TOTAL DISSOLVED SOLIDS

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1. SCOPE AND APPLICATION

1.1. Total dissolved solids (TDS) is defined as the portion of solids that passes through a filter of 2.0 microns nominal pore size. This method is applicable to drinking, surface, and saline waters. The practical range of determination is from the method detection limit (MDL) 15 mg/L to 20,000 mg/L. For very high salinity samples the range can be extended by adjusting the sample volume according to the table in section 6.10. The practical quantitation limit (PQL) is determined by the concentration at which 2.5 mg of residue remain in the crucible as required by the method. For a sample volume of 100 mL, this is 25 mg/L.

1.2. The test covered by this SOP is W-TDS.

2. SUMMARY OF THE METHOD

2.1. This method is based on Standard Methods 2540 C-2015.

2.2. A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is then poured into a pre-weighed evaporating dish and evaporated to constant weight at 180 °C. The evaporating dish is then cooled in a desiccator, weighed and the results used to calculate the TDS of the sample.

Note: The suspended matter left behind on the filter may be used for a total suspended solids (TSS) determination. See DEP SOP NU-051.

2.3. Interferences – highly mineralized waters containing significant concentrations of calcium, magnesium, chloride and/or sulfate may be hygroscopic and will require prolonged drying, desiccation and rapid weighing. Samples containing high concentrations of bicarbonate will require careful and possibly prolonged drying at 180 °C to ensure that all the bicarbonate is converted to carbonate. Too much residue in the evaporating dish will crust over and entrap water that will not be driven off during drying. Total residue should be limited to about 200 mg.

3. EQUIPMENT AND SUPPLIES

3.1. Instrumentation

Component	Manufacturer	Model
Analytical Balance	Mettler Toledo	XP204
Analytical Balance	Mettler Toledo	XPE204

3.2. Equipment

Equipment	Manufacturer/Vendor[1]	Model/Catalog Number
Oven	Fisher Scientific	IsoTemp Oven 13-247-650G
Oven	Thermo Scientific	Lindberg/Blue M LB305760M, and Heratherm Oven OMH180
Digital Thermometer	Fisher Scientific Traceable	Platinum High Accuracy, and 15-081-108
Desiccator	Fisher Scientific	
Assorted Graduated Cylinders, Class A	Fisher Scientific (SR)	08-564A, 08-548D, 08-553A, 08-548B
Volumetric Flask	Fisher Scientific (SR)	10-212-5L

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Dish Tongs		
1 L Filter Flask	Fisher Scientific (SR)	10-180F
Magnetic filter holder and funnel, 300 mL	Fisher Scientific	NC-0006472
Vacuum Pump	Welch	25468
Forceps		
Conductivity Meter	Oakton	54X002608C
Evaporation Dishes	CoorsTek(SR)	08-690L, 60200
Or Equivalent		
[1]Note: (SR) designates equipment is typically ordered through the in-house stockroom		

3.3. Supplies/Consumables

Supplies/Consumables	Vendor[1]	Catalog Number
Filter, Glass Fiber, Proweigh	Fisher Scientific (SR)	09-735-56
Filter, Glass Fiberm G-6, 5.5 cm	Fisher Scientific (SR)	09-804-55A
Beaker, Polystyrene, 50 mL	Fisher Scientific (SR)	08-732-122
Pipette, Transfer, Polyethylene, 5 mL	Fisher Scientific (SR)	13-711-5AM
Or Equivalent		
[1]Note: (SR) designates supply is typically ordered through the in-house stockroom		

4. REAGENTS AND STANDARDS (SEE DEP SOPS NU-041 and NU-042)

Note: Before preparing reagents or standards, or running samples, please read the safety notes in the Safety/Hazardous Waste Management section of this SOP and the MSDS for the chemicals used in this analysis.

