Volunteer Monitoring of Suspended Sediment Concentrations and Turbidity in Humboldt, Mendocino and Trinity Counties, California

Quality Assurance Project Plan
September 2001

Salmon Forever
Watershed Watch

Project Director: _____ Date: _____

Field Manager: _____ Date: _____

Laboratory Manager: _____ Date: _____

QA Manager: _____ Date: _____

Table of Contents

Distribution List

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2. Salmon Forever - Jesse Noell, Clark Fenton
3. USEPA - Janet Parrish, Chris Heppe, Mark Kutnink, Palma Reisner
4. North Coast Regional Water Quality Review Board - Ranjit Gill, Fred Blatt
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24. Humboldt State University Library
25. Humboldt County Library

Introduction

This Quality Assurance Project Plan (QAPP) covers volunteer monitoring conducted by Salmon Forever in North Coast California watersheds. Salmon Forever has been conducting volunteer monitoring in these basins since 1998. Salmon Forever promotes the continued development of volunteer monitoring and cooperation between research activities and state agency monitoring efforts to develop an understanding and record of sediment loading and transport and the turbidity responses to land use activity in North Coast watersheds.

Project Management

Project Organization

Salmon Forever is the lead organization implementing this study. Salmon Forever is responsible for purchasing equipment, training volunteers, processing and analyzing collected samples and producing reports. The US Forest Service's Redwood Sciences Laboratory (RSL) has provided technical evaluation of grab sampling methods, assistance in installation and operation of sampling instruments, and data analysis. Redwood Sciences Lab, Humboldt State University (HSU), US Environmental Protection Agency (USEPA), North Coast Regional Water Quality Control Board (NCRWQB) and National Marine Fisheries Service (NMFS) act as technical advisors to this study. Principal data users include Salmon Forever, U.S. Forest Service, USEPA, the Trinity River Advisory Committee, NCRWQCB, HSU, RSL and NMFS.

The persons assigned to the positions listed below are responsible for oversight of their respective project tasks:

- Project Director- Jesse Noell / Salmon Forever
- Field Manager- Jesse Noell / Salmon Forever
- Laboratory Manager - Clark Fenton / Salmon Forever
- Interim Quality Assurance (QA) Managers (2001 only) – Dr. Margaret Lang and Dr. Eileen Cashman, Humboldt State University
- Data Processing Manager- Clark Fenton / Salmon Forever.
- Watershed Coordinators – Long-term, committed volunteers within each watershed

The Project Director is responsible for question formulation, parameter selection and developing the sampling design with RSL advisors. The Project Director and Quality Assurance Manager review all field and laboratory data for QAPP objectives and reject or qualify data. The Project Director is responsible for report production and distribution and will use the results of reports to implement any necessary changes to the study for subsequent sampling seasons.

The Field Manager conducts creek reconnaissance and selects and documents station locations. The Field Manager also provides field training, re-training and on call technical support; collects and checks completeness of field samples; and verifies the field data.

The Lab Manager supervises and trains all volunteers processing lab samples, checks and copies field data, is responsible for lab and field equipment supplies and service, keeps all equipment calibration records,

trains lab technicians, provides on call technical support and maintains field and lab QA proficiency checklists.

The Field and Lab Managers share responsibility for maintenance, operation and documentation for the continuous, turbidity-controlled ISCO automatic sampling stations.

The Quality Assurance Manager conducts lab and field certification, documents lab and field volunteer proficiency through proficiency checklists and conducts periodic visits to observe lab and field technique. The QA Manager analyzes Quality Control checks (approximately 10% of data collected in the study), reviews all field and lab data for QAPP objectives and corrects any failures in the analytical system. The QA Manager also analyzes QC field and lab tests performed by the Field Manager and Lab Manager, respectively. Results of these analyses and corrective actions are reported to the Project Director.

The Data Processing Manager proofreads data entered into databases against the original data sheets, verifies re-testing, clarifies ambiguous issues with field operators and reviews all field and lab data for QAPP objectives. The Data Processing Manager also assists the Field Manager and Lab Manager in presentations for data users and presentations for field operators.

Problem Background

Many North Coast streams and rivers have been identified as impaired due to sediment under the Clean Water Act, Section 303d (CSWRCB, 1998). Total Maximum Daily Loads (TMDLs) have or are being developed to identify and mitigate the impacts of sediment and to provide for attainment of Basin Plan water quality objectives. In addition, these watersheds are identified as key watersheds for salmonid production by the Northwest Forest Plan (USDA, 1997). Anadromous fish stocks on the North Coast of California have declined well below historical levels (Brown et al., 1994). Increased sediment delivery to stream channels is thought to be a significant contributor to the decline of fish populations. Sediment can contribute to the decline of fish populations through several mechanisms including, but not limited to: clogging spawning gravel (Chapman, 1988), impacting feeding ability and growth rates (Newcombe and MacDonald, 1991), and simplifying habitat by filling in pools and low gradient reaches (Frissel, 1992). Extensive efforts to restore the fishery are planned. The effectiveness of these efforts will benefit from monitoring turbidity and suspended sediment concentration (SSC) and duration of exposures to assess whether restoration has reduced sediment transport within the channel and whether the turbidities and SSCs present will allow recovery of the fishery.

The project goals are:

- To provide information necessary to adapt management practices to better meet the objectives of the Northwest Forest Plan by quantifying the association between management activities and downstream turbidity and SSC levels.

- To provide information useful for implementing TMDLs by identifying background and current turbidity and SSC regimes.

- To provide information necessary for planning fisheries restoration by determining whether salmonids are likely to be exposed to harmful levels of turbidity and suspended sediment.

- To facilitate education, involvement and empowerment of watershed residents by organizing a community-based volunteer program for monitoring.

- To develop approaches to monitoring and impact evaluation that can be applied to other watersheds.

Project Description

Salmon Forever primarily collects grab samples for turbidity and SSC determination. To supplement the grab sampling, Depth Integrated Sampling (DIS) is conducted in larger streams to measure turbidity and suspended sediment variation with position along a stream cross-section. DIS results are compared to grab sampling results collected at the same time to identify differences or biases between the two sampling methods. Salmon Forever anticipates collecting more than 1,600 grab samples, and that more than 400 of these samples will be processed to determine the suspended sediment concentrations.

Salmon Forever also operates a continuous, turbidity-controlled sampling station (Lewis, 1996) to develop relationships between turbidity and SSC. This station includes a continuous turbidity probe, stage recorder, and an ISCO automatic sampler capable of collecting 24 samples. Sample collection is controlled by the rate of change of turbidity and stage.

Additional measurements needed to evaluate the impacts of turbidity and SSC are also collected. These measurements include stream discharge or stage at sites where a rating curve has been or is being established. Either a direct (discharge) or indirect (stage) measurement must be recorded at the time water samples are collected. When possible position on the storm hydrograph (rising, peak, or falling limb) is also noted.

Salmon Forever maintains their Sunnybrae Sediment Lab for turbidity and SSC determination. If sampling sites are added that are too far to deliver samples to the laboratory within the required time period, a field laboratory will be set up to allow timely sample analysis. The Quality Assurance protocol developed by Salmon Forever requires rapid processing of samples to prevent algae growth.

Data is entered into a computerized management system and checked by the data processing team prior to analysis. Regular analysis of data with review by appropriate Salmon Forever Technical Advisory Panel members will facilitate timely detection of error or need for modification of protocols. Analysis is conducted when data processing is completed.

Data Quality Objectives for Measurement Data

Data quality objectives (DQOs) are "quantitative and qualitative statements of the overall level of uncertainty that a decision-maker is willing to accept in results or in decisions derived from environmental data (USEPA, 1996)." The overall level of uncertainty is based on estimates of measurement error, sampling error, and site variability.

The data collected is intended to inform TMDL development and implementation and watershed analyses by providing monitoring data that can be compared to action levels for turbidity and suspended sediment concentrations found in applicable regulations and guidelines. Water quality objectives in the North Coast Basin Plan provide action levels for turbidity (turbidity shall not be increased more than 20% above naturally occurring background levels) and suspended sediment (the suspended sediment load and suspended sediment rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial use) (NCRWQCB, 1993).

It is difficult to state DQOs for the parameters measured in this study in terms of quantitative data quality measures because specific estimates of variability are site and measurement range dependent. The primary mechanism used to ensure data quality is strict adherence to accepted sample collection and analysis methods described in the Standard Operating Procedures (SOPs). Also incorporated into the monitoring are efforts to quantify the variability and reliability of the data collected such as: developing the relationship between depth-integrated turbidity, turbidity sensor readings and volunteer grab samples; and comparing discharges determined using the current meter to those from float velocities. The experiments

and analyses being conducted to evaluate data quality and assist in defining DQOs are presented in the annual QA report and will be used to update project DQOs.

Accuracy, Precision, and Measurement Range Objectives

Accuracy is the degree to which a measured value agrees with an accepted known or true value. For instruments, accuracy is specified by the manufacturer and assured by proper calibration and maintenance of the instruments. Laboratory instrument accuracy is evaluated using check weights, filter re-weighs, filter blanks and other standard QA methods.

Precision is the measure of variation among repeated independent observations of the same property under controlled similar conditions. Precision is quantified using split samples analyzed independently by Salmon Forever and RSL or other suitably qualified laboratories. The goal of training and initial calibration is to train volunteers so their estimate of subjective parameters meets the DQO's. Additionally, mid-season comparison of volunteer measurements will be used to assess their precision. Precision will be estimated for depth, velocity, and cross-section surveys by repeating the measurement and comparing results.

Volunteer precision is estimated for stage, velocity, and grab sampling. Comparison of individual measurements of the same parameter is used to analyze the statistical precision of volunteer measurements. Laboratory precision is determined from analysis of repeated weighing of the balance check weight.

Table 1 summarizes the accuracy, precision, and measurement range estimated for the parameters of interest for the study. Values are derived from knowledge of measurement device characteristics and accuracy and also accounting for expected field and laboratory conditions.

Table 1. Precision, accuracy and measurement range for study parameters

Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
Water	Turbidity	Nephelometer	± 5.0%	± 2.0%[1]	0-2000 NTU
Water	Turbidity	Probe	± 5.0%	± 2.0%[1]	0-2000 NTU
Water	Suspended Sediment	Gravimetric	± 5.0 %	± 2.0%[1]	0.00001-2.0 g/L
Water	Velocity	Float	± 8.0%	1.0 ft/sec.	0-10 ft/sec
	Velocity	Meter	± 8.0%	± 8.0%[1]	0.25 - 8.0 ft/sec
Water	Depth	Staff Plate	± 5.0%	0.1 ft	0-20 feet
	Depth	Pressure Transducer	Not Appplicable	0.05 ft	0 - 10 feet

[1] The accuracy and precision for these parameters is a function of the magnitude of the measurement value.

Comparability

Comparability is a measure of the degree to which different methods and data sets can be represented as similar. Comparability of the suspended sediment concentration data will be evaluated using audit samples and laboratory and field split samples.

To ensure comparability all monitoring activities will follow protocols established and approved by the EPA and Redwood Sciences Laboratory. See the SOP's in Appendix 1 for sampling and laboratory protocols.

Completeness

Completeness is the ratio or percentage of the amount of valid data obtained compared to the planned amount. Our completeness goal is to sample turbidity and suspended sediment concentration during all major storm events in study tributaries. Lack of volunteers, breakdown of equipment, frequency of major storms, etc. may hamper completeness.

At the end of the season the number of samples collected will be compared to the planned number and the completeness will be presented as a percent for each parameter. Reasons for not meeting the completeness objective will be recorded. It is expected that samples will be collected from at least 90% of the sites unless unanticipated weather conditions prevent sampling.

At the end of each field season, completeness will be assessed as the amount of data (and samples) actually collected compared to the planned amount and will be calculated using the following formulas:

$$\%\ \text{Completeness (samples)} = \frac{\text{samples collected}}{\text{planned samples collected}} \times 100$$

Following data entry into the project database, the amount of validated data will be compared to the number of samples collected, using a formula similar to that above. The measurement quality objective is 100% completeness.

Representativeness

Representativeness is the degree to which data truly characterize a population or environmental condition. Sampling methods are designed to be as representative as possible and experiments are included to compare different methods of measuring the same parameter to quantify the representativeness of the sampling and analysis methods. Descriptions of experiments designed to assess representativeness are listed below and additional experiments will be identified and incorporated into the study when needed.

Experiments to assess representativeness and the conditions under which they should be conducted include:

- Where stream discharge is sufficiently energetic to transport large particles (such as sand) in the lower water column, depth integrated sampling (DIS) will be conducted at a range of flows representative of the hydrograph to provide a correlation to grab sample collected 6 to 8 inches depth below the water surface.

- Stream velocity, in streams large enough to permit use of a current meter, will be measured with a current meter at a range of flows representative of the hydrograph to provide a correlation to the float velocity method of estimating discharge.

- Previous monitoring conducted by Redwood Sciences Laboratory and Salmon Forever has shown that the highest levels of suspended sediment transport occur on the rising limb of the hydrograph during large storms. Therefore, samples must be collected on the rising limb, at peak discharge, and on the falling limb to truly characterize the sediment transport during a storm. Fifteen or more samples may be needed at each monitoring site to establish a suspended sediment concentration correlation that characterizes the full range of stream discharge response. The actual timing of sampling activities cannot be predicted with much accuracy by more than a few hours in advance. Thus, it may be difficult to ensure volunteer availability throughout each storm event. The sampling protocol assumes that frequent sampling of many storms will capture the turbidity and SSC behavior at each sampling site. Whether this data will also be transferable to other sampling sites in the same watershed or other basins in the region will remain unknown until sufficient data from a variety of sampling location is collected and analyzed.

Study design also addresses representativeness to the extent possible by site selection using a gradation of watershed sizes and geology. Adjacent watershed basins as small as 100 acres and as large as 2000 acres will be chosen where feasible. Constraints on access to sites due to winter snow conditions, closed roads and private lands may limit representativeness to subsets of a given litho-topo type. However access is sufficient to permit representative sampling of a substantial fraction of the litho-topo types. Additional details of site selection are provided in the project monitoring plan.

Data Quality Ratings

A variety of methods are used in the field to obtain measurements and each method has inherent limitations in its ability to capture representative samples or results. To account for different data quality obtained by different methods, a rating is assigned to each data point based on the criteria shown in Table 2. Rating values are defined for the turbidity and SSC measurement method and for the discharge measurement method. The total data point rating is the sum of these two intermediate rating values. For example, if a grab sample is collected on a small stream and the discharge is determined by timing a floating object, the rating for that data point is 1 + 2 = 3. Lower rating numbers indicate measurements methods that are more likely to be representative with 2 being the best rating value for a sample data point. Data point rating values are initially recorded on the field forms and follow the data into all other databases.

Table 2. Field Measurement Rating Values

Discharge Method	Rating Value	Sample Collection Method	Rating Value
Direct Measurement using Price AA	1	Grab sample (small stream)	1
Stage reading w/rating curve derived from Direct Measurements	1	Grab sample (large stream)	2
Timed Bucket Filling at Low Flow	2		
Floating Object Velocity (FOV)	2		
Stage reading w/rating curve derived from FOV	2		
No discharge estimate	3		

Training and Certification

All volunteers collecting or analyzing samples receive consistent training and are observed and certified for performance of the SOPs specific to their tasks by the QA Manager. The goal of training is to educate volunteers so that their estimates of subjective parameters meet the Data Quality Objectives (DQOs). As the study progresses experienced volunteers will become proficient to train and certify others. Field training takes place at established sampling sites. Laboratory training is conducted at the Sunnybrae Sediment Lab.

Training topics include:

- Safety
- Data Recording
- Selecting and preparing sampling locations
- Grab Sampling methods
- Stage measurement
- Velocity measurement
- Cross-section measurements for discharge
- Depth Integrated Sampling
- ISCO Automatic Sampler use
- USGS Type AA/Pygmy Current Meter use
- Turbidity Measurements
- Suspended Sediment Sample Processing

Proficiency checklists (Appendix 3), listing the sequence of sampling and data collection tasks and notes on their proper execution, have been prepared for evaluating the performance of individual and teams of volunteers. The Field Manager, Lab Manager, QA Manager or Watershed Coordinators use these checklists during training to document volunteer proficiency.

The Field Manager, QA Manager or Watershed Coordinators conduct all field training. Volunteers are also assembled once during the field season, for "calibration" in the collection of depth, velocity, cross-section and grab sampling measurements.

Safety procedures for sampling in stormy or hazardous conditions are explained at every training session. High stream flows during storm events present the main hazard that volunteers encounter so sampling

stations are selected with safety as the most important criteria. Under no circumstances is anyone to risk injury for data.

Training seeks to encourage commitment and responsibility of volunteers as well as imprting awareness of sources of error and uncertainty. Requirements for volunteers include good physical health, the ability to consistently repeat sampling procedures and time to devote to sampling and analyzing data.

Documentation and Records

The Project Director will ensure that the most current QAPP version is available to all sponsoring and co-operating organizations involved in this study. The organizations in the Distribution List will, if necessary, receive revised copies of the QAPP at the beginning of each sampling season. Current versions of the QAPP are available to any individual or organization requesting one.

Field data are initially recorded on the appropriate data sheets (Appendix 2 contains examples of all data sheets). Most volunteers also maintain field books where they record the information that they collect. All field data sheets and notebooks are Rite-in-the-Rain, waterproof paper to withstand the field conditions.

Laboratory data documentation and recording varies with the analyses being performed. Grab samples are analyzed for turbidity with a HACH 2100P Turbidimeter and then processed for suspended sediment concentrations. Sample sign-in, turbidity determination, and suspended sediment concentration data is recorded in pen on all appropriate data sheets. Suspended sediment calculations are performed and maintained in an Excel spreadsheet and are also written on paper worksheets.

ISCO samples are first analyzed using the HACH 2100P Turbidimeter then processed for suspended sediment concentration. The ISCO station also collects continuous turbidity and stage (using a pressure transducer). This data is recorded electronically with a Campbell CR10X Datalogger and post-processed by RSL using software developed by RSL scientists.

All data summaries and databases developed from raw parameter measurements are in Word and Excel software formats. Paper copies are on 8-1/2 by 11 or 8-1/2 by 14 paper. All data sheets include the Hydrologic Year, initials of the person entering data, the date of data entry and the date of copying. Sign-in sheets and filter tare sheets are numbered sequentially as they are filled out. Laboratory data sheets are filed chronologically and given sequential numbers at the end of each Hydrologic Year. Data presentation will be in a format acceptable to EPA, RSL and NCRWQCB.

