STANDARD OPERATING PROCEDURE FOR TURBIDITY MEASUREMENTS USING TURBIDITY TUBE

WILLARD SPUR 2011 MONITORING ACTIVITIES

State of Utah
Department of Environmental Quality
Division of Water Quality

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Utah Division of Water Quality (DWQ) Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical experts. The primary purpose of this document is for internal DWQ use. This SOP should not replace any official published methods.

Any reference within this document to specific equipment, manufacturers, or supplies is only for descriptive purposes and does not constitute an endorsement of a particular product or service by the author or by DWQ. Additionally, any distribution of this SOP does not constitute an endorsement of a particular procedure or method.

Although DWQ will follow this SOP in most instances, there may be instances in which DWQ will use an alternative methodology, procedure, or process.

REVISION PAGE

Date	Revision #	Summary of Changes	Sections	Other Comments
9/102011	1	NA	NA	New SOP. Began document control/revision tracking.

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1.0 SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for performing turbidity measurements using a turbidity tube in water columns where the use of the Secchi Disk method is not practical due to excessive growth of submerged aquatic vegetation and/or shallow water conditions. This SOP applies to all Division of Water Quality field staff, non-DWQ cooperators, and citizen volunteers.

Turbidity is a measurement of how cloudy water appears. Turbidity is also a measure of how much light passes through water, and it is caused by suspended solid particles that scatter light. These particles may be microscopic plankton, stirred up sediment or organic materials, eroded soil, clay, silt, sand, mud, industrial waste, sewage, chemical precipitates or urban runoff. Therefore, turbidity is a key test of water quality, and this parameter is a key indicator used to asses the suitability of water for human consumption.

2.0 SUMMARY OF METHOD

The turbidity tube is either dipped into the water or slowly filled with water from the water source at the sampling location. The sampler has to make sure that the filled turbidity tube is taken to a shaded spot. If there is no shade around, the sampler has to use his/her body to block the sun from shining on the tube. If the water is too murky, the monitor should block the opening with his/her hand and shake the tube vigorously to re-suspend any sediment that has settled at the bottom. Next, the sampler should look down through the tube toward the black and white target disk on the bottom of the tube. If the black and white target disk is visible, the water level is recorded in centimeters (cm). If the black and white target disk is not visible, water should slowly be released from the release valve, until the target disk becomes visible. Record the water level in centimeters (cm). Convert from centimeters (cm) to turbidity units (NTU's) using Table 1 or Equation 1 provided in the Data and Records Management section.

3.0 DEFINITIONS

cm:	Centimeters
EPA:	Environmental Protection Agency
DWQ:	Utah Division of Water Quality
NTUs:	Nephelometric Turbidity Units
OSHA:	Occupational Safety and Health Administration
PFDs:	Personal Flotation Devices
QAPP:	Quality Assurance Project Plan
SAP:	Sampling and Analysis Plan

SOP: Standard Operating Procedures

4.0 HEALTH AND SAFETY WARNINGS

Prior to initiating field work, the field personnel must be briefed by the Field Lead on the project safety protocol. Field staff must have a working knowledge of the contents within this SOP and DWQ's safety guidance.

Field personnel should take appropriate precautions when operating the turbidity tube and working on, in, or around water, as well as possibly steep and unconsolidated banks. All field crews should be equipped with safety equipment such as proper wading gear, gloves, first aid kits, cellular phone, etc.

DWQ safety guidance should be followed at all times and field personnel should always wear disposable gloves during turbidity sampling to avoid contact with potentially harmful pathogens present in the water body.

Field personnel should be aware that hazardous conditions potentially exist at every waterbody. If unfavorable conditions are present at the time of sampling, the sample visit is recommended to be rescheduled. If hazardous conditions arise during sampling, such as lightning, high winds, rising water, or flash flood warning, personnel should cease sampling and move to a safe location.

When working in hazardous situations, personnel should follow EPA, OSHA, and specific health or safety procedures. All proper personal protection clothing, such as waders and PFDs (personal flotation devices), and equipment should be worn.

5.0 CAUTIONS

Field personnel should attempt to minimize disturbance of substrate covering the bottom of the water body (river, reservoir, wetland, etc) because this may stir already settled particles, which can increase the turbidity in the water column and provide higher turbidity readings than the actual values. Personnel should always work from downstream to upstream and wait for any disturbed substrate/sediment to settle or otherwise dissipate before taking a water column sample for the turbidity measurement.

Caution also needs to be taken on the proper handling of the turbidity tube. The tube needs to be placed in a safe place within a vehicle to prevent damage.

6.0 INTERFERENCES

Several factors may affect the turbidity readings. Since the eyesight of samplers may vary, all readings on the same waterbody should come from the same person. Weather conditions and site conditions such as high water runoff events, vegetation growth, and animal or human disturbances can alter and affect turbidity of the sampling locations. On the other hand, a water body may have color caused by dissolved substances or

reflections from rocks and vegetation, but it is important to remember that color itself is not turbidity. Therefore, field conditions potentially affecting the measurement should be noted on the field sheet/notebook. If conditions inhibit the ability to properly sample turbidity, this should be noted in the field notebook and the site should be revisited.

