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Standard Guide for Monitoring of Suspended-Sediment Concentration in Open Channel Flow Using Optical Instrumentation[1]

This standard is issued under the fixed designation D7512; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers the equipment and basic procedures for installation, operation, and calibration of optical equipment as a surrogate for the continuous determination of suspended-sediment concentration (SSC) in open channel flow.

1.2 This guide emphasizes general principles for the application of optical measurements to be used to estimate suspended-sediment concentration (SSC) in water. Only in a few instances are step-by-step instructions given. Continuous monitoring is a field-based operation, methods and equipment are usually modified to suit local conditions. The modification process depends upon the operator skill and judgment.

1.3 This guide covers the use of the output from an optical instrument, such as turbidity and suspended-solids meters, to record data that can be correlated with suspended-sediment concentration. It does not cover the process of collecting data for continuous turbidity record, which would require additional calibration of the turbidity readings to the mean turbidity of the measurement cross section. For the purposes of this method it is assumed that the dependent variable will be mean cross-sectional suspended-sediment concentration data.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3977 Test Methods for Determining Sediment Concentration in Water Samples

D4411 Guide for Sampling Fluvial Sediment in Motion

D7315 Test Method for Determination of Turbidity Above 1 Turbidity Unit (TU) in Static Mode

3. Terminology

3.1 *Definitions:*

3.1.1 *calibration drift, n*—the error that is the result of drift in the sensor reading from the last time the sensor was calibrated, and is determined by the difference between cleaned-sensor readings in calibration standards and the true, temperature-compensated value of the calibration standards.

3.1.2 *continuous, adj*—refers to a time series of unit values that are close enough in time to simulate a continuous record.

3.1.2.1 *Discussion*—Generally, in studies of open-channel flow, 15-min intervals are used and are adequate to estimated continuous record. However, the time interval maybe as little as a minute or as great as an hour.

3.1.3 *fouling, n*—the error that can result from a variety of sources (such as biological growth on the sonde and covering of the probe with sediment), and is determined by the difference between sensor measurements in the environment before and after the sensors are cleaned.

3.1.4 *sonde, n*—part of the monitoring equipment that contains the measurement sensors.

3.1.4.1 *Discussion*—A sonde may be either a single parameter sensor or a combination of different sensors of different parameters.

4. Summary of Guide

4.1 This guide covers the equipment and basic procedures for installation, operation, and calibration of optical equipment as a surrogate for the continuous or near continuous determination of SSC in open channel flow.

[1] This guide is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.07 on Sediments, Geomorphology, and Open-Channel Flow.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4.2 This guide emphasizes general principles for one particular application of optical measurements in water. This guide covers the use of nephelometers and backscatter type turbidity meters to record data that can be correlated with SSC.

5. Significance and Use

5.1 This guide is general and intended as a planning guide. To satisfactorily monitor a specific site, an investigator must sometimes design specific installation structures or modify those given in this guide to meet the requirements of the site in question. Because of the dynamic nature of the sediment transport process, the extent to which characteristics such as mass concentration and particle-size distribution are accurately represented in the monitoring program depends on the type of equipment used and method of collection of the SSC samples used to calibrate the optical readings. Sediment concentration is highly variable in both time and space. Numerous samples must be collected and analyzed with proper equipment and standardized methods for the rating of the optical equipment at a particular site (see Guide D4411 and Practice D3977).

5.2 All optical equipment have an upper limit for valid readings, beyond which the meter will not read properly, commonly referred to as "blacking out." If upper range of SSC are expected to cause optical instrument black out, then some other means should be devised, such as automatic pumping samplers, to collect samples during this period. See Edwards and Glysson (**1**)[3] and Glysson (**2**) for information on collection of suspended sediment samples using pumping samplers. It should be noted that other technologies, such as lasers and acoustic dopplers, are also being used to monitor SSC continuously.

5.3 The user of this guide should realize that because different technologies and different models of the same technology of turbidity meters can produce significantly different outputs for the same environmental sample, only one manufacturer and model of the turbidity meter can be used to develop the relationship between the SSC and turbidity readings at a site. If a different manufacturer or a different model type of turbidity meter is used, a new relationship will need to be develop for the site.

6. Apparatus

6.1 In general, three types of configurations of installations of monitors can be used: *(1)* the flow-through monitoring system, *(2)* the in-situ monitoring system, and *(3)* the self contained, combined sensor and recording system.

6.2 Optical instruments such as photoelectric nephelometer (best used for lower levels of SSC) and backscatter sensors (best used for higher levels of SSC) provide the basis for this method. For more information concerning the advantages and disadvantages of each, see Test Method D7315. As they become available, other sensors may be used.

6.2.1 The Alliance for Coastal Technologies (ACT) did an in-situ evaluation of different nephelometer technologist. Users of this guide may be interested in the results of this study which can be found online.[4]

6.3 Before selecting the type of meter to be used, the operator needs to review the site requirements in order to ensure selection of the proper instrumentation. Things to consider, but are not limited to, are: the instruments ability to survive the study site environment, the degree of fouling that may take place, and the range of readings likely to be encountered at the site.

6.4 If a flow-through or in-situ monitoring device is used, a recording system must be installed. The recording system must have enough storage capacity to store all data recorded between site service visits. See manufacturer's advice on which recording devices will work best for the type of monitor being used.

6.5 Remote access and near real-time transmission of data from the site to the office can be very important in meeting the objectives of the monitoring station. Remote access and the near real-time transmittal of the recorded data take other equipment (such as a data collection platform (DCP), and transmittal antenna) in addition to the optical sensor. A DCP performs the same fundamental function as a basic data recorder (BDR). They both collect data from attached sensors on a timed interval and store the results. The difference is the BDR retains the data until it is retrieved manually, while the DCP has the ability to transmit the collected data to another location. Since data is transferred elsewhere for storage shortly after collection, a DCP may have less memory than a BDR. The data may be transmitted via telephone modem, line-of-site radio link or satellite. It is beyond the scope of this guide to discuss how to instrument a site for remote data transmission and no single reference on how to do this is available for reference here. The user is encouraged to visit the U.S. Geological Survey's Hydrologic Instrumentation Facility website[5] for information on equipment needs and used by the USGS.

6.6 The installation of an automatic pumping sampler, especially in remote areas, will allow samples to be collected that can be used to relate the optical reading to the suspended-sediment concentration in the stream and also address the blackout periods discussed in 5.2. Detailed information concerning the installation and operation of pumping samplers is beyond the scope of this guide. See Edwards and Glysson (**1**) and Glysson (**2**) for more information on the use of automatic pumping samplers.

7. Site Selection

7.1 The procedure for establishing a sampling location should emphasize the quest for a stream-data site. A stream-data site is as a cross section displaying relatively stable hydrologic characteristics and uniform depths over a wide

[3] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[4] Available from http://www.act-us.info/evaluation.php.

[5] Available from http://water.usgs.gov/hif.