Originals of all field and laboratory data sheets, QA/QC analyses, and computer databases will be kept in the Sunnybrae Sediment lab. Copies of field and laboratory data sheets, QA/QC analyses, and computer back-up disks will be kept in the Salmon Forever office. Salmon Forever will maintain hard copies of all data sets and computer back-up disks for at least 10 years. Original ISCO Automatic Sampler field sheets will be stored for 10 years at the Sunnybrae Sediment Lab. Copies of these documents will also be given to RSL.

A QA report will be prepared for each hydrologic year with a tentative deliverable date of August 1st. An annual project report will be completed by September 1st of each year.

Final reports will include raw data, field data sheets, suspended sediment data sheets, equipment calibration data sheets, laboratory data sheets and QA/QC results.

Measurement/Data Acquisition

Procedures for sampling methods, sample handling and custody, and analytical methods are all described in detail in Standard Operating Procedures (SOPs) developed for each method needed in the study. The SOPs are attached as Appendix 1, which includes SOPs for the following methods and procedures:

- Field Grab Sample collection
- Turbidity Measurement using the Hach 2100P Turbidimeter
- ISCO 2100 Automatic Sampler Sampling
- Continuous turbidity measurements using the OBS-3 Continuous Turbidimeter
- Stage measurement using the DRUCK 1830 Stage/Pressure Transducer
- Depth Integrated Sampling – Crane (DH-48) and wading (DH-49)
- Discharge measurements – Crane and wading with the Price AA current meter
- Suspended sediment concentration laboratory measurement

The monitoring plan [under development – will be referenced here] details the sampling design and site selection. A brief summary of the sampling process design is included here.

Sampling Process Design

The monitoring plan [Reference] discusses sampling process design in detail. As a general overview, sampling sites are chosen to meet the following project goals:

- To develop predictive relationships between turbidity and suspended sediment concentrations in North Coast watersheds,

- To measure conditions in relatively undisturbed sites to define "background" conditions, and

- To identify the effects of land use activities in the watershed by sampling above and below select locations within a watershed.

The intentions of this project are to operate a scientifically and statistically valid monitoring program. However, limited access to sampling sites on private property and limitations of volunteer time commitments may not allow perfect adherence to ideal spatial and temporal distribution of sampling. With these limitations, sampling is necessarily directed but opportunistic.

Sampling Methods Requirements

The SOPs, attached to this document as Appendix 1, contain detailed information on the methods used for sample collection and analysis. Three methods are used to collect samples: turbidity-controlled suspended sediment collection using an ISCO automatic sampler (Lewis 1996), depth integrated sampling (DIS) using a DH-48 on a sampling crane or a hand-held DH-49, and surface grab sampling. Turbidity and SSC values determined from simultaneous sampling by two or more different sample collection methods are used to quantify data quality.

Methods used to measure stage, discharge, cross-section and other channel characteristics needed to analyze the significance, impacts, or transport rates of the turbidity or SSC are adopted from USGS or USDA Forest Service (Harrellson, C. C. et al., 1994) protocols.

Sample Handling and Custody Requirements

All sample handling and custody requirements are described in detail in the SOPs (Appendix 1).

Samples are identified using unique stickers attached to bottles and bottle caps. At the beginning of the hydrologic year all bottles (ISCO bottles, DIS bottles, HACH cells and other grab sample bottles) used in sampling are assigned a waterproof sticker with a unique ID number. The Lab Manager procures these stickers, keeps a logbook of the ID numbers, and labels all sample bottles before they are used in the field. Circular stickers are used for the HACH cell samples so they do not interfere with turbidity determinations. All other sample containers will receive a sticker on the side of the bottle. After turbidity and SSC processing the sticker are taken off the sample bottle and replaced with a new sticker.

The numbering system for the stickers is a 7 letter alphanumeric code described in Table 3.

Table 3. Description of code used for sample containers.

ID number examples	00G1234, 01D1234, 99I1234
Code description	
1st two digits	Hydrologic year (e.g. 00, 01, 99)
Letter indicating sample method type	G – grab sample I – ISCO sample D – depth integrated sample
Last 4 digits	Unique, sequential number for each sample within the hydrologic year

All ISCO, DIS and grab sample bottles are further labeled in the field with the pertinent data (volunteer, site, time, date, stage, etc.) and logged onto the sign-in sheets when delivered to the lab. ISCO sample bottles are labeled when removed from the sampler. The sample ID # is also written on the field form at the time of sampling.

The chain-of-custody for samples is:

- Volunteers are responsible for samples until they are brought to the Lab or until they are picked up and measurements recorded by the Field Manager or Watershed Coordinator.

- The Field Manager or Watershed Coordinator is responsible for samples until they are checked into the lab. The Field Manager or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data.

- The Lab Manager is responsible for storing and processing samples. The date and time of arrival at the Sediment Lab is recorded on the Lab Sign In sheet by whoever brings the sample into the lab.

Samples at the lab are stored in a cool dark place until processing.

Analytical Methods Requirements

Analytical procedures follow Redwood Science Lab (RSL, 2001), EPA and Standard Methods for the Examination of Water and Wastewater (AWWA, 1990) where appropriate. Analytical procedures are detailed in the SOPs (Appendix 1).

Redwood Sciences Lab performs SSC determination on QC split samples taken during the sampling season. Salmon Forever will perform all other turbidity and SSC determinations.

Volunteer grab samples are analyzed for turbidity with a HACH 2100P Turbidimeter and then processed for suspended sediment concentrations through tared 1.0-micron filters on a vacuum assembly. ISCO samples are analyzed using the HACH Turbidimeter and are processed for suspended sediment concentration until a sufficient range of samples are analyzed to develop a turbidity vs. suspended sediment correlation.

The Lab Manager and QA Manager are responsible for correcting any failures in the analytical system. Detailed information on the corrective actions and any samples affected shall be kept in the lab records.

Quality Control Requirements

The Quality Assurance Manager is responsible for implementing, recording and analyzing the quality control measures undertaken to ensure data quality objectives are met. Quality Control measures for each sampling procedure are detailed in its SOP. In general, quality control will total 10% of the data collected in this study. Results of quality control analyses and corrective actions is reported to the Project Director and described in the annual report.

Instrument/Equipment Testing, Inspection and Maintenance Requirements

A list of all equipment used for the monitoring is included in Table 4 below. All equipment is inspected and maintained to EPA and manufacturer specifications. Records of maintenance and calibration are kept for all appropriate equipment. The Laboratory Manager maintains these records to track scheduled maintenance on all equipment. All records and laboratory equipment will be kept at the Sediment Lab. All spare parts are stored at the Sunnybrae Sediment Lab. Adequate replacement parts will be kept at the lab and are the responsibility of the Lab Manager. If equipment does not meet specifications or is not working properly, it shall not be used until inspected by the QA Manager and acceptance, repair or replacement has been documented. Table 5 summarizes the inspection frequency and performance assessments used to identify equipment malfunctions.

Table 4. List of analytical equipment used.

Instrument	Number Owned	Serial Numbers
ISCO 2100 Automatic Sampler	1	A 2586-50
OBS-3 Turbidity Probe	1	S/N 430
CR10X Campbell Data Logger	1	S/N X14856
Druck 1830 Pressure Transducer	1	S/N 1088275
HACH 2100P Turbidimeter	4	S/N 960100009614; S/N 990800022423; S/N 990800022431; # S/N 990800022441
USGS Type AA current meter	2	
USGS Pygmy current meter	1	
DH-48 Depth Integrated Samplers	3	
DH-49 Depth Integrated Samplers	1	
Mettler H20T Analytical Balance	1	S/N 418151
AND FY 3000 scale	1	S/N 5608313
Grieve Laboratory Oven LR270C	1	
Welch/Thomas Vacuum Apparatus	1	Model # 2522B-01 S/N 040000000715

Table 5. Equipment inspection and performance assessment measures.

Equipment	Inspection Frequency	Type of Inspection or Assessment	Inspector
Balances	Each use	Weigh check weights	Lab manager or responsible volunteer
Hach 2100 turbidimeters	Each use	Proper operation	Lab or field manager
ISCO samplers	Each bottle change	Proper operation	Lab or field manager
Data loggers	Each data download	Check computer operation	Lab or field manager
Pressure transducer	Weekly	Check computer operation and compare to staff plate	Lab or field manager
DH-48 and DH-49 samples	Each use	Visual inspection	Field Manager or responsible volunteer
Price AA	Each use	Visual inspection and spin test	Field Manager or responsible volunteer

Instrument Calibration

Calibration frequency and descriptions are found in the appropriate SOP's (Appendix 1). All equipment calibration records are kept by the Laboratory Manager and are available upon request. Each piece of equipment has an identifying number that is linked to calibration records. Table 6 summarizes the instrument calibration schedule.

Table 6. Instrument calibration schedule.

Instrument	Calibration Frequency	Type of Calibration	Conducting Party
Balances	Annual	Woolard & Sons Standard Wts No. 349-B traceable to NIST Standard Weights	Woolard and Sons PO Box 3438 Salem Or 97302
Hach turbidimeters	Quarterly	Stablcal Calibration	Laboratory Manager
Pressure transducers	Beginning/mid-season	RSL protocol	Lab or Field Manager
Continuous turbidimeter	Beginning/mid-season	RSL protocol	Lab or Field Manager

Data Acquisition Requirements

Volunteers associated with Salmon Forever collect most of the data required to analyze the turbidity response and sediment transport. At a few sites, HSU or RSL scientists are also conducting monitoring projects, primarily continuous stage measurements and rating curve generation. Where continuous records of discharge are recorded and determined by others, Salmon Forever requests copies of the data and to use in their analyses. Redwood Sciences Laboratory and HSU scientists cooperate in this monitoring effort and provide access to their data.

Additionally, Salmon Forever also maintains a collection of maps and aerial photographs of sampling sites and target watersheds. These materials are acquired from the USGS and other appropriate agencies.

Data Management

Sample information and data are all recorded on standardized field and laboratory data forms (Appendix 2). The Field and Laboratory Managers are responsible for checking and copying Field Data sheets and delivering them to the Project Director. The Laboratory Manager is responsible for checking and copying lab data sheets and delivering them to the Project Director. Original laboratory data sheets are kept in the Sunnybrae Sediment Lab. Reports and data are transferred to Excel spreadsheets and Word documents and copies kept at the Sunnybrae Sediment Lab and Salmon Forever Offices.

All data are examined and rated on the basis of field and laboratory codes pertaining to the quality of data (Table 1). Outliers or nonsensical data will be detected during calculations and transfer to electronic spreadsheet and documented by the QA Manager.

Data handling equipment includes data sheets, data loggers, RSL spreadsheets and programs, hand calculators, Excel spreadsheets and Microsoft Word documents. Data collected at the ISCO station will be entered directly into RSL's analysis programs. Data will be presented in a format acceptable to EPA, RSL and NCRWQCB.

Data used to produce annual reports and is kept on paper copies and as electronic copies of Word documents and Excel spreadsheets. Data and calculations are checked at the time of transfer from paper to spreadsheets.

Assessment and Oversight

Quality Assessment/Assurance (QA) refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance is the shared responsibility of all project managers (Field, Lab and Database) and the Watershed Coordinators with oversight and evaluation of these activities provided by the QA Manager. QA activities include evaluating data quality, accuracy and precision; staff training; documentation and development of methods and standard operating procedures; and appropriate handling, processing, and tracking of all data and samples collected. Most of these topics have been thoroughly covered in either the Appendices (SOPs–Appendix 1, Proficiency Check Lists for Volunteer Certification–Appendix 3) or other sections of this document. This section describes additional QA activities and how the responsibilities for these activities are divided among project managers.

Assessment and Response Actions

Watershed Coordinator QA Responsibility

Watershed Coordinators meet every 2 months to compare progress, to discuss and resolve problems that they may have encountered, and to address any issues brought to their attention by the results of internal QA checks. These meetings are extremely important for identifying problems with sampling procedures or logistics in the field. Watershed coordinators will discuss difficulties encountered in specific situations, adopt corrective actions (after consultation with project managers), and implement appropriate modifications for standardizing methods between volunteers.

Field Manager QA Responsibility

The Field Manager, QA Officer or Watershed Coordinator shall observe each volunteer at the beginning of the project and again at least once a year conducting sampling. Proficiency checklists (Appendix 3) will be used to provide a written record and evaluation of volunteer performance. All volunteers are required to pass proficiency evaluations during training. If volunteers do not meet the proficiency criteria, they will receive additional training until they are proficient or they will not be utilized in this study. Volunteers are required to perform all sampling procedures correctly before their data is included in any databases or used for analyses.

During training, any methods that the volunteers find confusing will be noted, and modifications to the method, the training or the checklist will be adopted as needed.

Laboratory Manager QA Responsibility

Laboratory QA procedures are detailed in each SOP (Appendix 1). Either the QA or Laboratory Manager conducts QA laboratory procedures. The Laboratory Manager trains lab technicians before they begin conducting sample processing and observes their proficiency on the job until they are certified to work independently. Technicians work under direct supervision for a minimum of 2 sessions. Certification using the proficiency checklists for turbidity and SSC determination and filter weighing are conducted for all lab technicians at the beginning of each sampling season and once more during the sampling season. The Lab Manager reviews technician data for errors and incomplete data entry. The Lab Manager is responsible for implementing these assessments, correcting technician deficiencies and keeping the checklists on file in the lab. Results of assessments and certifications are reported to the Project Director.

Performance and System Audits

Technical system audits provide an external review of the research and QA activities. External personnel from EPA, NCRWQCB, RSL or HSU may audit this project during the field season. Findings will be discussed with the volunteers and summarized in audit reports submitted to EPA, NCRWQCB, RSL and HSU.

The objectives of field visits by EPA, RSL, or NCRWQCB assessors are to:

- observe implementation of field methods by the field crews;
- assess personnel performance, equipment, and procedures;
- evaluate Salmon Forever training methods;
- assess consistency of volunteers in implementing field methods;
- answer questions arising about sampling design or methods; and
- determining whether DQOs are being met from review of quality assurance data

If deficiencies or problems are identified, agency assessors will make recommendations to the Field and Lab Managers and Watershed Coordinators. Any identified deficiencies or problems will be summarized in an audit report.

Reports

An annual report will be produced and distributed in August of each year. The Project Director is responsible for report production and distribution. Reports will be forwarded to the county, state, and regional agencies, and other members of the Advisory Panel. Reports will contain data analysis for the previous year's sampling, an update on project status and findings to date, volunteer highlights, results of quality assessment audits and internal assessments, and identify any significant QA problems and their recommended solutions. The Project Director will incorporate the recommendations in this report by implementing any needed changes to the study for the next sampling season.

In addition to the annual project report, an annual QA report is also be prepared by the QA Manager. The QA Report summarizes the outcome of all quality assurance efforts undertaken for the sampling season and make recommendations for improving activities for the next year. The QA Report specifically addresses data quality and information management by:

- evaluating all QA data and sampling;
- summarizing data entry errors and describing any difficulties with data;
- evaluating data entry completeness;
- documenting data management activities, including the content and location of project notebooks (field, laboratory, data management) and data sheets.

The QA Report also summarizes the results of quality assurance activities including identifying the greatest sources of error and evaluating of SOPs, DQOS, and training effectiveness.

Data Validation and Usability

Data Review, Validation and Verification Requirements

The Project Director, QA Manager and the Data Processing Manager review all field and laboratory data to determine if the data meets the QAPP objectives. In addition, personnel from the EPA and RSL and HSU who are not directly connected to the project may also review data. Decisions to reject or qualify data are made by the Project Director and the QA Manager.

All data will be rated by several methods to rank usefulness. Final results are ranked poor, fair or good based on field sampling ratings (Table 2) and Lab and Turbidity codes (see Lab and Turbidity Codes in the appropriate SOP's in Appendix 1).

Validation and Verification Methods

Once data has been entered into the database, the Data Processing Manager proofreads it against the original data sheets. Errors in data entry are corrected. Outliers and inconsistencies are flagged for further review or discarded. Problems with data quality will be discussed in the annual report to data users.

Following processing and checking by the Data Processing Manager, the QA Manager evaluates all project data using appropriate techniques such as graphical comparisons and statistical analysis. Results of the QA Mangers findings are reported in the annual QA report.

Reconciliation with Data Quality Objectives

Calculations of precision, accuracy, representativeness, and completeness will be made and included in the annual report. If data quality indicators show that sampling methods are not meeting the project's specifications the cause of failure will be evaluated and corrective action implemented. If the cause is found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is found to be sampling error, volunteers will be retrained. Any limitations on data use will be detailed in the final report and other documentation as needed.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the RSL, EPA and NCRWQCB quality assurance officers for approval. Limitations on the use of data will be reported in the annual QA report.

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Lewis, Jack. 1996. Turbidity-controlled suspended sediment sampling for runoff-event load estimation. Water Resources Research 32(7): 2299-2310.

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USEPA. 1996. The Volunteer Monitor's Guide To QUALITY ASSURANCE PROJECT PLANS Office of Wetlands, Oceans and Watersheds EPA 841-B-96-003. September 1996. http://www.epa.gov/OWOW/monitoring/volunteer/qapp/vol_qapp.pdf

USEPA:
Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995
EPA QA/G-4 Guidance for the Data Quality Objectives Process
EPA QA/G-5 Guidance for Quality Assurance Project Plans
EPA QA/G-6 Guidance for the Preparation of Standard Operating Procedures (SOP's) for Quality Related Documents
EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations

USGS:
Techniques of Water-Resources Investigations of the USGS:
- Stage Measurements at Gaging Stations Book 3 Chapter A7
- Discharge Measurements at Gaging Stations Book 3 Chapter A8
- Laboratory Theory and Methods for Sediment Analysis Chapter C1 Book 5
- Field Methods for Measurement of Fluvial Sediment Chapter C2 Book 3

Surface Water Techniques: Discharge Ratings at Gaging Stations - Hydraulic Measurement and Computation Book 1 Chapter 12 1965

Appendix 1 – Standard Operating Procedures

SOP Number	SOP Title	Total Pages
SOP_1	Field Sample Collection	7
SOP_2	Hach Turbidity Measurements	6
SOP_3	Discharge Measurements	6
SOP_4	Laboratory SSC Determination	14
SOP_5	ISCO Automatic Sampler	11
SOP_6	Continuous Turbidity Probe	10
SOP_7	Pressure Transducer	6
SOP_8	Rain Gauge	3
SOP_9	Temperature Probe	3

STANDARD OPERATING PROCEDURE

Field Sample Collection For Turbidity and Suspended Sediment Concentration

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope:

This Standard Operating Procedure (SOP) covers the proper way to collect water samples from various sites for representative turbidity and suspended sediment concentration determination. Grab sampling provides only a single point representation of turbidity and suspended sediment concentration in a stream. Where possible grab samples will be compared to Depth-Integrated samples collected at the same time to provide a better understanding of the suspended sediment distribution throughout the water column and identify any error/bias associated with grab sampling near the surface.

