



MassDEP

**Massachusetts Department of Environmental Protection
Bureau of Water Resources
Watershed Planning Program**

STANDARD OPERATING PROCEDURE

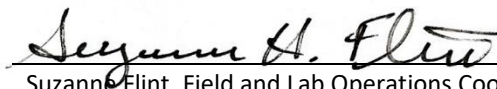
Turbidity Measurement

CN 95.3

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Date: 7/15/25

LIST OF REVISIONS

| Rev. # | Date | Description of Revision(s) | Page #s | Initials |
|--------|--------|--|---------|----------|
| 0 | 9/2004 | Original draft | | RFC |
| 1 | 4/2009 | Added provisions for calibration and electronic lab notebook documentation | 4-6 | |
| 2 | 5/2023 | Revisions throughout; update to use of AQUAfast AQ4500 Turbidimeter; update program name to Watershed Planning Program | | SF |
| 3 | 5/2024 | Added Appendix B | | SF |
| 4 | 3/2025 | Updated title page and added QuickGuide as Appendix C | | SF |
| | | | | |

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1.0 SCOPE AND APPLICATION

This SOP is intended to provide guidance in the measurement of turbidity in surface waters using available Watershed Planning Program (WPP) field/lab turbidimeters.

2.0 SUMMARY

Standard procedures for collecting and analyzing turbidity samples using WPP turbidimeters are provided.

3.0 SAFETY CONSIDERATIONS

Standard safety considerations for WPP field surveys, as contained in *Sampling Techniques for WPP Surface Water Quality Monitoring* (CN 1.23), apply. There are no SOP-specific, additional safety rules, except to review standard protocols and to consider any project- and/or location-specific safety issues that may exist.

SDS sheets for turbidity standards are located in the Instrument Lab at WPP in Worcester, MA.

4.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Take water samples consistent with WPP protocols (see *Sampling Techniques for WPP Surface Water Quality Monitoring* (CN 1.23)).

The analytical holding time is 48 hours, but samples should be analyzed as soon as possible (i.e., next day and within 24 hours if feasible). Store in dark at 4 deg. C. Remove from fridge for 1-2 hours before analysis.

5.0 APPARATUS, EQUIPMENT AND MATERIALS

The following materials are used: i.e.,

AQUAfast QA4500 Turbidimeter

Prepared standards (0.2, 10, 100 and 1000 NTUs)

Sample vials

Manufacturer's User Guide: https://www.fondriest.com/pdf/thermo_aq4500_manual_09.pdf

6.0 REAGENTS

NA

7.0 CALIBRATION

Every six months or as needed, the turbidity meter is calibrated using turbidity standards with concentrations of 0.2, 10, 100 and 1000 NTUs. This procedure follows steps outlined in the instrument manual.

Calibration: Every six months or as needed. (See Appendix B)

1. Select the measurement mode: EPA 180 by scrolling up or down until the desired mode is displayed.
2. Press the CAL (#8 key). "H2O INSERT" will be displayed.
3. Insert vial containing DI water and press the YES key.
4. "H2O WAIT" will be displayed and then "1.00 YES?".

5. If the standard is 1.00, insert standard vial and press the YES key. (If standard is another value, press the 6 or 3 key, "CHANGE?" will be displayed. Press the YES key. "STD VAL?" will be displayed. Enter value of standard using numeric keypad. Press the YES key to accept.)
6. Repeat step 5 for each additional standard (10, 100, 1000).
7. When the calibration is complete the AQ4500 will proceed to the measure mode.

Calibration Check: monthly/quarterly

1. Insert the CAL 1 standard (0 NTU) into the sample chamber.
2. Press down the vial until it slides fully into the instrument. Cover the vial using the vial cover.
3. Select the measurement mode.
4. Press the MEAS (#9 key). Wait 5-10 seconds for internally averaged result.
5. The meter will display the results. Record the reading.
6. Repeat the calibration check for CAL 2, CAL 3, CAL 4, and CAL 5 calibration standards.
7. If the displayed results are within 10% of the nominal NTU value of the standard or the precision criteria required by your method, the calibration check passed, and the meter is now ready for measurement.

