*Name of Facility*

Standard Operating Procedure for

the Analysis of Turbidity

Method: SM 2130 B-2020

Effective Date:

Supervisor Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_

Supervisor Name (print):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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*Blue text is replaceable instructional language to be customized for your facility.*

1. Summary of Method
   1. Turbidity is considered a method-defined parameter per the definition in the Code of Federal Regulations, Part 136.6, Section (a) (5). This means that the method may not be modified per Section (b) (3).
   2. Turbidity is the measure of clarity of a liquid. Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher the turbidity.
   3. *State what type of samples are analyzed (e.g., wastewater effluent, ground water monitoring well, etc.) and the permit limits, if applicable.*
   4. This SOP is applicable to grab samples only.
   5. *State what your reporting range is.*
2. Definitions
   1. *If preparing calibration standards in-house a dilution water blank is recommended.* Dilution water blank: A dilution water blank is a volume of reagent water of the same matrix as the calibration standards with a measured turbidity of ≤ 0.2 NTU.
   2. Calibration standard: A standard of known turbidity used to calibrate the instrument.
      1. Primary standard: Liquid suspensions prepared in-house from hydrazine sulfate and hexamethylenetetramine, or a commercial stock formazin suspension.
      2. Secondary standard: Commercially prepared, stabilized, sealed liquid or gel turbidity standards calibrated against properly prepared and diluted formazin or styrene divinylbenzene polymers.
   3. Calibration check standard: A standard analyzed each day prior to sample analysis to check the calibration.
   4. Nephelometer: A turbidimeter with scattered-light detectors located at 90° to the incident beam.
   5. NTU: Nephelometric Turbidity Units, the units for the measurement of turbidity.
   6. NC WW/GW LCB: North Carolina Wastewater/Groundwater Laboratory Certification Branch
   7. Post-Analysis Calibration Verification Standard: A Calibration Check Standard that is analyzed after all sample analyses.
   8. *Add any other applicable acronyms used by your facility*
3. Safety and Waste Handling
   1. *Items that would be included in this section are things such as:*

* *Precautionary measures (list here and at the critical steps in the procedure)*
* *Personal protective equipment (e.g., gloves, eye protection, lab coat, work in a hood, etc.)*
* *Hazardous chemicals/reagents*
* *Storage and disposal of samples and reagents*
* *Reference to Chemical Hygiene Plan, if applicable*
* *Location of Safety Data Sheets (SDSs)*
  1. ***CAUTION: Standards are prepared with Hydrazine sulfate, which is a carcinogen; avoid inhalation, ingestion, and skin contact. Formazin suspensions can contain residual hydrazine sulfate.***

1. Apparatus, Equipment and Standards

*Note: Include storage conditions and expiration dates for standards and reagents. It is recommended that catalog numbers also be included*

* 1. *List the meter with make and model. NOTE: The method specifies the following design criteria for a nephelometer:*

1) Light source—Tungsten-filament lamp operated at a color temperature between 2200 and 3000K.

2) Distance traversed by incident light and scattered light within the sample tube—Total not to exceed 10 cm.

3) Angle of light acceptance by detector—Centered at 90° to the incident light path and not to exceed ±30° from 90°. The detector and filter system, if used, shall have a spectral peak response between 400 and 600 nm.

* 1. *Delete if not applicable. Stock Primary Standard: 4000 NTU suspension.* 
     1. *Mix 5.0 mL of Solution 1 and 5.0 mL of Solution 2 in a flask. Let stand for 24 hours at 25 ± 3 °C. Store in amber glass or other UV-light-blocking container. May be used for up to one year.*
     2. *Solution 1: Add 1.000 g hydrazine sulfate, (NH2)2•H2SO4, to 100-mL volumetric flask and dilute to mark with distilled water.*
     3. *Solution 2: Add 10.00 g hexamethylenetetramine, (CH2)6N4, to a 100-mL volumetric flask and dilute to mark with distilled water.*
  2. Calibration standards: *State if using primary or secondary standards, as required by the meter manufacturer. If preparing primary standards, state stock solution used and how to prepare. If primary standards are purchased, state concentrations. If using secondary standards, provide product information.* 
     1. *If preparing primary standards* Prepare standards immediately before use and discard after use.
  3. Calibration check standard: *State if it is a primary or secondary standard. If it is a primary standard and prepared in the laboratory, state how it is prepared.*
     1. *If preparing primary standards* Prepare standards immediately before use and discard after use.
  4. Dilution water: *State what type of water is used e.g., purchased distilled water, etc.* To obtain low-turbidity water with a nominal value of ≤0.02 NTU for standard preparation and dilutions, pass laboratory reagent-grade water through a filter with pore size sufficiently small to remove essentially all particles larger than 0.1 µm. The usual membrane filter used for bacteriological examinations is not satisfactory.
  5. *Include your sample cell size.*
  6. Chemical containers are dated when received and when opened.
  7. The date received, date opened (in use), vendor, lot number and expiration date of reagents is documented on a traceability log OR on the benchsheet.
  8. The analyst’s initials, date of preparation, the volume or weight of standard(s) used, the solvent and final volume of the solution are documented when any solutions are prepared.