2. Apparatus:

Sample Containers - HACH Sample Cells, Plastic bottles (various sizes), Glass Bottles (various sizes)

Stopwatch

Rite in the Rain note paper or book w/pencil

Tape measure

Orange peel or floating objects for velocity measurements

Bottle of HCL solution (for sterilizing sample after turbidity is run)

Waterproof boots and raingear

Flashlight or headlamp

Staff Gauge for measuring water depth.
This can be:

1. A standard stream gauge marked in 0.01 feet
2. 1-1/4" or 1-1/2" metal pipe staff gauge (to be driven into streambed in flat water just upstream or downstream of the velocity gauging section)
3. Rod with markings driven in streambed
4. Marks on bridge piers or culverts

All supplies used will either be ordered from the manufacturer or through a scientific supply house. Supplies will not be accepted unless in proper working order. All supplies and equipment are purchased and inspected by the Lab or Field Manager. Lab water shall be retail distilled water purchased locally. Before use, the Lab Manager shall inspect sample bottles cleaned in the lab and affix a unique ID # sticker to each bottle before it is used in the field. Copies of equipment invoices shall be kept in the Sediment Lab and Salmon Forever Offices.

3. Calibration:

None of the sampling equipment requires calibration.

4. Sample Collection:

A. SAFETY FIRST!

1. Establish a safe path to the site: stream banks are soft and slippery.
2. Be careful! Please don't wade when you sample. We want all the grab samples to be consistently collected from the stream bank. Remember, when you go out in the field, you do so as a volunteer and must assume responsibility for your own safety. Please take your time and be careful.

B. ESTABLISHING THE SITE

Before the rainy season begins, new sites need to be established. Existing sites must be checked for maintenance issues and accessibility. Know the route to your site and establish an alternate route and/or someone else to sample in case of road flooding. Ask permission if a site is to be established on private property.

1. Locate a safe water-sampling site and give it a short, preferably descriptive, name (HH, SFELK, GG etc.). If there are other sites in the same watershed, avoid duplication. Make a photocopy of a topographic map of the area with the sampling location marked, if possible, and give it to your watershed coordinator or the Sunny Brae Lab.
2. Locate the appropriate site to measure water level . Measure down from a bridge guardrail, or measure water level on a staff/stage gauge. Find a spot safe from flooding and one you can read at high water level.
3. Establish the velocity gauging section of the creek (straight, uniform stream reach, long enough to give velocity time measurements in the 6-12 second range at high flow if possible).
4. Measure the cross-sectional area at the velocity gauging section. The cross section must be surveyed at least once a year and tied to a constant elevation point such as a bridge, house foundation or a large nail put in a utility pole. The cross-section surveys can be done during low flows and will be organized by the Field manager,
5. Photograph the site from an identifiable, repeatable site (the photo point) and make a location map. Describe the lens and focal length of the camera used.

C. WHEN TO MONITOR

Aim to sample as the creek rises and throughout a storm event and as the water begins to go down. The goal is to collect representative samples that illustrate the full range of stream flow. A hydrograph, showing the rise and fall of water level in a creek, and the corresponding rise and fall of turbidity levels and PPM of sediment during a storm event will be produced with this data. The data will also show when turbidity levels that are injurious or lethal to salmonids are occurring and what sediment loads the individual creek is carrying. It is most useful to sample near the peak of the flows to get a good representation of the highest discharges (up to 90% of sediment transport may occur during high flow events). Photograph the site, from your established photo point, at the high stage!

1. Sample after the rain starts
2. As the creek rises (for long storms, sample at several stages.)
3. Sample at the **peak**, if at all possible
4. Sample as the creek falls (if it is a long duration storm, sample at several stages.)
5. Dump the lowest flow samples if you run out of bottles. The peak flow is the most important!
6. During quiet times between storms you can minimize the number of samples collected to save the bottles for the next storm.
7. Call your watershed coordinator for directions or answers to any questions you may have.

D. HOW TO MEASURE STAGE

Locate an appropriate site to measure creek water level (measure down from a bridge guard rail, or measure water level on a staff/stage gauge or distance down from the top of a culvert). Measurements should be made to the nearest 1 inch or 0.1 ft. At high flows, waves will make an accurate reading difficult; read the average water level, not the peak or trough of the waves.

If there is a bridge available record the height of the creek from the bridge. One does this by measuring the distance between the water's surface and a fixed point on the bridge (top of guardrail) to the nearest inch. The fixed point must be correlated to a spot on the stream bank and your cross-section.

E. HOW TO MEASURE STREAM VELOCITY.
Set up a known, measured length of stream channel (to the **nearest 1/2 a foot**) beforehand (For example inserting two colored sticks in the ground 20 feet apart above the bank and out of flood levels). Time an orange peel or floating object as it travels between the two sticks to the **nearest tenth of a second** using your stopwatch. Velocity is the distance your orange peel travels divided by the time it took to travel that distance.

A volunteer releases an orange peel (or a stick, leaf, etc.) at the upstream of the established stream length and times (to the **nearest tenth of a second)** how long it takes the float travel the known distance.
With other simple measurements done at low flow, Salmon Forever can estimate the discharge (creek flow rate). Using discharge and the grams/liter of sediment in your samples, we can estimate the amount of sediment travelling down your creek.

F. COLLECTING THE GRAB SAMPLE FROM THE STREAM
Use the same location each time and take a sample by standing on the bank, holding a bottle in your hand and reach into the water. You can also sample from a bridge by tying a bottle to a string and lowering it into the water or set up a pole to hold a bottle and lower it into the water that way. If you sample from a bridge always sample at the same spot. You can put a mark on the bridge where you sample. Volunteers may be trained in other sampling methods as needs arise. Please keep your coordinator informed of changes in your availability for sampling.

In general, sample away from the riverbank in the main current. Never sample stagnant water or backwater eddies. The outside curve of the river is often a good place to sample since the main current tends to hug this bank.

To collect water samples using screw-cap sample bottles, use the following procedures.

1. Label the bottle with the site name, date and time. Use a piece of tape to write on the plastic bottles and use a pencil only to write on the white portion of the glass HACH cell. Note site on ID # label if possible.
2. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
3. Hold the bottle near its base and plunge it (opening downward) below the water surface. Collect a water sample 4 to 6 inches beneath the surface or mid-way between the surface and the bottom if the river reach is shallow.
4. Turn the bottle underwater into the current. In slow-moving river reaches, push the bottle underneath the surface and away from you in an upstream direction.
5. Leave an air space. Do not fill the bottle completely (2/3 is fine so that the sample can be shaken, just before analysis**). HACH cells must be filled to above the white line**. Recap the bottle
6. **LABEL THE SAMPLE BOTTLE!** Label the bottle with, date, time, location, stage, and velocity. Mark the water level in the bottle at the time of sampling with a mark on a piece of tape on the outside of all sample bottles, **except the HACH cells.** We can tell if the bottle leaked if the water level is different when we receive them in the lab. Use only a pencil to mark HACH Turbidity cells. Check legibility because wet bottles can ruin good information**. Incomplete or unclear labeling, even failure to mark the water level, is wasted effort.**
7. **WRITE IN YOUR NOTEBOOK**: date, time, location, the sample ID #, stage, and velocity for each sample. Failure to record any of this information renders the sample useless and it must be thrown out.

5. Sample Handling and Preservation:

The chain-of-custody for these samples is as follows:

1. The Volunteer is responsible for samples until they are picked up or measurements recorded by a Field Manager or Watershed Coordinator or until the volunteer drops off and signs the samples into the Sunny Brae Sediment Lab.
2. The Field Manager or Watershed Coordinator is responsible for samples until they are checked into the lab.
3. The Field Manager or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data.
4. The Lab Manager is responsible for processing samples.

The date and time of arrival at the Sediment Lab is recorded on the Lab Sign In sheet by whoever brings the sample into the lab.

A. PREPARING SAMPLE CONTAINERS

Sample containers and glassware must be cleaned and rinsed before the first sampling run and after each later run. The lab volunteers may prep containers for field volunteers beforehand. If there are dirty bottles in the lab when you sign-in your samples, please try to clean some for everyone else. The following method should be used when preparing all sample containers and glassware for monitoring.

1. Wash each sample bottle with a brush and phosphate-free detergent (Alconox).
2. Rinse three times with cold tap water.
3. Rinse twice with distilled or de-ionized water.

B. STORING THE SAMPLES

Samples must be kept in a dark and cool place or refrigerated. Return samples to your Watershed coordinator or the Sunny Brae Sediment Lab ASAP**.** Make sure all your samples are labeled. Ideally, the turbidity (NTU's) should be measured within 48 hours. After you take the turbidity reading put a drop of HCL in the sample afterwards to retard algae. Turbidity reading protocols are provided in a separate SOP

6. Troubleshooting:

Try to keep field forms and bottles dry when writing down information.

7. Data Acquisition, Calculations & Data Reduction:

Volunteers will record field-sampling data (discussed in Section 4 of this SOP) using ready-made sheets in binders or Rite in the Rain notebooks. The Field Managers or Watershed coordinator makes copies and returns the binder or field notebook to the samplers. Field data is recorded along with laboratory measurements on laboratory forms completed when sample analyses are performed. Calculations and data reduction are performed primarily in Excel spreadsheets after all measurements are completed and both field and laboratory data are recorded from the Field and Laboratory forms.

Originals of Lab forms will be kept in the Sunny Brae Sediment lab. Copies of Field and Lab forms will be kept in Salmon Forever Offices. Hard copies of all data (field and sediment lab), as well as computer back-up disks, will be maintained by Salmon Forever for at least 10 years. QA/QC sheets will also be maintained by Salmon Forever for 10 years. Originals of ISCO Automatic Sampler field sheets will be maintained for 10 years at the Salmon Forever Sediment Lab location. Copies will be given to RSL.

8. Computer Hardware and Software Used:

No special hardware is needed for suspended sediment concentration determination, calculations and data analysis. Software used will primarily be Microsoft Word and Excel programs. Software may also include specialized statistical and graphing programs developed by Redwood Sciences Lab personnel.

9. Data Management & Records Management:

Sample information is entered on standardized field and data forms. See Appendix 2 for examples of all standardized forms. The Volunteer, Watershed Coordinator and Field Manager are responsible for double checking and copying Field Data forms and delivering them to the Project Manager. Salmon Forever will keep the originals. Upon determination of turbidity and suspended sediment concentration results will be transferred to Excel spreadsheets and Word documents. Copies will be kept at the Sunny Brae Sediment Lab and Salmon Forever offices.

All data sheets will have the Hydrologic Year, initials of the person entering data, the date of data entry and the date of copying. Sign-in sheets will be numbered sequentially.

Data will be examined and rated using field codes that indicate the quality of the data. Any outliers or nonsensical data will be detected during calculations and transfer to spreadsheets and documented. Data will be in a format acceptable to EPA, RSL and NCRWQCB.
Data and calculations will be checked at the time of transfer from paper to spreadsheets and during data analysis.

11. References:

EPA:
Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995
EPA QA/G-5 Guidance for Quality Assurance Project Plans
EPA QA/G-6 Guidance for the Preparation of Standard Operating Procedures (SOP's) for Quality Related Documents
EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations

USGS

Techniques of Water-Resources Investigations of the USGS:
- Stage Measurements at Gaging Stations Book 3 Chapter A7
- Discharge Measurements at Gaging Stations Book 3 Chapter A8
- Laboratory Theory and Methods for Sediment Analysis Chapter C1 Book 5
- Field Methods for Measurement of Fluvial Sediment Chapter C2 Book 3

Surface Water Techniques:
- Discharge Ratings at Gaging Stations - Hydraulic Measurement and Computation Book 1 Chapter 12 1965

Others:

Laboratory Procedure for Total Suspended Solids, Redwood Sciences Laboratory, USDA Forest Service, Arcata Ca, Rand Eads, 12-10-98

Harrellson, C. C., 1994, Stream Channel Reference Sites: An Illustrated Guide to Field Technique: USFS, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-245.

STANDARD OPERATING PROCEDURE

HACH 2100P Turbidimeter

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope

The HACH 2100P Turbidimeter operates on the nephelometric principle of turbidity measurement. Turbidity is the cloudiness or opacity of a normally clear liquid due to a suspension of solid particles or colloidal droplets. A light of a known intensity is directed through a liquid and the amount of light blocked by particles suspended in the liquid is the degree of turbidity.

This Standard Operating Procedure covers the proper handling of samples and turbidity determination for the Watershed Watch program. Since most samples are processed for suspended sediment concentration (SSC) after turbidity determination, the sample handling and preservation protocols are the same. Turbidity of samples should be measured in the field and then samples are delivered to Sunny Brae Sediment Lab for SSC determination. If a turbidimeter is not available in the field, the turbidity measurement should be made as soon as the sample is delivered to the laboratory.

2. Apparatus

The Hach 2100P Turbidimeter measures turbidities from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The instrument operates on 4 AA batteries. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1

The optical system includes a tungsten-filament lamp, a 90-degree detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90-degree and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Range: 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU.
Accuracy: ± 2% of reading plus stray light from 0-1000 NTU
Resolution: 0.01 NTU on lowest range
Repeatability: ± 1% of reading or 0.01 NTU whichever is greater (with Gelex Standards)

Turbidity is measured using one of the four identical instruments listed below:

HACH 2100P Turbidimeter - Serial # 960100009614
HACH 2100P Turbidimeter - Serial # 990800022423
HACH 2100P Turbidimeter - Serial # 990800022431
HACH 2100P Turbidimeter - Serial # 990800022441

Other equipment needed to perform turbidity analyses are listed below:

StablCal Ampule Kit, 2100P, Hach Catalog # 26594-05
Gelex Standards, Hach Catalog # 24641-05
Sample Cells pk/6, Hach Catalog # 24347-06
Instrument Manual, Hach Catalog # 46500-88
Silicone Oil, Hach Catalog # 1269-36
Oil Cloth, Hach Catalog # 47076-00
Beaker
Calculator
Data Sheets (SSC Lab data sheet, Lab Sample Sign-in Sheet, Field Data Sheet, and NTU Dilution Sheet)

3. Calibration

The HACH 2100P Turbidimeters is calibrated at least quarterly using the HACH StablCal Stabilized Formazin Ampule Kit (Catalog #26594-05). More frequent calibration is performed if needed. Calibration with the StablCal ampules follows the manufacturer's instructions included in the kit. Ampules have a limited shelf life and are not used after the expiration date. Turbidimeters are not used for measurements until Stablcal calibration is successfully completed.

StablCal Stabilized Formazin Primary Standards are cited as calibration standards in USEPA-accepted *HACH Method 8195 for Determination of Turbidity by Nephelometry*. The letter of acceptance states specifically that Method 8195 may be used for wastewater (NPDES) and drinking water (NPDWR) compliance monitoring.

The HACH 2100P Turbidimeters are checked with Gelex standards every month . If Gelex results are more than 5% different than the previous month's results the Turbidimeter is not used until recalibrated successfully with Stablcal standards.

The Lab Manager is responsible for implementing and documenting calibration of HACH 2100P Turbidimeters. All equipment calibration records are kept by the Lab Manager and are available upon request. All equipment shall have an identifying number and linked to calibration records.

4. Sample Processing

Turbidity determination follows the turbidimeter manufacturer's instructions. Refer to the instrument manual for further instructions or clarifications. Turbidity is to be run on all samples as soon as samples enter the lab and recorded on sign-in sheet and data sheet. Turbidities are recorded, 3 drops of 1:1 HCL solution are added, and samples are placed back in order for SSC processing.

A. Use this protocol for determining the turbidity of samples in HACH cells:

1. Put 1 drop of silicone on HACH cell and wipe cell with black cloth; do not wipe off sample label.
2. Shake HACH cell for at least 10 seconds and then insert HACH cell into turbidimeter with white diamond point of HACH cell label aligned with bar on case of HACH 2100P Turbidimeter.
3. Wait 2 seconds for air bubbles to rise before pressing read button.
4. Record turbidity on sign-in sheet.

B. Use this protocol for samples in sample bottles other than HACH cells:

1. 1.Shake sample bottle vigorously until no sediment is stuck to the bottom.
2. Pour shaken sample bottle water into the HACH cell as quickly as possible.
3. Fill HACH cell up to white label line and run and record turbidity follow the steps listed in "A" above.

C. If the HACH 2100P Turbidimeter reading is a flashing E3 or 1000+ thenthe sample needs dilution to determine the turbidity. Use the NTU Dilution sheet (Attachment 1) to record and calculate dilution data.

If you are not proceeding directly to suspended sediment concentration processing, do not proceed with the dilution. Pour the sample back into its original container. Check the original volume mark to make sure that the water level is the same and store the sample in a cool, dark place until you are ready to dilute and run SSC.

If dilution is needed and you are proceeding directly afterwards to SSC processing, weigh the total sample bottle weight before running turbidity then follow the steps below:

1. Shake sample bottle thoroughly until no sediment is clinging to the bottom.
2. Pour the sample water into a tared beaker and record the sample weight in grams as “original volume”.
3. Add the appropriate dilution volume of distilled water to the beaker to original volume and record the total water weight in grams as “1st dilution volume total". Use this additional dilution water to rinse interior of sample bottle and lid and/or the HACH cell into beaker.
4. Mix sample water thoroughly and pour sample water into a HACH cell.
5. Continue dilutions until turbidity can be determined
6. Calculate the actual sample turbidity.
7. For small volume dilutions pour the sample water in the beaker into the HACH cell as soon as possible.
8. For large volume dilutions, stir with a spoon and dip the HACH cell into the beaker to capture a representative sample.
9. Follow the steps in “A” above to determine the turbidity.
10. Either pour HACH cell water back into sample bottle or proceeded to SSC processing using both the HACH cell and the remainder of sample in the beaker

5. Handling & Preservation

Samples need careful handling to avoid scratching the cells. Be sure to wipe all moisture and fingerprints off the cells before oiling and inserting them into the turbidimeter for measurements.