8.0 ANALYTICAL PROCEDURE

SETUP:

1. Retrieve samples and allow to come to room temperature; transfer sample custody by signing the Chain of Custody.
2. Record sample information the Turbidity printed worksheet (large binder): OWMID, lab numbers, date/time collected. Add lab numbers for a lab blank (LB) and lab duplicate (LD) and record the OWMID of the sample being used as a duplicate.
3. Set up the electronic workbook: Save a copy ("save as") of the Color Turbidity Workbook Template from OneDrive ([WPP Lab SOPs and Results 2023](#)) with the new batch number as the file name. Check the Turbidity binder for the next batch number. Turbidity batch numbers are designated "TCyy-xx" with yy = year and xx = batch number. (E.g., TC23-01)
4. Turn on Turbidimeter and check battery condition. If low (<20%), replace batteries (4 AA batteries).
5. Check the measurement mode = EPA 180.1 (if not, change using SETUP key. See Field and Laboratory Operations Coordinator.)
6. Lab QC for each batch: Run lab blank (DI water) first, and one lab duplicate (select one of the field samples to run a second time) per batch or one per every ten samples for larger batches.

MEASUREMENTS:

7. Use gloves. NEVER TOUCH (OR SCRATCH!) THE VIALS WITH BARE HANDS! ALWAYS USE KIM WIPES.
8. Run the lab blank (DI water) first following Steps 9-14 (below). The blank should be ≤ 0.02 NTU. If the blank is > 0.02 NTU, check that the vial is clean (or switch vials), and retest before continuing measurements for the regular samples. If the problem persists, talk with the Field and Laboratory Operations Coordinator.
9. **Rinse** the turbidity vial: 2 rinses DI water and one rinse with the sample.

10. **Mix** the field sample gently but thoroughly to disperse the solids immediately before pouring.
11. **Pour** the sample into the vial up to the fill-line and recap. Wait until all bubble disappear.
12. **Wipe** the vial clean with Kimwipes. Place the vial in the measurement sample chamber, lining the triangle on the vial with the notch (red arrow in picture). And cover the sample well with the well cap.
13. **Take the reading:** press the “avg” (4) key to activate the averaging feature, press “meas” (9) to take the measurement. (Averaging will stay active until you press the “avg” key again.)
14. **Record** the reading on the worksheet.
15. Repeat Steps 8-13 to analyse all samples.
16. After last sample, review lab sheet to ensure that all sample and analysis information has been recorded.
17. When done, turn unit off and clean up work area.
18. Enter raw results and related information into the electronic Turbidity worksheet. The e-lab sheet will automatically incorporate any dilution factors and will apply rounding rules and significant figures for the final result.
19. Once the final values are calculated, transfer final e-results back to the paper raw lab sheet. Save the manual lab sheet (bench sheet) in the lab binder for turbidity.

9.0 QUALITY CONTROL and REPORTING

For each lab batch, run the following QC samples (in addition to field QC samples) at approx. 1 per every 10 samples: lab blank (run as first sample), and a lab duplicate.

Manufacturer specifications for turbidity are as follows:

| Analyte | Units | Expected Range | Accuracy (+/-) | Resolution | Overall Precision (RPD) |
|-----------|-------|----------------|---|---------------|-------------------------|
| Turbidity | NTUs | 0-100 | 1% of full scale (0-10) 5% of full scale (0-100) 10% of full scale (0-1000) | 0.1% of range | 10% |

Estimated detection and reporting limits:

0-10 RANGE LIMITS:

Instrument detection limit (est.): 0.01 NTUs

Lowest reference standard used: 0.02 NTUs

Method detection limit, MDL (est.): 0.2 NTUs

Reporting detection limit, RDL (est.): 0.5 NTUs

Auto-Reporting Rules:

All values less than 0.2 NTU are reported as “<MRL”. Estimated Method Detection Limit or MDL= 0.1 NTU. Designated Reporting Limit or RL= 0.2 NTU.

Auto-Reporting Rules: round based on Standard Methods.

- 1) For all reported values from 0.2 to 10 NTUs, report data to the nearest 0.1 NTU.
- 2) For all values between 10 and 40 NTUs, report data to the nearest 0.5 NTU.
- 3) For all values between 40 and 100 NTUs, report data to the nearest 1 NTU.
- 4) For all values between 100 and 500 NTUs, report data to the nearest 5 NTUs.
- 5) For all values between 500 and 1000 NTUs, report data to the nearest 10 NTUs.