1. Interferences
   1. Dirty glassware and air bubbles give false results. Remove air or other entrained gases in the sample before measurement. *State how samples are treated to prevent interference from dirty glassware or air bubbles.*
   2. Condensation may occur on the outside surface of a sample cell when a cold sample is being measured in a warm, humid environment. This interferes with turbidity measurement. *State how samples are handled to prevent interference from condensation.*
   3. *State any other applicable interferences (e.g., presence of activated carbon, color-causing substances, etc.) and how to mitigate them.*
2. Sample Collection, Preservation and Holding Time
   1. *State what containers samples are collected in. Samples must be collected in glass or polyethylene containers.*
   2. The holding time is 48 hours.
   3. If the sample cannot be analyzed within 15 minutes of collection, the sample must be thermally preserved to ≤ 6°C, without freezing, within 15 minutes of collection.
   4. *State where the sample is generally analyzed e.g., in the stream, immediately at the sampling site, in the lab within holding time, etc.*
3. Calibration
   1. The turbidimeter must be calibrated according to manufacturer’s instructions.
      1. *State the frequency the meter is calibrated. State the steps used to calibrate the turbidimeter as described in the manufacturer’s user manual.*
   2. The following standard concentrations are used: *List your standard concentrations here.*
   3. Before analyzing Compliance Samples each day, a calibration check standard is analyzed and the results documented.
4. Procedure
   1. *State the actual steps to take for analyzing the sample. Include steps such as allowing the meter to warm up, gently agitating the sample to ensure homogeneity, pouring into the same vial, ensuring no air bubbles are present, wiping the vial with a Kimwipe or lint-free cloth to remove fingerprints and condensation, applying silicon oil, inserting into the chamber and closing the lid, and reading the measurement at the first stable reading.*
   2. *If the meter is transported by vehicle after calibration, include this section. Delete if not.* If the meter is transported by vehicle after calibration, a post-analysis calibration verification check standard must be analyzed at the end of the run. See Section 12 for the acceptance criterion.
5. Documentation

The following must be documented in indelible ink whenever sample analysis is performed:

* 1. Date and time of sample collection
  2. Date and time of sample analysis to verify the 48-hour holding time is met
  3. Permitted facility name or permit number, and sample site (ID or location)
  4. Collector’s/analyst’s name or initials
  5. Meter calibration and meter calibration time(s)
  6. True values of the standards used for calibration
  7. Values obtained for standards
  8. Quality control assessments (i.e., evaluation of acceptance criteria)
  9. *True value and value obtained for the post-analysis calibration verification(s), when applicable*
  10. *Indication of when the post-analysis calibration verification was performed (e.g., time of analysis, end-of-day analysis, etc.)*
  11. All data must be documented and reported in units of measure as specified in the permit (NTU)
  12. Traceability for chemicals, reagents, standards and consumables
  13. Instrument identification (serial number preferred)
  14. Parameter analyzed
  15. Method reference
  16. Data qualifiers, when necessary.