Note: Standard preparations must be documented in the Laboratory Information Management System (LIMS) 'Standard Preparation Tracker' module. Unique ID numbers for each standard are generated in the module and documented in the TDS excel worksheet submitted with each analysis folder. A Certificate of Analysis for each purchased standard is maintained in REAGENT_PREP folder for TDS, TSS, and TS on the Nutrients drive at \\FLDEP1\DEAR\Labs\Lab3\Chem_Data\Inorganic\Nutrients\. All containers holding standards must be labeled with their unique ID and expiration date.

4.1. Chemicals

	Chemical	Alias	Manufacturer[1]	Catalog Number	Purity	Expiration	Storage
4.1.1.	Deionized (DI) Water	H_2O	In house	N/A	N/A	Daily	N/A
4.1.2.	Drierite, 10-20 Mesh, White	$CaSO_4$, Desiccant	W. A. Hammond DRIERITE Co. LTD (SR)	14005/07-577-4B	>99.5% $CaSO_4$	N/A	Room Temp
4.1.3.	Drierite, 8 Mesh, Blue	$CaSO_4$ and $CoCl_2$, Desiccant	W. A. Hammond DRIERITE Co. LTD (SR)	23005/S6 92-212	≥98% $CaSO_4$, <2% $CoCl_2$	N/A	Room Temp
4.1.4.	WatR™ Pollution Solids Concentrate	LFB, ALTQC	Environmental Resource Associates	4032	See CoA	See CoA	Room Temp
4.1.5.	Nitric Acid	HNO_3	Fisher Chemical	A509-P212	67-70%	See CoA	Room Temp, Acid Cabinet
Or Equivalent							
[1]Note: (SR) designates chemical is typically ordered through the in-house stockroom							

4.2. Desiccant -

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4.2.1. A mixture of approximately 10 % blue desiccant (4.1.3.) and 90 % white desiccant (4.1.2.) should be placed in the desiccator(s) used to store filters and dishes.

4.2.2. The blue desiccant changes color to indicate water absorption. Once the desiccant has turned from blue to pink, heat the desiccant in a 180 °C oven for one hour, let cool and reuse. Desiccant may be regenerated 3 times before replacing with new desiccant. The old desiccant can be discarded in the trash.

4.3. Nitric Acid Solution –

Nitric Acid (4.1.5.)	100 mL
DI Water (4.1.1.)	~4 gallons

Fill up a designated container with approximately four gallons of DI water and add 100 mL of nitric acid to make an acid bath.

Used for cleaning evaporating dishes only.

4.4. LFB/ALTQC –

WatR Pollution Solids Concentrate (4.1.4.)	See ERA's Instructions
DI Water (4.1.1.)	See ERA's Instructions

The LFB/ALTQC is prepared using a purchased certified quality control sample. See the certificate of analysis for the preparation instructions, concentration, and expiration date of the purchased standard.

Holding time, 180 days.

Note: Since the concentration of the purchased certified quality control sample (4.1.4.) may vary, the LFB/ALTQC standard concentration may change. To prevent confusion, the following naming convention of the LFB/ALTQC standard should be followed: LFB/ALTQCx, with x being a number, starting with 1, increasing with each new lot number of quality control sample received.

5. SAMPLE HANDLING AND PRESERVATION

5.1. Samples are stored on ice or in a refrigerator at ≤ 6 °C (not frozen) in order to minimize microbiological decomposition of solids.

5.2. Non-representative particulates such as leaves, sticks, fish and lumps of fecal matter should be excluded from the sample if it is determined that their inclusion is not desired in the final result.

5.3. Samples are stored in the Nutrient refrigerator in the receiving room of the DEP laboratory. Allow samples to come to room temperature before processing.

5.4. Samples should be analyzed within seven days of collection. Samples analyzed after this seven-day holding time must be reported with a test comment describing the nature of the delay as well as the appropriate qualifying code, Q.

6. SAMPLE ANALYSIS/QUANTITATION (SEE DEP SOP NU-033)

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Note: Be sure to record all of the necessary information neatly and correctly on the TDS Excel worksheet (NU-TDS). The worksheet is located at \\FLDEP1\DEAR\Labs\Lab3\Chem_Data\Inorganic\Nutrients\Solids\

Make sure to always use the latest version of the worksheet. The TDS results are automatically calculated on the worksheet.

Important: The worksheet contains functional formatting to indicate unacceptable results – do not copy/paste or "click and drag" any information in the worksheet.

Note: Do not handle the dishes with your hands. Always use tongs when handling the dishes.

Note: All ovens are kept at a constant temperature. The minimum and maximum (MIN/MAX) oven temperatures are recorded for each drying cycle of the analysis on the Oven Temperature Log Sheet (NU-OVENTEMPLOG). The log sheet is located at \\FLDEP1\DEAR\Labs\Lab3\Chem_Data\Inorganic\Nutrients\Solids\.

To use the MIN/MAX function on the digital thermometer, see the manufacturer directions located on the door of each oven. Record the START time of the drying cycle as the time when the oven has reached its set temperature, and the MIN/MAX function on the thermometer has been activated. After the MIN/MAX settings have been checked and recorded to verify the oven was in compliance, record the STOP time for the drying cycle as the time when samples are removed from the oven. If an oven temperature is found to be out of compliance, an explanation and corrective action is recorded on the log sheet, and another drying cycle is monitored. The oven temperature log sheet is submitted with each analytical folder. Make sure that whenever samples are in the oven at least one temperature reading is recorded every day or the Min/Max temperature is recorded over an extended period of time. If samples are in the oven over the weekend the MIN/MAX temperature is recorded as well.

6.1. If using a programmable oven, set the oven at its correct temperature to initiate its temperature ramp (initial temperature for 95 °C and a ramp to 180 °C). If not using a programmable oven, set one laboratory oven at a temperature of 95 °C and a second at 180 °C. It will take about 1 hour for the ovens to reach their set temperatures.

6.2. To clean the evaporating dishes for use, wash the evaporating dishes 5-6 times with hot tap water and then rinse 2 times with DI water. Place the evaporating dishes into the container containing the nitric acid solution (4.3.). Allow the evaporating dishes to soak at least overnight. Remove the evaporating dishes and scrub with a cleaning pad to remove all residue from previous use. Rinse at least 5 times with DI water.

6.3. If the dish number is fading, re-write the number using a permanent marker. If the dish number is not clear, assign a new number to the dish.

6.4. Place the dishes in a 180 °C oven for at least 4 hours to dry and remove any trapped water in the porcelain. You can dry overnight if it is convenient.

6.5. Remove the dishes from the oven with dish tongs and place the dishes in desiccators to cool. Clean dishes are stored in the desiccators until they are needed. If clean dishes are needed immediately, then allow them to cool for at

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least 2 hours prior to weighing. More time will be needed if there are a large number of hot dishes in the desiccators. Do not weigh any dish that is still hot.

6.6. Check the calibration of the analytical balance using the certified weights in the laboratory and document the work in the balance maintenance logbook. If the balance passes the calibration check, continue with the operation. If not, recalibrate the balance with the certified weights following the manufacturer's instructions and recheck the calibration. Record your actions in the balance maintenance logbook. If after the first calibration attempt the balance does not seem to function properly, inform your supervisor immediately and record your observation in the balance maintenance logbook. Do not use this balance until the calibration problem has been corrected.

Note: The calibration of the analytical balance will need to be checked each day the balance is used, prior to use.

6.7. After verifying the calibration of the balance, open desiccators, remove the first clean dish to be weighed (using tongs) and close the desiccator door immediately. Place the dish on the analytical balance and close the balance door. Allow the balance to stabilize before taking a reading. This is the initial or TARE weight of the first dish. Repeat this process for each dish that is needed.

6.8. Check to see if your samples require TSS. If the TSS test is requested, then the filtrate from the TSS test can be used for TDS providing you follow the modification stated here. Please familiarize yourself with DEP SOP NU-051 prior to combining these tests.

An example run sequence includes:

- MBLK (DI water, 4.1.1.)
- LFB/ALTQC (4.4.)
- Batched samples, with one sample duplicate per batch of up to 20 samples.
- Blank (DI water, 4.1.1.)

6.9. Assemble the vacuum filtration flask by attaching the filtration flask to the filter holder. Connect the flask to the vacuum.

6.9.1. TDS ONLY – Place a glass fiber filter onto the filter holder. Turn on vacuum and rinse the filter with three aliquots of DI water (at least 20 mL each). This is to remove any water-soluble impurities that may reside on the glass filters and bias the TDS residue high. Turn off vacuum, disconnect flask and discard the rinse water. Dry the flask by shaking out as much of the water as possible and reattach to filter assembly.

6.9.2. FOR TSS/TDS – For samples above 15000 µmhos/cm, refer to section 6.3. of DEP SOP NU-051. For samples below 15000 µmhos/cm, place a ProWeigh brand filter (see 3.3.) onto the filter holder and attach the membrane filter funnel over the filter. Thoroughly wet the filter with DI water and apply vacuum. When all water has passed through the filter, turn off the vacuum, remove the filter flask, pour out the rinse water, and re-attach the flask. Make sure the interior of the flask is as dry as possible.

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6.9.3. FOR TSS/TDS – Turn on the vacuum. Vigorously invert the sample and rapidly transfer 250 mL of sample to a graduated cylinder. Pour the contents of the cylinder onto the filter and collect the filtrate in the flask. DO NOT rinse the graduated cylinder at this stage.

Note: If it is not possible to filter the amount of sample required for TDS (see Table 1 below) or 250 ml for TSS due to particulate matter, determine the sample volume you are able to filter and start over at step 6.9.1 through 6.9.3.

6.10. If the field conductivity of the sample is greater than about 3000 µmhos/cm, there may be too much residue in the dish for the TDS measurement. The method recommends that the total residue should not exceed 200 mg. If there is more than 200 mg, it may be difficult to dry to a constant weight (especially if it is a saltwater). Samples >1000-3000 µmhos/cm may also have difficulty drying to constant weight due to high interferences, as listed in section 2.3. Using the table below, determine how much sample volume you will need to perform TDS. For volumes of 25 mL and above, use a graduated cylinder. For volumes of 10 mL and below, use a pipette.

If the field conductivity (µmhos/cm) is:	Measure out this amount for TDS:
0 – 1,000	100 mL
>1,000 – 5,000	50 mL
>5,000 – 10,000	25 mL
>10,000 – 18,000	10 mL
>18,000 – 25,000	5 mL
>25,000 – 30,000	3 mL
>30,000	2 mL

6.11. FOR TDS ONLY – Turn on the vacuum. Vigorously invert the sample and rapidly but ACCURATELY transfer a volume of sample according to the table in 6.10. onto the filter and collect the filtrate in the flask. You may rinse the cylinder (if used) with a few squirts of DI water and pour those onto the filter. Do not add too much water.

6.12. FOR TDS ONLY – After the sample has passed through the filter, continue to apply the vacuum for approximately 30 seconds to remove as much water as possible from the glass filter. Pour the contents of the filter flask into a drying dish. You may rinse the flask with a few squirts of DI water.

6.13. FOR TSS/TDS – Turn off the vacuum and remove the flask. Transfer the recommended amount of filtrate into a drying dish (see the table in 6.10.).

6.14. FOR TSS/TDS – Re-attach the flask and turn on the vacuum. Rinse the cylinder with enough DI water to remove any remains of the sample. Then, rinse the filter with DI water (approx. 3 × 30 mL) to remove any sample that remains on the filter and on the sides of the filtering apparatus. (See DEP SOP NU-051 for details on rinse procedure for high conductivity samples).

6.15. FOR TSS/TDS – Continue to apply the vacuum until no more liquid drips into the flask. This may take up to three minutes depending on the matrix of the sample.

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Discard the filtrate and remove the filter for TSS analysis (See DEP SOP NU-051 for details).

6.16. Carefully place the dishes in a 95 °C oven to allow the sample to evaporate to dryness. This takes approximately 18 hours. DO NOT spill ANY sample. If any sample is lost, you will need to discard the sample and filter a new aliquot.

6.17. After the sample has evaporated (about 18 hours), transfer the dishes from the 95 °C oven to the 180 °C. Dry the dish for at least 1 hour at 180 ± 2 ºC. See the **Note** above regarding documentation of drying cycles on the Oven Temperature Log Sheet.

6.18. Check the desiccant in the desiccators for blue color. Regenerate or change the desiccant if it is pink. See Section 4.2. for details.

6.19. Remove the dishes from the oven and place in the desiccators to cool for at least 2 hours. DO NOT weigh any dishes that are still hot. You may leave dishes in the desiccators overnight.

6.20. Weigh the cooled dishes using the same analytical balance that was used to tare the dishes. Record the weight on the TDS worksheet under Crucible and Residue Weight (g): 1st.

6.21. Return the dishes to the 180 ± 2 °C oven for at least 1 hour to repeat drying cycle. Return the dishes to the desiccators and cool.

6.22. Weigh the cooled dishes again and record this second weight on the TDS worksheet under Crucible and Residue Weight (g): 2nd. If the two weights have a difference of less than 0.5 mg, no more drying/weighing cycles are required. If not, return to the drying oven for a third time and repeat the weighing process. Record third weight on the TDS worksheet under Crucible and Residue Weight (g): 3rd. Continue the drying/weighing cycles recording the weight in the appropriate cell in the TDS worksheet until the last two weights differ by less than 0.5 mg. Do not perform more than six weighings. Samples with large amounts of calcium sulfate or salts are very difficult to dry and may require data qualifiers.

6.23. The TDS is calculated using the following equation:

$$\text{TDS (mg/L)} = \frac{\{[\text{final wt. of dried residue + dish (g)}] - [\text{wt. of dish (g)}]\} \times 1000000}{\text{Volume of sample (mL)}}$$

6.24. Save the TDS Excel file as a text file (.txt) and use the GenChem: TSS-TDS Balance–XPE2042 driver or the GenChem: TSS-TDS Balance-XP204 driver to convert the text file into QC Manager. Check that the number of significant figures has been set correctly.

6.25. Place the completed TDS worksheets along with the standard sheet in a folder labeled YYMMD**XE**D (for the Mettler Toledo XPE204-2 balance) or YYMMDD**X**D (for the Mettler Toledo XP204 balance), where YY is the year, MM is the month, DD is the day of the analyses, XE or X identifies the balance, and D indicates a TDS analysis. Initial the folder and hand to a supervisor for review.

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7. DATA ARCHIVAL/VALIDATION

7.1. The raw data is archived in paper format. A report folder is created for each analytical run. Occasionally more than one run may be in one folder. The folder is labeled with the test (W-TDS), filename(s), and initials of the analyst.

7.2. Each report folder should contain the following items - the TDS excel worksheet, bench sheet(s), the oven temperature log sheet, the backlog containing the batching documentation, and a copy of the data and QC assessments uploaded from QC Manager to LIMS at the time of test authorization. If a pipette was used during the run, include the pipette form (NU-PIPETTE).

7.3. The report folders are on file with the nutrients and general chemistry supervisory personnel. Periodically, the files are moved to the State Records Center for long time storage according to DEP SOP LB-006.

7.4. Excel transfer files for upload to QC manager are stored in electronic format in the current year's subfolder located at \\FLDEP1\DEAR\Labs\Lab3\Chem_Data\Inorganic\Nutrients\Solids\.

7.5. Method validation data is on file with the supervisor. Digital copy is also stored on the network, under an appropriate sub-folder in \\FLDEP1\DEAR\Labs\Lab5\Chemistry\Inorganic\Nutrient\Validations.

8. QUALITY CONTROL/DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES (SEE DEP SOPS NU-038 AND NU-043)

8.1. An MBLK (analyzed at the beginning of every batch of twenty samples or less) and the final blank on the run must be < 15 and > -15 mg/L. If the result is outside of this range, the blank and all associated samples may be rerun until the blank passes or the results may be qualified with an appropriate code and comment (refer to DEP SOP NU-043, Section 4.2.1.).

8.2. One set of sample duplicates per batch of twenty samples or less. If the sample result is above the PQL (25 mg/L), the relative percent difference (RPD) must be less than 10% to report the result without qualification. If the replicate sample result is below the PQL, no precision data is uploaded and an appropriate test comment is added to all samples in the batch.

8.3. An LFB/ALTQC (4.4) is run at the beginning of every batch of twenty samples or less. The recovery for the LFB/ALTQC must be within the manufacturer's certified limit but not exceed 85 to 115%.

8.4. Sample results obtained based on a residue exceeding 200 mg must be confirmed using a smaller sample volume or qualified appropriately. It is recommended to pour an aliquot for confirmation as soon as the first weight indicates that the residue may exceed the limit.

8.5. For general method performance and acceptance criteria for QC measures and corrective action for out-of-control data and contingencies for handling out-of-control or unacceptable data, refer to DEP SOP NU-038 and DEP SOP NU-043.

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8.6. For general calculations, including RPD, see Section 5.9 of the FDEP Quality Manual.

9. SAFETY/HAZARDOUS WASTE MANAGEMENT

9.1. Safety glasses, gloves and lab coats should be worn at all times whilst handling samples. Excess samples may be flushed down the sink.

9.2. Review the Laboratory Health and Safety Plan (accessible at https://floridadep.sharepoint.com/dear/SitePages/Lab Health and Safety.aspx).

10. REFERENCES/DEFINITIONS

For definitions see section 3 of the FDEP Quality Manual. All abbreviations used throughout the document are defined at least once in the document usually at the first time of use.

10.1. Standard Methods Online, 2540C-2015.

10.2. DEP SOP NU-033, Summary of Sample Analysis Procedures for the General Chemistry and Nutrients Workgroups.

10.3. DEP SOP NU-038, Nutrients and General Chemistry: Quality Assurance and Quality Control.

10.4. DEP SOP NU-041, Reagent Preparation Procedure.

10.5. DEP SOP NU-042, Standard Preparation Procedure.

10.6. DEP SOP NU-043, Nutrients and General Chemistry Quality Assurance and Data Authorization Guidelines.

10.7. DEP SOP NU-051, Total Suspended Solids.

10.8. Oven Manuals.

10.9. Quality Manual, Bureau of Laboratories, FDEP.

10.10. Laboratory Health and Safety Plan.

10.11. DEP SOP LB-006, Standard operating procedure for records maintenance and storage.

10.12. DEP SOP CM-011, Gravimetric Analysis: Analytical Weight and Balance Calibration.

Appendix of Significant Changes

03/07/2008 Batches changed from 20 samples to ten. Acceptance limits for duplicates changed to 20% from 10%.

06/03/2008 Reference method changed from 160.1 to SM 2540 C.

05/19/2011 The Practical Quantitation Limit (PQL) was changed from 60 mg/L to 25 mg/L. See Section 1 for details.

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05/09/2012 Section 6 was edited to include modifications to the TSS analysis procedure put into practice on 05/21/2012.

05/07/2013 Section 4.4 was edited to correct the holding time of the ALTQC. Section 6.9.3 was further clarified. Section 7.2 was edited to correct the RPD control limit.

04/16/2015 Data archival information was clarified in section 7. Oven temperature recording procedure was modified in section 6.

05/16/2018 Table 1, section 6.10 was modified. Use 50 mL of sample starting at a conductivity above 1000 µmhos/cm. Appendix A and B were removed. The relevant forms are referenced in the section 6.

11/23/2021 Added tables for instrumentation, equipment, supplies/consumables, and chemicals.

10/03/2022 Updated reference method from SM 2540 C 2011 to SM 2540 C 2015. Changed batch size from ten to 20 samples. Introduced LFB/AltQC for every batch and added LFB acceptance limits. Clarified evaporating dish cleaning procedure.

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