Record Keeping:

Hard-copy workbook: *(during the analysis)* Record all data in the paper lab notebook, AND

Electronic workbook: *(during and immediately following analysis)* When sample analysis is complete, transcribe raw data from the paper lab notebook to the electronic notebook. The e-notebook is set up to make final calculations automatically (blue shaded areas). Once these values are calculated, transfer final results to the paper lab notebook and add paper lab sheet to the color lab worksheet binder. Save the final e-notebook spreadsheet as (read-only) "lab batch ID" (e.g., "TC09-12") designed file folder (see Field and Laboratory Operations Coordinator).

10.0 INTERFERENCES

- scratched or dirty glass
- foam or air bubbles
- true color (resulting in low bias)
- coarse sediment (resulting in large fluctuation in readings)

11.0 PREVENTIVE MAINTENANCE

- Keep vial cover in place at all times to prevent water/dust from contaminating the optical well.
- Keep vial clean and unscratched. Wash with soft cloth and detergent periodically. Replace as necessary.

12.0 CORRECTIVE ACTIONS

Take the following corrective actions as needed:

- Replace sealed standards that are no longer consistently accurate due to scratched glass, beyond expiration date or other reason.
- Replace scratched sample vials with new ones.
- Review usage of instrument and discuss with appropriate staff re: any defects due to misuse.
- Re-train staff as needed

13.0 WASTE AND POLLUTION PREVENTION

Consider the following in order to minimize waste:

- Continue to use sealed factory NTU standards, not formazin preparations.

14.0 REFERENCES

- EPA 600/R-93/100 Methods for Determination of Inorganic Substances in Environmental Samples, 1993.

- Thermo Scientific Orion AQUAfast AQ4500 Turbidimeter User Guide 2009 (downloaded from https://www.fondriest.com/pdf/thermo_aq4500_manual_09.pdf)
- Standard Methods for the Examination of Water and Wastewater, , APHA/AWWA/WEF, 23rd edition
- ASTM D-1889-00 Standard test method for Turbidity in Water, 2003

15.0 DEFINITIONS/ACRONYMS

NTU: Nephelometric turbidity units

16.0 APPENDICES

Appendix A: Turbidimeter Calibration Form

Appendix b: Manufacturer's Instructions AQUAfast QA4500 Turbidimeter

Appendix C: Turbidity QUICK GUIDE AQUAfast AQ4500 TURBIDIMETER

APPENDIX A

Turbidimeter Calibration Form

Date: _____

QC Check Staff: _____

Calibration Standards Used:

Reference SOPs: EPA 180.1; SM 2130B; WPP Lab Turbidity SOP (CN 95.3)

| Standard Used | "True" NTUs | Reading | Difference | Comments |
|---------------|----------------|---------|------------|----------|
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Instruction Sheet

Thermo Scientific Orion AC45ST Turbidity Standards Kit

Supplies required

1. Clean sample cell (cuvette, vial) – free from scratches, smudges, scuff marks. For best accuracy and low-level (<5 NTU) measurements, it is best to use either matched cells or the same cell for both calibration and sample measurement. A procedure for matching cells is described in **Creating a Set of Matched Sample Cells** section.
2. Primary turbidity calibration standards in 0, 1, 10, 100, and 1000 NTU.
3. Orion AQ4500 Turbidimeter.
4. Lint-free wipers.
5. Silicon oil (optional).

Definitions

1. Primary Calibration Standards – turbidity standards that are traceable and equivalent to the reference turbidity standard, within statistical errors, including styrenedivinyl benzene (SDVB) polymer standards. The bottles of standard supplied in the AC45ST kit are primary calibration standards.
2. Calibration – performed using primary calibration standards to assure proper operation for the range of interest. One sample cell or matched sample cells are used. The primary calibration standard solutions placed into the sample cell(s) are decanted and discarded after one use. Calibrations are typically performed periodically, such as quarterly or twice a year or when the calibration is determined to be invalid.
3. Secondary Standards – standards used to verify the accuracy of the calibration in the measurement range of interest. Secondary standards are prepared in dedicated sample cells that are not the calibration cell or the matched cells used for calibration and sample analysis. Secondary standards may be used repeatedly and must be monitored for deterioration.
4. Calibration Verification – performed using a standard of known value to verify that the calibration is still valid. Verification may be performed using secondary standards. Verification should be performed at timely intervals between calibrations; in general, before and after any sample determinations. The frequency and acceptance limits will be determined by the method reference that the user is following: EPA, Standard Methods, ISO, ASTM, USGS, etc.