Samples are kept in a cool, dry place and covered with black plastic. Samples will be transported to the Sunny Brae Sediment Lab as soon as possible after acquisition and turbidity measured within 48 hours of sampling.

Samples are preserved by adding 3 drops of a 1:1 HCL solution to retard algae growth after the turbidity is determined. The maximum sample holding time is 1 year. Cells are washed with Alconox lab detergent or an equivalent non-abrasive detergent. Cells are rinsed 3 times with tap water and then rinsed three times with distilled water and allowed to dry before reuse.

6. Troubleshooting

The HACH 2100P Turbidimeter manual has a troubleshooting section beginning on page 53. Please consult the manual for specific problems. The turbidimeter will display error codes to indicate sample interferences and/or instrument malfunction.

If a turbidimeter is consistently reading 99.9 NTU on samples that are easily over that, check to make sure the auto range is displayed on the readout. The instrument range is limited to 3 pre-set ranges if auto range is not selected. The battery icon will flash when battery replacement is needed. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them.

Maintenance:
All equipment is inspected and maintained to EPA and Manufacturer requirements. The 2100P requires very little maintenance other than keeping the instrument clean. Maintenance logs are kept for all appropriate equipment. All records, lab equipment and spare parts are stored at the Sediment Lab.

If equipment is not working, it will not be used until inspection by the QA manager and repair or action documented.

7. Data Acquisition, Calculations & Data Reduction

Turbidity is read directly from the display of the HACH 2100P Turbidimeter and no calculations are involved. When sample turbidity is above 1000 NTU, the upper limit of the turbidimeter, then the sample is diluted and the actual turbidity is calculated. That calculation is described below.

Dilution calculation:

> Use the NTU Dilution form to document dilution of samples too turbid to measure turbidity of the sample directly. Transfer all identification data from the label and data sheet to the dilution form for each sample. Conduct dilutions immediately before the SSC measurement.
>
> **Dilution Calculations:** $\frac{\text{Original volume x Dilution Turbidity}}{\text{Total SampleVolume after dilutions}}$ **= Actual Turbidity**

Other data sheets used to record sample information are:

Sign-in Sheet

1. Persons bringing samples into the lab must record the date of samples brought into lab and name of person who brought the samples into the lab on the sign-in sheet .

2. Record the ID #, location, date, time of sample and who collected the sample on the sign-in sheet.

3. Run turbidity on sample per this SOP and record NTU, date, time and who conducted NTU determination.

4. If turbidity is too high initially for HACH 2100P Turbidimeter, note this by assigning the sample a turbidity code of 1 on sign-in sheet and the turbidity will be run by diluting by lab techs. at the time of suspended sediment concentration determinations. A sample with a turbidity of less than 1000 should have a recorded a turbidity code of 0.

5. Record stage, velocity, and type of sample and all other pertinent data on sign-in sheet.

6. Put samples in appropriate place and cover with a black piece of plastic or proceed with suspended sediment concentration determination using appropriate data sheet.

Field Data Sheet

Grab Sample labels shall, at minimum, include a sample location, sampling time and date. Data recorded shall include time and date, location, person sampling, velocity, and stage. If turbidity is determined in the field the Field Data Sheet will describe who conducted the determination and when.

8. Computer Hardware and Software Used

No special hardware is needed for turbidity determination and calculations and data analysis.

9. Data Management & Records Management

Turbidity measurements are written on the Lab sign-in sheet. These results are also transferred to the suspended sediment concentration data sheets as each sample is processed for SSC. The SSC data are entered into Excel databases for data analysis. Data and calculations are double-checked as data are entered into spreadsheets. Turbidity may also be measured in the field and entered on Field Data sheets. Field measured turbidity are transferred to the Lab sign-in sheet when samples are brought to the Lab.

The Volunteer, Watershed Coordinator and Field Manager are responsible to double check and copy Field Data sheets and deliver them to the Project Manager. The Lab Manager is responsible for double-checking and copying lab data sheets and delivering them to the Project Manager. Lab data sheet originals are kept in the Sunny Brae Sediment Lab. Reports and data are transferred to Excel spreadsheets and computer disk copies kept at the Sunny Brae Sediment Lab and Salmon Forever Offices.

Data are examined and rated on the basis of field and lab codes pertaining to the quality of data and whether or not dilutions was needed.

Turbidity Codes:

0 - Sample turbidity < 1000 NTU.
1 - Sample turbidity > 1000 NTU. Dilution needed for turbidity determination

10. References

HACH 2100P Portable Turbidimeter
Instrument and Procedure Manual Catalog # 46500-88

Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995

STANDARD OPERATING PROCEDURE

Discharge using Price AA and Pygmy Current Meters

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope:

This SOP covers the proper use of a current meter to determine the discharge of a stream or river. Stream discharge is the volume of water passing a cross-section per unit of time and is generally expressed as cubic feet per second. Simply, discharge is calculated as water velocity times stream cross-sectional area. However, the velocity in a stream varies with position on the cross section so velocity must be measured at numerous points along the cross-section to accurately measure the discharge. The purpose of collecting discharge measurements is to develop a rating curve. A rating curve defines the relationship between stage (water depth) and discharge at a particular location on a stream or river.

2. Apparatus:

- USGS Price AA current meter
- USGS Pygmy current meter
- 4 foot top set wading rod
- Headphones
- USGS Type A Crane with Type A 4-wheel truck with 2-60 lb counter weights
- A-55 reel and Columbus weight with AA Price meter
- Calculator
- Data Sheet / Clipboard / Pencil
- Waders / Bag for waders
- Stopwatch
- Measuring Tape (300 ft long and in 0.1 feet increments) / Spikes
- Camera
- Drying Cloth,

3. Calibration:

The manufacturer calibrates all equipment used before purchase. The meter cannot be adjusted by the samplers.

4. Sample Collection:

There are no sample collection requirements.

5. Handling Preservation:

There are no sample handling requirements.

6. Troubleshooting:

Before each use, the meter should be spin tested. Spin testing is accomplished by holding the meter perfectly level and spinning the cups by hand. A meter in good working order will spin freely for greater than 60 seconds, preferably closer to 90 seconds. Be careful to avoid wind while checking the meter. Debris or dirt in the pivot bearing may slow the spin duration of the meter cups to below 90 seconds. Remove any debris and add a drop of oil and recheck spin duration. Another reason the cups may not spin freely is that the wire that

contacts the shaft is too tight against the shaft. This wire can be adjusted very carefully with tweezers or a small screwdriver. Watch for wobble in the cups as they spin, this indicates the pivot pin is not properly installed.

If the cups are spinning properly and no clicks are heard, check the batteries. If the batteries appear to be charged, check that the contact wire is touching the shaft on each revolution. If the wire is not making good contact, use tweezers to adjust the wire until clicks are heard. Be careful not to make the wire pressure too hard.

Periodically check the reel and wire of the A-55 cable/reel sampler for frayed wire or worn areas that should be replaced. Lubricate the wire and reel with the appropriate grease.

7. Data Acquisition, Calculations & Data Reduction:

Safety:

- Never wade deeper than your waist under any conditions. In high velocity, conditions even water waist deep is not safe.
- Always have a partner nearby.
- Watch for debris coming downstream.

Site Selection:

For best accuracy, select a discharge measurement cross section with the following characteristics:

1. A straight reach, with a uniform depth and as rectangular a channel morphology as possible.
2. A streambed free of large rocks, weeds, and obstructions that create turbulence.
3. A site with a stable stream bottom.
4. A site that can be accessed for measurements over a range of discharges.

When measuring discharge, note the stage before you start and right after you finish to assess whether water levels are rising or falling and how rapidly.

Setting Up:

1. Determine the wetted width of the stream. Secure a tape measure extending from behind the water's edge on the left bank to beyond the water's edge on the right bank. Use a cloth or fiberglass tape and use spikes to secure both ends so the tape is tight across the stream. Set up the tape perpendicular to the direction of flow. Determine and record on the data sheet the locations on the tape measure of the Right-edge-of Water (REW) and LEW. Determine, and record on the data sheet, the dead right-edge-of Water (DREW) and DLEW. This can also be called zero velocity right and zero velocity left. This is the point where the water with no current meets the water with a current. **Left and Right are determined when facing downstream.**
2. Determine spacing of the subsections. Generally use 15 to 25 subsections. However, no subsection should have more than 5 % of the discharge or be less than 0.5 feet in length
3. Preferably discharge is taken consistently at the same cross-section.

Meter Selection:

- If the water depth is below 0.5 feet use the Pygmy current meter.
- If water velocity is below 0.25 ft/sec use the Pygmy current meter.
- Use the Price AA meter with a top-setting rod for depths up to 3 feet.
- Use a crane and weight for high stage measurements.

Top Set Wading Rod Use:

1. Place the rod in stream so the base plate rests on the streambed.
2. Holding the wading rod at the tag line (tape measure line), record the position on the cross-section.
3. Stand in a position that least affects the velocity of water passing the meter. Stand well behind the meter with your arm extended, 18 or more inches from the wading rod.

4. Read the depth of water on the hexagonal rod. The hexagonal rod is marked with 1 line every 0.1 feet, 2 lines every 0.5 feet and 3 lines every 1.0 feet.
5. The numbers on the handle at the top of the wading rod corresponds to tenths of a foot of water depth. Use the measured water depth and the scale on the wading rod handle to place the meter at the correct depth in the water column.

   If the water depth is 2.5 ft or below, match the feet measurement on the round rod with the number of tenths of feet on the handle. For example, if water depth is 2.3 feet, squeeze the rubber trigger and raise the round rod so the #2 mark on the round rod (representing 2 feet) is even with the #3 on the vernier scale at the top of the hex rod.

   If the water depth is more than 2.5 feet, you need to make velocity measurements at two depths (0.2 and 0.8 of the actual water depth) at each measurement position. The average of these two velocities is the subsection velocity. To set the top set rod for the 0.8 depth below surface position, use depth numbers corresponding to 1/2 the water depth. To set the top set rod for the 0.2 depth below surface position, use depth numbers corresponding to twice (2) the water depth.

6. To collect your velocity measurement:

- Keep the wading rod in a vertical position and the meter parallel to flow.
- After the meter is positioned at the proper depth, allow it to adjust to the current before starting your measurement (usually 10 seconds).
- Count the revolutions (clicks) made by the meter.
- Count for at least 40 seconds, one minute is best.
- Start your stopwatch simultaneously with the end of the first click, starting counting with zero.
- Stop the stopwatch at the end of the click after at least 40 seconds.
- If flow is not at right angles to the measuring tape line, measure the angle of flow and record it.

Rapid changes in the water depth will affect the quality of the measurements. Always record the beginning and ending water level (stage) and the beginning and ending time of your discharge measurements.

Bridge Use: A-55 Sounding Reel and Crane

The Columbus weight is lowered until the horizontal fins are level with the water surface.
The A-55 depth-measuring reel is zeroed out and the weight is lowered until it touches bottom.
The depth of water is read off the reel and a chart is consulted for the proper depth of the current meter.
The weight is raised to the proper depth and velocity measurements begin.
All other measurement procedures are the same as with the top set rod, step 6.

Record all of the following information on your data sheet:

- The name of stream and exact location, any rebar point and/or photopoint.
- Who is doing the measurements?
- The date, type of meter suspension (top set rod or crane), and meter id #.
- The distance points on the tape measure of the REW and LEW.
- The distance points of DREW (dead right edge of water) and DLEW or zero velocity.
- The distance point on the tape measure of each subsection.
- Starting, Finishing and Elapsed time of the measurement in military time. Read the time to the nearest sec.
- Record which bank of the stream is the starting point and bank of stream where measurement ends.
- Record stage heights from a staff plate and corresponding times when staff plates are read (at least at beginning and end of measurement). Also record any electronic stage levels at the same time.
- Record measurement method (0.6 depth from bottom position or others).
- Record measurement time to the nearest tenth of a second and number of revolutions.
- If flow is not at right angles to the measuring tapeline, measure the angle of flow and record it.
- The spin duration check results

Calculations:
To determine velocity with the Pygmy current meter use the following formula:

V = 0.977 R + 0.028 V = velocity in Feet /Second R = Rev / Time in seconds (0.1)

To determine velocity with the Price AA meter use the following formula:

Less than 40 revolutions	More than 40 revolutions
$V = \frac{Rev}{Time} \times 2.180 + 0.020$	$V = \frac{Rev}{Time} \times 2.170 + 0.030$

Note: These formulas are specific to a meter and are determined during calibration by the manufacturer. Be careful that you are using the correct formula for your meter.

The rating chart or velocity equation is used to determine velocity. The width and depth of each subsection are used to calculate the subsection's cross-sectional area. The area multiplied by the velocity gives the discharge for each subsection. The discharges for all subsections are summed to determine the total discharge in cubic feet per second for the cross-section at the stage measured. See the references listed below for more details

8. Computer Hardware and Software Used:

Excel or similar software will be used to calculate discharges and create discharge-rating curves for stream locations.

9. Data Management & Records Management:

Copies of the discharge measurements will be given to the data analysis manager for analysis. Original discharge records will be kept at the Sunny Brae Sediment Lab and copies will be kept at Salmon Forever offices for 10 years.

10. Maintenance:

Clean and oil the meters after each day's use. If measuring in dirty water, rinse immediately after each measurement with clean water. Clean and oil the pivot bearing, pentagon teeth and shaft, cylindrical shaft bearing and thrust bearing. After oiling spin the rotor to make certain it operates freely. The duration of spin should be over 90 seconds. An obvious decrease in spin duration indicates the need for attention to the bearings.

After every 8 hours of use or at least once a week, lube the pivot, pivot bearing, and the upper bearing in contact chamber.

When transporting the Price AA meter keep the pivot off the pivot bearing by tightening the nut beneath the cups. The nut is a reverse thread so rotate nut as if to loosen to tighten and vice versa. Tighten nut until cups no longer rotate freely. Completely loosen to use. When transporting a Pygmy meter replace the pivot bearing with the transport bearing. Repair minor dents in cups in the field. If there is major damage replace the set of cups.

11. References:

Harrellson, C. C., 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique: USFS, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-245.

Buchanan, Thomas J.,1973. Discharge Measurements at Gaging Stations, USGS, Chapter A8, Techniques of Water-Resources Investigations of the USGS, Book 3 Applications of Hydraulics.

STANDARD OPERATING PROCEDURE

Laboratory Procedures For Suspended Sediment Concentration

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope:

This Standard Operating Procedure covers the proper handling of samples and suspended sediment concentration (SSC) or total suspended solids (TSS) determination. This SOP follows the Redwood Sciences Lab SOP for suspended sediment concentration determination. Suspended Sediment Concentration is determined by vacuuming water samples through tared 1-micron glass fiber filters with a vacuum assembly. Filters will be dried in an 105^0 C oven, cooled in a dessicator and then weighed on a Mettler H20T balance to the nearest 0.00001 g. Sample water weight and sediment weight is used to calculate suspended sediment concentrations in mg/L and PPM.

Depending on the size of a sediment particle, a stream transports the sediment by maintaining the particle in suspension with turbulent currents or by rolling or skipping the particle along the streambed. In general, fine-grained sediment (silt and clay) is transported in the water in a suspended state supported by the action of turbulence. Suspended sediment load is that part of the solid load the weight of which is transmitted by the fluid of the main flow to the fluid in the interstices of the grain bed. The excess or immersed weight of the suspended load must be equal to the mean upward flux of momentum by upward fluid currents in the turbulent eddies. (Leopold 1994).

2. Apparatus:

All supplies used in the study will be either ordered from the manufacturer or through a scientific supply house. Supplies will not be accepted unless in proper working order. All supplies and equipment are purchased and inspected under the supervision of the Lab and Field Leader. Lab water shall be retail distilled water purchased locally. The Lab Manager shall inspect sample bottles before use. Copies of equipment invoices shall be kept in the Sediment Lab and Salmon Forever Offices.

Mettler H20T Analytical Balance S/N 418151 and appropriate Checkweight
AND FY 3000 scale S/N 5608313 and appropriate checkweight
Filters - Gelman P/N 61631 Type A/E 47mm, 1 micron, glass fiber
Grieve Laboratory Oven LR270C
Dessicator /Sanplatec Co.
Desiccant
Humidity Reader - VWR Digital
Vacuum Pump and 47mm-filter filter flask and funnel vacuum assembly
Forceps
Distilled Water, spray bottles
Timer
Drying Racks

3. Calibration:

All equipment calibration records will be kept by the Lab Manager and are available upon request. The only equipment used in this SOP that requires calibration are the Mettler H20T Analytical Balance S/N 418151 and the AND FY 3000 scale S/N 5608313.

Balances are calibrated annually by Woolard and Sons - PO Box 3438, Eugene OR, 97302, 503-581-9669. Balances are calibrated and tested for accuracy in accordance with National Institute of Standards and Technology Circular No. 547, Section 1, of the Precision Laboratory Standards of Mass and Laboratory Weights and meet the manufacturers specifications for these balances in conformance with ANSI/NCSL 540-1-

1994. These weights are directly traceable to the National Institute of Standards and Technology through our master set No. 349-A, Ainsworth Inc. Class "M", Serial No. 27572, Watson Bros. Inc. Test No. 1659, and directly traceable to NIST by Watson Bros. Inc. Set No. 1254-M, Serial No. 27925, NIST Test No. 523/240632. Balances shall be calibrated more frequently if needed. Scales shall not be used that have not been successfully calibrated.

The Lab Manager is responsible for calibrating balances and scales and taking out of use any scale or balance not in working order. The Lab Manager shall document all calibrations and keep records for at least 10 years.

4. Sample Processing:

The Volunteer is responsible for samples until they are brought to the Lab or until they are picked up or measurements are recorded by the Field Manager or Watershed Coordinator. The Field Manager or Watershed Coordinator is responsible for samples until they are checked into the lab. The Field Leader or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data. The Lab Manager is responsible for processing samples. The date and time of arrival at the Sediment Lab is recorded on the Lab Sign-In Sheet by whomever brings the sample into the lab. Samples at the lab shall be kept in a cool dark place until processing. The Lab Sign-In Sheet format is presented in Appendix 2 of the QAPP.