7.0 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

To ensure that credible and useable data are collected, the Project Manager/Field Lead must be knowledgeable about all aspects of the project including sampling goals and objectives and quality assurance and quality control issues specific to the project-specific Quality Assurance Project Plan (QAPP) or Sampling and Analysis Plan (SAP). The Field Lead should also check all of the work performance and verify that the work performed in the field satisfies the specific tasks that are outlined in this SOP and project-specific documents. If sampling procedures need to deviate from project-specific documents, it is the responsibility of the Field Lead to communicate this information to the field personnel.

All personnel performing turbidity sampling using a turbidity tube must read this SOP annually and acknowledge they have done so via a signature page (see **Appendix A**). New field personnel must also demonstrate successful performance of the method. The signature page will be signed by both trainee and trainer to confirm that training was successfully completed and that the new monitor is competent in carrying out this SOP. The signature page will be kept on-file at DWQ along with the official hard copy of this SOP.

8.0 EQUIPMENT AND SUPPLIES

A turbidity tube is a simple device made from 1-1.75" (4.4cm) clear polycarbonate tubing with a bottom comprised of alternating white and black quadrants (black and white target disk). On the outside, the tube is marked with easy to read black numbers on a white tape. Before use, make sure the markings are still clearly visible.

9.0 PROCEDURE

This instrument or method does not require calibration or standardization prior any use. Instructions for using the tubidity tube are adapted from WHO guidance found at http://www.who.int/water_sanitation_health/emergencies/envsanfactsheets/en/index1 (WHO, 2011)

Upon arrival to the sample site, establish which sampler is going to perform the turbidity measurements. To sample a water column using a turbidity tube, follow the steps below (see figure 1).

1) Obtain a sample of water from the water source.

2) Hold the tube in one hand near the bottom and look into the open end with your

head about 10 to 20 centimeters (cm) above the tube so that you can clearly see the black and white target disk/circle on the bottom of the tube.

3) Slowly pour the water sample into the tube, waiting for air bubbles to rise if necessary, until the black and white target disk on the bottom of the tube just disappears.

4) Stop pouring the water sample into the tube and look at the level of water in the tube. Make sure to take the readings in a shaded area. If there is no shaded area, block the sun from shinning on the tube with your body. For murky waters, block the open end with your hand and shake the tube vigorously to re-suspend any sediment that has settled at the bottom. For turbidity tubes which have turbidity scale marked on the side, read the number on the nearest line to the water level. This is the turbidity of the water. If the tube does not have a scale marked, measure the distance from the bottom of the tube to the water level with a tape measure and convert or calculate the turbidity of the water sample using either Table 1 or Equation 1 or the instructions provided with the tube. Table 1 and Equation 1 allows you convert from centimeters (cm) to turbidity units (NTU's).

5) After use, wash the tube in clean water and store the two parts of the tube where they cannot be damaged (World Health Organization, 2011).

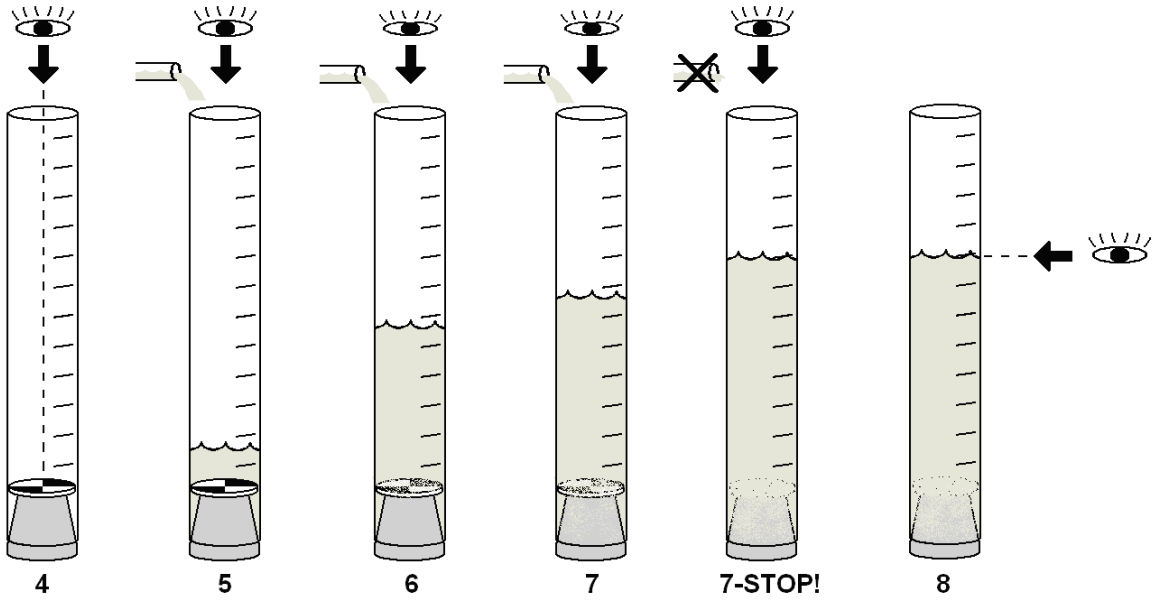

Figure 1: Schematic of turbidity measurement using a Turbidity tube (Myre and Shaw, 2006)