1. Proficiency Testing (PT) Procedure
   1. Analysis of a blind PT Sample is required at least once during every 9-month PT calendar year (January 1- September 30).
      1. A list of approved PT Sample Providers may be found on the NELAC website at [http://nelac-institute.org/content/NEPTP/ptproviders.php](http://nelac-nstitute.org/content/NEPTP/ptproviders.php). Check this list yearly to assure the chosen vendor is approved.
      2. A PT Sample can be analyzed as early as January 1 and the graded result must be reported to NC WW/GW LC office from the PT Sample Provider no later than September 30.
   2. PT Samples must be analyzed in accordance with the routine testing, calibration and reporting procedures, unless otherwise specified in the instructions supplied by the PT Sample Provider.
      1. PT Samples are logged in and analyzed using the same staff, sample tracking systems, standard operating procedures including the same equipment, reagents, calibration techniques, analytical methods, and the same quality control acceptance criteria.
      2. PT Sample preparation must be documented. The instruction sheet provided with the PT Sample will be signed and dated.
      3. PT Samples shall not be analyzed with additional quality control. They are not to be replicated beyond what is routine for Compliance Sample analysis.
      4. PT Sample analysis must be documented on the laboratory’s daily benchsheet.
   3. The PT Sample Provider’s instructions for preparing the PT Sample must be followed and the practice documented by the analyst. The instruction sheet will be initialed and dated when the PT Sample is prepared and retained for 5 years.
   4. The following information must be included when reporting the PT Samples.
      1. EPA Lab Code: (*enter here so it is easy to retrieve*)
      2. State Lab Certification number: *(enter here so it is easy to retrieve)*
      3. Method description (refer to Certified Parameters Listing (CPL) for current method description): *(enter here so it is easy to retrieve)*
      4. Mailing address for NC WW/GW LC: 1623 Mail Service Center, Raleigh, NC 27699-1623
2. Calculations and Reporting
   1. *State how the data is recorded on the benchsheet.*
   2. Report turbidity results on the DMR, along with qualification if applicable, as summarized in the table below:

|  |  |
| --- | --- |
| Measured Turbidity Range  *NTU* | Report to the Nearest  *NTU* |
| 0 – 1.0 | 0.05 |
| 1 – 10 | 0.1 |
| 10 – 40 | 1 |
| 40 – 100 | 5 |
| 100 – 400 | 10 |
| 400 – 1000 | 50 |
| > 1000 | 100 |

* 1. *State who is transcribing the data to the DMR and whether anyone peer reviews (checks) it. Peer review is recommended, but if that is not possible, it is recommended that the analyst rechecks their own transcription for errors after a certain amount of time has passed.*

1. Quality Assurance and Quality Control
   1. Analyze a calibration check standard each day before analyzing Compliance Samples. *State the concentration used. State if the calibration check standard is a primary or secondary standard.* The turbidity reading must check within ± 10% of the true value. *State the range of acceptable values.*
   2. If the calibration check standard does not measure within the acceptance criteria, do not proceed with sample analysis. Initiate corrective action as described in Section 14.0.
   3. *Delete this section if the post-analysis calibration verification is not needed:* The value obtained for the post-analysis calibration verification check standard must read within 10% of the standard’s true value. If the obtained value is outside of the ± 10% range, corrective action must be taken. See Section 14.0.
   4. All documentation errors shall be corrected by drawing a single line through the error so that the original entry remains legible. Entries shall not be obliterated by erasures or markings. Wite-Out®, correction tape, or similar products designed to obliterate documentation are not to be used; instead the correction shall be written adjacent to the error. The correction shall be initialed by the responsible individual and the date of change documented. All manual data and log entries shall be written in indelible ink.
2. Preventative Maintenance
   1. *State if a maintenance log or record is maintained.*
   2. *Include care and cleaning of sample cells as described in SM 2130 B (2) (b).*
3. Troubleshooting and Corrective Action
   1. *State what will be done if a meter does not pass the calibration checks (e.g., recalibrate, clean or replace the vials, etc.)*
   2. *If the post-analysis calibration verification does not read within 10% of the standard’s true value, corrective action must be taken as stated in 14.1 and the associated samples must be reanalyzed, if possible. If samples cannot be reanalyzed, the sample results are reported on the DMR with qualification.*
4. Employee Training

The following employee training must be documented and kept on file.

* 1. *Include education, training, experience and/or demonstrated skills required for the position*
  2. Employee must have read and acknowledged understanding of this SOP *– may also include reading the Approved Procedure for the Analysis of Total Residual Chlorine*
  3. *Employee must obtain acceptable results on Proficiency Testing samples or other demonstrations of proficiency (e.g., Initial Demonstration of Capability (IDOC), side-by-side comparison with established analyst, etc.) before analyzing compliance samples for reporting. Specify how proficiency is demonstrated and how the results are evaluated.st, etc.) before analyzing compliance samples for reporting.*

1. References
   1. Standard Methods, 2130 B-*2020*.
   2. North Carolina Wastewater/Groundwater Laboratory Certification Approved Procedure for the Analysis of Turbidity, Revision *09/20/2023 (consult NC WW/GW LCB website for latest revision)*.
   3. 15A NCAC 02H .0800
2. Revision History

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| --- | --- | --- |
| Type: Review or Revision | Date | Summary of Changes Made if Revision |
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