Analytical procedures follow Redwood Science Lab (RSL), EPA, and Standard Methods (#2540B - Total Solids Dried at 103-105^0 C) protocols. Suspended sediment concentration is determined by vacuuming water samples through tared 1-micron filters with a vacuum assembly. Filters will be dried in an oven, cooled in a dessicator and then weighed on a Mettler H20T balance to the nearest 0.00001 gram. The filter used is Gelman P/N 61631 Type A/E 47mm. The filters are dried at 105^0 C and cooled in a dessicator before weighing. Sample water weight and sediment weight are used to calculate suspended sediment concentrations in mg/L and PPM.

A. Types of samples:

TTS (Turbidity Threshold Sample) - ISCO Sampler

Samples are collected in ISCO 1000mL plastic bottles (the nominal sample volume is 350mL). These samples are collected under data logger program control where pre-established turbidity threshold criteria are met. See ISCO SOP for details

AUX (Auxiliary Samples) - ISCO Sampler

AUX samples are similar to TTS samples but are manually triggered via the data logger program. AUX samples are collected when too few samples have been collected during a storm and/or when equipment has malfunctioned. The label, in addition to normal ISCO identification, should also include “AUX".

DIS (Depth Integrated Samples) - DH-48 Sampler

Samples are collected in 500mL (l-pint) glass “milk bottles" in intervals across the width of the entire stream using a DH-48 sampler. They will be collected using the equal time retrieval method. See DIS SOP for details These samples represent the cross- sectional average of sediment concentration and are used as “truth" to correct the TTS pumped samples (which are not flow-averaged, but are point samples). A simultaneous pumped sample is collected, via the data logger program, while the field crew manually collects the DIS bottle. The plastic ISCO bottle, in addition to the normal identification, should also include "DI". (The DIS and matching ISCO "DI" bottle should always be analyzed as a pair; e.g. they both would require sand fraction analyses to permit comparison later).

Grab Samples

Samples are collected in HACH Sample Cells, 2 X 6 Plastic Bottles (2x6 P.B.), 3 x 8 plastic Bottles (3x8 P.B.), 500 mL glass “milk bottles" or any other useful container. These samples are usually taken by hand from shore or with string off a bridge. Usually collected by volunteers, these samples represent a single point sample. Labels will include location, date, and time sampled. See Field Sampling SOP for details.

B. Preparing Filters

1. Always handle filters with forceps.

2. A fingerprint weighs approximately O.OOOl g. This adds a lO% error for a sample weighing O.OO1Og.

3. When first taking filters out of the box, inspect them carefully since they have a tendency to stick together; separate as necessary. Hold each filter up to the light to verify that there are no holes. Discard defective filters.

4. Write the filter ID number on "furry” side of filter with light pressure from a dull-pointed "Ultra-Fine Sharpie" marker. Underline the numbers so that they will not be confused when read upside down. Wait at least 10 minutes to allow the ink to dry before rinsing filter on vacuum assembly.

5. Record filter ID number on initial tare sheet. If a filter is contaminated or punctured, discard that filter and record it as "discarded" on tare sheet (the "missing" filter is then accounted for).

6. Seat filters, slightly off-center, with furry side down on the vacuum manifold.

7. Turn on the vacuum and rinse the filter several times with lab grade water to remove any loose fibers. Check for holes. If there is a hole, air will whistle through it and make a jet-like sound.

8. Turn off the vacuum and carefully remove filter with forceps. Place the filter on a wire rack and allow 1 hour for the filter to air-dry.

9. Place filters on a Teflon or glass or aluminum pan and heat in oven at 105°C for at least l/2 hour.

10. Remove pan from oven and place in desiccator cabinet to cool for at least l/2 hour before weighing. Do not remove filters from desiccator cabinet until ready to weigh since they will absorb moisture from the air.

ll. Take out only 4 or 5 filters at a time. If the last filter in your batch has been out of the desiccator cabinet for more than 10 minutes before weighing, you have taken out too many filters. Reduce the number of filters the next time a new batch is removed. The filters should not be weighed when the relative humidity in the desiccator is more than 28%. Try to keep the humidity level in the desiccator between 10-25%. When the humidity approaches 20%, place the desiccant in the oven to bake overnight. Never weigh filters when your hair or clothing is wet.

12. Weigh each filter and record the weight on initial tare sheet. See Section 7 for details on weighing filters. Store prepared filters in a clean, dust-free container or a pan covered with aluminum foil. Do not stack or overlap the filters.

C. Volume Marks

1. Volume marks are made on all ISCO, DIS and AUX bottles in the field. The volume mark on plastic bottles is made on the middle of a strip of 3M-nylon first aid tape that is taped on the edge of the bottle. Bottles shall be taped in the field. The volume mark on glass DIS bottles is made on the vertically etched strip with a pencil or tape.

2. In the lab before processing place bottle on a level counter and loosen the cap if it is a plastic bottle.

3. Check the volume mark for accuracy when samples are signed into the lab. Compare the volume mark on the tape or etched glass to the actual water level (read the level from the bottom of the meniscus).

4. If the difference between the volume mark and the actual sample volume is more than 1.0 cm attempt to determine the cause (cap not tight, cracked bottle, tape did not adhere, mark missing, unknown cause, etc. Assign a Lab Code of 6 on the lab form.

5. After processing the sample, fill the bottle to the field volume mark then weigh the bottle and record the weight.

6. Make notes in "Comment" column.

D. Volume Measurement for a Missed Bottle Weight

1. After processing the sample, add filtered water to the bottle until the bottom of the meniscus matches the volume mark on the side of the bottle.

2. Weigh the bottle, with the water, with or without the cap depending on the type of sample, and write the value in total weight column. If there are no other problems with the sample, place a lab code of 6 on the data sheet. Pour the water from the bottle into a graduated cylinder, note the total volume, measured from the bottom of the meniscus (+/- 1mL), and write this volume in the comment column.

E. Suspended Sediment Determination

l. Use appropriate sheet for sampling method (ISCO,DIS,Grab).
See Section 7 for filling in appropriate data sheets before processing.

2. Use tared blank filters in numerical order.
Record the filter ID number on the appropriate data sheet.

3. Transfer the filter initial weight value to the data form.

4. Place a filter, numbered side down, on funnel support.

5. Turn on vacuum and wet the filter with lab grade water to check for tears or holes. Clamp the funnel on top of filter.

6. ISCO/DIS samples - Weigh the sample bottle with the cap off. Weigh container after drying to obtain tare bottle weight.
Grab Samples- Weigh sample bottle with the cap on.

7. Record the weight of the full bottle under the "Total Bottle Weight" column.

8. Pour the sample from the bottle into funnel. For faster filtration, try to pour the clear water through first without disturbing the sediment on the bottom of sample bottle. Then swirl last portion of water with settled sediment and pour into funnel. Rinse the inside of the cap into funnel.

10. Rinse sediment from bottom of the bottle into funnel, using lab grade water. Rinse the sample bottle several more times, making sure to remove all of the sediment. It may take several filters per sample to assure a reasonable filtering speed and drying time; if it takes more than two seconds per drop of filtrate (that part which passes through the filter), then another filter should be used.

11. Shake Grab Sample bottles thoroughly to get rid of any excess water and record bottle and cap weight under " Tare Bottle Weight " column. Weigh empty ISCO bottles after drying thoroughly.

12. Rinse funnel thoroughly with squirt bottle to wash sediment down onto filter and carefully remove funnel. If any sediment remains on inside rim of funnel after funnel is removed, carefully rinse off the funnel over the filter. Turn off vacuum.

13. Remove filter using forceps and place on wire rack for one hour. Do not touch fingers to filter.

14. Record the number of filters used under the column labeled "Filter Total". If total number filters used is one, the notation in column "Filter Total" would be “l l", or one-of-one. If two filters are used, the notation would be "1 2" (one-of-two) for the first filter, and “2 2" (two of-two) for the second filter for the next line, and so on. Since it is difficult to determine how many filters per bottle will be required, process the bottles in numerical order (so enough space is available for multiple filters on the data sheet).

15. Remove any large organic debris (e.g. leaves, wood, algae, hair, etc.) with tweezers, and describe it in the "Comment" column. Try to remove the debris while the water is in the funnel to avoid the loss of sediment. If this proves too difficult, carefully remove the debris while the filter is on the drying rack.

16. Record spills, errors, or notes in the "Comment" column of the data form. It is important to record any observations or suspicions that may explain unusual results. Put a red dot next to entry on sign-in sheet after running suspended sediment concentration to signify that the sample has been run.

F. Sand Fraction Determination

l. This process may be requested for selected samples. When requested, the process is carried out before the routine filtering steps, but after weighing the full sample bottle.

2. This procedure uses the 0.063mm (#230) mesh sieve to separate sands from silts and clays. Determination of particles larger than sand size requires additional sieves, such as 0.5 mm, l. O mm and 2.0 mm. When determining more than one size fraction, the required sieves are stacked together, with the largest mesh on top and decreasing in size to the smallest mesh. Each sieve is rinsed and transferred to a separate filter.

3. Before starting, wet the sieve with lab grade water from a squirt bottle to reduce the surface tension, and rinse the bottom pan out with lab grade water. Then pour the sample through the 0.063mm sieve with pan in place beneath the sieve to catch the filtrate Rinse the sample bottle into the sieve using lab grade water from a squirt bottle. Tilt the sieve in pan (keep the pan flat on the counter) and "chase" the sediment to the lower side of the sieve with a stream of water from the squirt bottle.

4. Rinse sieve thoroughly, up to 10 times, so that only sand particles remain in the sieve, and the suspended sediment fraction goes into the pan underneath. Use water efficiently to reduce the total volume that requires filtering.

5. Chase and rinse the sand particles from the sieve into a container (one with a pour-spout will make transferring the sample into the funnel much easier during the filtering process). Rinse the sieve thoroughly so that all the sand particles are transferred into the container.

6. Process the sand fraction sediment portion using the filtering method described previously in the "Suspended Sediment Determination" section. This yields the first filter (or more if necessary) for the sand fraction.

7. Pour the suspended sediment fraction (< 0.063mm) from the pan into a pour-spout container. Rinse the pan thoroughly with the squirt bottle to remove all of the sediment. Continue to process the suspended sediment fraction using the method described previously in the "Suspended Sediment Determination" section. These filters shall be numbered in a continuing sequence following the sand portion filter(s).

8. Record which filters are "sand fraction" and which are "suspended sediment fractions" in the "Comments" section of the data or put a checkmark in the appropriate column.

9. When finished, place the bottom of the sieve upside down to allow the remaining water to drain.

G. Large Filter Procedure

1. If a sediment sample contains a large amount of sediment and is taking an excess amount of time to process (usually more than 6-8 filters), then switch to large filters. Fold large filter to fit funnel.

2. Place a large folded filter on the funnel apparatus on top of a clean empty flask, because you will be refiltering this filtrate later on a small filter. (Remember to record the filter I.D. number on the lab form.)

3. Weigh and record the bottle's weight on the lab form.

4. Slowly pour the water from the bottle onto the filter. Aim for the center of the filter and be very careful not to spill any of the material over the edges of the filter. Squirt lab grade water into the sample bottle and rinse all the sediment over to one corner of the bottle. Slowly pour the sediment onto the center of the filter. Do this procedure several times without splashing or spilling sediment over the edges of the filter. Since the funnel is larger than the filter, sediment can spill over the edges and lodge itself on the underside of the filter. This could cause problems, especially if this sediment falls off unnoticed during the drying or weighing procedure.

5. Do not discard the filtrate from the flask. Save both the filtrate and the sample bottle portion that hasn't been washed out. Set these aside for the time being.

6. Put the large filter on the drying rack. Rinse the spatulas through the funnel and then rinse the funnel into the flask.

7. Set up a small filter on another vacuum flask apparatus. Make sure to record the filter I.D. on the lab form. Pour the filtrate (from the filter flask) onto the small filter. Rinse the flask three times. Repeat the same procedure with the sample bottle. Rinse the small filter funnel as normal and place filter on drying rack.

8. Oven-dry large filters for 2 hours (instead of the usual l and l/2 hours). Cool filters in the dessicator for one hour, then weigh. The large filters absorb moisture more rapidly than the small filter. Remove no more than three large filters at a time from the dessicator and weigh them quickly.

9. Oven-dry the large filters again for 1/2 hour.

10. Cool the filters for 1/2 hour in the dessicator and weigh a second time. Make sure that the weight difference between the first and second weighing is 4% or less. If the weight difference is greater than 4% or greater than 0.5mg then repeat oven-drying for another 1/2 hour, cool in dessicator for another 1/2 hour and weigh. Repeat procedure until the weight difference stabilizes at 4% or below.

11. Record the second and third weight (only if needed) in the comment section of the lab form.

12. When processing a sand fraction sample, use the large filter for the suspended portion and the small filter for the sand portion.

5. Handling & Preservation:

The maximum holding time for all samples shall be 1 year.

All ISCO pump samples shall be given 3 drops of HCL solution. All other samples shall be given 2 or 3 drops of HCL after turbidity determination is done. This retards the growth of algae that can interfere with Turbidity determination. Samples will be kept in a cool dark place until processing. Samples will be covered with plastic to keep in the dark.

Washing Procedure

l. After processing samples, wash all sample bottles, lids, and glassware using Alconox soap and hot water. Rinse thoroughly with tap water twice, and then twice with lab grade water.

2. Set ISCO bottles upside down on pegs on the glassware dryers if available and turn switch on. Put lids on blue racks in the fume hood if available. Set Grab sample bottles on drying rack.

3. Tare the ISCO bottles, without lids, after making sure they are completely dry and are at room temperature.

4. Record the weight of the ISCO bottles in the appropriate column and place the lids back on the bottles when both are completely dry.

5. When the ISCO bottles are completely dry, tared, the lids replaced, and everything has been double-checked, the labels can be removed. Check with the supervisor first before removing any labels. Once approved, remove tape labels from bottles and return bottles to crates. Erase the pencil mark on the etched portion of the glass DIS bottles.

6. Watch for cracks, holes, or collapsed corners in plastic bottles. If any defects are noticed, discard the bottle after the label is removed.

Notes

The samples should be processed in approximately the same order in which they arrive at the lab. This limits the amount of evaporation from the bottles, reduces fading of the labels, and generally keeps the processing as parallel to the sampling as possible. Cover the bottles with black plastic to minimize light and fading of the labels. Store bottles in a cool location. Bottles that have been stored over a month or two may have significant evaporation and growth of algae. Samples will be kept in a refrigerator for long term storage.

Some bottles arrive empty or nearly empty. Check the field volume mark on the bottle to see if it was low in the field. Test for leaks by placing the bottle on paper towels for several hours. After processing, fill the bottle and place it on its side on paper towels to determine if the sampled leaked through the cap-seal.

Prepare and weigh about 50-200 new filters periodically, depending on backlog of samples and the size of the crew in the lab.

Monitor the number of bottles that are ready to be processed and organize them as you proceed.

Be aware of data dumps that have a higher priority and process them as directed by the Lab Manager

The sample bottles are very unstable and will fall over very easily. Therefore, never remove a bottle cap and set the bottle down to do something else. Keep the cap on until you are ready to filter the sample.

Plan the low-attention tasks (e.g. washing or stripping labels) when you feel you will be least alert.

Dry the desiccant every 3 weeks at 105 C for 4 hours min. or overnight. Keep the desiccator door closed as much as possible; transfer desiccant quickly. Periodically grease the door seal with silicon lubricant.

ISCO Samples are normally acidified in the field. If a sample requires acidification in the lab, use three drops of l: l HCL per sample. Samples should be acidified as soon as possible to reduce fungal growth and to flocculate the sediment, which speeds up filtering (laboratory turbidity measurements, if required, will be taken before acidification). Once the samples reach the lab, try not to disturb the samples after acidification, to allow the sediment to settle.

Use the following procedure to make a new batch of acid. CAUTION: Use face shield and gloves whenever handling acid. To make a batch of l:l HCL, add 100 mL of acid to 100 mL of water, in that order, acid to water. If acid should contact your skin, wash the area thoroughly with copious amounts of water ONLY, and notify your supervisor. A sodium bicarbonate solution should be kept near the acid; this will neutralize the effects of acid spilled on lab surfaces only. Mixing baking soda and water makes a sodium bicarbonate solution. This solution should never be used to neutralize acid spilled on skin, since the heat produced by neutralization will increase cellular damage. Use acid only under the fume hood in the lab.

6. Troubleshooting:

Troubleshooting:
Check existing tared filters in trays before labeling new filters to avoid duplicating #'s
Filters are clogged if water is dripping from filter assembly under vacuum more than 2 seconds apart. Add another filter to the assembly for that sample and pour water from clogged filter into new filter.
If analytical balance will not settle make sure doors are closed. Look for debris on balance pan if check weight is off.
Use spatula or table knife to support heavy loaded filters from filter assembly to drying rack to balance to avoid loss of sample from filter.

Maintenance:
All equipment shall be inspected and monthly. Maintenance logs will be kept on all appropriate equipment. The Lab Manager maintains a maintenance log book to track scheduled maintenance on all equipment. All records and lab equipment will be kept at the Sediment Lab. All spare parts will be kept at the Sediment Lab. Adequate replacement parts will be kept at the lab and are the responsibility of the Lab Manager. If equipment is found to be out of spec or not working, it shall not be used until inspection by the QA manager and documented.

7. Data Acquisition, Calculations & Data Reduction:

A. Data Sheets:

Sign-in Sheet

1. Persons bringing samples into the lab must record when samples are brought into lab and name of person who brought the samples into the lab on the sign-in sheet .

2. Record the sample ID #, location, date, time of sample and who collected the sample on the sign-in sheet.

3. Run turbidity on sample per Turbidity SOP and record NTU, date, time, turbidimeter # and who conducted NTU determination.

4. If turbidity is too high initially for the HACH 2100P Turbidimeter, note this by assigning the sample a turbidity code of 1 on sign-in sheet and the turbidity will be run by dilution by lab technicians at the time of suspended sediment concentration determinations. A sample with a turbidity of less than 1000 should have a recorded a turbidity code of 0. See Turbidity SOP for details

5. Record stage, velocity, and type of sample and all other pertinent data on "comment" portion of sign-in sheet.

6. Put samples in appropriate place and cover with a black piece of plastic or proceed with suspended sediment concentration determination using proper data sheet.