10.0 DATA AND RECORDS MANAGEMENT

Turbidity readings will be converted from cm to turbidity units (NTUs) using Table 1 (from Wyoming Stream Team, 2011) or Equation 1 (from Myre and Shaw, 2006). Turbidity readings will be recorded on the field notes form sheet (see **Appendix B**). Once back in the office, personnel will scan and save the field note sheets in the project folder located in the "monitors" folder on the shared drive, which is backed up daily. Hard copies of the field notes form will be filed in the project binder, which is locate din the QA Project Manager's office. These field note sheets hold important information that will be kept with the sampling trip data including weather, flow direction, water depths, secchi depth/turbidity readings, sampling time, water clarity and etc (see **Appendix B**). Data management staff will review these sheets on a biweekly basis for completeness.

Table 1: Conversion chart converting centimeters (cm) to turbidity units (NTU's). Table and equation 1 from Wyoming Stream Team, 2011.

Distance from bottom of tube (cm)	NTU's
<6.25	>240
6.25 to 7	240
7 to 8	185
8 to 9.5	150
9.5 to 10.5	120
10.5 to12	100
12 to 13.75	90
13.75 to 16.25	65
16.25 to 18.75	50
18.75 to 21.25	40
21.25 to 23.75	35
23.75 to 26.25	30
26.25 to 28.75	27
28.75 to 31.25	24
31.25 to 33.75	21
33.75 to 36.25	19
36.25 to 38.75	17
38.75 to 41.25	15
41.25 to 43.75	14
43.75 to 46.25	13
46.25 to 48.75	12
48.75 to 51.25	11
51.25 to 53.75	10
53.75 to 57.5	9
57.5 to 60	8
Over 60	<8

$$\textbf{Depth in Centimeters} = 244.13 * (\textbf{Turbidity in NTU})^{-0.662} \qquad (1)$$

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

There are limited QA/QC procedures for turbidity readings using a turbidity tube. For quality control, turbidity readings should be taken by one person for an entire sampling trip

Duplicate readings may be performed on sites that have duplicates established or two readings may be averaged by the sampler, if desired. Duplicate samples should be collected at a minimum rate of 1 replicate for every 10 regular samples. The duplicate sample should be collected by the same field team member who performed the associated normal sample collection. To perform the duplicate sampling, clean the turbidity tube after processing the first sample, return the same location where first sample was located, turn about 45 degrees, sample another 5 m into open water, and collect the duplicate sample following the procedures in **Section 9.0**. Note on the field note sheet that a duplicate was collected. Refer to the program/project specific quality assurance plan or sampling and analysis plan for performance goals for replicate measurements.

12.0 REFERENCES

1) World Health Organization (WHO), Water Sanitation and Health Fact Sheet on Environmental Sanitation, Fact Sheet 2.33 - Turbidity (accessed online at http://www.who.int/water_sanitation_health/emergencies/envsanfactsheets/en/index1.html on September 7, 2011).

2) Wyoming Stream Team, Stream Team Resources, Turbidity Instructions (PDF) (accessed online at http://wyomingstreamteam.org/resources.php on September 7, 2011).

3) Myre, E., & Shaw, R. (2006): The Turbidity Tube: Simple and Accurate Measurement of Turbidity in the Field, Michigan Technology University, Michigan

13.0 APPENDIX A

SOP Acknowledgment and Training Form (front and back)

SOP Acknowledgement and Training Form

This SOP must be read and this form signed annually. This form must be kept with the current version of the SOP.

Document Title:	
Document Revision Number:	
Document Revision Date:	

Please sign below in accordance with the following statement: "I have read and understood the above referenced document. I agree to perform the procedures described in this SOP in accordance with the document until such time that it is superseded by a more recent approved revision."

Printed Name	Signature	Date

SOP Acknowledgement and Training Form (continued)

Trainee: Sign below to acknowledge that training on this SOP was received, understood, and all questions/concerns were addressed by the trainer.

Trainer: Sign below to acknowledge that training on this SOP was completed for the individual listed and that trainee is competent to perform the procedures described within.

Date of Training	Trainee Printed Name	Trainee Signature	Trainer Printed Name	Trainer Signature