analyte or parameter measured
* Measurement or test result
* Reporting units
* Initials or name of analyst performing the measurement
* Unique identification of the specific instrument unit(s) for the test(s).

Continuous Monitoring Instrument Calibration Documentation: Document acceptable calibration and verification for each TSS sensor, linking this record with affected sample measurements.

Retain vendor certifications of all factory-calibrated instrumentation.

Designate the identity of specific instrumentation in the documentation with a unique description or code for each sensor used. Record manufacturer name, model number, and identifying number (such as a serial number) for each instrument.

Record the time and date of all initial calibrations and all verifications.

Refer to the documentation requirements for daily verifications in Section 4 of FT 1910.

Record the name of the analyst(s) performing the calibration.

Retain manufacturers’ instrument specifications.

Document whether successful (e.g., pass/fail) calibration and verification occurred.

Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

Document date and time of any corrective action.

Note any incidence of discontinuation of use of the instrument due to calibration failure.