Grab Sample data sheet and Depth Integrated Sample (DIS) data sheet

1. Arrange the sample bottles by location and then by chronological order.

2. Start a new data sheet for each day's work in the lab. If different people work on the same day at different times, use a different data sheet for each person's work.

3. Data forms are filled out as each sample is processed.

4. Carefully read the bottle label and locate its entry on sign-in sheet.

5. Transfer ID #, location, date, and time from label and turbidity from sign-in sheet onto data form.

6. Run suspended sediment determination per this SOP. Put a red dot next to each samples entry on sign-in sheet after running suspended sediment concentration to signify sample has been processed.

Turbidity Threshold Sample (TTS / ISCO Bottles) Sheet

1. Arrange the sample bottles in order by.
   Station ID - Data Dump # - Bottle Number

2. Start a new data form for each station.

3. Data forms are filled out as each file name / data dump is processed.

4. Under no circumstances should information for more than one station be recorded on the same data form. Record name of person running samples and date and HY and page numbers if more than one page is used.

5. You may include more than one data dump on a single form if the dumps are in sequential order.

6. Carefully read the bottle labels.

7. Transfer all data from bottle labels to the lab data forms (double-check the data as it is entered). Put a red dot next to entry on sign-in sheet after running suspended sediment concentration.

8. The bottles are labeled as follows: Data Dump Number - station ID - Bottle Number For example, 04FTR11 would indicate data dump 4, station FTR, bottle number 11. In addition, the first bottle in the dump will have the number of bottles in the dump in parentheses on the bottle label.

9. Run suspended sediment determination per this SOP.

Suspended Sediment Concentration (SSC) Calculation Sheet

Transfer volume, NTU, and filter weight data to SSC calculation sheet and compute suspended sediment concentration using calculator and/or excel spreadsheet. When results are transferred from paper calculation worksheet to Excel database spreadsheet, the suspended sediment concentration shall be compared and any discrepancies investigated and resolved.

B. Data Sheet Completion

1. Make sure all the data is on the data form and check it for errors.

2. See that all pertinent remarks are recorded.

3. Confirm that the station, date, your initials and page numbers and Hydrologic Year are filled out on top of data form.

4. Complete the " Lab Code" column indicating the quality of the sample and processing procedure after the final filter weigh.

C. Drying and Weighing (Mettler H20t Balance)

1. After air-drying filters at least 1 hour on wire rack, place filters on a clean tray in rows of 4 and 5 filters and heat at 105^{o} C for 1 and 1/2 hours for sediment sample filters and 1/2 hour for filter tares (blanks).

2. Remove tray from oven and immediately place in desiccator to cool for at least 1 hour for sample filters and 1/2 hour for filter tares before weighing. Only weigh filters when the humidity in the dessicator is below 25%. If it is above 25% ,stop and let humidity descend to 17% before proceeding.

3. Zero the balance between each weigh. Check the pan for debris, and if present, gently remove it using a brush or compressed air with the scale at full arrest.

4. Zero the balance by first full releasing the scale gently from full arrest with all weights at zero and let the balance settle for at least 10 seconds. Use the zero knob to set zero by moving the horizontal line corresponding to the numbers 00 on the lighted display between the split arrow marks with the zero knob. Return the scale gently to full arrest.

5. Weigh the check weight before weighing filters and for every 10^{th} weigh and record it's weight on the data sheet and on the Check Weight data sheet. An acceptable weight for the one-gram Check Weight is between 1.00001 grams to 1.00013 grams.

6. **To weigh a Check Weight:**
Always use forceps to handle the checkweight. Make sure the balance is at full arrest. Open the sliding door and carefully place the Check Weight on the center of the weighing pan and then close the door. The general weight of the check weight is known so set the appropriate large weight knob and bring the balance to full release. Determine the remainder of the Check Weight's weight with the fine weight knob by bringing the horizontal line in between the split arrow marks. After letting the balance stabilize for at least 10 seconds and fine adjusting with the fine weight knob record the first 3 digits first on the sample data sheet. Then look back and adjust the fine weights and record the last 2 digits. Bring balance back to full arrest and zero the weight knobs. Open the door and remove the Check Weight and place in container. Close the balance door.

7. **To weigh a filter:**
Set balance gently to full release so scale is settling while transferring filters, open dessicator, remove sample tray and transfer a row of filters to another tray. Immediately put tray with the remainder of filters back into dessicator and close door. Zero the balance by setting the horizontal line corresponding to the numbers 00 on the lighted display between the split arrow marks with the zero knob. Bring balance back to full arrest.
Open the sliding door and carefully place the filter on the center of the weighing pan and then close the door. Determine filter weight to a tenth of a gram with half release. If downward pointing arrows appear at the bottom portion of lighted display at half release it means the selected tenth of a gram increment is too high. Bring balance to full arrest and reduce the tenth of a gram weight knob by a tenth of a gram and bring balance to half arrest again and observe if arrows appear. If arrows do not appear and display scrolls the other way the tenth of a gram setting is appropriate.

   Set the balance to full release. Determine the remainder of the filter weight with fine weight knob by bringing the nearest horizontal line in between the split arrow marks. Record the first 3 digits first on the sample data sheet. Record last two after letting the balance stabilize for at least 10 seconds and fine adjusting with the fine weight knob. Bring balance back to full arrest and zero the weight knobs. Open the door and remove the filter and place on tray. Close the balance door.

8. Check the final weight against the initial weight. The final weight should be larger. If the initial weight is larger than the final weight try to determine where the error occurred. Record a lab code of 2 on the sample data sheet if the difference is less than 0.0005 grams and 7 if the difference is larger.

9. To store weighed / used filters, place weighed filters on foil in a box and cover with aluminum foil when layer is full. Lay another layer of filters on top and cover and so on until box is full.

10. After double checking the data forms, calculate data as soon as possible.

D. Lab Codes

0 ok

1 organic debris or foreign materials present, but < 15% by mass includes any non-sediment items (leaves, wood, algae, hair, slug excrement)

2 minor weighing or volume errors other than spillage
- final weight less than initial weight by less than 0.0005 g and very little sediment is present

3 spilled < 15% of sample volume before weighing bottle
- use this when water level differs from field mark by < 15%
- before refilling, record sample weight in comments
- refill to mark, reweigh, and record as “Total bottle weight”

4 spilled < 15% of sediment mass during or after filtering
- includes minor spillage transferring sediment to filter
- includes loss of sediment when handling filter

5 low volume, less than 150 ml, but processed

6 organic debris or foreign materials present as in code 1, but > 15% of sediment by mass

7 major weighing or volume errors other than spillage, e.g.
- final weight < initial weight by more than 0.0005 g
- balance malfunction
- tare or total bottle weights missing

8 spillage before weighing bottle as in code 3, but > 15% of sample volume

9 spillage during or after filtering as in code 4, but > 15% of sediment mass

10 Label error

E. Calculations: The calculation for **PPM or Mg/L** is as follows.

mg/L = (Sediment weight / Total Volume) X 1,000,000

Total Volume = (sediment volume + water volume)

mg/L=(a / ((a/2.65+(b-a))) x 1,000,000
a = sediment weight b = total bottle weight

10. Hand calculations or a computer program will compute the concentration in PPM of the total suspended sediment (including sand fraction, if present) and the concentration in PPM of the sand fraction (if it was separated). The computation is as follows:

$$\frac{\text{(NetWt. sand fraction -mg) + (NetWt. suspended sedirnent -mg)}}{\text{Total Volume -L}} \times 1{,}000{,}000 = \text{PPM of entire sample}$$

$$\frac{\text{NetWt. sand fraction - mg}}{\text{Total Volume -L}} \times 1{,}000{,}000 = \text{PPM of Sand Fraction}$$

Where NetWt. (mg) = (Filter Final weight (mg) - Initial weight (mg))

8. Computer Hardware and Software Used:

No special hardware is needed for suspended sediment concentration determination. Software used will include Microsoft Word and Excel programs. Software may also include specialized statistical and graphing programs such as Unix, Pearl and S+ for data analysis.

9. Data Management & Records Management:

All data sheets will have the Hydrologic Year, initials of the person entering data, the date of data entry, the sample ID # and the date of copying. Sign-in sheets will be numbered sequentially. Filter tare sheets will be numbered sequentially. Lab data sheets will be filed chronologically and given sequential numbers at the end of the Hydrologic Year. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

The Lab Manager is responsible for double-checking and copying lab data sheets and delivering them to the Project Manager. Lab data sheet originals will be kept in the Sunny Brae Sediment Lab. Reports and data will be transferred to Excel spreadsheets and Word documents and computer disk copies kept at the Sunny Brae Sediment Lab and Salmon Forever Offices.

Originals of Lab Sheets will be kept in the Sunny Brae Sediment lab. Copies of Lab sheets will be kept in Salmon Forever Offices. Hard copies of all data as well as computer back-up disks will be maintained by Salmon Forever for at least 10 years. QA/QC sheets will maintained by Salmon Forever for 10 years. All Sediment Lab data to be maintained by Salmon Forever for 10 years. Originals of ISCO Automatic Sampler field sheets will be maintained for 10 years at the Salmon Forever Sediment Lab location. Copies of ISCO data sheets will be given to RSL.

Data and calculations are double-checked as data is entered into spreadsheets. Suspended Sediment Concentration data is calculated twice by separate spreadsheets and compared. A check will be entered on the paper copy signifying correct data comparison. Data will be examined and rated on the basis of field and lab codes pertaining to the quality of data.

Data will be used to produce an annual report. Data report information and records will be in Word and Excel software formats. Paper copy will be in 8 1/2 by 11 paper with some data sheets in 8 1/2 by 14 paper. The final report will include raw data, Field Data Sheets, equipment calibration sheets, lab data sheets and QA/QC results. Data will be examined and rated on the basis of codes pertaining to the quality of data.

10. References:

Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995
EPA QA/G-4 Guidance for the Data Quality Objectives Process
EPA QA/G-5 Guidance for Quality Assurance Project Plans
EPA QA/G-6 Guidance for the Preparation of Standard Operating Procedures (SOP's) for Quality Related Documents
EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations

USGS Techniques of Water-Resources Investigations of the USGS:

Laboratory Theory and Methods for Sediment Analysis Chapter C1 Book 5
Field Methods for Measurement of Fluvial Sediment Chapter C2 Book 3

Others:

Leopold, L. B. 1994. *A View of the River*., Harvard University Press, Cambridge Massachusetts.

Standard Methods for the Examination of Water and Wastewater 1990 2540 B. Total Solids Dried at 103-105^0 C

Laboratory Procedure for Total Suspended Solids, Redwood Sciences Laboratory, USDA Forest Service, Arcata Ca, Rand Eads, 12-10-98

STANDARD OPERATING PROCEDURE

ISCO 2100 Automatic Sampler

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope:

This SOP covers the operation of an ISCO 2100 automatic pump sampler. By combining automatic pump sampling and turbidity threshold sampling one can efficiently determine the annual suspended sediment load of a stream.

The sampling program in the data logger controls the collection of information from the pressure transducer and turbidity probe, and activates the pump sampler at the appropriate turbidity thresholds. Sampling intervals follow Redwood Sciences Laboratory's (RSL's) turbidity threshold sampling (TTS) protocols as programmed in the TTS V 3.1 software (Eads, 2000).

2. Apparatus:

The TTS station on Freshwater Creek at Roelofs incorporates an ISCO Model 2100 automatic sampler, a Campbell CR101X datalogger, Druck 1830 pressure transducer, OBS-3 turbidity probe, Campbell 107 Thermistor temperature probe and a Campbell TR525I Tipping Bucket rain gauge.

The 2100 autosampler is 25 inches high by 20 inches in diameter. It weighs 40 pounds. The Model 2100 Wastewater Sampler is a portable device designed to collect up to 24 separate discrete samples of a pre-determined volume from a liquid source. It has a sampling interval of 1 to 999 minutes between samples. The samples can be collected on a time proportional basis using the internal sampler timing circuitry or on a flow proportional basis. It can pump up to 990 ml per sample but for this application it will pump 350 ml per sample. The sample volume repeatability is ± 10 ml. Up to 8 bottles can be filled at each sampling time. Each sample pumping cycle includes an air prepurge and postpurge to clear the suction line both before and after sampling.

Technical specifications for the autosampler are described in Table 1.4-1 of the ISCO 2100 manual.

3. Calibration:

There is no calibration involved in the 2100 ISCO Automatic Pump Sampler. The sample volumes collected are adjusted in the field prior to sampling.

4. Sample Collection:

See sections 1 through 8 of the attached document: CAMPBELL DATA LOGGER TURBIDITY THRESHOLD SAMPLING FIELD MANUAL Freshwater Station (FTR) (R. Eads, 1999)

5. Handling & Preservation:

See sections 7 of CAMPBELL DATA LOGGER TURBIDITY THRESHOLD SAMPLING FIELD MANUAL Freshwater Station (FTR) (R. Eads, 1999) for sample handling and preservation instructions.

Sample bottles are taken to the Sunny Brae Sediment Lab after removal from the ISCO barrel and stored in a cool dark place.

6. Troubleshooting:

If the Sampler is completely inoperative and the displays do not light, check for a dead battery or a blown 2-amp fuse and replace or recharge battery or replace the front panel 2-amp fuse as necessary.

If the Sampler pump is inoperative but displays will light, check for a blown front panel 5-amp fuse and replace it if needed. If this fuse blows repeatedly, check to see if the pump is jammed with debris.

If the battery voltage is low, check for loose connections or faulty charger. Low voltage can reset certain offsets and operating parameters to default values. If you find the battery voltage low, check the autosampler settings or contact the Field manager. The LED display may not work with low voltage in battery.

If sample volumes are incorrect:

- Check that the pump tubing is installed correctly and repair if needed.
- Check for defective tubing and replace if needed.
- Check that the SUCTION HEAD and/or SUCTION LINE switches are set correctly.

If the numeric display for the CR10X datalogger is blank - turn off all windows and shut down the computer. The display might have used up all available RAM and needs to be cleaned out.

Maintenance:
All equipment is inspected and maintained to EPA and manufacturer requirements. Maintenance activities are record on the ISCO field forms and kept at the Sediment Lab.

Regular maintenance is required only for the suction and pump lines. These lines should be cleaned by pumping an Alconox cleaning solution through the tubing system using the FWD position of the MODE switch. Follow the line cleaning with Alconox with at least 3 complete distilled water rinses.

7. Data Acquisition, Calculations & Data Reduction:

Section 6 of the attached TTS Field Manual describes the procedure for downloading data from the Campbell CR10X datalogger.

8. Computer Hardware and Software Used:

A Campbell Scientific CR10X Datalogger is used and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software. The TTS software (V 3.1) is from Redwood Sciences Lab - USDA. Turbidity Threshold Sampling software is used to trigger the pumping of samples by the ISCO 2100 Automatic Sampler in response to input from the OBS-3 continuous turbidimeter probe.

9. Data Management & Records Management:

Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically download turbidity data and take a floppy disk back to RSL for data analysis. Back-up floppy disks are stored at the Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab.

Attachment 1

CAMPBELL DATA LOGGER
TURBIDITY THRESHOLD SAMPLING
FIELD MANUAL
Freshwater Station (FTR)

Rand Eads
Redwood Sciences Laboratory
USDA Forest Service
Revised: 09-O8-99

1.0 Record Observations

1.1 The computer and your wristwatch should always be checked/set with the telephone time recording (767-8900) before you service the field equipment.

1.2 Start a new field form (use carbon paper to make a duplicate).

1.2 Read the staff plate as accurately as possible and make a visual check up and downstream for changes to the channel, banks, or addition/loss of debris jams.

1.3 Complete the top two lines of the field form. This is important!

1.4 Note in the comment section of the field form any conditions that may affect data quality that you observed while reading the staff plate.

2.0 Check Equipment

2.1 Immediately following a wakeup remove debris from boom and periodically clean the T-Probe optical window with water/dish soap solution and toothbrush.

2.2 Note on the field form the "Boom Depth" (the depth marks on the vertical section) and the "Cable Mark" (the paint marks on the cable relative to the top of the reel).

2.3 Note the time under "Time Boom Lifted" on the field form.

2.4 Note on the field form if debris is present on the boom.

2.5 If debris is present, indicate if the debris was on or near the turbidity probe optics (the debris may only be lodged on the vertical section of the boom and not affecting the turbidity readings).

2.6 Remove the debris:

- Loosen the reel securing the horizontal position.

- Unclip the D-snap to release the chain from the cable/link attached to the stump.
- If the stage is 1.5 feet or less elevate the boom with the upper reel providing until the turbidity probe housing is out of the water then push the boom upstream until it contacts the tree.
- If the stage is higher than about 1.5 feet, or it is unsafe to approach the edge of the stream, elevate the boom then swing it to a position behind the shelter (pushing the boom downstream then towards the shelter).
- Remove the debris by hand (a garden hose can be used if the housing contains a lot of sediment).
- Periodically (once a week or so depending on the time of year) clean the optics with the squirt bottle and soft bush

2.7 Return the boom to the sampling position:

- Push the boom to the approximate sampling location.
- Lower the boom to the correct depth.
- Fasten the chain and D-snap to the ring on the cable that is attached to the stump.
- Take up the slack in the horizontal reel.

2.8 Note the time on the field form under "Time Boom Submerged".

- Cleaning the T-Probe may cause the program to collect an ISCO sample at the next wake-up because the turbidity dropped after removing the contamination.

2.9 Press the button on the left side of the ISCO controller labeled "Press to Read Display" then check the right LED display for the Next Sample number and record it on the field form.

2.10 With at least 5 minutes remaining until the next wake-up (wake-ups occur every 15 minutes, e.g. 1000, 1015, etc.):

- Unfasten the three bale rings holding the ISCO together.
- Lift the mid-section and support it on the two wooden arms.
- Note on the field form low/high sample volumes, missed samples (bottles should be about 1/3 full, depending on the stage), and whether the last pumped sample matches the display, less one bottle.
- Re-assemble ISCO.

3.0 Establish Communications

• Skip this section if the connection is already established.

3.1 Connect the computer to the serial cable from the shelter.

3.2 After the Window's desktop appears, double-click on the Campbell icon.

3.3 Double-click on the "Connect" icon on the task bar.

3.4 Single-click the "Connect" button (lower right corner).

3.5 Communications are established when both the PC and data logger's date and time are displayed in the upper right corner and the two plugs in the box are "connected".