Calibration of Orion AQ4500 with primary calibration standards

1. Select a clean sample cell, free from scratches, smudges, or scuff marks. Preferably, use one from a set of matched sample cells (especially for turbidity measurements of < 5 NTU). Pour out the DI water, if the sample cell was stored filled with DI water. If the sample cell has never been used, clean it thoroughly before use. A procedure for cleaning and maintaining sample cells is described in **Cleaning and Maintenance of Turbidity Sample Cells and Caps** section.
2. Starting with the 0 NTU primary standard solution, slowly and gently invert the bottle five times. Never shake or agitate the solution, since air bubbles can be incorporated and lead to high bias of the measurement.
3. Rinse the clean sample cell by placing 3 to 4 mL of the primary calibration standard into the cell and capping. Invert the cell 5 times. Uncap and dispose of the rinsate.
4. Repeat the rinsing step and dispose of the rinsate.
5. Fill the vial with primary standard solution to the fill line or above, and cap the cell.
6. Clean the exterior of the sample cell by using a lint-free wiper to remove all traces of liquid, dirt, or fingerprints. Remove stubborn smudges with alcohol or a non-abrasive glass cleaner.



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7. Optional: Cells may be coated on the outside with a thin layer of silicon oil to minimize imperfections and slight scratches that could cause light to scatter off the surface of the sample cell. Spread a thin layer of silicon oil onto the cell and wipe off excess with a soft lint-free cloth or wiper. The cell should appear to be nearly dry with little or no visible oil.
 8. Once the cell exterior is clean, handle the cell by the cap to avoid leaving fingerprints.
 9. Initiate the calibration procedure for the measuring mode of interest. See the AQ4500 Turbidimeter user guide for details on calibration.
 10. When the meter prompts for the standard, place the cell into the AQ4500 and place the cap over the sample well. Press the "yes" key to calibrate on the standard. Note: Use the 0 NTU standard when the meter prompts "H2O".
 11. When the calibration of that standard is done, the meter will prompt for the next standard.
 12. Remove the sample cell and discard the standard solution. Rinse the vial several times with DI water.
 13. Repeat the rinsing, filling, and calibration steps (steps b through h) with the 1, 10, 100 and 1000 NTU primary standard solutions until the calibration is complete. Note: For best accuracy and low-level (<5 NTU) turbidity measurements, use the same cell for all standards. For sample measurements, use the same cell used for calibration or a matched cell.
 14. After completing the calibration, immediately rinse the sample cell multiple times with DI water to remove all traces of the standard. Wash sample cells with laboratory soap, if necessary, and rinse thoroughly with DI water. It is recommended that sample cells be stored filled with DI water and capped.
- the range of interest. All five solutions may be used if covering the whole range is desired.
- c. Slowly and gently invert the bottle of primary standard five times. Never shake or agitate the solution, since air bubbles can be incorporated and lead to high bias of the measurement.
 - d. Fill each cell with one of the five primary standard solutions, 0, 1, 10, 100, and 1000 NTU respectively, rinsing each cell twice with small portions (3 to 4 mL) of the standard before filling and capping.
 - e. Clean the exterior of the cell as described previously. Silicone oil may be applied if desired.
 - f. Once the cell exterior is clean, handle the cell by the cap to avoid leaving fingerprints.
 - g. The secondary calibration standards are ready for standardization.
 - h. Directly after calibrating the AQ4500 meter with primary calibration standards, read and record the values of the secondary calibration standards prepared above. These are the values (within acceptance limits) that the AQ4500 meter should read when performing the calibration verification/IPC.
2. All secondary standards change with time. Deterioration can be detected by measuring the turbidity of the secondary standards after calibrating the AQ4500 meter with primary calibration standards. Not all secondary standards have to be discarded when comparison with a primary standard shows that their turbidity value has changed. In some cases, e.g., a small change, the secondary standard can simply be relabeled with the new turbidity value.