4.0 View the Current Data

4.1 Click on the "Numeric Display" tab on the lower left corner of the "Datalogger Connection" window. Note the following values on the field form:

- "station" time displayed in the lower right corner of the window
- "stage" (average stage)
- "med_turb" (median turbidity)
- "nxt_isco" (should match the ISCO's "Next Sample")
- "dump_cnt" (current data dump number)
- "bat_volt" (current battery voltage)

5.0 Manual Sample Options

5.1 Determine if a manual sample should be collected:

- No manual sample if stage is less than the "min_stg" (minimum stage, see the parameter sheet) or the current turbidity is within a previously sampled range (see the Tally Sheet).

- Collect a DI (depth-integrated) sample and simultaneous ISCO sample if the stage is above the minimum stage and the current turbidity range has not been previously sampled.

- Collect an AUX (auxiliary) sample, without a matching DI, if:

  The "Next Sample" displayed on the ISCO is not the same as "nxt_isco"; or

  ISCO bottle volumes are too low/empty; or

The stage is receding and nearing the minimum stage and less than 4 samples have been collected for the storm.

5.2 DI Sample

5.2.1 Assemble DI sampling equipment for a bridge or wading measurement.

5.2.2 The ISCO will sample on the next wake-up after the flag is set.

5.2.3 Plan to start the DI sample collection about 3-5 minutes before the wake-up.

5.2.4 With the cursor on the "Datalogger Connection" window, single click the "Ports/Flags" button.

- **SELECTING OR DESELECTING THE WRONG FLAG MAY CAUSE THE PROGRAM TO MALFUNCTION!**

5.2.5 Carefully click on the box next to the Flag labeled "DI" (it will darken when selected).

5.2.6 Click on the 113 in the upper right corner of the Ports/Flags window to close it.

5.2.7 Make a "hatch" mark on the DI Tally Sheet in the column most closely matching the current turbidity ("med_turb").

5.3 AUX Sample

5.3.1 With the cursor on the "Datalogger Connection" window, single-click the "Ports/Flags" button.

5.3.2 Carefully click on the box next to the Flag labeled "AUX" (it will darken when selected).

5.3.3 Click on the ~ in the upper right corner of the Ports/Flags window to close it.

5.3.4 Explain in the "Comments" why you collected an AUX sample.

6.0 Changing the ISCO Bottles, Incrementing the Dump Number, and Collecting the Data File

- IF COLLECTING A DI OR AUX SAMPLE WAIT UNTIL AFTER THE NEXT WAKE-UP AND SAMPLE COLLECTION BEFORE PROCEEDING WITH THE ISCO BOTTLE EXCHANGE AND INCREMENTING THE DATA DUMP NUMBER.

6.1 Change the ISCO bottles, increment data dump number, and "collect" the file if either of the following conditions is true:

O If 8 or more bottles contain samples; or
O There is a possibility of all 24 ISCO bottles filling before next visit

6.2 Remove the caps from the replacement bottles in the spare ISCO base and confirm that the bottles are labeled with the station "FTR", numbered 124, is in order, and that bottle 1 matches the # 1 position in the base.

6.3 Immediately following a wake-up exchange the ISCO bases (you have less than one wake-up interval to exchange the bottles, reset the ISCO, and increment the data dump number).

6.4 Detach the bale fasteners that attaches the base to the mid-section, keep the base on the floor of the shelter, then lift the mid-section onto the arm supports resting the ISCO on its handles. Slide the replacement base under the mid-section then re-assemble the ISCO.

6.5 Reset the ISCO to bottle position-1 (move the "Distribution Tube" switch to the "Reset" position, then release).

6.6 With the cursor on the "Datalogger Connection" window (assumes that communications are already established) single-click the "Ports/Flags" button.

6.7 Click on the box next to the Flag labeled "DUMP" (it will darken when selected). This will cause the program to increment the data dump counter ("dump_cnt") by 1 and to reset the "nxt_isco" counter to 1 at the next wake-up.

6.8 Click on the D3 in the upper right corner of the Ports/Flags window to close it.

6.9 Collect the file from the data logger and copy it to the hard disk.

a. Click on the Collect button.

b. A pop-up box will appear with a suggested filename; click on the Browse button.

c. First make sure the path in the right side box is correct
Drive is C:

Folder is FTRyy (for example FTR00, for hydro year 2000)

d. Each file will have a unique filename with the following format
(no longer one appended file such as FTR99.dat):
FT991003.02d
Where FT is the station (always the same, the "R" is dropped)
991003 the date (year month day) that the file was STARTED.
02d is the second data dump of the hydro year

e. Click the OK button on the active window.

f. Click the OK button on the other window (make sure the filename you entered is correct).

g. Make sure that the entire file was collected (watch the "% Collected" box).

6.10 Copy the file from the hard disk to the backup floppy.

a. Insert the floppy into the drive.

b. Double click on Window Explorer.

c. Under the C drive click on the current hydro year folder (for example FTR00).

d. Locate the filename you just collected and drag and drop it into the A: drive icon towards the top of the screen (this will copy the file to the floppy).

e. Remove the floppy.

7.0 Complete the Bottle Labeling (if there are two people this can be done while the data is being downloaded)

7.1 Wearing safety glasses and gloves carefully place 3 drops of a 1:1 HCL acid into each bottle containing a sample.

7.2 Tightly cap then remove the bottles containing samples.

7.3 Complete the bottle label as follows:

- Add the dump number in front of the station identifier: dd FTR—nn.
- On bottle, number 01, in parenthesis, and after the bottle number, indicate the number of samples in the dump: dd FTR—01 (xx).

- Place a 1-inch long piece of tape straddling the water surface on the thick edge of the bottle and carefully mark a horizontal line indicating the water surface with the bottles on a level surface.

7.4 Store the samples in an upright position in a box or bucket and cover them with black plastic.

7.5 Label the shoulder of each replacement bottle with a permanent marker and a strip of first aid tape.

7.6 Label the replacement bottles for the next dump with the station identifier and the bottle number: FTR—nn (leave space in front of "FTR" for the dump number).

7.7 Load the new bottles, in the correct order, in a spare ISCO base (double-check the number sequence of the bottles and confirm that the bottle-1 matches position #1 in the base).

7.8 Leave the bottles capped.

8.0 Adjusting the Stage Offset

Adjust the stage offset ("stg_off") when the electronic stage differs from the staff plate by more than 0.05 feet.

8.1 Calculate the correction to the offset (pay attention to the +/- signs):

The electronic stage is too high:

Calculate the error,

1.57' staff—1.64' electronic = -0.07' error

Calculate the new offset,

-0.475' current offset + -0.07' error = -0.545' new offset

The electronic stage is too low:

Calculate the error,

2.45' staff—2.37' electronic = +0.08 error

Calculate the new offset,

-0.475' current offset + 0.08' error = -0.395' new offset

Click on the "Numeric Display" tab on the lower left corner of the "Datalogger Connection" window to display the current values.

8.2 Place the arrow of the cursor on the value to the right of "stg_off", then right-click. An "Edit Value" window will appear. Left-click on the "Edit Value" window. The location highlights yellow. Type in the new value, with "-" in front, the press [ENTER] when done.

8.3 The new offset will become effective at the next wake-up.

8.4 Make a note on the field form under "Comments" and change the "Parameter Sheet" to reflect the new offset.

Attachment 2

ISCO / Freshwater Datalogger
Instructions for PC208W version 3.0

To View a File:

1) Click on view from the PC208W toolbar.
2) Choose FILE / OPEN or click on the OPEN icon

NOTE: You can also choose the file from the list located under FILE / RECENT FILES.

3) Choose the data file that you want to choose, i.e. FTR99.DAT.
4) You can also choose the *.FSL file that corresponds to the data file, i.e. TTS_V2_3.CSI. This enables column headings to be shown when viewing and plotting the data file.
5) If no *.FSL file is chosen then a dialogue box appears asking what you want . . .

- Choose: I want to select an *.FSL file, if you know the corresponding *.FSL file related to the data file.
- Choose: I do not want an *.FSL file for this data file, if you do not know the correct *.FSL file or you don't care to associate one.

6) Click OK.
7) If an *.FSL file is associated to the data file, you must click inside the data file to update the column headings.
8) To make the file easier to view, click on the EXTEND TABS icon to expand the file into neat columns.

To Graph a File:

1) With the data file already opened in view, click on the column or columns (up to 2) that you wish to plot.
2) Choose VIEW / GRAPH or click on the SHOW GRAPH (1Y AXIS) to plot the array(s) on a single y-axis versus time.
3) Choose VIEW / SEPARATE AXIS or click on the SHOW GRAPH (2Y AXIS) to plot 2 arrays on 2 different y-axis versus time.
4) If you click on the plot a box containing the value and time of that point is shown.
5) Use the scroll bar to scroll through the graph.
6) To zoom in on a point, hold down the left mouse button and draw a box from left to right around the region to be zoomed, then release the mouse button.
7) To zoom out, click on the MAGNIFYING GLASS icon or draw a box from left to right to restore the graph to full view.

Input Locations

thr_count A sample is collected when the value = 2 (second interval >= threshold)
thr_code baseflow = 0 rising = 1 falling = 2
nxt_thresh The next expected threshold (assuming no reversal)

Program Sampling Thresholds & Rules

Rising Thresholds	Falling Thresholds
0	1900
20	1698
77	1507
170	1328
300	1160
467	1004
670	858
910	724
1187	602
1500	491
1850	391
	302
	225
	159
	105
	62
	30

Baseflow
This condition occurs when the stage is less than the "minimum stage". Minimum stage is the lowest stage where both the turbidity probe and ISCO intake are adequately submerged and functional. No ISCO sampling takes place in this mode.

Rising
At the first interval above minimum stage, if the turbidity is also above the first threshold, and no rising thresholds have been sampled in the past 3 hours, a sample is collected. The threshold becomes rising at the first interval above baseflow. For subsequent rising mode samples the current turbidity must be equal to, or greater than, the next rising threshold for 2 intervals.

Reversals
Turbidity mode switches between rising and falling. The turbidity must change direction for at least 2 intervals, and drop 10% from the prior peak or rise 20% from the prior trough, but at least 5 FTUs in both cases. A sample is collected if a threshold has been crossed since the previous peak or trough, but not if that threshold has been samples within the past hour.

Falling
Turbidity mode is falling and the current turbidity is less than, or equal to, the next falling threshold for 2 intervals.

STANDARD OPERATING PROCEDURE

D & A OBS-3 Continuous Turbidimeter
(A component of the Turbidity Threshold Sampling Station)

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope:

Turbidity is a measure of the cloudiness or opacity of a liquid due to suspended particles or colloidals. This Standard Operating Procedure covers the proper use of a D&A OBS-3 Turbidity Probe. The D&A OBS-3 Turbidity Probe uses an optical sensor to measure turbidity by detecting infrared (IR) radiation scattered from suspended matter. The probe measures the turbidity of water flowing by the probe within a range of approximately 2 to 6 inches depending on the clarity of the water.

This probe is connected to a CRX10 Campbell Data logger as part of the Turbidity Threshold Sampling station installed on the main stem of Freshwater Creek just above Graham Gulch

2. Apparatus:

The following proabes and parts are owned and operated by Salmon Forever:

D&A Instrument Co. OBS-3 Turbidity Probe	S/N # 430	Factory Calibrated Field Calibrated	3-11-99 11-14-99
D&A Instrument Co. OBS-3 Turbidity Probe	S/N # 370	Factory Calibrated	3-11-99

D&A Factory Manual Part # OBS-1/3 MAN

The probe sensors consist of a high intensity infrared emitting diode (IRED), a detector (four photodiodes), and a linear, solid-state temperature transducer. The IRED produces a beam with half-power points at 50^0 in the axial plane of the sensor and 30° in the radial plane. The detector integrates IR scattered between 140° and 160°. Visible light incident on the sensor is absorbed by a filter (< 1% transmission below 790 nm). Sensor components are potted in glass-filled polycarbonate with optical grade epoxy.

Range:	0.02 - 2,000 FTU
Nonlinearity:	± 2.0%

Probe #430 is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and the Turbidity Threshold Sampling software. The probe is attached to the datalogger by a 20-foot cable running through a boom to the probe in the stream. A probe housing has been fabricated to protect the probe at the end of the boom.

3. Calibration:

Turbidity probes are calibrated twice a year. Calibration occurs at the beginning of the sampling season in November and once in the middle in February. Probes are etiher calibrated in the field with HACH Formazin solutions or sent to the manufacturer for factory calibration. If a probe is unstable, has been repaired, or is placed in a different housing, then it is calibrated again and not used until calibration is documented. The Lab Manager is responsible for implementing and documenting calibrations. Calibration records are kept in the Sunny Brae Sediment Lab and Salmon Forever offices.

Salmon Forever and Watershed Watch use a 3-point calibration of 0.0 NTU, 750 NTU and 1500 NTU. All other procedures for the calibration of a probe are the same as Redwood Sciences Lab procedures (Attachment 1). The HACH Formazin solution is mixed in the field and used within 6 hours. A HACH 2100P Turbidimeter sample is used to check the Formazin calibration solutions below 1000 NTU.

The QA Manager is responsible for removing any probe from service if it is acting unstable and documenting any subsequent actions and recalibration.

4. Sample Collection:

No samples are collected.

5. Handling & Preservation:

There are no handling and preservation requirements for the OBS-3 turbidity electronic data.

6. Troubleshooting / Maintenance:

Higher than reasonable turbidity readings may result from debris blocking the optics. The probe optics should be cleaned with soap, toothbrush and water as frequently as possible, usually during each visit to the site. To test the probe, place a finger about a half-inch from the optics at a sensor data reading period and a NTU of at least a 1000 should be recorded. If no readings are being collected, check the connections at the probe and datalogger. Cleaning the probe optics may cause the program to collect an ISCO sample at the next wake-up because the turbidity dropped after removing the contamination.

Maintenance:

Periodically (approximately once a week during the sampling season) clean the optics with the squirt bottle and soft brush. Documentation on cleaning of the probe optics is located in the RSL Field Form.

7. Data Acquisition, Calculations & Data Reduction:

The OBS-3 Turbidity probe records a data point every 15 minutes on the Campbell Datalogger. The probe produces turbidity data in mV and is converted to NTU using calibration slope and offset data. Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download turbidity data and collect a back-up floppy disk for data analysis at RSL.

8. Computer Hardware and Software Used:

The Druck 1830 Pressure Transducer is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and the Turbidity Threshold Sampling software (TTS software V 3.1) from Redwood Sciences Lab (Eads, 1999).

9. Data Management & Records Management:

The OBS-3 Turbidity probe records a data point every 15 minutes on the Campbell Datalogger. Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab periodically, at least monthly, downloads data and takes a floppy disk back to RSL for data analysis. Back-up floppy disks are stored at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab.

Attachment 1

Field Calibration of D&A OBS-3 Turbidity Probes

Connected to Campbell Data Loggers

R. Eads
Redwood Sciences Lab
USDA Forest Service

Document Revised: 99 10 19

General Information

The following instructions are used to periodically calibrate D&A OBS-3 turbidity probes connected to a Campbell data loggers. It is recommended that the turbidity probe be calibrated at the beginning and the mid-point of each season, if the data is suspect, or when the optics become scratched. It is worth noting that both new and factory re-calibrated probes may have minor calibration errors (multiplier and offset) induced during shipping or handling if jarring disrupts the trim-pot settings inside the probe. Expect the probe's LED light source to age about 3% in 2000 hours of operation resulting in a calibration shift (the output signal decreases exponentially over a period of about 5 to 8 years in normal deployment with TTS). During calibration at the factory the probe is opened while in the each calibration solution and manually adjusted, for example, at two point's 0 and 2000 FTUs. The procedure below does not manually adjust the calibration but compensates for shifts in calibration by changing the software parameters "offset" (intercept) and "multiplier" (slope). It is a recommended that the probes are returned for factory calibration every three to five years. The probe, when connected to a CR10X, CR10, CR510, or CR500, has a maximum output of 2500mV. The CR21X can accept a 5000mV-(5V) signal from the probe. For the following instructions, it is assumed that the probe has a turbidity range of 0 to 2000 FTUs and a maximum output of 2500mV (2.5V). Therefore, the factory calibration multiplier would be 0.8 and the offset 0 because 1 FTU = 0.8mV, derived from 2000FTU / 2500mV. The following procedure will probably result in a non-zero offset and a multiplier slightly different than the factory derived value. The formazin standard is first prepared in the lab then the turbidity probe is calibrated in the field. The formazin standard must be prepared the same day that the field calibration is preformed because of the short shelf life of the standard once it is mixed. In the following example, a two-point calibration is performed using a 0 FTU standard (distilled water) and a 400 FTU standard. Remember to always perform the calibration starting with distilled water and proceed to the formazin standard to prevent contamination.

Laboratory Preparation of the Formazin Standard

Supplies Needed:

Volumetric flasks

- Pipette
- Formazin 4000 FTU standard stock solution

- Calibration containers (see under field section)
- De-ionized water
- Funnel
- Paper towels

Protective Equipment Required:

- Latex gloves
- Long-sleeved shirt or lab coat
- Goggles
- Fan; vent hood; or adequate ventilation
- Material safety data sheet (MSDS) from formazin supplier

Calculate the amount of solution needed:

Vstk = Vtot * (Tstd / Tstk)

Where:

Vstk = Volume of 4000 FTU stock solution needed to make field standard

Vtot = Volume of field standard

Tstd = Turbidity of field standard

Tstk = Turbidity of stock solution (4000 FTU)

The following example makes a 400 FTU field standard with the correct volume (and depth of 6 inches) for a 6.5-inch id, straight-sided, black rubber bucket.

(400 / 4000) * 3500 = 350 ml of 4000 FTU stock solution needed.

Calculate the amount of de-ionized water required: 3500ml - 350ml = 3150 ml of de-ionized water. Therefore the final solution would contain 3150ml of de-ionized water + 350ml of 4000 FTU stock standard, yielding 3500 ml of 400 FTU field standard.

Mixing Procedures:

The formazin 4000 FTU standard accuracy is +/- 2%. Careful preparation of the field standard is **critical** because inaccurate volume measurement could raise the error to unacceptable levels.