Calibration Verification/IPC

Preparation of Secondary Calibration Standards for Calibration Verification

Note: The term Instrument Performance Check (IPC) is also used interchangeably with the term calibration verification and the term calibration check.

1. For convenience, a set of secondary calibration standards may be prepared and standardized for use as calibration verification/IPC between primary calibrations.
 - a. Select up to five clean sample cells - free from scratches, smudges, scuff marks.
 - b. Decide which standard solutions are desired for the calibration verification checks, depending on

1. Verify calibration and instrument performance with one or more calibration verification standards/IPC. The frequency and acceptance limits will be determined by the method reference that the user is following; e.g., EPA, Standard Methods, ISO, ASTM, USGS, etc. In general, verify instrument performance within the range of interest, and run calibration verification checks prior to and after any sample determinations.
2. For convenience, use the secondary calibration standard(s), **Preparation of Secondary Calibration Standards for Calibration Verification** section, for calibration verification/IPC.

3. Slowly and gently invert the secondary standard cells five times. Never shake or agitate the solution, since air bubbles can be incorporated and lead to high bias of the measurement.
4. Clean the exterior of the cell as described previously. Silicone oil may be applied if desired.
5. Once the cell exterior is clean, handle the cell by the cap to avoid leaving fingerprints.
6. Insert the secondary standard into the AQ4500 and place the cover over the sample well. Press "measure".
7. Record the reading and compare to the values determined from the preparation of secondary standards, **Preparation of Secondary Calibration Standards for Calibration Verification** section.
8. If the reading of the secondary standard falls within the desired acceptance limits, proceed with sample analysis.
9. If the reading of the secondary standard does not fall within the desired acceptance limits, take corrective action as suggested below.
10. Suggested corrective actions if the reading is too high:
 - a. Wait 30 seconds and press "measure" again. High bias can occur due to tiny aggregates or foreign particles floating through the light beam.
 - b. Remove the cell from the meter and inspect for smudges, dirt, or fingerprints. Clean the exterior as described previously. Silicone oil may be applied if desired. Reinsert the cell and press "measure" again.
 - c. To remove possible air bubbles, sonicate the cell for no more than 1 to 2 seconds
11. Suggested corrective actions if the reading(s) are too low:
 - a. Remove the cell from the meter and inspect for smudges, dirt, or fingerprints. Clean the exterior as noted above in the primary calibration section. Silicone oil may be applied if desired. Reinsert the cell and press "measure" again.
 - b. Remove the cell from the meter and invert slowly and gently five times to ensure that the standard solution is uniformly suspended. Do not shake or agitate the standard solution. Reinsert the cell and press "measure" again.
12. If suggested corrective actions above are not successful, prepare a fresh secondary standard as follows:
 - a. Pour the standard solution out of the cell and dispose of properly.
 - b. Wash the cell as described in the section below on cleaning sample cells.
 - c. Slowly and gently invert the bottle of primary standard five times. Never shake or agitate the solution, since air bubbles can be incorporated and lead to high bias of the measurement.
 - d. Fill the cell with the primary standard solution, rinsing twice with small portions (3 to 4 mL) of the standard before filling and capping.
 - e. Clean the exterior of the cell as described previously. Silicone oil may be applied if desired.
 - f. Insert the cell into the AQ4500 and press "measure" for the new reading.
13. If suggested corrective actions above are not successful, it will be necessary to perform a new calibration of the AQ4500. See instructions above for performing a calibration of the AQ4500 with primary calibration standards.

Cleaning and Maintenance of Turbidity Sample Cells and Caps

Sample cells and caps must be kept scrupulously clean both inside and outside. This level of cleanliness must be established prior to cell matching process and maintained throughout the cell's working lifetime. For best accuracy and when routinely measuring turbidity values of < 5 NTU, it may be desirable to use a more rigorous cleaning and maintenance procedure, such as the one described in ASTM Method D6855-03.

1. Cleaning:
 - a. Clean sample cells by thorough washing with laboratory soap inside and out. Follow by multiple rinses with distilled or deionized water.
 - b. If stronger cleaning measures are required, rinse the cell and the cap three times with 1:4 hydrochloric acid. Follow by multiple rinses with distilled or deionized water. Use care – acid can remove or smear the white markings.
 - c. Fill cell with DI water and cap.
 - d. Clean the exterior of the sample cell using a lint-free wiper to remove all traces of liquid, dirt, or fingerprints. Remove stubborn smudges with alcohol or a non-abrasive glass cleaner.
 - e. Store cells filled with DI water.

2. Maintenance:

- a. Before using cells, inspect and discard any cells that are damaged, deeply scratched or no longer give the readings required for a matched set. See **Creating a Set of Matched Sample Cells** section, for creating matched sample cell sets.
- b. After using sample cell, pour the sample or standard out and rinse the cell several times with distilled or deionized water. Do not let the sample or standard sit for extended periods in the cell, since the cell can become contaminated.
- c. If necessary, clean the sample cell as described in the cleaning section above to remove all traces of the sample or standard solution.
- d. Store cells filled with DI water.

Creating a Set of Matched Sample Cells

Ideally, the one single sample cell should be used for every primary calibration standard and sample (unknown) reading. If this is not possible, then sample cells should be matched. This is especially important when routinely measuring samples with turbidity values of < 5 NTU and when best accuracy is desired.

1. Clean sample cells can be matched by first filling with turbidity-free water.
2. Allow the sample cell to stand for 5 to 10 minutes to allow for bubbles to vacate the cell. Alternately, sonicate the cell for no more than 1 to 2 seconds.
3. Use a lint-free wiper to remove all traces of liquid, dirt, or fingerprints from the exterior. Remove stubborn smudges with alcohol or a non-abrasive glass cleaner.
4. Optional: Cells may be coated on the outside with a thin layer of silicon oil to minimize imperfections and slight scratches that could

cause light to scatter off the surface of the sample cell. Spread a thin layer of silicon oil onto the cell and wipe off excess with a soft lint-free cloth or wiper. The cell should appear to be nearly dry with little or no visible oil.

5. Once the cell exterior is clean, handle the cell by the cap to avoid leaving fingerprints.
6. Measure each cell. Cells in a matched set should read no different than 0.01 NTU apart.
7. Continue with the evaluation of the cells until sufficient cells are obtained that meet the 0.01 NTU criteria and fulfill the analytical needs of the user.
8. The cells passing the evaluation criteria now can be used for sample analysis.
9. Sample cells must be evaluated frequently (weekly evaluations are recommended) or before use to determine if they remain matched.

References

1. EPA Method 180.1, Determination of Turbidity by Nephelometry, Revision 2.0, August 1993, Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.
2. Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, EPA 815-R-99-010, April 1999.
3. Standard Methods for the Examination of Water and Wastewater, 2130B, 20th edition.
4. American Society for Testing and Materials (ASTM) Method D6855-03, Standard Test Method for Determination of Turbidity Below 5 NTU in Static Mode.
5. ASTM Method D1889-00, Standard Test Method for Turbidity of Water.

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Appendix C

Turbidity QUICK GUIDE

AQUAfast AQ4500 TURBIDIMETER

MassDEP Watershed Planning Program

Equipment needed: Turbidimeter, clean, unscratched vials(s), Kim-wipes, worksheet, disposable gloves, DI water.

Sample Holding Time: 48 hours from collection.

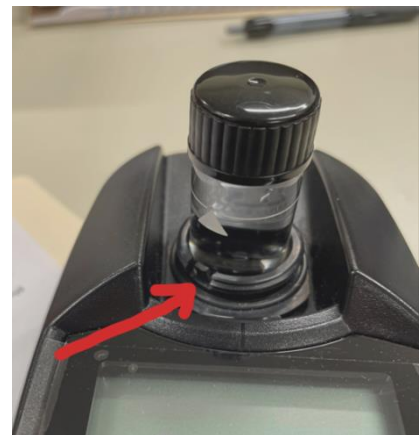
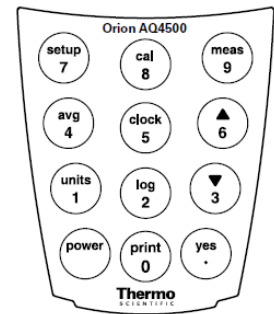
Measurement Range: 0-1000 NTUs (i.e., calibration range)

SETUP:

20. Retrieve samples and allow to come to room temperature; transfer sample custody by signing the Chain of Custody.
21. Record sample information the Turbidity printed worksheet (large binder): OWMID, lab numbers, date/time collected. Add lab numbers for a lab blank (LB) and lab duplicate (LD) and record the OWMID of the sample being used as a duplicate.
22. Set up the electronic workbook: Save a copy (“save as”) of the Color Turbidity Workbook Template from OneDrive (check with Field & Lab Operations Coordinator for current folder) with the new batch number as the file name. Check the Turbidity binder for the next batch number. Turbidity batch numbers are designated “TCyy-xx” with yy = year and xx = batch number. (E.g., TC23-01)
23. Turn on Turbidimeter and check battery condition. If low (<20%), replace batteries (4 AA batteries).
24. Check the measurement mode = EPA 180.1 (if not, change using SETUP key. See Field and Laboratory Operations Coordinator.)
25. Lab QC for each batch: Run lab blank (DI water) first, and one lab duplicate (select one of the field samples to run a second time) per batch or one per every ten samples for larger batches.

MEASUREMENTS:

26. Use gloves. NEVER TOUCH (OR SCRATCH!) THE VIALS WITH BARE HANDS! ALWAYS USE KIM WIPES.
27. Run the lab blank (DI water) first following Steps 9-14 (below). The blank should be ≤ 0.02 NTU. If the blank is > 0.02 NTU, check that the vial is clean (or switch vials), and retest before continuing measurements for the regular samples. If the problem persists, talk with the Field and Laboratory Operations Coordinator.
28. **Rinse** the turbidity vial: 2 rinses DI water and one rinse with the sample.
29. **Mix** the field sample gently but thoroughly to disperse the solids immediately before pouring.
30. **Pour** the sample into the vial up to the fill-line and recap. Wait until all bubble disappear.
31. **Wipe** the vial clean with Kimwipes. Place the vial in the measurement sample chamber, lining the triangle on the vial with the notch (red arrow in picture). And cover the sample well with the well cap.
32. **Take the reading:** press the “avg” (4) key to activate the averaging feature, press “meas” (9) to take the measurement. (Averaging will stay active until you press the “avg” key again.)



33. **Record** the reading on the worksheet.
34. Repeat Steps 8-13 to analyse all samples.
35. After last sample, review lab sheet to ensure that all sample and analysis information has been recorded.
36. When done, turn unit off and clean up work area.
37. Enter raw results and related information into the electronic Turbidity worksheet. The e-lab sheet will automatically incorporate any dilution factors and will apply rounding rules and significant figures for the final result.
38. Once the final values are calculated, transfer final e-results back to the paper raw lab sheet. Save the manual lab sheet (bench sheet) in the lab binder for turbidity.

Reminders:

- 1) Keep vial cover in place at all times to prevent water/dust from contaminating optical well.
- 2) When aliquoting samples into measurement vial, always shake/swirl sample thoroughly in original bottle to ensure complete mixing of the sample prior to pouring sub-sample into vial.
- 3) When reading samples, always align white triangle with tab.
- 4) Keep vials CLEAN and UNSCRATCHED. Wash with soft cloth and detergent periodically.
- 5) Follow minimum rinse protocols at all times: 2/1/1
 - a. Rinse with DIW (2X)
 - b. Rinse with standard/sample (cap and swirl vial) (1X)
 - c. Pour standard/sample into vial (1X)

Calibration Check: MONTHLY/QUARTERLY (See Field and Laboratory Operations Coordinator)

1. Insert the CAL 1 standard (DI water blank) into sample chamber and put the cover on.
2. Select the measurement mode.
3. Press the MEAS (#9 key). Wait 5-10 seconds for internally-averaged result.
4. The meter will display the results. Record the reading.
5. Repeat the calibration check for CAL 2, CAL 3, CAL 4 and CAL 5 calibration standards.
6. If the displayed results are within 10% of the nominal NTU value of the standard or the precision criteria required by your method, the calibration check passed and the meter is now ready for measurement.

Calibrate: EVERY SIX MONTHS AND/OR AS NEEDED (Refer to SOP: CN 95.2 SOP Analysis for Turbidity for directions).

Reference Methods: 1) Standard Methods 2130 B, EPA 180.1; 2) AQ4500 Operating Manual