- Wear the protective clothing mentioned above and direct the fan toward an open window (or use a vent hood).
- Determine which size volumetric flasks will be needed to make the field standard (a combination of flasks may be required).
- Measure-out the formazin standard first. Thoroughly mix the stock standard bottle by inverting the bottle several times before pouring into the volumetric flask (do not introduce air bubbles by shaking).
- Slowly pour the solution into the flask until it is about 1/2 inch below the line on the flask.
- Use a pipette, fitted with a squeeze-bulb valve (**do not use your mouth to draw-up the standard**), to add the remaining stock standard up to the line. The bottom of the meniscus should be even with the line on the flask. Pour the solution into the transportation container.

- Next, thoroughly rinse out the used volumetric flasks if they will be reused for measuring the de-ionized water.
- Measure the de-ionized water for formazin stock solution using the same procedure listed above and pour the water into the same transportation container.
- Cap the calibration container and gently swirl the solution to complete the mixing.
- Wash and rinse all equipment used for preparing formazin standard.

NOTE: In case of spill use absorbent towels or a sponge to wipe up the solution. Rinse out the sponge/towels in the sink drain using plenty of running water.

Field Calibration (requires two persons)

Equipment Needed

- Bucket, 4 or 5 gal, for 0 FTU, painted flat black inside, 10" id at bottom
- 3 gallons of distilled water
- Bracket to hold turbidity probe 2.75" off bottom of buckets
- Black rubber, or brown plastic, bucket, 6.5", or larger at the base
- 3500ml of 400FTU field standard (more is required if used a larger container)
- Plunging rod (perforated disk with handle) for mixing field standard
- Tap water for washing turbidity probe
- Squirt bottle for washing turbidity probe
- Non-abrasive dish soap for washing turbidity probe
- Soft cloth and brush for washing turbidity probe
- 2 Large funnels to return distilled water and standard to carrying vessels
- Spill-proof container for transporting field standard
- Tools and nylon ties for removing/attaching turbidity probe to boom
- Tape measure
- Safety equipment listed under the lab procedures

Collect the Current File

Follow the instructions in the TTS manual and perform a data dump to collect the current file (the data file will probably be erased in memory while loading the calibration program) and make a backup copy of the file. Make sure you have the latest TTS program revision available and that the current parameters are recorded. Make notes on the field form.

Load the Calibration Program

Follow the instructions in the TTS manual for loading programs. The executable program is called "obs3_ftr.dld".

Get the Probe Ready

- Remove turbidity probe from boom.

- Next, clean probe (and housing if PVC) first with tap water then with soap and a soft brush or cloth then rinse with tap water.
- Mount the probe on the calibration bracket (or place the entire housing in the container if the probe is mounted in a PVC housing) and place it into the zero FTU-bucket.
- Pour the distilled water into the zero FTU-bucket and move the probe around to dislodge any bubbles that may be adhering to the optics.
- Attach the calibration bracket to the side of the zero-FTU bucket wall container so that the probe is 2.75" above the bottom of the bucket and the optics are facing the opposite bucket wall at a minimum distance of 10".

Start the Calibration Software

The program starts executing once it is loaded but it will not collect data until the flags are set. Open the "Numeric" and the "Port/Flags" windows.

Setting the flags invokes the following operations:

Flag #1 Starts the calibration for the distilled water

Flag #2 Starts the calibration for the 400 FTU standard

Flag #3 Computes the multiplier and offset

Paste these Input Locations into the Numeric Window:

1	holds the lowest raw turbidity reading (mV)
60	hold the highest raw turbidity reading (mV)
med_0	median turbidity of the distilled water (mV)
med_400	median turbidity of the 400 FTU standard (mV)
turb_mult	multiplier
turb_off	offset

Start the Zero FTU Calibration (distilled water)

- Highlight Flag #1 to start the distilled water data collection.
- The calibration is completed when the Flag #1 is no longer highlighted.
- You can view the data in the Numeric window.
- Either calibration may be repeated if the data are suspect and prior to calculating the multiplier and offset, but make sure the data from the distilled water calibration is OK before moving the probe to the next standard.
- Remove the probe and then save or discard the distilled water.

Start the 400 FTU Calibration

- Gently swirl the 400 FTU standard in the transportation container.
- Carefully pour the standard into the calibration container.
- Attach the probe bracket to the side of the bucket (or place the PVC housing in the bucket).
- Thoroughly mix the standard with the plunger, then stop mixing and highlight Flag #2 when 10 seconds remain until the next execution interval (watch the data logger's clock display).

- The calibration is complete when Flag #2 in no longer highlighted.
- When satisfied with the data, highlight Flag #3 to calculate the multiplier and slope.
- When the Flag #3 is no longer highlighted, you can view the results.
- Record all of values from the input locations in the Numeric window onto the field form.
- Remove and clean the probe, then remount to the boom and place in the water.
- Pour the 400 FTU standard back into the transportation container using the correct funnel.

Load and Start the TTS Program

Follow the instructions in the TTS manual to load and start the program. After the first TTS, wakeup open the Numeric window and paste in all the normal input locations. Then update the turbidity slope and offset values. Update the multiplier and slope on the parameter sheet. Complete the field form notes. The new values will take effect at the next wakeup.

End

Redwood Sciences Lab Calibration Procedures

STANDARD OPERATING PROCEDURE

Druck 1830 Pressure Transducer
(A component of the Turbidity Threshold Monitoring Station)

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope:

This SOP covers the operation of a Druck 1830 pressure transducer. The Druck 1830 pressure transducer is an integral component of the TTS station installed on Freshwater Creek at Roelofs residence.

2. Apparatus:

Druck Model PCDR 1830 Pressure Transducer

This model measures pressures in the range from 5 to 900 psi with an accuracy of ± 0.25% of the full scale range.

A vent tube incorporated into the cable vents the sensor diaphragm to the atmosphere. The vent tube eliminates the need to compensate the water level measurement for changes in barometric pressure. The sensor is connect to a Campbell CR101X datalogger via a 6-wire connection.

3. Calibration:

The Druck 1830 Pressure Transducer is calibrated twice a year. Calibration occurs at the beginning of the sampling season (October or November) and mid-season (February). Redwood Sciences Lab calibration procedures are used for calibration in the field. If a pressure transducer is unstable, has been repaired, or is moved, then calibration is repeated. The Lab Manager is responsible for implementing and documenting calibrations. Calibration records are stored in the Sunny Brae Sediment Lab and Salmon Forever offices.

The QA Manager is responsible for removing any pressure transducer from of service if it is acting unstable and documenting any subsequent actions and recalibration.

The RSL field calibration procedure is attached as Attachment 1.

4. Sample Collection:

The Campbell Datalogger records a stage data point every 15 minutes. Data are downloaded onto an on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

5. Handling & Preservation:

There are no handling and preservation requirements for the stage electronic data. See Sample Collection (#4) for data back-up procedures.

6. Troubleshooting:

Common causes of erroneous data include:

- Poor sensor connection to the datalogger,
- Damaged cables, damaged transducers, or
- Moisture in the vent tube.

To avoid these conditions, check all connections to the datalogger and regularly inspect the cable for wear. Check the vent tube for plugging and condensation.

Major and sudden differences between the recorded stage and the staff plate readings may be caused by the transducer and cable being moved. Check the placement of the transducer in its pipe and, if necessary, change the stage offset to match the staff plate.

Maintenance needs include:

- Replacing the 3 or 4 small desiccant packs kept in the transducer enclosure each month, and
- Inspecting the wiring to ensure it is in good physical condition, and
- Checking the transducer cable connections.

7. Data Acquisition, Calculations & Data Reduction:

The Campbell Datalogger records a pressure transducer data point every 15 minutes. The probe records pressure as mV and this data is converted to stage using the calibration slope and offset data. Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download turbidity data and collect a back-up floppy disk for data analysis at RSL.

Offset is determined by comparing the pressure transducer stage with the site staff plate. Both the transducer stage and staff plate stage readings are documented on each RSL Field Form and compared with each time a new field form is filled in. Instructions for calculating the offset are included as Attachment 2.

8. Computer Hardware and Software Used:

The Druck 1830 Pressure Transducer is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and the Turbidity Threshold Sampling software (TTS software V 3.1) from Redwood Sciences Lab (Eads, 1999).

9. Data Management & Records Management:

The Druck Pressure Transducer records a data point every 15 minutes on the Campbell Datalogger. Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab periodically, at least monthly, downloads data and takes a floppy disk back to RSL for data analysis. Back-up floppy disks are stored at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab.

Attachment 1

Field Calibration of the Druck 1830 Connected to A Campbell Data Logger Configured as a Full Bridge (P9)

USDA Forest Service
Redwood Sciences Lab
R. Eads
Revised: 99 10 21

Equipment

- 1" PVC calibration pipe about 10 ft. in length, cap glued on bottom
- 10 ft. of cloth measuring tape in tenths of feet
- Electric tape
- Water bucket to fill pipe
- Ladder

End the TTS Program

- Follow the TTS manual and dump the data; back up the data on floppy
- Make notes on field form

Load the Calibration Program

- Follow the TTS manual and load the calibration program "druckcal.dld"
- After the first wakeup open the Numeric Window and paste in "avg_stg"
- The program runs every 20 seconds

Setup the Equipment

- Attach the zero on the tape at the small radial holes (don't block the holes)
- Stand on a ladder with pressure transducer
- Fill the pipe with water until it overflows
- Submerge the transducer just past the radial holes
- Tap transducer to dislodge bubbles in holes

Calibration

- Carefully lower the transducer to .25 ft, overflowing the water
- Keep the desired depth on the tape at the surface of the meniscus
- Keep the tape taught
- Keep everything still
- Accept the second reading (avg_stg) after stabilization
- Record the depth and avg_stg on the field form
- Lower to the next depth (4 or 5 points is enough, end about 8 ft.)

Plot the Data

- Enter the depth/avg_stg pairs into an Excel spreadsheet
- Regress the data and record the slope (multiplier)
- Record multiplier on field form and on parameter sheet

Start Normal Data Collection

- Secure pressure transducer in normal sampling position
- When finished will all calibrations load the TTS program
- After the first wakeup open the Numeric Window
- Edit the multiplier value for stage

Note

Whenever a new program version is loaded the “old” values for multipliers and offsets may be loaded instead of the current values. A better way (but more dangerous) is to edit the program, enter the new values, save the program and load it into the data logger. This will ensure the current values are preserved.

Attachment 2

CAMPBELL DATA LOGGER
TURBIDITY THRESHOLD SAMPLING
FIELD MANUAL
Freshwater Station (FTR)

Rand Eads
Redwood Sciences Laboratory
USDA Forest Service
Revised: 09-O8-99

Section 8 only – the entire document is attached to the ISCO Automatic Sampler SOP

8.0 Adjusting the Stage Offset

Adjust the stage offset ("stg_off") when the electronic stage differs from the staff plate by more than 0.05 feet.

8.1 Calculate the correction to the offset (pay attention to the +/- signs):

The electronic stage is too high:

Calculate the error,

1.57' staff—1.64' electronic = -0.07' error

Calculate the new offset,

-0.475' current offset + -0.07' error = -0.545' new offset

The electronic stage is too low:

Calculate the error,

2.45' staff—2.37' electronic = +0.08 error

Calculate the new offset,

-0.475' current offset + 0.08' error = -0.395' new offset

Click on the "Numeric Display" tab on the lower left corner of the "Datalogger Connection" window to display the current values.

8.2 Place the arrow of the cursor on the value to the right of "stg_off", then right-click. An "Edit Value" window will appear. Left-click on the "Edit Value" window. The location highlights yellow. Type in the new value, with "-" in front, the press [ENTER] when done.

8.3 The new offset will become effective at the next wake-up.

8.4 Make a note on the field form under "Comments" and change the "Parameter Sheet" to reflect the new offset.

STANDARD OPERATING PROCEDURE

Campbell TR5251 Tipping Bucket Rain Gauge
(A component of the Turbidity Threshold Sampling Station)

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope

This SOP covers the use of a Tipping Bucket Rain Gauge to record precipitation. The gauge is attached to a Campbell CR10X Datalogger. Each tip of the bucket records 0.01 inches of precipitation.

2. Apparatus

Texas Electronics Inc. Tipping Bucket Raingauge Model # TR525I Serial # 23623-199.

3. Calibration

Field Calibration of the Campbell TE52I Tipping Bucket Rain Gage
USDA Forest Service - Redwood Sciences Lab - R. Eads
Revised: 10-21-99

Equipment
- Soft brush, water in squirt bottle, and soap
- Calibrated vessel holding a known volume of water (411ml = 50 tips is the minimum volume to detect a calibration error of 2 tips)
- Screwdriver
- Paper or cloth towels

Software
- Dump the TTS data and make a backup on floppy
- Follow the TTS manual instructions and load the calibration program “rain_cal.dld”
- Open the Numeric window and paste in “tips” (holds the number of tips)

Procedure
- Check the calibration at the beginning of the hydrologic year
- Remove and clean the screen
- Remove the outer shell of the rain gage.
- Dry-brush debris out of the buckets and base
- Holding the tipping mechanism with one hand wash out the tipping mechanism with soap and a soft brush
- Rinse with clear water and wipe dry
- Reassemble the rain gage but leave the screen off
- Using the squirt bottle slowly add water until one tip occurs
- Setup the water delivery vessel
- Slowly drip the water into the gage at a rate no faster than 1 drop every 35 seconds (411ml would take about 30 minutes)
- Compare the number of tips to volume delivered
- 1 tip = 0.01 inches = 8.23ml
- See the tipping bucket manual for calibration procedures
- The manual recommends adjustment if tip error exceeds 3 tips / 100
- Follow the TTS manual and load the TTS program and paste the variables into the Numeric window following the first wakeup

4. Sample Collection

Opposing buckets on a teeter-totter arrangement are filled by precipitation through a screen and funnel. As one bucket fills and tips the other bucket is brought up under the funnel spout and when it fills and tips the other bucket is brought back up. The buckets hold a known volume before they tip and bucket tips are summed to provide an ongoing precipitation total. The Rain Gauge is a passive data collector and no special instructions are needed for sample collection.

5. Handling & Preservation

No samples are preserved. As each bucket full of water is tipped it flows out the bottom of the instrument to the ground below.

6. Troubleshooting

If data is unusual or no tips are recording during rainfall the buckets and funnel should be inspected.
The screen and funnel should be cleaned monthly. The tipping bucket should be checked monthly for debris collecting in the bucket.

7. Data Acquisition, Calculations & Data Reduction

The Campbell Datalogger records rainfall every 15 minutes. Data are downloaded onto an on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

8. Computer Hardware and Software Used

The Campbell TR525I Tipping Bucket Rain Gauge is connected to a Campbell Scientific CR10X Datalogger and operated by Widows 95, Microsoft Explorer and Campbell PC208W Window support software and Turbidity Threshold Sampling software.

9. Data Management & Records Management

The datalogger records a data point every 15 minutes from the rain gauge. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab downloads data monthly and makes a backup a floppy disk for data analysis at RSL. Additional back-up floppy disks are stored at the Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab.

STANDARD OPERATING PROCEDURE

Campbell 107 Thermistor Temperature Probe
(A component of the Turbidity Threshold Monitoring Station)

In Rivers and Streams of Humboldt, Trinity and Mendocino Counties California

Salmon Forever

Prepared by _Clark Fenton/Margaret Lang_____ Date _____

Approved by _____ Date _____

1. Scope

This SOP covers the proper use of the Campbell 107 Thermistor temperature probe.

2. Apparatus

Campbell 107 Thermistor temperature probe.
Instrument accuracy is ± 0.9 degree centigrade from – 38 C to 53 C.

3. Calibration

The Campbell 107 Thermistor Temperature Probe is calibrated once a year. Calibration occurs at the beginning of the sampling season in November. Redwood Sciences Lab calibration procedures (listed below) are used for calibration in the field. If a temperature probe is unstable, has been repaired, or is placed in a different housing, then it is calibrated again and not used until calibration is documented. The Lab Manager is responsible for implementing and documenting calibrations. Calibration records stored at the Sunny Brae Sediment Lab and Salmon Forever offices.

The QA Manager is responsible for removing a thermistor from service if it is acting unstable and documenting any subsequent actions and recalibration.

Field Calibration Check for Campbell 107 Thermistor Temperature Probes
USDA Forest Service
Redwood Sciences Lab
R. Eads
Revised: 99 10 21

Equipment

- Ice
- Warm water (about 30 deg C)
- Insulated calibration vessel
- ASTM MIG Thermometer (0.1 deg C resolution)
- Stirring rod

Dump the TTS Data

- Follow the instructions in the TTS manual and dump the data
- Make a backup to floppy disk

Load the Calibration Program

- Follow the instructions in the TTS manual and load “T107cal.dld”
- Open the Numeric Window and paste in “temp”
- You can also open a graphic window to watch the temperature equilibration
- The program will run every 30 seconds

Perform the Calibration

- In an insulated container add ice and then water
- Place the probe and thermometer in the center of the container
- Wait 4 minutes, then slowly stir while keep the probe and thermometer in the center of the container
- When the thermometer has stabilized (don’t lift it out of the water to read it) you can accept and record the electronic temperature reading and thermometer reading on the field form

- Replace the cold water with warm water about 30 deg. C
- Repeat the instructions above.

Reload the TTS program
Follow the instruction in the TTS manual and reload the TTS program. Open the Numeric Window and paste in the appropriate variables.

4. Sample Collection

The Campbell Datalogger records a temperature data point every 15 minutes. Data are downloaded onto a on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

5. Handling Preservation

There are no handling and preservation requirements for the electronic temperature data. See Sample Collection (#4) for data back-up procedures.

6. Troubleshooting

Common most common cause of erroneous data is poor sensor connections to the datalogger and damaged cables. If the sensor is not working properly, check connections to the datalogger and inspect the cable for wear.

7. Data Acquisition, Calculations & Data Reduction

The Campbell Datalogger records a temperature data point every 15 minutes. Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

8. Computer Hardware and Software Used

The Campbell 107 Thermistor temperature probe is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software (TTS software V 3.1) from Redwood Sciences Lab (Eads, 1999).
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9. Data Management & Records Management

The Campbell 107 Thermistor temperature probe records a data point every 15 minutes on the Campbell Datalogger. Data are downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab periodically, at least monthly, downloads data and takes a floppy disk back to RSL for data analysis. Back-up floppy disks are stored at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab.