National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Rocky Mountain Network Stream Ecological Integrity Monitoring Protocol

Standard Operating Procedures, Version 1.0

Natural Resource Report NPS/ROMN/NRR—2016/1132





ON THIS PAGE
Measuring bank angles, Starvation Creek, Glacier National Park, 2008
Photograph by: Billy Schweiger, NPS ROMN

ON THE COVER
Measuring discharge and *in situ* chemistry, Kintla Lake Tributary, Glacier National Park, 2008
Photograph by: Billy Schweiger, NPS ROMN

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Introduction

Rocky Mountain Network (ROMN) stream monitoring is guided by a detailed Stream Ecological Integrity (SEI) protocol. The SEI protocol describes an integrated approach to understanding stream ecological status and trend in ROMN parks. It consists of several pieces, including a main narrative (a separate publication), a set of standard operating procedures (SOPs; this document), appendices, and a dynamic set of materials available on the ROMN website or available from ROMN staff. The narrative portion of the SEI protocol (Schweiger et al. 2015) summarizes the rationale for monitoring streams in five of six ROMN parks, establishes specific monitoring objectives, and provides general context for the detailed set of methods in the SOPs.

The stream protocols ROMN has adopted were designed and assessed for efficiency, precision, and accuracy and they are adaptable for more intensive questions and applications as conditions may warrant in a given park. A high degree of flexibility is included in the protocol, allowing emphasis of select components to meet key short- and long-term management needs, yet maintain a core suite of measures, and sample and response designs to maintain comparability across ROMN systems. The SEI protocol includes sampling and analysis strategies with varying logistic and cost constraints.

Protocol development efforts and ongoing evaluation of the methods will include revision as necessary to address specific monitoring objectives of the network. Selection of supplemental measures and revision of the core measures of the protocols will be informed by developmental research conducted by ROMN and its partners.

Protocols Developed by the U.S. EPA

We base the bulk of SEI field methods on protocols developed by the EPA's Office of Research and Development as part of the Environmental Monitoring and Assessment Program (EMAP; Stoddard et al. 2005) and the Office of Water for the National Rivers and Streams Assessment (NRSA; EPA 2007). These methods are peer reviewed, published well-established and have been shown to generate high quality, repeatable data (Roper et al 2010; Somerville and Pruitt 2004). They are also used, at least in part, by many ROMN partners like MT DEQ (MT DEQ 2011, 2012a,b) and CDPHE (CDPHE 2005, 2010, 2011, 2012). Using methods employed by other agencies facilitates incorporation of partner data in SEI analyses (see below) and comparisons across sites and across ROMN park ecoregions. While other I&M networks (and within our own Alpine protocol; Ashton et al. 2010) simply cite published protocols, we have elected to develop and publish SEI protocols based on the procedures in EMAP and NRSA. Our edits of these methods were numerous enough that we believe it was appropriate to seek independent peer review and publish them.

Other stream monitoring protocols include the USGS National Water-Quality Assessment Program (NAWQA; USGS, variously dated) and the USFS Pacfish Infish Biological Opinion Effectiveness Monitoring Program for Streams and Riparian Areas (PIBO; Heitke et al 2008). While these and other programs may have worked as the basis for SEI monitoring, it was determined that the EPA methods were better suited to our largely survey-based approach and budget. Most importantly, the EPA methods fit SEI objectives well.

Most specific SEI wadeable stream methods are derived from Peck et al. (2006). EMAP developed these methods for the "Western Pilot" conducted in 13 western states from 2000 to 2004 and thus they are well suited to most stream types in ROMN parks. Most non-wadeable or boatable methods are from NRSA (EPA 2007) with some methods also derived from Lazorchak et al. (2000). These methods are also well suited to the non-wadeable rivers in ROMO and LIBI included in SEI monitoring.

Much of the text, figures etc. in the SEI SOPs are derived from or reproduced with permission from EPA documents and we are grateful for this collaboration from EPA.

Extractable Procedures

ROMN SOPs tend to have more description than ideal for use in the field. Therefore, we create procedure lists at the end of each SOP that are intended to be "extractable" from the supporting or introductory narrative in each SOP. Crews should print and use these in the field as step-by-step methods once all supporting information in the SOP body is understood.

Field Forms

We have elected to include images of field forms from 2014 (Appendix A). However, forms vary enough each year that they are quickly out of date and current versions should be obtained from the ROMN data manager.

ROMN SEI Quality Assurance Project Plan (QAPP)

At the time of publication, a detailed Quality Assurance Performance Plan (QAPP) for the SEI protocol was under review by the US Environmental Protection Agency (Schweiger, In Review.). The ROMN SEI QAPP provides an overview of all measurement and data quality objectives. These objectives ensure that the SEI protocol generates data of known and documented quality, resulting in complete, accurate and transferable information. The ROMN QAPP was developed for use by the U.S. EPA lab but is applicable to all ROMN contract labs. It has significant supporting information needed by labs analyzing SEI samples and by possible ROMN collaborators that may use our data. As such, it has a different structure and more detail than a single SOP. It also links to several QAPPs maintained by contract labs (but available from ROMN) and used by ROMN at the time of this document's publication.

Safety Considerations for ROMN Stream Monitoring

Overview

All ROMN streams are or may be cold, fast moving with high bed loads of surprisingly large debris (such as boulders and logs), and vary dramatically in flow. Being swept into a stream could potentially cause hypothermia or death. Therefore, crews conducting field samples need to practice good judgment and decision-making skills when planning for and conducting stream sampling. They also need to have the correct safety equipment and training for stream monitoring work.

Safety is the overriding concern for all ROMN sampling. All employees or volunteers who work in the field should follow the principles and guidelines detailed in The Rocky Mountain Network's safety plan (NPS-ROMN 2012). If a crew leader or any crew member judges conditions to be unsafe, they should not sample. "Getting the data" is never as important as crew safety.

The following is an overview of safety guidelines for streams sampling. It is intended to be concise enough to be easily read and followed by crews on the day of or just before a sample event. More complete safety SOPs are available from ROMN within the ROMN SOP: Safety Preparation and Training and in park specific Job Hazard Analyses (JHAs). (Contact ROMN staff for more information.) A stream-specific JHA can be found in Appendix B.

General Stream Sampling Safety Concerns and Procedures

- Job Hazard Analyses (JHAs) for general field sampling and this overview of stream sampling safety concerns must be reviewed by all crew members before sampling.
- Material Safety Data Sheets (MSDS) must be available for all chemicals used in sampling and in the lab.
- Supervisor must be notified of the location and all crew members present for each sample event.
- If administrative access to a closed road is required, the appropriate form must be filled out and signed by the Division Chief and dispatch must be radioed when entering and exiting gates.
- Crews should file a backcountry travel plan, even if the sample site is on the roadside. Stream monitoring can be dangerous regardless of how far the crew is from their vehicle.
- The crew leader has the responsibility to cancel a sampling event (either before leaving for a site or upon reaching a stream) if conditions are unsafe. Sampling should not occur if any crew member feels that the situation is unsafe. Upon reaching a stream, conditions should be assessed and a determination should be made regarding whether or not sampling can take place safely. The following considerations must be taken into account:
    - Weather
    - Road conditions
    - Trail conditions
    - Avalanche conditions (for roads, trails, and sample sites)
    - Stream velocity, depth, turbidity, and substrate

- Stream bank stability
- Debris in stream, especially at high water
- Snow and ice covering stream
- Amount of remaining daylight
- Threat from wildlife
- Crew member training and condition

- Guidelines and rules to follow for SEI sampling:
  - At least two people must be present on site at each sampling event.
  - Rule of thumb: if there are thoughts or conversation among crew members expressing concern over safety of a given method of sampling, it is probably unsafe and alternatives (including cancelling the sample event) should be assessed.
  - Personal floatation devices (PFDs) must be worn by crew members while sampling in the stream or from shore if appropriate given stream depth and/or velocity. A rule of thumb: if water is expected to be above mid-thigh level, or is unexpectedly swift (i.e. during peak runoff), wear PFDs.
  - If water levels are low enough that wading into the stream feels safe, proceed with normal sampling as near as possible to the thalweg (usually the line of fastest flow in the stream).
  - At high water, all sampling must be done from the shore or just away from the shore in no more than three feet of water. Do not attempt to get into the thalweg at high water.
  - If stream velocity or depth at thalweg creates any feeling of unease, wade only to a comfortable depth for sampling.
  - Only one person should be in the water at a time during high water (this usually occurs during May and June sampling events).
  - Whenever a crew member is in the water, a second crew member must be close-by (within 15' or within conversational hearing distance). The person on shore should also be wearing a PFD and have a throw rope ready.
  - If stream velocity or depth of entire stream creates any feelings of unease, sample from shore (wearing a PFD). A second crew member (wearing a PFD) should be standing by with a throw rope if there is any possibility of a fall into the stream.
  - If stream bank is unstable or undercut and no area along the stream bank is safe for sampling, cancel sample event.
  - If you must cross a deeper or faster water channel everyone must wear a PFD and do so in groups with linked arms or with one person directly behind the other with your arms on their shoulders. Do not cross upstream of “strainers” (piles of logs and debris) or “sweepers” (fallen trees just above or at the surface of the stream). Use trekking or sample poles for additional stability. Take a route that follows eddies or slack areas of water downstream of boulders. If you must cross a channel with a backpack on, undo the lower waist and chest belts realizing that the pack can shift more easily.

- While sampling or crossing a channel, consider using a trekking pole or the sample staff gauge as a tripod/support.
- Move slowly and deliberately; always have both feet secure on the stream bottom.
- The following are recommendations in case you fall in fast or deep water; however, if you are about to go into the water and are thinking "What should I do if I fall in this fast or deep water?" you should first consider if you should be sampling at all:
    - If you fall in fast or deep water, first yell to the other crew members to let them know your situation. Rotate so you are on your backside facing downstream and use your feet to fend off rocks and logs as you move downstream. You should be on your back, nose and toes to the sky with your head up so you can see where you are going. Your feet should be pointing down stream with your knees slightly bent. This way if you come in contact with a rock you can use your feet and legs as shock absorbers and push off the rock. Arms should be out to your side to help keep yourself in control.
    - Avoid "strainers" and low "sweepers" as you move with the flow into slack water as best you can (swimming and carefully using your feet and hands on the stream bed). Seek eddies as they are relatively calm and get you out of the main current. To traverse the current put your head in the direction you want to travel.
    - Stand up when out of the current, realizing the substrate will likely be uneven and slippery and you should guard against another fall. Trying to stand up while in the current can lead to your foot getting stuck.
    - If you fall, your waders will likely begin to fill. Don't panic, but do everything you can to get out of the water quickly and safely.
    - If a crew member falls or is submersed in the water, end the sample event. Get them dry and warm as soon as possible.
- Personal protective equipment (PPE) must be available for all crew members involved with sampling, including:
    - Waders with cinchable belt; the belt MUST be worn tight at all times.
    - Wading boots with rubber soles and (optionally) spikes
    - PFD (personal flotation device)
    - Neoprene gloves
    - Splash jackets for cold-water sampling (optional)
    - Nitrile gloves (large enough to fit over neoprene gloves)
    - Safety/throw rope (of the type rafters use)
    - Trekking poles or sample staff gauge (for support during sampling)
    - Current and well-stocked first aid kit
    - Bear spray
    - Radio

- Each crew member must have adequate personal gear on sampling day, including:
  - Dry clothing and footwear to change into if clothing gets wet
  - Plenty of warm clothing
  - Eye protection (sunglasses)
  - Adequate food, water, sunscreen, and bug spray
- Training will be offered for stream safety concerns:
  - First Aid/CPR
  - Backcountry travel and safety
  - Stream safety

Overview of ROMN Shared Administrative, Equipment, and Data Management SOPs

- ROMN maintains a set of common standard data management, administrative, and equipment operating procedures that are shared by all vital signs protocols. These common operating procedures ae maintained on the central ROMN network drive (\\inp2300fcvTUMA1\TeamShares\ROMN\), and listed below.
- ROMN SOP: Safety Preparation and Training
- ROMN SOP: Permitting
- ROMN SOP: Training
- ROMN SOP: Seasonal Hiring
- ROMN SOP: Park Logistics
- ROMN SOP: End of Season
- ROMN SOP: GSA Vehicle Leasing
- ROMN SOP: Specimen Tracking and Vouchering
- ROMN SOP: Using a Digital Camera
- ROMN SOP: Using the Garmin GPS 76csx
- ROMN SOP: Using Electronic Data Recorders
- ROMN SOP: Field Communications
- ROMN SOP: SPOT Transponder
- ROMN SOP: Archive Format Standards for Network Data
- ROMN SOP: Folder Structure and File Naming
- ROMN SOP: Scanning
- ROMN SOP: YSI Logger
- ROMN SOP: HOBO Logger
- ROMN SOP: Photo Management
- ROMN SOP: Database Design
- ROMN SOP: Quality Control and Quality Assurance

Portions of these standard procedures are incorporated into the SEI SOPs as appropriate, and cover all methods to ensure safety, resource protection, and compliance of a field crew working in ROMN parks. Guidance for permitting, vehicle leasing, safety training, communications and radio use, finding housing, hiring crews, and end-of-season procedures are also covered. Other SOPs provide instructions for operations of equipment shared by all protocols, such as compasses, GPS units, and SPOT transponders (GPS personal messengers). They may be obtained from the ROMN website (http://science.nature.nps.gov/im/units/romn/).

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SEI SOP 1: Pre- and Post-Season Workflow

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP presents procedures conducted before and after a stream field season. We include before and after activities together in one SOP because many are similar *and an SEI sample season should begin with an understanding of how it must end*. A standard workflow or timeline for a sample season is followed when implementing the SEI protocol in a park (Table 1-1). More detail is provided in the ROMN shared SOPs and in subject-specific SEI SOPs within this document.

Pre- and post-season activities are generally done by the ROMN field crew lead; however, close interactions with the ROMN ecologist, field crew lead, and data management team are important.

Timing of Field Sampling

Base/Full Events - Index Period

The timing of when to conduct base flow or full events within a field season (e.g., a given month during a year or a particular hour during a 24-hour period) is a key part of implementing the SEI protocol. The timing of sampling (also known as the index period) must be carefully chosen and justified. Index-period sampling focuses the time of sampling on the most ecologically relevant period(s) for a given response measure.

Sentinel - Limbs of the Hydrograph

- The four annual SEI sentinel events are timed to occur on the limbs of the hydrograph. The first event should be on the rising limb, the second at peak flow, the third on a falling or base flow, and the final a late-season base flow or winter base flow. Often the rising limb is the most difficult to get given access issues. The peak flow may also be challenging given safety issues. The third or base flow event is the main or full sample when all methods are done at most sites.

Table 1-1. Key events and timeline in SEI season.

Key Event	Timeline
Initiate field crew hiring	December/January
Review and revise protocols	February/March
Review sample frame, design points, and panel, to determine sites on the annual schedule	February/March
Submit Permit Requests	February/March
Brief the ROMN Technical Committee	March
Determine index period and the field schedule (draft)	March
Make lodging reservations	March
Other logistics	March-May
Vehicle rentals	April-May
Equipment to purchase	April-May
Equipment to ship	May
Coordination with park staff and other personnel	May
Training preparations	May
Final permits acquired (verify)	May
Final equipment inventory	May
Crew training	late May, early June
Field work	May-October
Season wrap-up	September-October
Data entry, quality assessment, and error corrections	October/November
Finalize database and close-out annual effort (triggers data manager to add annual data to master database files):	December/January

Pre- and Post-Season Procedure: Pre-Season Field Equipment Setup

GPS/Maps

1) Ensure all waypoints and tracklogs are cleared from the GPS units.
2) Export a .dbf or .csv file of all visited site locations from the Locations_ROMN_MASTER.mdb saved in the following folder on the shared server: Z:\MONITORING\Locations\Data\Certified.
   a) This will include all visited sites for all protocols.
   b) Be sure to also add the coordinates and site names of any anticipated new sites.
3) Create one shapefile per UTM Zone named Sites_ROMN_UTM##_YYYYMMDD and save the files in the following folder: Z:\MONITORING\Locations\Geospatial\GeoDatabases.
4) Connect the GPS to the base station computer via a USB cable.
5) Open DNR Garmin.
6) Make sure DNR Garmin is set to the correct projection, i.e. correct UTM zone for the park and NAD83 datum.

7) Select File-Load From-File and navigate to your shapefile for the UTM zone selected in the last step.
   a) Change the file extension to .shp to see shapefiles in the folder.
   b) The points from the shapefile will appear in the table in DNR Garmin.
8) Select Waypoint-Upload to upload all points from the DNR Garmin table onto each GPS unit.
   a) Not all waypoints will be visited, but all waypoints should be included.
9) Clear the DNR Garmin table and repeat steps 9-11 for each shapefile needed.
10) Use the same shapefiles to create annual maps for each park by updating the maps located in the following folder: Z:\MONITORING\Locations\Geospatial\MXDs.
   a) The display should be filtered based on anticipated sites.
11) Print two sets of maps for each park on "Rite in the Rain" paper.

Cameras

1) Ensure all photos have been cleared from the cameras.

Field Sheets and Printing

1) Make any desired field sheet edits in a new copy of the SEI_FieldForms_YYYY_FINAL database located on the shared server in the following folder: Z:\MONITORING\Streams\FieldForms.
2) Export all field sheets from the database into a single PDF named SEI_FieldForms_YYYY_YYYYMMDD located in Z:\MONITORING\Streams\FieldForms.
3) Print five more sets of field sheets than the scheduled visits using "Rite in the Rain" paper.
4) For additional details, refer to the Site Folders SOP in Z:\ADMIN\MASTER\SOPs\GeneralDataManagement.

Sample Container/Label Preparation

1) Refer to SOP SEI 3: Sample Tracking for detailed steps on how to label bottles with the appropriate sample information and compile needed materials into plastic bags.

Pre- and Post-Season Procedure: Pre-Season Database and Folder Structure Setup

Seasonal Folders

1) Ensure all legacy files have been cleared from all subfolders within Z:\MONITORING\Streams\Data\DataGathering. This will include DataEntry, Lab, Photos, Scans, and Waypoints folders.
2) Ensure all legacy files have been cleared from all subfolders within Z:\MONITORING\Loggers\Data\DataGathering. This will include Flowtracker, HOBO, and InSituYSI_WaterQuality folders.

Monitoring Databases

1) Complete any needed schema changes to the master database located on the shared server in the following folder: Z:\MONITORING\Streams\Data\Certified.
2) Edit the data entry interface as needed to accommodate any structure edits.
3) The interface consists of forms and VisualBasic sub routines within the master database.
4) Test the data entry interface.
5) Ensure any updates are reflected in the database template located in Z:\MONITORING\Streams\Data\Tools.
6) Make a copy of the database template in Z:\MONITORING\Streams\Data\Tools and name it SEI_ROMN_DataEntry_YYYY_YYYYMMDD in the following folder: Z:\MONITORING\Streams\Data\DataGathering\DataEntry.
7) From the newly created data entry database delete all records in tbl_Events.
8) Keep only "Calculate," "QAQC," and "CheckBox" macros, modules, queries, and forms.
9) Keep all tables except any "working*" tables.
10) Compact and Repair the data entry database.

Logger Databases: Flowtracker, HOBO, and InSituYSI

1) Make a copy the Flowtracker processing database located on the shared server in the following folder: Z:\MONITORING\Loggers\Data\Tools. Name the copy Flowtracker_ROMN_DataCompiling_YYYY_YYYYMMDD and save it in Z:\MONITORING\Loggers\Data\DataGathering\Flowtracker.
2) Delete all records in the Logger_Metadata and IMPORT_Logger_Flowtracker_Metadata tables.
3) Make a copy the HOBO processing database located on the shared server in the following folder: Z:\MONITORING\Loggers\Data\Tools. Name the copy HOBO_ROMN_DataCompiling_YYYY_YYYYMMDD and save it in Z:\MONITORING\Loggers\Data\DataGathering\HOBO.
4) Delete all records in the Logger_Metadata and IMPORT_Logger_HOBO_Metadata tables.
5) Make a copy the InSituYSI processing database located on the shared server in the following folder: Z:\MONITORING\Loggers\Data\Tools. Name the copy InSituYSI_ROMN_DCompiling_YYYY_YYYYMMDD and save it in Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality.
6) Delete all records in the IMPORT_Logger_InSituYSI_Metadata table.

Photo Database

1) Ensure all records have been deleted from the Photo_Metadata table of the photo database located on the shared server in the following folder: Z:\MONITORING\Streams\Data\DataGathering\Photos.

Pre- and Post-Season Procedure: Pre-Season Workflow Setup

Trello

1) The Data Manager administers the protocol workflow sites in Trello: https://trello.com/, a free online project management tool.
2) Copy the Workflow - SEI (Template) board and name it Workflow - SEI YYYY.
3) Modify the Check-in, Data Processing, and Data Tracking columns to reflect the anticipated site visits.
4) Assign estimated due dates and responsible personnel to each card.
5) Invite all ROMN personnel to join the new board.
6) Keep board up to date as tasks are completed.
    a) Most cards have Checkbox lists within them.
    b) Add comments if notes are needed.
    c) Move a card to the Done column once all lists are completed within the card.

Pre- and Post-Season Procedure: During-Season Operations

1) Refer to the SEI SOP 2: Pre- and Post-Sample Event Workflow for details on the procedures the field crew needs to follow to manage field sheets, photos, GPS points, logger data, and sample data.
2) The Data Management team is responsible for processing the photographs after they have been downloaded to Z:\MONITORING\Streams\Data\DataGathering\Photos\ReadyToProcess. Refer to ROMN SOP: Photo Management for details on these procedures.
3) The Data Management team is responsible for processing the field sheets after they have been turned into the Ready to Scan inbox. Refer to SEI SOP 15: Field Sheet Scanning and SEI SOP 13: Data Entry for details on these procedures.
4) Ensure both the Trello board and the wall hanging are accurately updated as data are downloaded and processed.
5) Run the Logic QAQC tool within the data entry database periodically throughout the field season and initiate discussion on the reasons and solutions for flagged data. Track progress in the QAQC_QualityTracking table.

Pre- and Post-Season Procedure: Post-Season Operations

Logger Databases

1) The Data Management team is responsible for processing the logger data at the end of the field season. Refer to SEI SOP 5: *In Situ* Water Physiochemistry and ROMN SOP: HOBO Logger for details on these procedures.
2) The discharge data are appended to the Logger_Metadata table in the Flowtracker database in Z:\MONITORING\Loggers\Data\DataGathering\Flowtracker and the Format Records tool is run from the database interface.

3) Make a copy of the final Flowtracker, InSituYSI, and HOBO logger databases for the year and save as SEI_ROMN_Logger_[Flowtracker/WaterQuality/HOBO]_YYYY_FINAL on Z:\MONITORING\Streams\Data\Certified\FY##\Databases
4) Only keep the SEI protocol records in the IMPORT_Logger_[Flowtracker/InSituYSI/HOBO]_Metadata tables.
5) Ensure the Trello board is accurately updated as data are processed.

Monitoring Databases

1) Run the CheckBox QAQC tool after all data are entered and QAQC'd. Resolve any discrepancies. Run the tool again until no records are flagged.
2) Run the Logic QAQC tool after all data are entered and QAQC'd. Finalize discussion on the reasons and solutions for flagged data. This process ends when all cells in the AcceptanceDate field are populated in the QAQC_QualityTracking table.
3) Update all EventNames in tbl_Events after all data are entered and QAQC'd.
4) Format all lab deliverables to match the corresponding IMPORT* tables in the data entry database.
5) Assign EventNames to each lab record.
6) Append all tabular lab data to the appropriate IMPORT* table and ensure all records are related to an Event.
7) Add Event recorts to the data entry database for all QAQC samples conducted by the lab.
    a) Use the ROMN vs Lab tools in the database to determine if any Events are missing
8) Check to see if any identified species are not represented in the species lookup tables.
9) Update the species lookup tables as needed.
10) If new GPS locations were needed, then temporarily import the .dbf extensions of the shapefiles located in Z:\MONITORING\Locations\Data\DataGathering into the data entry database.
11) Use these files to update the Lat_UTM_GPS and Lon_UTM_GPS fields in the tlu_Sites table and then remove the temporary files.
12) Save data entry database as SEI_ROMN_AnnualYYYY_FINAL on Z:\MONITORING\Streams\Data\Certified\FY##\Databases.
    a) This is the annual certified database; therefore, data may not be edited after this database is created.
13) Use the Lat_UTM_GPS and Lon_UTM_GPS fields in the tlu_Sites table within this certified SEI database to update the Locations_ROMN_YYYY_YYYYMMDD database located in Z:\MONITORING\Locations\Data\DataGathering.
    a) Use the annual Locations SOP in Z:\MONITORING\Locations\Documents\SOPs.
14) Make a copy of the SEI_ROMN_MASTER database located in Z:\MONITORING\Streams\Data\Certified, name it with YYYYMMDD appended to the end of the filename, and save it in the old folder.

15) Update the SEI_ROMN_MASTER with the certified annual database.
    a) Append all data in the tbl* tables.
    b) Append all data in the IMPORT* tables.
    c) Append any new records in the Species_SpeciesLookup* tables.
    d) Append any new records in the tlu_Crew table.
    e) Update the Lat_UTM_GPS and Lon_UTM_GPS fields in the tlu_Sites table.
16) The Ecologist and Protocol Lead can now run the Summary tools within SEI_ROMN_MASTER, and can work with the Data Manager on any additions and/or modifications that are needed.

Certify and Archive

1) Ensure all GPS files have been named correctly and then move the spatial data which pertains only to SEI to Z:\MONITORING\Streams\Geospatial\GeoDatabases.
2) Ensure the final SEI logger(s) and SEI annual monitoring databases are saved on Z:\MONITORING\Streams\Data\Certified\FY##\Databases.
3) Ensure all photos have been named correctly. Save a copy of the photo database as SEI_ROMN_PhotosYYYY_FINAL into Z:\MONITORING\Streams\Data\Certified\FY##\Databases and save all Core photos into Z:\MONITORING\Streams\Data\Certified\FY##\CorePhotos. The Misc photos are moved to Z:\MONITORING\Streams\Images\Photos.
4) Ensure all field sheet scans have been named correctly and move them to Z:\MONITORING\Streams\Data\Certified\FY##\Scans.
5) Ensure all lab deliverables have been moved to Z:\MONITORING\Streams\Data\Certified\FY##\Lab.
6) Establish a link from the certified annual database to the annual SEI logger database(s) by importing a link from all logger tables into the certified annual database.
    a) There are three types of SEI loggers: Flowtracker, InSitu/YSI/SmartTroll, and HOBO.
7) The Data Management team is responsible for processing, certifying, and archiving the data at the end of the field season. Refer to ROMN SOP: Archive Format Standards for Network Data for details on these procedures.
8) Ensure all sub folders in Z:\MONITORING\Streams\Data\DataGathering have been cleared of processing files.

SEI SOP 2: Pre- and Post-Sample Event Activities

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents methods for activities before and after a sample event. Pre-sample activities are generally conducted on the same day as a sample event. These activities are required to ensure that the field teams know where they are going, that access to the stream site is possible and permissible, that all the necessary equipment and supplies are in good order to complete the sampling effort, that all data management provisions (especially field forms and labels) have been made, and that samples can be packaged and shipped correctly and promptly after collection. Post-sample activities include processing of samples, sample tracking procedures, and data management of all data on instruments and field forms. Figure 2-1 provides the general workflow of steps before and after the actual fieldwork. Note that the creation of labels, tracking all sample containers, and shipping is handled in a separate SEI SOP 3: Sample Tracking given the complexity of these steps.

Some of the narrative that follows is modified from the EPA EMAP (Peck et al. 2006, Lazorchak et al. 2000) and the National River and Streams Assessment (EPA 2007).

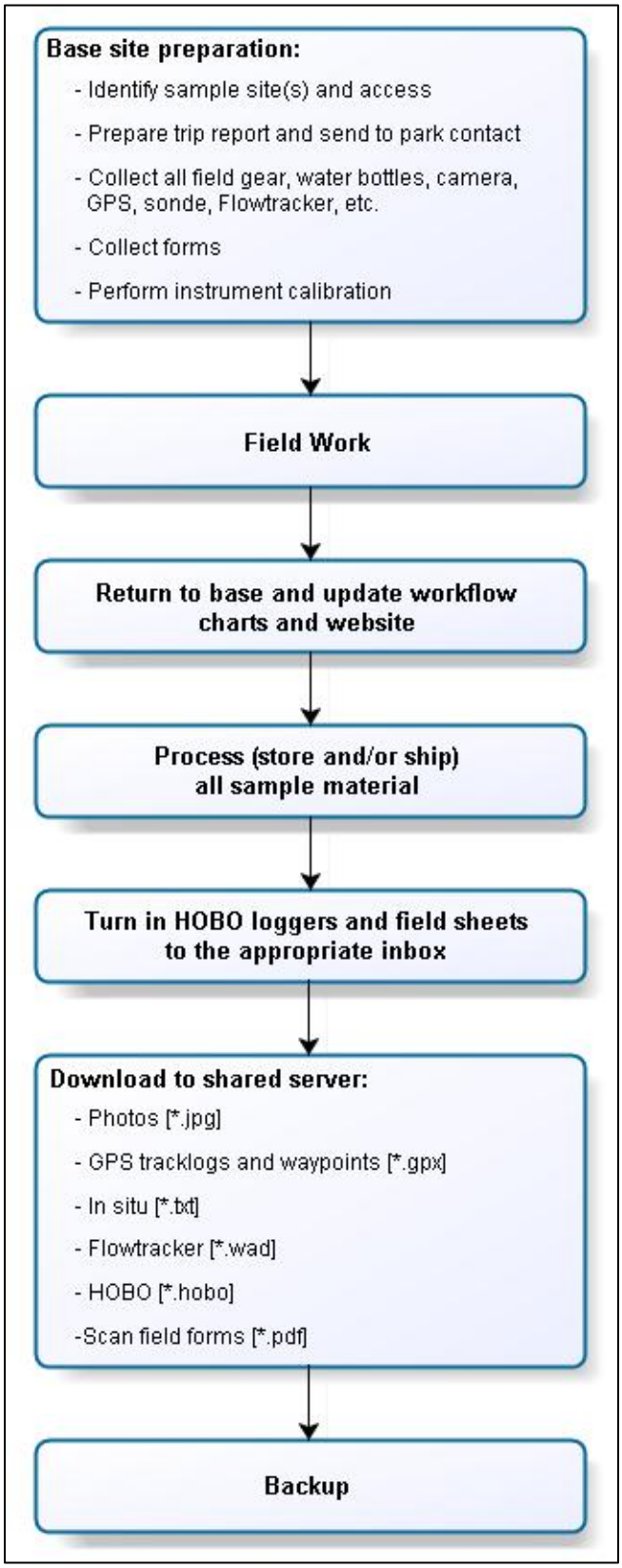


Figure 2-1. Overview of pre and post-sample event workflow.

Pre Sample Event Activities

Before each stream visit, crews must develop a sampling itinerary; confirm access to the stream site; inspect, calibrate and repair equipment; and check to make sure all supplies required for the visit are available, including sample containers. **Most importantly, crew leaders or the ROMN field coordinator must complete and submit all required material for a park's backcountry tracking process. This must be done 24 hours in advance in some ROMN parks.** Procedures to accomplish these activities are summarized in the following sections.

Backcountry Travel Plans

In some ROMN parks, any backcountry trip that involves NPS staff may require use of the park's Backcountry Travel Plan and reports to park dispatch via a NPS radio. The Backcountry Travel Plan provides the itinerary for the sample event to the crews park staff contact and park dispatch. They include departure time, routes of travel, location of any intermediate stops, radio no-coverage zones, other known safety issues, and estimated time of arrival at the final destination after completing the stream visit. Failure to adhere to the reported itinerary can result in the initiation of expensive search and rescue procedures and disruption of carefully planned schedules. Details on how to use a park's Backcountry Travel Plan, radio operation and other safety procedures are available from each ROMN park.

Daily Sampling Itinerary

Based upon the sampling schedule provided to each team, crew leaders are responsible for developing daily itineraries. The crew leader reviews each stream dossier to ensure that it contains the appropriate maps, contact information, copies of permission letters, and access instructions. The team leader also determines the best access routes, confirms permission with landowners or local contacts, confirms lodging plans throughout the sample event and coordinates rendezvous locations with individuals who must meet with a field team prior to or after accessing a site.

Special Non-wadeable Site Considerations

Non-wadeable sites require special planning. Primarily put-ins and take-outs and special safety considerations must be dealt with.

Confirming Site Access

Field crews are provided with dossiers containing important location and access information for each stream they are scheduled to visit. Before visiting a stream, review the contents of the specific stream dossier. Contact the Rangers in the district where the sites are located to confirm any known issues with fire or wildlife and any accommodations or assistance that the district Rangers may be providing. In some cases, private landowner(s) should also be contacted to confirm permission to sample or access a site.

Sample Gear

Check the inventory of equipment and supplies prior to departure using the detailed equipment lists in each SEI SOP.

Wadeable

Note that for many remote ROMN SEI wadeable sites, access is by hiking. Therefore, all gear will be packed into at least 2 backpacks. If crew size is greater than 2, items may be dispersed as needed, but once at a site the following arrangement may still be useful. This list does not include personal items or any overnight gear.

Pack 1. This pack will be placed at the location where discharge and water grab samples are taken, unless this is unknown or it is more efficient to carry this gear with the crew. Some items (benthos nets or buckets) may be in this pack when hiking to a site. Key items include:

- Field sheets and site maps
- Water bottles, collapsible coolers, dry ice or blue ice, and all other peripherals for grab samples
- Flowtracker, wading rod, and all peripherals
- HOBO loggers
- *In situ* multiparameter probe

Pack 2: This pack will travel with the crew as it moves up the channel sampling habitat, biota, and *in situ* water chemistry. This should be the larger of the two packs. Key items include:

- Field sheets and site maps
- Habitat gear (survey rod(s), vests with smaller items like a clinometer, densiometer, camera, etc.)
- Benthos nets, elutriation (bucket and sieves), and sample bottles/bags
- Periphyton filtration gear and sample bottles
- Calibration standards

For vehicle accessible sites, gear can instead be packed into coolers or other containers (although the arrangement into coolers might match Packs 1 and 2 as above). In all cases, instruments must be well padded and protected.

Non-wadeable

Special gear, in addition to that listed above, for non-wadeable sites such as boats, trailers, etc. requires extra attention. Flotemersch et al. (2000) and Angradi (2006) provide excellent treatment of these issues.

Instrument Inspection, Preparation, and Calibration

Some instruments require on-site testing and calibration prior to departure for the stream site (Table 2-1)**.** Detailed instructions for calibration of the *in situ* multiprobe are given in SEI SOP 5: *In Situ* Water Physiochemistry and in the manufacturers manuals for a given instrument. Some discharge meters also need calibration (but not the Flowtracker, in the traditional sense as used by ROMN SEI); these procedures are in SEI SOP 6: Water and Sediment Physiochemistry and the manufacturers manuals.

Table 2-1. SEI field instruments and associated on-site tests and calibrations required for each.

Instrument	Tests and Calibrations Required
Camera	Camera is functioning properly and has fully charged batteries
	There is an extra set of fully charged batteries
	Date and time set correctly
	All old photographs are removed
	Photo resolution is set to maximum
	Photographs format is set to JPG
	Date/Time photo imprint is set to OFF
GPS	The unit is functioning properly and has fully charged batteries
	There is an extra set of fully charged batteries
	The unit is set to UTM NAD 83. Use the Units Setup Menu to select the position format and map datum.
	WAAS is enabled
	Necessary waypoints and basemaps have been loaded on to the units
In situ Multiprobes (sondes)	The unit is functioning properly and has fully charged batteries
	There is an extra set of fully charged batteries for both the probe and logger
	All calibrations have been performed and readings properly entered on the field sheet
	Spare parts and tools are available
Flowtracker and Top-set Wading Rod	The unit is functioning properly and has fully charged batteries
	There is an extra set of fully charged batteries
	A beam check has been performed
	Spare parts and tools for the wading rod are available

Field Forms

Table 2-2. a summary of most of the forms needed at a site. SEI SOP 3: Sample Tracking database produces custom sample tracking forms..

Form	Notes
SEI Form #0 Calibration and Error Check	Used for both calibration and error check of water chemistry sondes
SEI Form #1 All Stream Types Stream Verification and Reach Layout	Used only for new or QAQC survey site sample events
SEI Form #3a All Stream Types SHORT FORM InSitu/WaterChem/Q	Used for sentinel events; may be used for survey events where discharge is simple
SEI Form #4 Discharge	Used infrequently when discharge is complex
SEI Form #5 Channel/Riparian Cross Section (and Woody Debris) – wadeable and boatable versions	Used for full events
SEI Form #6: Thalweg Profile and Woody Debris – wadeable and boatable versions	Used for full events
SEI Form #7: Slope and Bearing	Used for full events; done in GIS for boatable sites
SEI Form #8: Torrent Evidence and Channel Constraint	
SEI Form #9: All Stream Types Periphyton and Benthos	

Post-Sample Event Activities

Upon reaching a base station location after sampling a stream, review all completed data forms and sample labels for accuracy, completeness, and legibility. Fill in missing or illegible information on forms or labels as accurately as possible. In some cases, a completely new version of the form should be carefully reproduced. The team leader initials all data forms after review.

…if it is not legibly written down, it did not happen…

Additional post-sample activities are covered in several method-specific SOPs. Other team members should inspect and clean sampling equipment, check the inventory of supplies, make a final inspection of samples, and prepare samples for shipment. Additional activities include shipping samples, submitting sampling status and tracking information to ROMN SEI staff, and communicating with the field coordinator or other central contact persons.

Equipment Cleaning

Equipment cleaning procedures are given below. Inspect all equipment, including personal gear, and clean off any plant and animal material to minimize the risk of transferring harmful species between wetlands, and prevent possible cross-contamination of samples. Gear should be cleaned and disinfected with a 10% chlorine bleach solution or Sparquat. Some ROMN parks have specific gear and equipment protocols and these must be used by crews in addition to any ROMN procedures (Figure 2-2).

Take-out Site Cleanup

At non-wadeable sites, load the boat on the trailer and inspect the boat, motor, and trailer for evidence of weeds and other macrophytes. Clean the boat, motor, and trailer as completely as possible before leaving the launch site. Inspect all nets for pieces of macrophyte or other organisms and remove as much as possible before packing the nets for transport. Pack all equipment and supplies in the vehicle and trailer for transport. Keep equipment and supplies organized so they can be inventoried using the equipment and supply checklists. Lastly, be sure to clean up all waste material at the launch site and dispose of or transport it out of the site if a trash can is not available.

Data Management

Each time the crew returns to the office, it is important to immediately download all digital information to a pre-defined location. The following files are expected in accordance with the SEI protocol: photographs, waypoints, field forms, and logger files. See below for procedures describing how these data/information will be downloaded and placed in appropriate sub-folder(s).

National Park Service
U.S. Department of the Interior

Rocky Mountain National Park
1000 U.S. Highway 36
Estes Park, CO 80517
For more information, call (970) 586-1285

Rocky Mountain National Park Aquatic Disinfection Guidelines

Have you visited an area where whirling disease, chytrid fungus, or New Zealand mudsnails are known or suspected to exist?

Are you moving within a drainage to sites that are more than 2.5 miles (4km) apart?

Are you visiting a new drainage?

Is this your first time in Rocky Mountain National Park?

Are you using equipment that has been previously used?

If you answered **YES** to any of these questions, you are **REQUIRED** to disinfect any equipment that has had contact with water and/or soil.

Do not use felt wading soles (***highly recommended***). If felt wading soles are used, freeze the waders as outlined in step 3 (***required***).

Start at the top of a drainage and work downstream (***highly recommended***). Aquatic threats are typically located in lower elevation areas and this will minimize spread.

The Required Steps

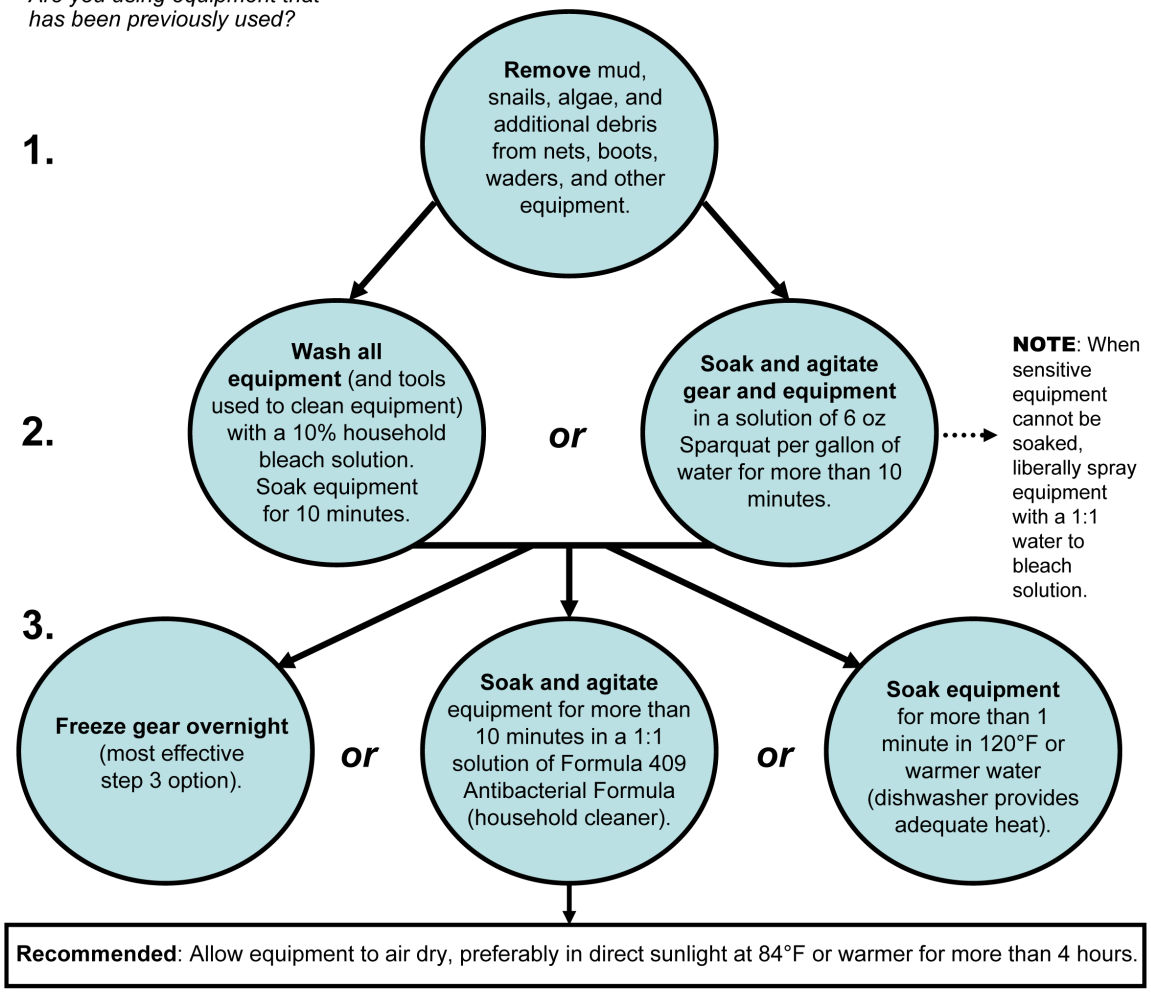


Figure 2-2. Example of an aquatic disinfection guidelines from Rocky Mountain National Park.

Pre- and Post-Sample Event Activities: Equipment Cleaning

1) Consult the site dossier and determine if the stream has been classified as whirling disease, chytrid, or mudsnail positive or negative.
2) If the stream is listed as "positive" *or no information is available*, chemically treat ALL sampling gear and other equipment that has come into contact with water (i.e., waders, boots, etc.) or sediments should be treated by a 10-minute soak in a bleach or Sparquat solution (3/4 cup bleach per gallon of water), followed by copious rinsing.
3) Inspect sampling gear and boots, etc. for evidence of plant fragments or animal remains and remove them. If there appears to be the potential for contamination, disinfect gear with a 10% bleach solution.
4) Clean all gear before leaving a site (a stiff-bristled scrub brush or high-pressure water is the best tool for this task). Inspect gear before it is packed for transport. Visible traces of sand, mud, gravel, and plant fragments are signs that gear has not been properly scrubbed and mudsnails may have been retained.
5) Thoroughly rinse your gear with clean water.
6) Thoroughly dry your gear and brush your gear off after it has dried to remove any clinging snails; pay special attention to seams, boot tongue, laces, and inserts.
7) If possible, keep several changes of field gear for use in different wetlands, both within a park and between parks.
8) Rinse coolers with water to clean off any dirt or debris on the outside and inside.
9) Rinse all beakers used to collect water chemistry samples three times with deionized water to prevent contamination of the next stream sample.
10) Physical treatments are recommended over chemical treatments because they are usually less expensive, more environmentally sound, and possibly less destructive to gear; however, most physical methods require longer treatment times and often cannot be performed in the field.
11) If a team has completed sampling at a known or likely whirling disease or chytrid-infested site, treat all gear and sampling equipment with either a strong bleach solution (3/4 cup of chlorine bleach per gallon of water) or a solution containing Sparquat disinfectant. Pay particular attention to boots, as the hard spores can embed in this material. Immerse boots in a solution of 1 part chlorine bleach or Sparquat and 5 parts water, brushing the solution into the soles to kill the parasite.
12) Remember: chemical treatments are not a substitute for physically scrubbing and cleaning your gear.

Pre- and Post-Sample Event Activities: Data Management

Photographs

1) Make sure all eight CORE photos (see SEI SOP 4: Verification of Site Status and Sample Reach Layout) are noted on SEI Form #3.
2) Connect the camera directly to the base station computer via a USB cable.

3) Avoid using the camera software for downloading since it places the photographs in a different location and can change file names. Instead, use Windows Explorer to copy and paste the photographs.
4) Copy all photographs to the following folder: Z:\MONITORING\Streams\Data\DataGathering\Photos\ReadyToRename.
5) Immediately after copying, it is important to verify this process was successful by viewing the thumbnails of the photographs and ensuring the proper number was copied.
6) Blurry, unnecessary or "error" photographs can be removed at this time; HOWEVER, kept photographs MUST NOT be edited at this time.
7) Once all photographs have been successfully copied from the camera and verified, the original photos should be removed from the camera and the workflow wall hanging should be updated.
8) The Data Management Team is responsible for all additional steps to process photographs. Refer to ROMN SOP: Photo Management for details on these procedures.

Waypoints

1) Connect the GPS to the base station computer via a USB cable.
2) Open DNR Garmin.
3) Make sure DNR Garmin is set to the correct projection, i.e., correct UTM zone for the park and NAD83 datum.
4) Select Waypoint-Download to download all waypoints on the GPS into DNR Garmin.
5) Use SEI Field Form #3 (or less frequently #2 or #4) to cross reference what waypoints were taken for the sample event.
6) Using the table of waypoints in DNR GARMIN highlight any waypoints collected in the field at a site or other important navigation waypoints and select Save To-File. Select projected shape file. Save the file in the following folder: Z:\MONITORING\Locations\Data\DataGathering.
7) Name the waypoint file [PARK]_NewXY_UTM##_YYYYMMDD.shp.
8) Note that ROMN SEI waypoints DO NOT have individual "special names" given to them in the field, rather the automatically assigned waypoint number is recorded on relevant forms.
9) Once all waypoints and tracklogs have been successfully verified, the waypoints collected in the field should be removed from the GPS and the Trello Board updated.
10) The Data Management Team is responsible for all additional steps to process the GPS data. Refer to the Post Season section of SEI SOP 1: Pre- and Post-Season Workflow for details on these procedures.

Field Forms

1) Field forms should be reviewed for legibility and completeness (e.g. no missing data) at the end of each sampling event. Once a form has been reviewed, initial it in the upper right corner.
2) Once in the office, turn the reviewed field sheets into the To Be Scanned inbox.
3) Update the workflow wall hanging to reflect what has been done.

4) The Data Management Team is responsible for scanning, naming, tracking, and filing the field sheets. Refer to SEI SOP 12: Field Sheet Scanning for details on these procedures.

Sondes

1) The download procedure for water table loggers will follow from manufacturer recommended methods. These methods may supercede the following procedures.
2) Once in the office, transfer the downloaded files to the ROMN shared server in the following folder: Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality.
3) Update the workflow wall hanging to reflect what has been done.
4) The Data Management Team is responsible for all additional steps to process the logger data. Refer to SEI SOP 5: *In Situ* Water Physiochemistry for details on these procedures.

FlowTracker

1) Connect the Flowtracker to the base station computer and establish a connection within the Flowtracker software on the PC.
2) ROMN SEI Flowtracker data files are named SiteIDQ.wad e.g., 001Q.wad.
3) When you have connected to a FlowTracker system, the Recorder module within the Flowtracker software becomes available. Recorder is used to download binary data files from the internal recorder, and to format (erase) data files from the internal recorder.
4) It establishes communication with the FlowTracker.
5) It downloads a directory of files on the internal recorder.
6) The process of downloading a *.wad file is menu driven and the user follows the prompts given by the software.
7) Save all *.wad files on Z:\MONITORING\Loggers\Data\DataGathering\Flowtracker.
8) The Data Management Team is responsible for all additional steps to process the logger data. Refer to the SEI Protocol Narrative for details on these procedures.

HOBO Logger

1) Once in the office, place the HOBO loggers from the field into the HOBO Inbox.
2) The Data Management Team is responsible for all additional steps to process the logger data. Refer to ROMN SOP: HOBO Logger Processing for details on these procedures.

Literature Cited

Angradi, T. R., editor. 2006. Environmental Monitoring and Assessment Program: Great River Ecosystems, Field Operations Manual. EPA/620/R-06/002. U.S. Environmental Protection Agency, Washington, D.C.

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Flotemersch, J. E, B. C. Autrey, and S. M. Cormier, editors. 2000. Logistics of ecological sampling on large rivers. U.S. Environmental Protection Agency, Cincinnati, Ohio.

Lazorchak, J. M., B. H. Hill, D. K. Averill, D. V. Peck, and D. J. Klemm, editors. 2000. Environmental monitoring and assessment program—surface waters: Field operations and methods for measuring the ecological condition of non-wadeable rivers and streams U.S. Environmental Protection Agency, Cincinnati, Ohio.

Peck, D. V., A. T. Herlihy, B. H. Hill, R. M. Hughes, P. R. Kaufmann, D. J. Klemm, J. M. Lazorchak, F. H. McCormick, S. A. Peterson, P. L. Ringold, T. Magee, and M. Cappaert. 2006. Environmental monitoring and assessment program-surface waters: Western pilot study - field operations manual for wadeable streams. EPA/620/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

SEI SOP 3: Sample Tracking

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP covers the generation, use, and tracking of field samples using a suite of sample tracking tools, sample labels and chains of custody. The sample bags are prepared in the office, collected in the field, returned to the office, shipped to labs for analysis and then sent back to the ROMN office with a sample analysis Excel deliverable. This SOP includes details on shipping samples between these destinations. The received Excel deliverable is formatted and imported into the Yearly SEI Data Entry Database in Access. This SOP is not intended to conflict with or override internal procedures used by ROMN contract/partner labs.

Some of the narrative that follows is modified from the EPA EMAP (Peck et al. 2006, Lazorchak et al. 2000) and the National River and Streams Assessment (EPA 2007).

Sample Tracking Components

There are several components to effectively tracking samples. They include a dedicated Sample Tracking Tool, use of unique Sample IDs, use of custom labels for each sample, specific sample containers, field sheets that record the samples taken, and use of Chain of Custody (COC) forms and process.

Workflow

The core of the ROMN SEI sample tracking process is a Workflow (Figure 3-1) that provides various critical functions for a sample crew during field operations. These steps control the flow of sample information by creating unique Sample IDs, sets of labels, documenting and tracking metadata on the actual set of samples taken after a sample event, creating a COC form based on the samples taken across multiple sample events, tracking the receipt of samples at a lab and finally the return of analytical results on each sample sent to a lab(s). The analytical results are formatted and imported into the Yearly SEI Data Entry Database in Access.

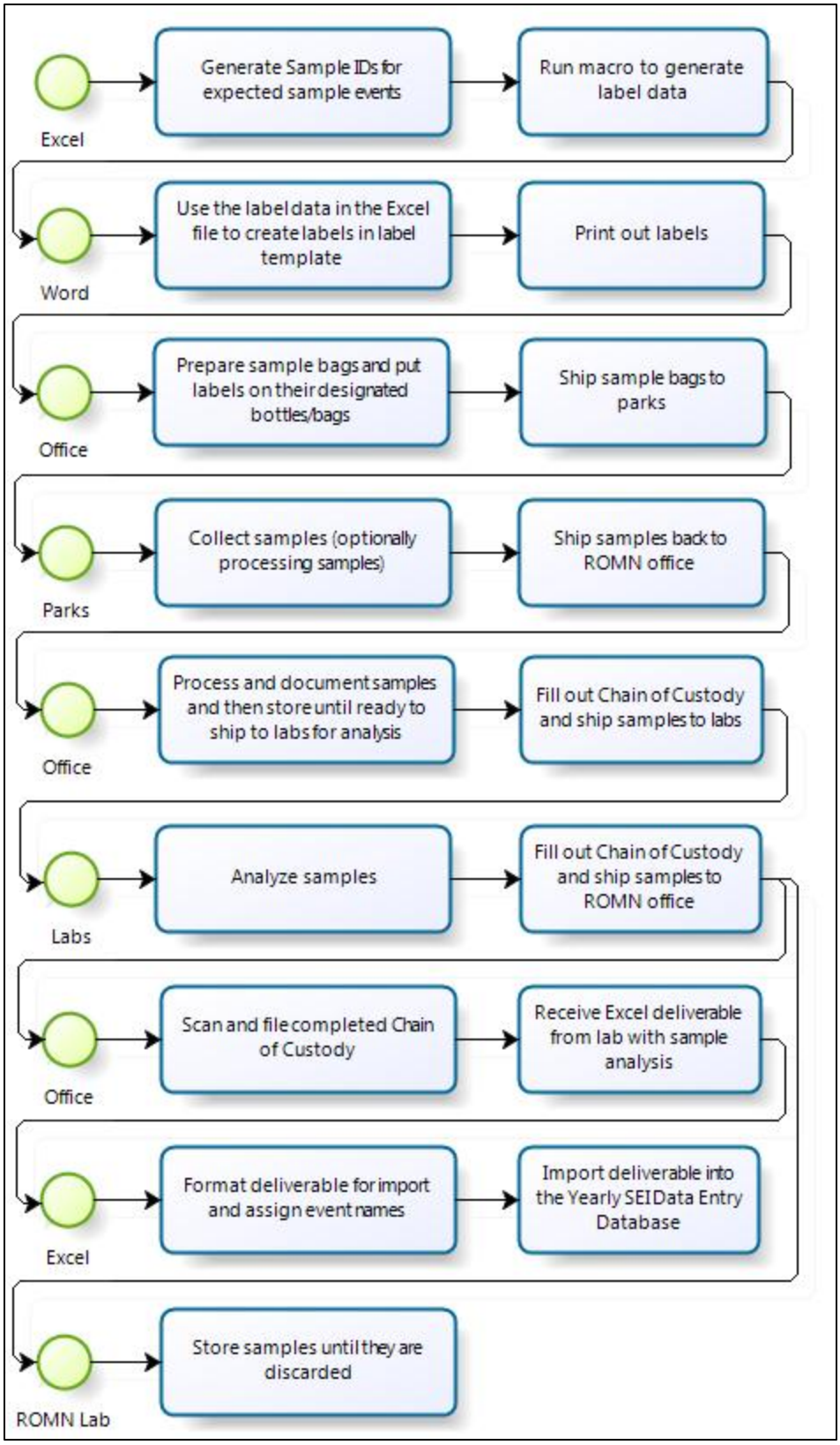


Figure 3-1. ROMN SEI sample tracking workflow.

Excel/Word Tool

A series of worksheets and macros are used before each field season to create the sets of labels needed for all anticipated samples in a field season.

Sample ID

All samples are be assigned a unique Sample ID. This ID will follow the sample through all analysis to the final report. It should be used to identify the sample on the container, the COC form, in all data sheets, in computer entry, and in the reports. All samples from the same event (e.g., water, benthos, periphyton) will have the *same Sample ID*.

Labels

Labels (Figure 3-2) are created by the Excel/Word Tool and are printed on waterproof self-adhesive labels. SEI labels will contain the Sample ID and encoded information as listed below. Labels will also be created for all QAQC sample types. Blank labels will also be made that can serve as extra or replacement labels as needed. Labels will be affixed to and (for benthos bulk samples) inserted inside each sample container.

Each label will have the following information (see Figure 3-2):

- A Sample ID
- Stream Name
- Site ID
- Bottle code: (W = whole water; F = filtered water, A = acidified; C = cold; Z = frozen)
- Date and time the sample was collected (written by the sample collector in the field)
- Initials of the person taking the sample (written by the sample collector in the field)



Figure 3-2. Example SEI sample label.

Sample Containers

Sample containers will be a high quality container as required by the protocol. All should have a surface big enough to attach the label. The SEI protocol details the exact bottles and other containers needed.

Shipping

Each type of sample has specific requirements in terms of timing and packing. See below for more details.

Chain of Custody

A Chain of Custody (COC) is a document that demonstrates the progression of samples as they travel from the original sampling location to the laboratory or testing facility. It is the documentary evidence of the capture, custody, control, transfer, and eventual disposition of physical evidence from a sampling event. These procedures, along with the required written documentation, provide the necessary backing to defend the integrity of the sample. The creation of the COC form (see Figure 3-3) is a key step within the Sample Tracking Workflow.

Confirming Receipt of Samples

When a COC is returned to the SEI base station, ROMN data management must confirm this within the Sample Tracking Workflow. The COC is checked for signatures and if there were any comments from the receiving lab on the condition and number of samples. The hardcopy COC is then scanned and placed on file with the site dossiers and field forms.

Confirming Final Receipt of Analytical Results

After analytical labs complete analysis of samples, data is returned to ROMN. The last step in the Sample Tracking Workflow is to connect these results with the Sample IDs within the ROMN SEI database. The set of queries that do this will flag any instance of a missing data value and ask for follow up.

Destroy

Destruction or proper archiving of samples is essential. Any sample is the property of the NPS and any sample taken from a national park and not “destroyed in analysis” must be curated in a qualified museum facility. Furthermore, destruction also prevents samples from being confused at some future date.

NATIONAL PARK SERVICE

Page __1_ of __3__

ROMN
1201 OAKRIDGE
DRIVE FORT COLLINS
CO 80525
970-267-2147 / 970-267-2150

Chain of Custody EPA

LSR NO./PROJECT NAME:
NPS VITAL SIGNS 2012

SAMPLER(S) NAME (PRINT AND SIGN):
E. WILLIAM SCHWEIGER

SITE ID.	BOTTLE CODE	SAMPLE NUMBER	DATE	TIME	MATRIX	PRESERVATIVE	CREW NOTES	ANALYSIS	NUMBER OF CONTAINERS	LAB ID OR TAG NUMBER	SHIPPING COMMENTS / RECEIVING LAB NOTES
GLAC_SEI-022	E3.WAC	12NP0000117	8/8/2012	9:25	2	1		SEE ATTACHED TABLE	1		
GLAC_SEI-S01	E3.WAC	12NP0000121	8/9/2012	12:06	2	1		SEE ATTACHED TABLE	1		
GLAC_SEI-S01	E3.WAC	12NP0000122	8/9/2012	12:05	2	1	Field duplicate	SEE ATTACHED TABLE	1		
GLAC_SEI-S04	E3.WAC	12NP0000124	7/3/2012	14:30	2	1		SEE ATTACHED TABLE	1		
GLAC_SEI-S04	E3.WAC	12NP0000125	8/6/2012	11:00	2	1		SEE ATTACHED TABLE	1		
GLAC_SEI-S05	E3.WAC	12NP0000129	8/7/2012	11:00	2	1		SEE ATTACHED TABLE	1		
GRKO_SEI_S01	E3.WAC	12NP0000133	8/14/2012	11:00	2	1		SEE ATTACHED TABLE	1		
LIBI_SEI_S01	E3.WAC	12NP0000137	8/16/2012	11:00	2	1		SEE ATTACHED TABLE	1		
ROMO_SEI_S01	E3.WAC	12NP0000141	9/13/2012	11:00	6	1		SEE ATTACHED TABLE	1		
ROMO_SEI_S01	E3.WAC	12NP0000142	9/13/2012	11:00	6	1	Field duplicate	SEE ATTACHED TABLE	1		
ROMO_SEI_S01	E3.WAC	12NP0000146	9/13/2012	11:00	6	1		SEE ATTACHED TABLE	1		

Relinquished By:	Date/Time	Received By	Date/Time	Received By:	Date/Time
Relinquished By:	Date/Time	Received By:	Date/Time	Received By:	Date/Time

Lab Remarks:

Split Samples:
: Accepted : Declined _____ Signature

PRESERVATIVES
1 - Nitric (HNO_3) 3 - Sodium Hydroxide (NaOH) 5 - Sodium Thiosulfate ($Na_2S_2O_3$) 7 - Ice Only
2 - Sulfuric (H_2SO_4) 4 - Hydrochloric (HCl) 6 - Sodium Sulfite (Na_2SO_3) 7 - eTOH 8 – M Fixative
9 – Phosphoric (H_3PO_4) 10 – Other _____

MATRIX
1 - Ground Water (GW) 2 - Surface Water (SW) 3 - Drinking Water (DW) 4 - Wastewater (WW)
5 - Soil (S) 6 - Sediment (Sed) 7 - Other _____

Figure 3-3. Example Chain of Custody Form.

Sample Tracking Procedure: Shipping and Prepping Stream Samples

Shipping

1) If ROMN staff are not participating on a sample event, ship bottles and bio to the ROMN offices in Fort Collins.
2) Keep bottles or bags in the fridge or freezer until they are shipped.
3) Use the fastest shipping method, overnight if possible. Samples should go out the day of or the morning after they are collected.
4) The day before (or same day of a pickup if done in the morning) log on to the FedEx site. Use a computer on the NPS domain so you can print. There may be shipper profiles in ROMN's FedEx account for our offices and each lab we ship to. **Note that it may default to the incorrect pickup address. This must be changed to your location.** If you have problems, just call FedEx and set up a pickup by phone. If you do call in a shipment the ROMN field coordinator or ecologist must be emailed or phoned.
5) Print labels for the coolers to be shipped. Print an extra and put in inside the package to be shipped. Save the receipt to a pdf and email to the ROMN field coordinator or ecologist.
6) Make sure all bottles or bio samples have the correct label that it is filled out and well attached to the bottle. Be sure all caps are tight.
7) See below for cooler packing tips.

COCs

1) **If you are direct shipping to the Kiowa or Rhithron lab, you must complete a COC.** You do not need a COC if direct shipping to the ROMN office (but still do double check the samples, their sample numbers, etc.).
2) Select the correct COC version and fill out the header by hand, or these can be done electronically using the word versions. Carefully cross reference every bottle or bag to its SiteID and sample number on the COC. Make sure there are full sets of bottles. If not, determine if a bottle was missed or lost. Make sure each label on a bottle or bag is correct and has sample date, time and initials completed. If you don't know one of these, find another bottle from the day or call the ROMN ecologist or field coordinator.
3) Fill in a COC sheet for all sets of bottles or bio samples to be shipped – **do not forget any frozen bottles**. Use separate COC(s) for each lab. Use 1 of 2, 2 of 2, etc. for multiple pages.
4) Sign and date the COC sheet in the top left most "Released By" space. If you are creating an electronic version you can insert "Signed electronically by xxxx."
5) Make two copies of the signed COC and keep a hardcopy file.
6) Place a signed COC in a Ziploc bag. **Be sure to add a copy of the methods table to the ziploc with the COC in it for each relevant cooler.** The COC in the Ziploc bag will go in the cooler with the samples.

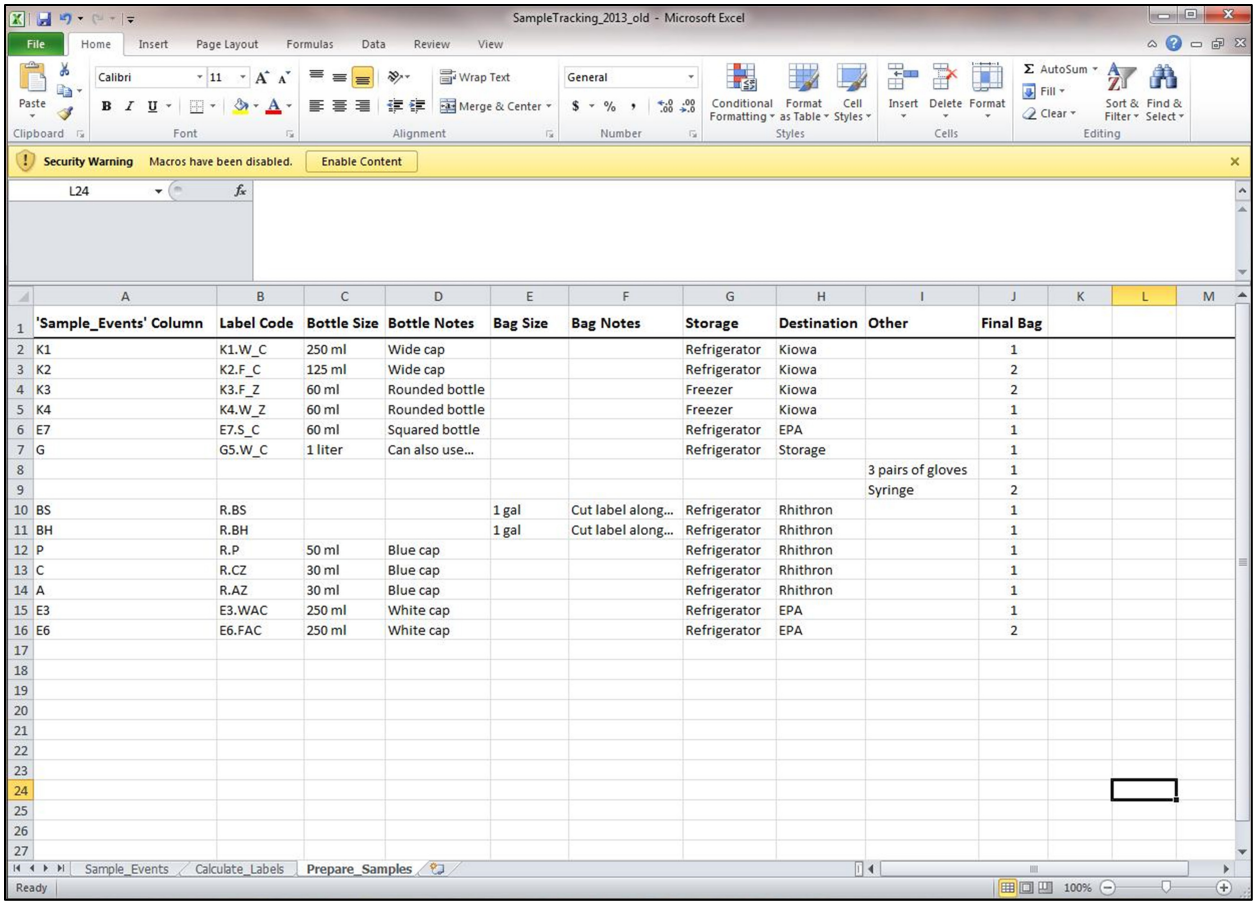
Packing Coolers

1) Be sure all bottle caps are tight and Ziplocs zipped. Place all non-frozen bottles in a Ziploc. Place all frozen bottles in a shipment in a single bag (so they stay more frozen). Write the SampleNumber and SiteID on these external bags with a Sharpie.
2) Benthos bags should be checked for leaking and double/triple/quad bagging should be added as needed. Benthos bags do not need the SampleNumber and SiteID in sharpie as the labels on the bags have this information.
3) Place lots of frozen water bottles into their own Ziploc bags (isolating them from the samples even more) and then into the coolers that will receive samples. Frozen water bottles are an easy, reusable alternative in place of ice. Ideally there will be one cooler going to a lab or ROMN offices, but use multiple coolers as needed.
4) Pack the bag with the frozen Kiowa samples (labels end with "Z") into the coldest part of the cooler. Place non-frozen samples in the same cooler.
5) The benthos do not need ice. The hard samples should be placed on the bottom of the cooler then the soft samples on top. Pack the cooler tightly with newspaper so the bags do not slosh around.
6) Tape the coolers shut well. Place shipping labels in FedEx bags stuck to the top of the coolers.
7) **Make absolutely sure they get picked up; if not, get samples back into fridge/freezer**.

Sample Tracking Procedure: Using the Excel/Word Tool

Prior to Field Season

1) Enter all of this year's planned sample events into the Sample_Events tab of the Excel Worksheet titled SampleTracking_yyyy (Figure 3-4).
   a) To do this, start with the yearly workflows document created by the field coordinator. It will be located at: Z:\ADMIN\ANNUAL\FY##\Field, where ## is the last two digits of the year.
   b) Go to the SEI tab and copy and paste those events and metadata into the Sample_Events tab of the sample tracking database.
2) Set up Calculate_Labels tab.
   a) Run macro to populate fields in Calculate_Labels tab (Ctrl + L).
   b) Delete the Calculate_Labels_Working tabs when prompted during the macro.
3) Print out labels for sample event.
   a) Open up the word document titled SampleTracking_LabelTemplate_yyyy.
   b) Click Yes when it asks you if you want to continue.
   c) If you need to remap it to the Calculate_Labels tab, map to the SampleTracking_yyyy Excel file you have been working in and select the Calculate_Labels tab.
   d) Under the Mailings tab, click Preview Results.
   e) Find the page where labels stop containing data like SiteID and stream.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	'Sample_Events' Column	Label Code	Bottle Size	Bottle Notes	Bag Size	Bag Notes	Storage	Destination	Other	Final Bag			
2	K1	K1.W_C	250 ml	Wide cap			Refrigerator	Kiowa		1			
3	K2	K2.F_C	125 ml	Wide cap			Refrigerator	Kiowa		2			
4	K3	K3.F_Z	60 ml	Rounded bottle			Freezer	Kiowa		2			
5	K4	K4.W_Z	60 ml	Rounded bottle			Freezer	Kiowa		1			
6	E7	E7.S_C	60 ml	Squared bottle			Refrigerator	EPA		1			
7	G	G5.W_C	1 liter	Can also use...			Refrigerator	Storage		1			
8									3 pairs of gloves	1			
9									Syringe	2			
10	BS	R.BS			1 gal	Cut label along...	Refrigerator	Rhithron		1			
11	BH	R.BH			1 gal	Cut label along...	Refrigerator	Rhithron		1			
12	P	R.P	50 ml	Blue cap			Refrigerator	Rhithron		1			
13	C	R.CZ	30 ml	Blue cap			Refrigerator	Rhithron		1			
14	A	R.AZ	30 ml	Blue cap			Refrigerator	Rhithron		1			
15	E3	E3.WAC	250 ml	White cap			Refrigerator	EPA		1			
16	E6	E6.FAC	250 ml	White cap			Refrigerator	EPA		2			

Figure 3-4. Sample tracking Excel worksheet.

f) If a page has some labels with data and some labels without data, select the labels without data, delete their content and remove their borders.

g) Print pages 1 through the last page with data on weather-proof address label sheets.

4) Set up labeled bags and bottles to take out into the field (See tables 6-3, 6-4, and 10-1 for complete lists of samples taken).

a) Use the Prepare_Samples tab for assistance. It will tell you which labels go on which bottles and bags based on their code.

i) Put the labels on around the lower portion of the bottles (near the base).

ii) For the G5.W_C samples, squishable 1 liter containers can also be used if out of the 1 liter bottles.

iii) The process for putting the labels on the BS (benthos soft sample) and BH (benthos hard sample) bags involves several steps. Cut the BS or BH label along the line. Remove smaller label piece from backing and use tape to “laminate” it so that it isn’t sticky (tape on front and back of label, then trim off extra tape). Put the smaller label piece in a 1gal bag (loose in the bag) and put the bigger label piece on the outside of the same bag (stuck to it). Then put in 3 1-gallon bags, folded and held together with a rubber band.

b) If it is a full sampling event, get out one 1-gallon bag and one 2-gallon bag. Write the Sample ID in permanent marker across them both.
    i) In the 1-gallon bag, place the bottles with the bottle codes: K2.F_C, K3.F_Z, E6.FAC, and a syringe
    ii) In the 2-gallon bag, place the bottles with the bottle codes: K1.W_C, K4.W_Z, E7.S_C, G5.W_C, R.BS, R.BH, R.P, C.P, R.CZ, R.AZ, E3.WAC, T8.W_C, and 3 pairs of gloves
c) If it is a partial sampling event, one 1-gallon bag will most likely be big enough. Write the Sample ID in permanent marker across it.
    i) Put the specified bottles or bags into it.

5) Update the Bottles column of the SampleTracking_yyyy Excel file to reflect the progress of the samples.
    d) If the samples for an event have been started, but the bag still needs something, note its needs in the Bottles column.
    e) Not started → Needs ____ → Finished

During the Field Season

1) Update the Where Now column of the SampleTracking_yyyy Excel file to reflect where the sample bottles and bags are currently located.
    a) They will begin with the location of ROMN office and then they will go to their designated parks.
    b) Afterwards, they will be brought or shipped back to the office and stored in the wet lab.
    c) Then they will be shipped to their destination listed in the Prepare_Samples tab (Kiowa, EPA, Rhithron, or storage) for testing.
2) Update the Collected and When column of the SampleTracking_yyyy Excel file to reflect whether the samples have been collected or not.
    a) If the samples have been collected, change the Collected column to Yes and note the day of their collection in the "When" column.
    b) Not yet → Yes; (blank) → yyyymmdd
3) When samples are sent to Kiowa, EPA, or Rhithron, complete a COC form for tracking the samples.
    a) A COC template will be located in: Z:\MONITORING\Streams\Data\SampleTracking\SampleTracking_yyyy\Tools.
    b) Make a copy of the COC template and save to: Z:\MONITORING\Streams\Data\SampleTracking\SampleTracking_yyyy\COCs.
    c) Fill out the COC and name it with this naming structure:
        i) COC_NPStoEPA_yyyymmdd
        ii) COC_NPStoKiowa_yyyymmdd

iii) COC_NPStoRhithron_yyyymmdd

d) Which samples go where (and thus, which naming structure to use) is explained in the Prepare_Samples tab of the SampleTracking_yyyy Excel file.

After Field Season

1) Update the Where Now column of the SampleTracking_yyyy Excel file to reflect where the sample bottles and bags are currently located.
   a) They will have been sent to their destination listed in the Prepare_Samples tab (Kiowa, EPA, Rhithron, or storage) for testing.
   b) The bottles that are being tested will be sent back to us for storage when testing is completed.
2) When the sample bottles are sent back to us after testing:
   a) Scan the COC sent with it.
   b) Rename it according to its designated naming structure (above) and put it in the folder: Z:\MONITORING\Streams\Data\SampleTracking\SampleTracking_yyyy\COCs.
   c) Then file the COC in the SEI filing cabinet drawer.

Literature Cited

Environmental Protection Agency (EPA). 2007. National Rivers and Streams Assessment: Field Operations Manual. EPA-841-B-07-009. U.S. Environmental Protection Agency, Washington, DC.

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Peck, D. V., A. T. Herlihy, B. H. Hill, R. M. Hughes, P. R. Kaufmann, D. J. Klemm, J. M. Lazorchak, F. H. McCormick, S. A. Peterson, P. L. Ringold, T. Magee, and M. Cappaert. 2006. Environmental monitoring and assessment program-surface waters: Western pilot study - field operations manual for wadeable streams. EPA/620/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

SEI SOP 4: Verification of Site Status and Sample Reach Layout

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP presents methods for establishing or verifying the target population membership and sampleability (together referred to as "status") of a sample site for any stream type (wadeable and non-wadeable sites) and any site type (survey, gradient, sentinel). Methods for laying out sample reaches for full and partial events are also given. We include procedures for sentinel sites where the full sample reach is fixed in space and the same sub-sample locations are sampled with revisits. Methods are provided for both wadeable and non-wadeable streams.

All site verification and reach layout data for any stream and full sample events are entered on SEI Form #1: All Stream Types Stream Verification and Reach Layout. Given the possible combinations of office and field activities it is possible to have up to three iterations of Form #1 completed for a site or a sample event. Note that partial sample events use SEI Form #3a in place of Form #1.

Some of the narrative that follows is modified from the EPA EMAP (Peck et al. 2006, Lazorchak et al. 2000) and the National River and Streams Assessment (EPA 2007).

High Flow

In addition to the safety concerns, avoid accessing a site for reconnaissance, field-verification, and any sampling during or soon after high-flow rainstorm events. Biological and chemical conditions during such episodes are often quite different from those during base flow; however, sampling cannot always be restricted to only base flow. Such a restriction would also greatly shorten the index period when sampling activities can be conducted, and is difficult in areas where access is challenging. Thus, some compromise is necessary regarding whether to sample a given stream because of storm events. To a great extent, this decision is based on the judgment of the field team. Some guidelines to help make this decision are presented below. If the crew leader decides a site is unduly influenced by

a storm event, do not sample the site that day. Classify the site as one of the temporarily inaccessible types.

- If the stream is running at bankfull discharge or the water seems much more turbid than typical for the class of stream, do not sample it that day.
- Do not sample the stream if it is unsafe to wade in over 50% of the stream reach.
- Keep an eye on the weather reports and rainfall patterns. Do not sample a stream during periods of prolonged heavy rains.
- If the stream seems to be close to normal summer flows and does not seem to be unduly influenced by storm events, go ahead and sample it even if it has recently rained or is raining.

Site Verification

Site verification includes up to three phases for determining whether a site can and should be sampled:

1) Office-based verification (optional to a degree)
2) Field reconnaissance (optional, may be the same as field-based verification)
3) Field-based verification (always conducted, first part of a sample event)

Office-based Verification

Office-based verification is an optional step that produces a rough call on site status, stream type, and directions to the site. These procedures occur before a site is visited, often prior to the start of the sample season. It should be done in consultation with experts familiar with a sites hydrology and accessibility. Often these procedures are done for many sites together and possible sample events are then allocated to hitches or sets of sites to be sampled in a backcountry trip.

Office-based procedures are often key for non-wadeable sites because GIS is often a key part of establishing reach layout. Non-wadeable stream types have special office phase verification procedures; these steps are not optional for these more complex systems.

The Office section on SEI Form #1: All Stream Types Stream Verification and Reach Layout is optional and often is not used if sites are evaluated in groups or in a GIS. In this case site status information may be recorded directly in the design file or SEI database.

<u>Office Site Status</u>

The possible site status codes are given in Table 4-1. Site status in the office phase deals largely with whether the site is in a natural (not a canal or ditch) perennial, flowing reach (all of which equate to the site being “target”), and if it appears to be a sampleable, meaning that access is safely possible and there are no compliance or landowner permission issues.

At the office phase, stream type options are simple and include only a wadeable, non-wadeable, partial (i.e., some percentage is wadeable some is non-wadeable) and unknown type. Notes may be

made about more complex channel structures, but until the site is visited in the field more detailed data is likely of limited accuracy.

Table 4-1. SEI office phase site status codes.

Status Code	Name	Description
TO	Target and sampleable office only; field recon or verification NOT needed	**Clearly perennial flowing water (target) as well as a sampleable (safely accessible) site. Common status call from office review only.**
NT	Non-target, office only, NO field recon or verification needed	**Clearly non-target (non-perennial, a canal, or lentic), no need to field visit.**
TA	Likely target, but not sampleable due to access, compliance, etc. issues, NO field recon or verification needed	**Site is likely target, but will not be sampleable due to access or other issues. This should be a rare status call from office review only.**
UN	**Unknown, office only field recon or verification needed**	**Target or access status is irresolvable in the office, field visit is needed. Common status call from office review only**

Field-based Reconnaissance and Verification

Actual field visits (as reconnaissance prior to an event or with a sample event) generate a more refined site status, stream type (channel form and hydrology; and therefore the likely sampling strategy), reasons for sliding the reach, reach layout strategies, and defines likely access routes to sites. Reconnaissance is optionally done prior to a sample event. It is similar to field-based verification, which occurs at the time of sampling a site. If field reconnaissance does not occur (e.g., for sites that are difficult to access or are obviously target and sampleable from office-based verification), field-based verification replaces these steps.

Field verification coupled with a sample event will be completed for each stream site visited (regardless of whether more sampling is conducted at the site). The steps of field-based verification are similar to those for reconnaissance, but have more immediacy as they actually define the sampleability of a site, its specific reach length, etc. In some cases (difficult or remote sites), the only phase of on-site verification used is field-based verification (no field reconnaissance). It is done for all site types (survey, gradient, and sentinel), whereas the other phases of site verification may not be needed for sentinel sites. For sample events at sentinel sites where only water physiochemistry and discharge data are collected, an abbreviated version of site verification is done.

<u>Field Site Status and Stream Type</u>

The target status and sampleability classes for field phases of verification are combined and are given in Table 4-1 at the end of this section. The permanence of the causes of any deviation from a target and sampleable condition are also taken into consideration.

The status and sampleability types in Table 4-1 are the same for recon and verification occurring just prior to a sample event; however, if anything changes between reconnaissance and sampling of a site it is the final day of sampling decisions that matter.

Reconnaissance (and field-based verification) can also be used to identify stream types that will require sample reach layout and sample procedure modifications. The following sections detail the types of stream morphology and hydrology that are likely to be encountered.

Tributaries
Tributaries that are larger (higher stream order) than the sample reach will cause a reach to be "slid" (see below); however, if a smaller order tributary is encountered on the reach, transects can cross it at its confluence with the main reach. There are no real modifications needed for dealing with confluences with a smaller order stream. Tributary presence is carefully documented in SEI SOP 8: Physical Habitat.

Streams with More than One Channel (but Not Braided) as Caused by In-Channel Bars or Islands
Complex channels (but not braided, see below) do not typically require much modification in sample methods or reach layout (so this is not a type that is on the Stream Verification Form as something crews can select as a modified channel). However, the placement of transects and plots and the distance over which wetted widths, bankfull widths, etc. are measured can be confusing in these slightly more complex channels. SEI SOP 8: Physical Habitat presents a diagram of how to deal with in channel features. In summary, channels that are separated from the main channel by in- hannel **bars** (at a lower elevation than the bankfull elevation) are considered part of the active channel and the transect extends across these features. If the transect intersects an **island** (above bankfull) and <u>if less than 15% of flow is in the side channel</u>, the presence of the channel is noted; but bankfull, wetted width, etc. measures stop at the island's bank (and the riparian plot is on the island). If more than 16% of flow, but less than 50% of flow (if it was more than 50% it would be the main channel) is in the side channels, they are treated as "Xtra" channels and all cross-section, bank, riparian, etc, measures are repeated in these channels (see SEI SOP 8: Physical Habitat).

Non-perennial
Channels that are completely dry during a field visit are not sampled. Future SEI monitoring may develop methods for dealing with non-perennial systems on a park-specific basis.

Braided Systems
Depending upon the geographic area and the time of the sampling visit, crews may encounter a stream having "braided" channels, which are characterized by numerous sub-channels that are generally small and short, often with no obvious dominant channel. If a crew encounters a braided stream, establish the sampling reach using the procedures presented below. Figuring the mean width of extensively braided systems for purposes of setting up the sample reach length is a bit of a challenge. For braided systems, calculate the mean width as the <u>bankfull</u> channel width as defined in SEI SOP 8: Physical Habitat. For relatively small streams (mean bankfull width < 15 m) the sampling reach is defined as 40 times the mean bankfull widths. For larger <u>wadeable</u> streams, (mean bankfull width > 12.5 m), sum up the actual wetted width of all the braids and use that as the width for calculating the 40 channel width reach length. If this exceeds 12.5 m, the default maximum reach length is 500 m. *However, if that seems too short for the system in question, set up a longer sample reach in order to sample enough stream to incorporate the variability in habitat types. Generally, the objective is to sample a long enough stretch of a stream to include 2 to 3 meander cycles (about 6*

pool-riffle habitat sequences). In the case of braided systems, the objective of this protocol modification is to avoid sampling an excessively long stretch of stream. In a braided system where there is a 100 m wide active channel (giving a 4 km reach length based on the standard procedure) and only 10 m of wetted width (say five, 2-m wide braids), a 400 m sample reach length is likely to be sufficient, especially if the system has fairly homogenous habitat throughout its length. Make detailed notes and sketches on the Stream Verification Form about what was done.

Streams with Interrupted Flow

The full complement of field data and samples cannot be collected from streams that are interrupted (the flow of water is not continual, but there is water in the sample reach; e.g., isolated pools). Note that no data should be collected from streams that are completely dry (a discernible stream channel is present but there is no water anywhere within an at least 150-m reach centered on the X site). Completely dry streams are classified as Dry. Interrupted streams will have some cross-sections with biological and habitat measurements and some with none. In summary, samples and measurements for water chemistry should be collected at the X site (even if the reach has been adjusted by "sliding" it). If the X site is dry and there is water elsewhere in the sample reach, the sample and chemical measurements are taken from the location nearest to the X site having water with a surface area greater than 1 m^2 and a depth greater than 10 cm; if there are no such pools, do not collect water chemistry samples or do *in situ* measurements. Collect data for physical habitat indicators along the entire sample reach from interrupted streams, regardless of the amount of water present at each transect. Obtain depth measurements along the deepest part of the channel (the "thalweg") along the entire sampling reach (even if dry) to provide a record of the "water" status of the stream for future comparisons (e.g., the percent of reach length with isolated pools or no water). Other measurements associated with characterizing riparian condition, substrate type, etc. remain useful to help infer conditions in the stream at other times when water may be flowing continuously.

Partially Wadeable Sites (non-boatable)

At some sites, it is not possible to safely wade part of the sample reach because of excessive depth or current speed, cascades or rapids, or extreme siltation. These sites are also *not amenable to sampling by raft* due to remoteness and lack of access for rafts, shallowness, barriers, or low current velocity. In these reaches, it will be impossible to do all of the wadeable sample protocols, but wading a portion of the site will provide some data. *At least 50% of a reach needs to be sampleable* (in this case using wadeable protocols in the portion of the reach that is safely wadeable) for the site to be classified as PARTIAL WADE. If the majority (>50%) of the reach is not sampleable the site must be classified as TARGET Not Sampleable, permanent or temporary. See Table 4-2.

Layout the site following normal procedures for transect placement. Keeping safety in mind, attempt as much of the usual wadeable stream sampling as possible. At some locations, it may be impossible to do thalweg depth profiles and all flow measurements, but it should be possible to do the various assessments that don't require getting in the water (stream/river assessment, RBP form, riparian condition). It is also usually possible to collect a water sample for grab chemistry samples and perhaps to collect benthos and periphyton samples at transects by sampling near the stream margin or at suitable locations between established transects. The amount of sampling that can actually be done

will depend on observed conditions; do only what can be done **safely**. Be sure to make detailed comments on the Stream Verification SEI Form #1, describing what the conditions were like and how much sampling could actually be done. Use the sketch map on the back of the Stream Verification Form to indicate problem areas and where samples were collected if you had to go off transect.

Table 4-2. SEI field phase(s) site status codes.

Name	Description
WADE	Wadeable. Meets all target status criteria (perennial, flowing, not an anthropogenically modified channel). Also meets all sampleability criteria (safe, accessible, no compliance or ownership issues).
N.WADE	Non-wadeable. Meets all target status criteria (perennial, flowing, not an anthropogenically modified channel). Also meets all sampleability criteria (safe, accessible, no compliance or ownership issues).
PARTIAL WADE >50%	At least 50% of the sample reach is continuous target wadeable water and sampleable.
PARTIAL N.WADE >50%	At least 50% of the sample reach is continuous target non-wadeable water and sampleable.
INTERUPTED WADE >50%	At least 50% of the sample reach is target wadeable and sampleable but is in isolated pools that in sum are >50% of the reach.
INTERUPTED N.WADE >50%	At least 50% of the sample reach is target non-wadeable and sampleable but is in isolated pools that in sum are >50% of the reach.
DRY	A discernible stream channel is present but there is no water anywhere within a 150-m reach centered on the X site. Site is part of another stream type (non-perennial or ephemeral or intermittent).
STREAM/LOTIC (NO CHANNEL)	Site is >50% lentic or stream with no flowing water.
MAP ERROR	Stream channel does not appear the way it is on the dossier site map. No evidence that a water body or stream channel was ever present at the coordinates provided for the X site.
IMPOUNDED, CANAL, DITCH	More than 50% of the reach is submerged under a lake or pond due to man-made or natural (e.g., a beaver dam) impoundments. To be classified as a non-target canal or ditch, the channel is constructed where no natural channel has ever existed, or the sole purpose/usage of the reach is to transfer water or there are no other uses of the waterbody by people (e.g., fishing, swimming, boating).
SAFETY/ACCESS/COMPLIANCE	Site is non-target AND compliance issues or a landowner denied access to the site OR safety or physical barrier prevents access to the site. Rare.
NON-WADEABLE (RETURN WITH BOAT or FEET)	A site that should be sampled but wasn't because the crew did not have the right equipment (e.g., a raftable river visited by a wadeable stream crew without rafts or vice versa).
TEMPORARY SAFETY/ACCESS/COMPLIANCE (RETURN WHEN RESOLVED)	The site cannot be sampled at the present time due to conditions that may not be present at some future date (e.g., forest fire, high water, roads temporarily closed, unsafe weather conditions, bear closure).
TARGET BUT PERMANENTLY NON-SAMPLEABLE	Site is target but has a permanent feature or reason that will never allow it to be sampled.
OTHER (TARGET or NON-SAMPLEABLE OR NON-TEMPORARY or PERMANENT)	Any other status, stream and permanence combination

Surprise Non-wadeable Sites (but boatable)
At some sites, it is not possible to safely wade the majority or all of the sample reach because of excessive depth or current speed; however, the non-wadeable portions of these sites are sampleable by a rafting crew. This should be rare that these are surprise encounters in the field as most raftable sites will be identified in the office phase of verification. If this does happen, classify the site as "Target not yet sampled, wrong gear." The site will be sampled by the rafting crew at a later date (see below).

Non-wadeable streams (but boatable)
There are a few rivers in ROMN parks that may require non-wadeable methods. If more than > 50% of a reach is best sampled from a raft, the entire site should be sampled with non-wadeable protocols. This does not apply to sites where rafts are only used for access and transport of gear, but the site is still sampled using wadeable protocols. These methods are presented throughout all ROMN SEI SOPs.

The SEI Sample Reach

Unlike chemistry, which depending on the stream and the monitoring objectives, may be measured at a point or along a single transect, most biological and habitat structure measures require sampling a certain length of a stream to get a representative picture of the ecological community. For full sample events we use a length of 40 times the wetted channel width to characterize the habitat and several biotic assemblages associated with the sampling reach. For partial or sentinel sample events, an abbreviated sample reach is used, with water taken at the *de facto* X site or another accessible and representative location and sediment collected from an ad hoc array of sites near this.

Figures 4-1 and 4-2 show the basic layout of the default SEI sampling reach for wadeable and non-wadeable sites. Additional figures in the set of SEI SOPs (in this document) provide more details such as the locations used for *in situ* water quality, physical habitat characterization, riparian data collection, periphyton samples, and benthic macroinvertebrate samples.

Wadeable sites have a minimum reach length of 150 m and a maximum of 500 m. Non-wadeable sites also have a minimum reach length of 150 m (but this would be a very odd stream and is not likely). There is no maximum reach length for non-wadeable sites.

The "X site" Design and de Facto
The original "X site" is the location that the sample design selects from all possible locations in the sample frame. It is important for navigating to a site and its location relative to other features or aspects of the stream (like the mean wetted width) controls the reach length and the eventual sampleability of the site. During SEI pilot studies, the actual sampled area may "flex" around this X site through time given the hydrogeomorphology of the stream. For sentinel sites, however, the sample reach does become fixed in space.

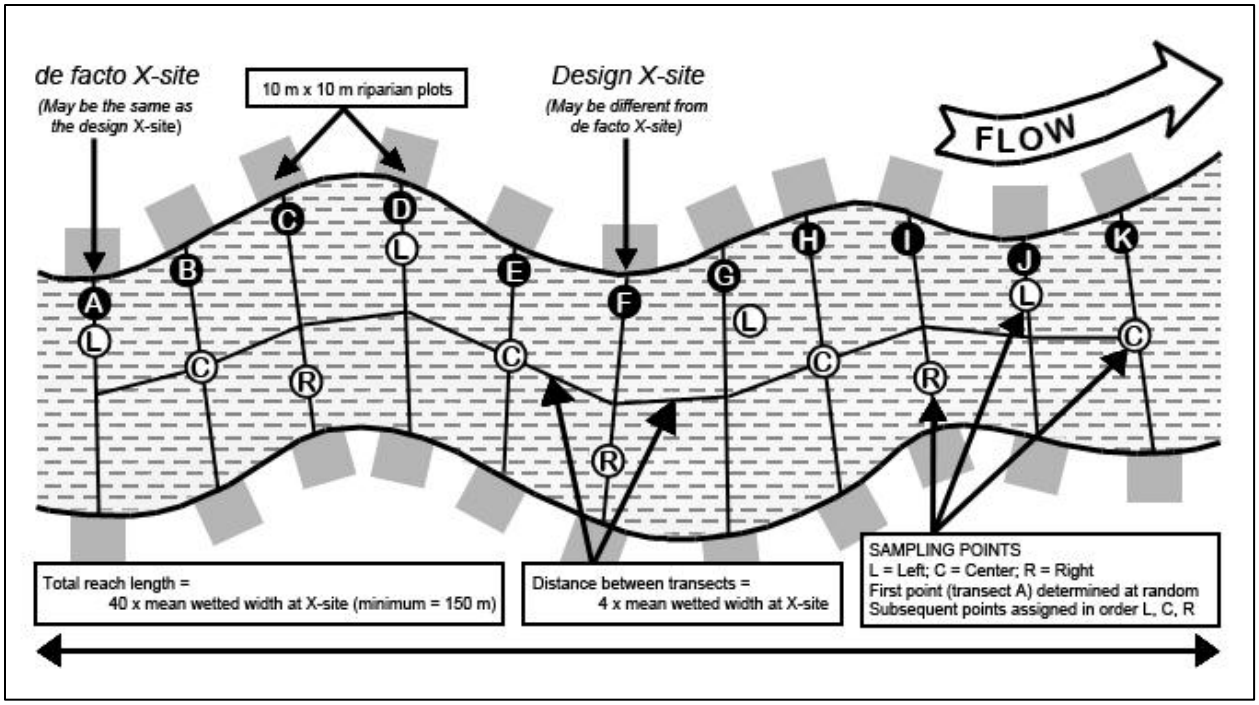


Figure 4-1. Generalized diagram of a wadeable sample reach. Letters in black circles are the transect labels. Letters in white circles are biological sample locations on these transects. Figure is based on a similar diagram in Peck et al. (2006).

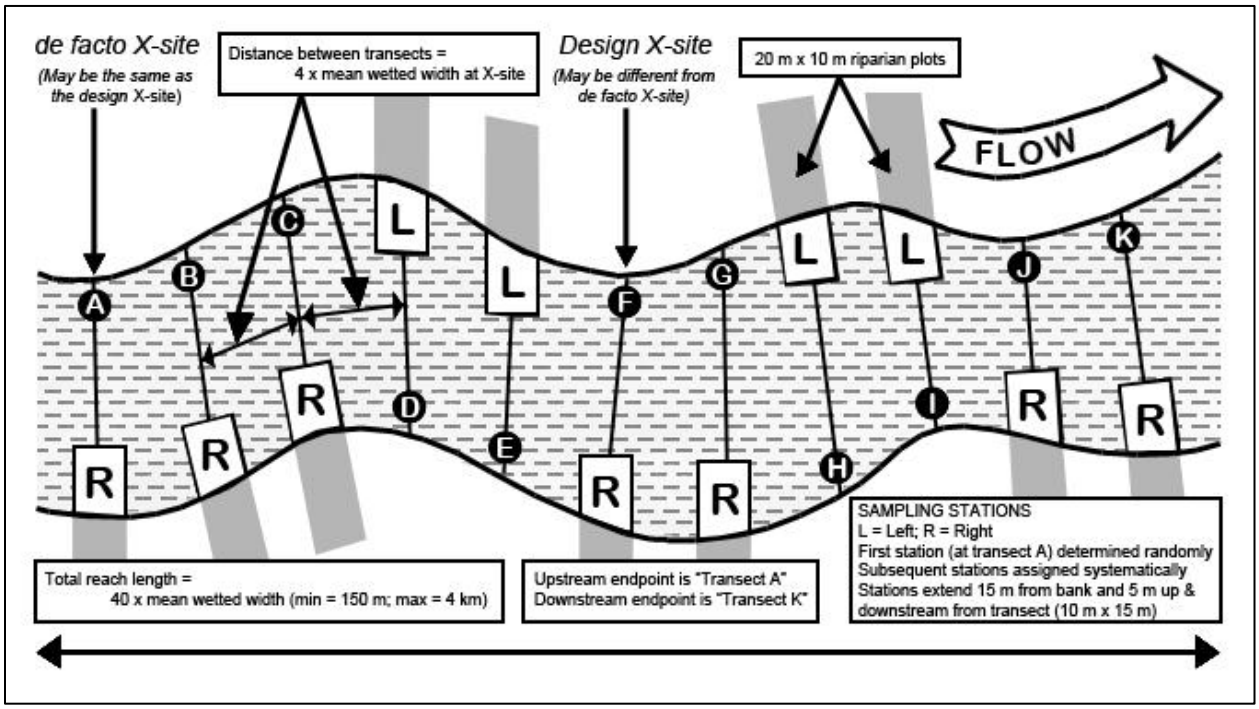


Figure 4-2. Generalized diagram of a non-wadeable sample reach. Letters in black circles are the transect labels. Letters in white polygons in the channel are littoral plots. Figure is based on a similar diagram in Lazorchak et al. (2000).

One key operational change in the SEI protocols from the EMAP and NRSA methods on which they are based is the way in which the starting point of a sample reach is established. The methods used here retain the unbiased nature of the survey design, yet allow more efficient initiation of the sample effort at a site. In a wadeable site, once the total length of a reach has been established and any 'slides' needed for safety or compliance purposes are done **the ideal discharge location is located and serves as the start of the reach (transect A, see Figure 4-1). This becomes the *de facto* X site**. Given the importance of a relatively fixed location in space for discharge and water chemistry sampling, site monuments are placed at the *de facto* X site. For wadeable sites, all other transects are laid out above this location following the procedures detailed in this SOP. Sampling occurs upstream from this location. In a non-wadeable site, the sample reach is placed above (or around, if needed) the X site, often in a GIS platform during office verification (see above). However, because crews sample from rafts that move with the current, the start of the reach is the uppermost transect (transect A, see Figure 4-2) and sampling moves downstream. The top of the non-wadeable reach becomes the *de facto* X site. All other transects are laid out below this location (initially in a GIS platform) following the procedures detailed in this SOP.

Note that, all else being equal, the preferred location for the de facto *X site is near or at the original X site. Moreover, the slide rules detailed below require that the* de facto *X site is always within a 40x the wetted width of the design X site.*

The *de facto* X site location is always the place that crews first return to when re-sampling an established site. Note that because the *de facto* X site is not determined until the first visit to the site these could appear anywhere in the 40x reach (and is not shown on Figure 4-3).

Sliding a Reach

In some situations, a sample reach may be "slid" from the design X site (Figure 4-3). Reaches **cannot** be slid:

- To avoid man-made obstacles, such as bridges, culverts, rip-rap, or channelization (unless they are unsafe to sample). These represent features and effects that are of interest in SEI monitoring.
- To obtain more water to sample if the flow is interrupted.
- **So that the X site falls outside of the reach boundaries (in all cases). If the site must be slid more than 40x the mean wetted width, the site is non-target.**

Reaches **can** be slid:

- If the access to the site is very difficult (yet the site is target and safe to sample). Problematic access is common in parks with survey sites selected in remote off-trail locations. The classification of a site as "very difficult" is up to the crew, but should be done as conservatively as safety allows. As a rule of thumb, if it takes more than 1 hour to travel 200-300 meters off trail, the site is very difficult. *In these kinds of sites,* ***safety can become an overwhelming consideration,*** *and such sites can be completely rejected as "Target, but permanently not sampleable." Figure 4-3 presents an overview of difficult access based slides.*

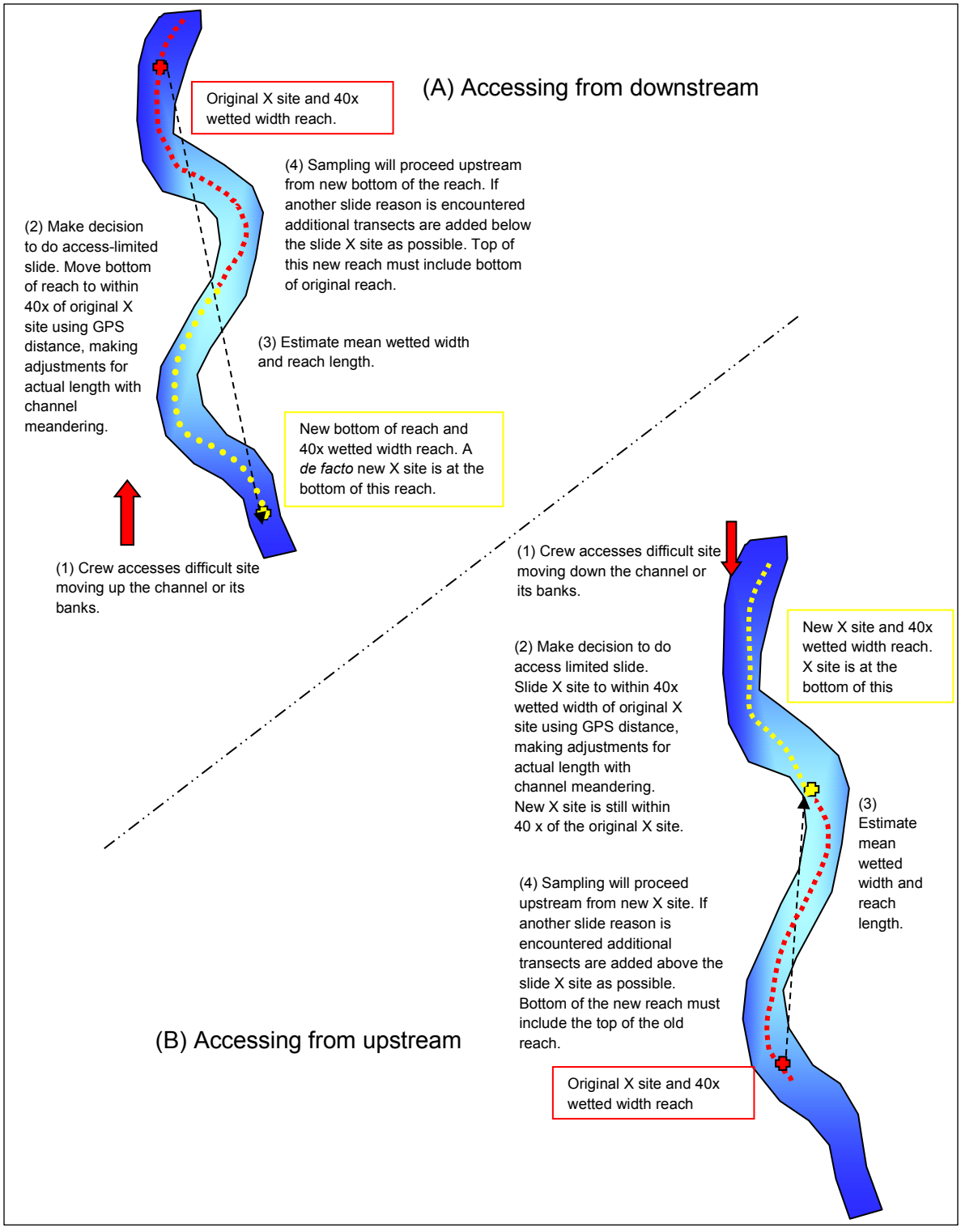


Figure 4-3. Generalized diagram of procedure for creating a new X site given difficult access on a wadeable reach during reconnaissance or verification.

- If the original reach would include a confluence with a larger Strahler order stream **or** a stream with clearly more discharge than that being sampled (order is based on a GIS calculation using 1:24000 scale maps and is given on-site dossiers, but is sometimes not well correlated with a stream's discharge at time of sampling).
- If the original reach would include an impoundment (lake, reservoir, or pond), or a significantly impassible barrier (e.g., a waterfall, a cliff). Note this is different from when the X site itself falls within an impounded channel (the site is not sampled).
- If the original reach would include an unsafe area (waterfall, bear closure, etc.). In contrast with the situation described above, this is just for a portion of the site.
- If the original reach would include an area where a park compliance issue (e.g., an archaeological site) prohibits sampling.

Reach Layout

After a site has been verified as target and sampleable, and all needed slides have occurred, the actual sample reach will be laid out. See detailed procedures below. Note that verification and layout occur somewhat in tandem. For example, often a need for a slide or the possible locations for the *de facto* X site are not know until the reach length is known, which is a product of site layout. The same form used for verification is used to record key aspects of the reach layout (SEI Form #1).

Fixing Reach Layout at Sentinel Sites

Sentinel sites have all subsample locations, such as transects and the top and bottom of the reach, fixed in space based on sample events at the site conducted during pilots, or in some cases, with the first sample at the site. Pilot sample events determine typical discharge and channel morphology at base flow. These data are then used to set the default total reach length, inter-transect distance, etc.

With every new sample event, measurements of wetted width are taken as if a new sample reach was to be set up. Unless there are safety or compliance issues using the default data, these values are not used to establish new sample locations.

When the first sample event is conducted that establishes the default locations, GPS readings are taken at each transect on each side of the stream. These locations will become the long-term sample sites for the reach, and they should be established with great care. When these sites are established, photos with a temporary pin flag at the transect location are taken on each side of the stream at the transect.

Site Photos and Sketch

Photos are important for documenting reach condition and detecting change through time. Photos are one of the easier tasks that you will perform. Relax, take your time, and take quality photos. Because many of the photos may require entry into the channel, the photos may be taken at the end of the sample event or after sample activity has moved upstream of the photo location. If the site is not going to be sampled, take site photos as able and relevant (e.g., site will probably not be monumented so there are no monument photos). Always include the Site Placard (Figure 4-4) in the four core

photos. Take additional photos at each site, capturing interesting features, sampling activities, and other relevant features. Record the required photo numbers and first and last photo numbers in any "action shots" taken on SEI Form #1.



Figure 4-4. Site photo including placard with stream and date information shows correct orientation relative to stream.

In addition to photographs, a site sketch is drawn to help describe the complex and help relocate the site in the future. Often sketches convey information that is not possible in photos or notes. Their value should not be underestimated. Each sketch should include an approximate scale and indication of cardinal directions (Figure 4-5).

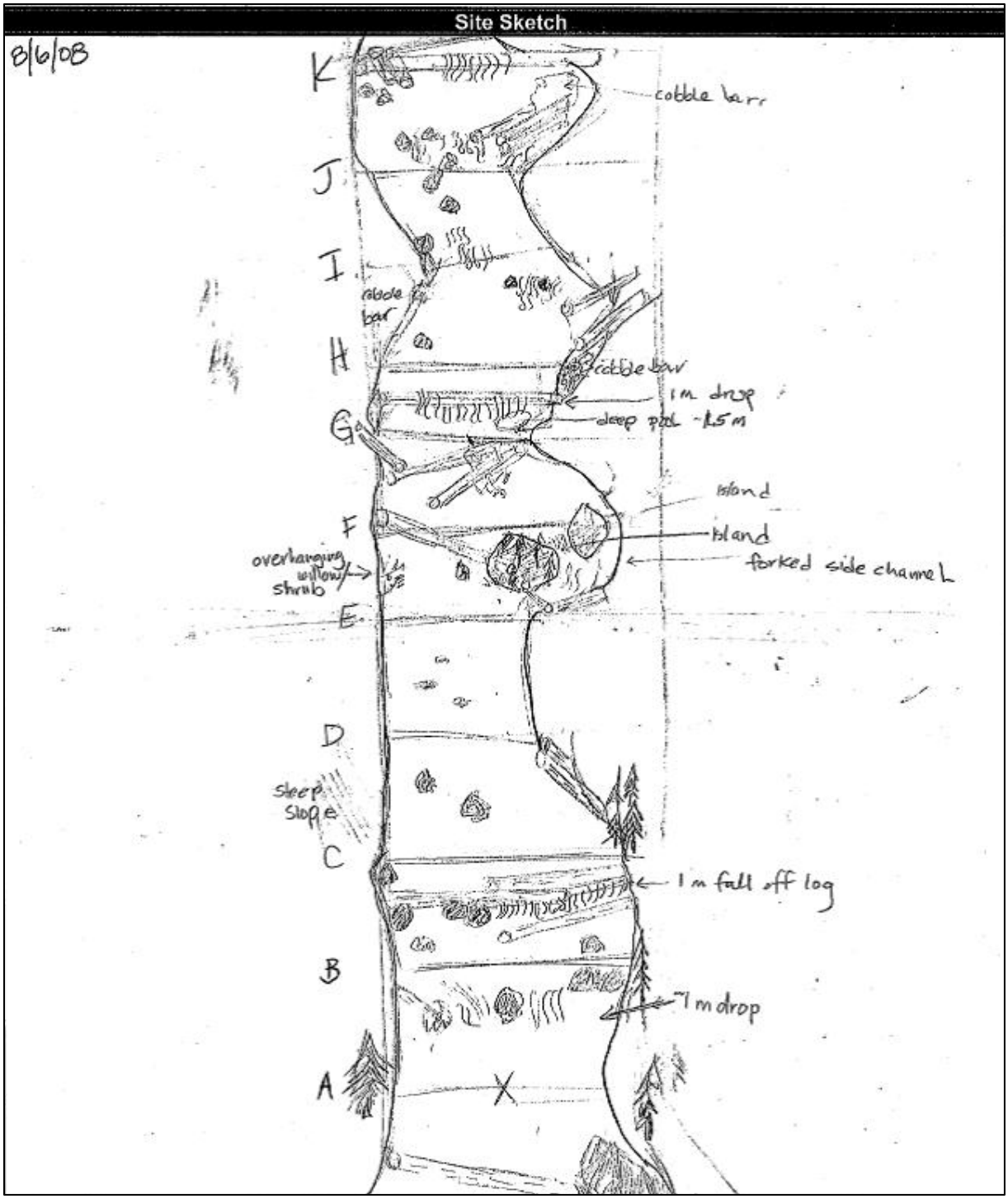


Figure 4-5. Example site sketch of North Boundary Creek SEI site in Glacier National Park. Stream is approximately 6 meters wide on average.

Office and Field Equipment for Verification and Reach Layout

Table 4-3. A complete checklist of items needed for site verification methods.

Item	Quantity
SEI Protocol Document and/or laminated sheets of SOPs	1
SEI Form 1: Stream Verification (filled out during office-based phase if done)	1+
Site maps (“dossier”)	1
Soft lead (#2) pencils	Many
Previous versions of “dossier” from earlier site visits, if they exist	1
SEI Protocol Document and/or laminated sheets of SOPs	1
Other relevant maps	1
Compass	1
GPS with site location waypoints	1
Extra batteries for GPS receiver	Many
Digital camera, with site placards	1
Surveyor’s telescoping leveling rod (optional)	1
25-m or 50-m fiberglass measuring tape with reel	2
Laser Rangefinder	1
Safety gear	-
Pin flags, two colors	Many

Site Verification and Reach Layout Procedure (Optional): Office-based Evaluation (SEI FORM #1)

1) Using SEI Form #1: All Stream Types Stream Verification and Reach Layout fill out the site ID, the site type being evaluated (sentinel, gradient or survey), stream name, etc. Note that SEI Form #1 is also used for Field reconnaissance and initial reach layout.
2) If the site is not being sampled the same date as the office activities are occurring, do not fill in the sample date; the form will be used in the field on the actual sample date.
3) Evaluate site status based on the best existing data, stream order, elevation, expert knowledge, and the ROMN cost surface model. This should be done for the expected hydrology at base flow.
4) Place in one of four categories: target office, non-target, target but not sampleable, non-wadeable, or unknown.
5) Evaluate stream type (hydrologic status) of the site based on the best existing data, stream order, elevation, and expert knowledge. This should be done for the expected hydrology at base flow.
6) Place in one of these categories: wadeable, non-wadeable, partial, or unknown.
7) Note that some sites will still be reconned in the field even if office-based verification suggests it is not needed. This can happen because a site is reconned on the way to another site.
8) Fill in general directions to site.

Non-wadeable Sites (in addition to the above)

1) Locate the X site within a GIS. Use the most current imagery as a background.
2) Measure the wetted width at 5 representative locations near the X site, average and calculate 40 x this distance as the total reach length and then generate the inter-transect distance as $1/10^{th}$ this length and then the inter-thalweg point distance as $1/10^{th}$ the inter-transect distance. Record all these data on SEI Form #1 or in the SEI database.
3) Locate the most likely put-in and take-out spots above and below the reach.
4) Determine if the entire 40x reach can be fit downstream of the X site, with the put in and outs, safety, and all other reach placement considerations. If so, this is the preferred location (and the X site will become transect K; Figure 4-2). If not, fit as much above the X site as possible, placing the X site on a transect above K. Take complete notes on this layout schema.
5) Randomly select a starting plot at transect A (e.g., use the seconds display on a digital watch to select the initial sampling station: 1-5=Left Bank, 6-9=Right Bank).
6) From here, three stations will be on the first (randomly selected) side of the river, then 2 on the other, then 2 on the first side, and so on through transect K (as shown in Figure 4-2).
7) Create sets of 2 waypoints at each transect: one on each selected bank and one on the likely thalweg. Label these as SiteID. Transect[A-K].[L/C/R].
8) Transfer these waypoints to the GPS to be used in the field.
9) When at the site, ground truth wetted width measurements to see if the layout needs to be adjusted.

Site Verification and Reach Layout Procedure: Field Reconnaissance/Verification and Establishing the *de Facto* X Site (SEI FORM #1)

These procedures are the same for a reconnaissance and a sample event visit. If both phases are done, the sample event visit is the actual relevant data that determines sampleability, status, and reach layout parameters.

1) If not already auto filled, fill out the header information on SEI Form #1: All Stream Types Stream Verification and Reach Layout including site ID, the site type being evaluated, the date of field-based activities, the verifier(s).
2) Make sure GPS ID, and Camera ID are filled out in the Field section.
3) **If the sample event is not a QA visit:** If a previous year's reconnaissance is available, be sure to reference these data (especially photos). If this is a recon effort and it was recent and/or no large changes in the site have occurred, it may be sufficient and no new reconnaissance is needed.
4) **Note that for most first visits to survey sites, reach layout is based on current conditions, not previous hydrology or channel morphology.**
    a) **If the site is a revisit, especially if a sentinel site, follow the procedures for sentinel sites given below.**
5) Navigate to general area of the site using GPS and other navigation tools (see ROMN GPS SOP).

6) Use all available means to ensure that you are at the correct stream as marked on dossier map including topographic landmarks, park road maps, local contacts, etc.

7) If sample site and its reach are accessible, navigate to the actual X site. Within common sense and safety limits, "believe" the GPS and attempt to zero out the distance to the site. In many cases the distance will "jump around" with the GPS signal; use the first location that minimizes the distance to the X site and also matches the imagery in the dossier and other cues.

8) For non-wadeable sites navigation should be from the boat put-in to the top of the reach (transect A) as noted in the GIS.

9) If the site is not easily accessible, indicate this on the form and all evaluation is done remotely (e.g., at the top of a bank or road vantage point). Make sure to comment where the site was evaluated from.

10) If a recon, visually estimate mean wetted width (in meters) at or near the X site and calculate subsequent reach length of channel. Record these values in wetted width and reach length fields on the form.

11) Note that in non-wadeable streams this will be at the most accessible location nearest the X site (often at the top of the reach as identified in the GIS).

12) If a wadeable sample event, when at the design X site and in four other representative locations measure wetted width. Wetted width is defined as the point at which substrate particles are no longer surrounded by free water.

    a) Side channels created by in channel bars are included in the width estimates. SEI SOP 8: Physical Habitat details how to include (or not) in channel bars, secondary channels, etc. in the distance over which the wetted width is calculated. *However, unless side channels are a dominant aspect of the reach, these complications should be avoided in finding the 5 "typical" wetted widths.* For channels with "interrupted flow," estimate the width based on the unvegetated width of the channel and do not include any side channel separated by an island as part of this width.

13) Average the five readings together and round to the nearest meter. Unless one of the situations occurs as detailed below, calculate the reach length by multiplying this value by 40. Divide by 10 to determine the distance between transects. Divide this by 10 to determine the distance between thalweg points. Record all values on the form.

    a) Channels with a mean wetted width less than **4 m** are assigned a default reach length minimum of **150 m**.

    b) **Wadeable** channels with a mean wetted width greater than **12.5 m** are assigned a default reach length maximum of **500 m.**

14) If a non-wadeable sample event, use a laser range finder to determine the wetted width of the channel at 5 places of "typical" width within approximately 5 channel widths upstream and downstream from the design X site. **In many cases the design X site will not be efficiently accessible and these will be done at the GIS suggested top of the reach (*de facto* X site).** Average the five readings together and round to the nearest meter. Unless one of the situations

occurs as detailed below, calculate the reach length by multiplying this value by 40. Divide by 10 to determine the distance between transects. Divide this by 10 to determine the distance between thalweg points. Record all values on the form.

a) If the average width is **< 4 m**, use **150 m** as a minimum reach length (but this should be very rare)

b) There is **no maximum** non-wadeable reach length.

c) For channels with interrupted flow, estimate the width based on the unvegetated width of the channel (again, with a 150 m minimum and 4 km maximum).

d) **If these values are meaningfully different from the GIS based measurements**, be sure to note this.

15) In very difficult terrain it is permissible to estimate a new X site within 40x the wetted width from the original X site without accessing the actual original X site (see Figure 4-3). The sample reach layout and order of steps will also be different in these situations. In rough (but still safe) terrain, move as close to the X site as possible and by using the GPS, determine a new X site that will result from an access slide (see Figure 4-3). Record the slide reason as difficult access and estimate the distance and direction of the slide.

16) If the full sample reach can be scouted, do so. Look for reasons to slide the reach. These include the following:

a) If the original reach would include a confluence with a higher Strahler order stream (order is given on site dossier maps and the header of forms)

b) If the original reach would include an impoundment (lake, reservoir, or pond), or an impassible barrier (e.g., a waterfall, a cliff)

c) If the original reach would include a significant unsafe area

d) If the original reach would include an area where a park compliance issue (e.g., an archaeological site) prohibits sampling

e) Note that in access limited terrain, these features may not be visible. Use any imagery or maps available.

17) If such a confluence, barrier, or access restriction is present, note the distance from the confluence, barrier, or the limit of access to the estimated endpoint of the reach. Move the other endpoint of the reach an equivalent distance away from the X site. **The X site must still be within the reach after adjustment.** The total reach length does not change, but the reach is no longer centered on the X site.

18) In wadeable streams, a key feature to look for while scouting is the **location where discharge measurements** will be taken. This will define the ***de facto* X site** and will become the bottom of the sample reach. This will be within the 40x reach.

19) Fill in the target and sampleability status following Table 4-2.

20) *When the de facto x site is located* take a GPS waypoint. Record this waypoint #, the number of points averaged and the error in the form.

Site Verification and Reach Layout Procedure: Laying Out a Survey Sample Reach (SEI FORM #1)

1) All header information including site ID, the site type being evaluated, the date of sampling, the verifier(s), GPS ID, and Camera ID, etc. should have been filled out in the various sections on SEI Form #1.
2) Following field-based verification, crews position themselves at the *de facto* X site. This will be the same location used for discharge and monuments. *All else being equal, the preferred location for this is near or at the original X site*.
3) Record the time of day; the next steps are the start of actual site measurement. Throughout the sample event, keep track of "down time" when actual sampling is not occurring. At the end of the sample event, record the time. There are other specific events for which a start/stop time are required in other SOPs.

Wadeable Streams

1) A mean wetted width, reach length, and *de facto* X site should be available from the site verification procedures.
2) Note that this is the sample location where water quality data will be collected, so care should be used entering the channel, and water samples should be collected immediately before any other activities are carried out.
3) Starting at the *de facto* X site, crews will be moving a distance of 40 wetted widths UP one side of the stream. Be careful not to "cut corners;" the measured distance includes all meanders of the channel. ***Enter the channel only when necessary to avoid disturbing the stream channel prior to sampling activities.***
4) Using a tape measure, laser range finder, or well-calibrated pacing, measure $1/10^{th}$ of the sample reach length at a time (4 channel widths in "normal" streams, 15 m in small streams or 50 m in large streams) from the start point (transect A). Flag each spot as the next cross-section or transect.
5) Transects are oriented perpendicular to the main channel's thalweg from wetted width to wetted width. To minimize disturbance in the channel when establishing transects, only the left side of the channel is flagged. The other side may be flagged as needed during sampling.
6) The 40x wetted width endpoint is the upstream end of the reach, and is transect K.
7) Perform any other sampling activities as noted in other SOPs and return to the bottom of the reach.

Non-wadeable Streams

1) The office-based verification GIS procedures will have generated a suggested reach length, transect positions, and plot locations. Field-based verification procedures will have confirmed this or generated changes in these values. If this was not a recon event and the reach layout values have been changed with a sample event, the GPS waypoints will be incorrect and should not be used in any exact sense.

2) For **most non-wadeable sites, the reach will not be laid out prior to sampling**. This runs the risk of finding surprises, so all imagery and local experience should be used to avoid safety issues, reasons for sliding the reach, etc.

3) Starting at the *de facto* X site (top of the reach), conduct all needed activities at the designated shore plot. From this location, estimate or measure with the range finder the $1/10^{th}$ of the reach length downstream from transect A to the next downstream plot and mentally flag this or create a waypoint if possible. Be careful to measure all of the bends of the river/stream; do not artificially straighten out the line of measurement. Enter the channel to make measurements only when necessary to avoid disturbing the stream channel prior to sampling activities.

4) Plot location (right bank or left bank) are assigned systematically at each site. Three stations will be on the first side of the river, then 2 on the other, then 2 on the first side, and so on through transect K.

5) At each shoreline plot, replicate these procedures after completing sampling activities at the plot.

Departures from "Normal" Streams

1) Difficult access. Because a reach that is difficult to access has not been scouted (at least at its first sample event), it is possible that safety barriers or other reasons for a slide will be encountered. *This should be minimized as much as possible using maps and imagery and local knowledge.* However, if it does happen and more than 2 transect(s) or other sample points (e.g., a stretch of thalweg profile) must be skipped, 'extension transects' placed ideally above or below the sampled reach at similar distance as the normal transects can be added to the reach. If the access-slide was the full 40x the wetted width this extension may push the slide beyond the allowed 40x wetted width distance. This is the only time this is allowed. The extension transects and any intervening or associated plots (riparian) can be sampled for all measures as if they were part of the original 11.

2) Braided streams. *Estimate the mean wetted width as the bankfull channel width* as defined in SEI SOP 8: Physical Habitat.

   a) If this width is less than or equal to **12.5** m, set up a 40x channel width sample reach in the normal manner with using the **maximum length of 500 m.**

   b) If more than 12.5 m, and the maximum reach length determined above seems too short for the system in question, set up a longer sample reach taking into consideration that the objective is to sample a long enough stretch of a stream to include at least 2 to 3 meander cycles (about 6 pool-riffle habitat sequences).

   c) Sum up the actual wetted width of all the braids and use that as the width for calculating the 40x channel width reach length.

   d) If braided conditions are encountered in reaches that are difficult-to-access (see above), make adjustments as each transect is created moving up the channel.

3) Interrupted flow. At each of the transects (cross sections), sample the stream depending on flow status. If these interrupted conditions are encountered in reaches that are difficult to access (see above), make adjustments as each transect is created moving up the channel:

a) DAMP, NON-FLOWING CHANNEL: No flowing water at transect, only puddles of water <10 cm deep

   i) Take *in situ*, water grab samples and discharge (if possible) measurements at the *de facto* X site which will be a pool or flowing water (for Q) location that is most ideal for a discharge measurement. ***The minimum that allows these measures is flowing water or a pool of water having a surface area greater than 1 m^2 and a depth greater than 10 cm***.

   ii) Collect all physical habitat data. Obtain a complete thalweg profile for the entire reach. **At points where channel is dry, record depth as 0 cm and wetted width as 0 m.**

   iii) Collect periphyton samples from wet spots closest to the normal locations, these are great places for periphyton.

   iv) **Do not** collect a benthic macroinvertebrate sample.

b) DRY CHANNEL: No surface water anywhere in cross section

   i) Do not collect a water sample if there is no acceptable location (***flowing water or a pool of water having a surface area greater than 1 m^2 and a depth greater than 10 cm)*** within the sampling reach. Record a K flag for the chemistry sample on the sample collection form and explain why the sample was not collected in the comments section of the form.

   ii) Collect all physical habitat data. Use the unvegetated area of the channel to determine the channel width and the subsequent location of substrate sampling points. Record the wetted width as 0 m. Record substrate data at the sampling points located in the un-vegetated, but dry, channel.

   iii) Do not collect macroinvertebrates or periphyton;

c) FLOWING WATER PRESENT: Transect has flow or pools > 10 cm deep

   i) Collect all data and measurements for physical habitat, periphyton, sediment, and benthic macroinvertebrate indicators, using standard procedures.

   ii) For benthos and periphyton, if at the end of sampling, there were more than 2 transects Dry or Damp so that there are missing macroinvertebrate or periphyton transects in the composite (< 11 transects in composite), then take additional samples from one of two places. Try to get an equivalent amount of material as you would from an 11 transect composite. Make detailed notes on how and where sampling took place. Note that all substrate data collected with these samples normally must also be done at these replacement locations:

      (1) "Extension transects" placed ideally above or below the sampled reach at similar distance as the normal transects.

      (2) If these locations are also dry, scout the normal reach for sufficient water to sample. Preferably, these samples would be taken at the mid-point between transects but may be taken anywhere in streams with only a small amount of water.

4) Partially wadeable but non-raftable sites. These sites have *at least 50% of a reach sampleable* using wadeable protocols and no possible raft access.

a) Layout the site following normal procedures for transect placement (see 'normal reach set up).

b) Keeping safety in mind, attempt as much of the usual wadeable stream sampling as possible as close as possible to the designed locations.

c) Take *in situ*, water grab samples and discharge (if possible) measurements at the location that is most ideal ***and safe*** for a discharge measurement.

d) For benthos and periphyton, if the designed point is too deep it is usually possible to collect samples at transects by sampling nearer the stream margin. If at the end of sampling, there were more than 2 transects too deep so that there are missing macroinvertebrate or periphyton transects in the composite (< 10 transects in composite), then take additional samples from one of two places. Try to get an equivalent amount of material as you would from an 11 transect composite. Make detailed notes on how and where sampling took place. Note that all substrate data collected with these samples normally must also be done at these replacement locations.

e) Extension transects placed ideally above or below the sampled reach at similar distance as the normal transects.

f) If these locations are also too deep, scout the normal reach for sufficient wadeable water to sample. Preferably, these samples would be taken at the mid-point between transects, but may be taken anywhere in streams with large amounts of water.

g) Collect all physical habitat data as possible. Obtain a complete thalweg profile for the entire reach, making estimates for points where it is too deep to wade. At some locations, it may be impossible to do thalweg depth profiles, but this should be minimized as much as possible.

h) Do the various assessments that don't require getting in the water (stream/river assessment, RBP form, riparian condition).

i) If these non-wadeable non raftable conditions are encountered in reaches that are difficult to access (see above), make adjustments as each transect is created moving up the channel.

5) Surprise non-wadeable sites (but raftable). These sites will be sampled by the rafting crew at a later date. Record site status data and schedule a return visit by raft.

6) Non-wadeable streams. These sites will be sampled by the rafting crew at a later date.

Site Verification and Reach Layout Procedure: Establishing Site Monuments (Optional) (SEI FORM #1)

1) These procedures are optional – please work with the ROMN ecologist to determine if monuments should be installed.

2) Use a die set to add site information to a pre-stamped aluminum cap.

   a) All markers may be pre-labeled and numbered prior to the sample event. Note that if a site becomes non-target or non-sampleable, these markers may be unused.

3) Mark the cap by updating the year, adding the alpha numeric design Site ID (e.g., 001) and a code corresponding to the river bank (R or L) (Figure 4-4).

4) Once a site has been determined to be target and sampleable and the location of the *de facto* X site (discharge and water quality transect) determined, the site can be monumented. This can be done prior to, during or after all other activities, but it is usually done while one crew member is doing the discharge readings.
5) Monuments are placed as orthogonal as possible to the discharge transect (e.g., as if the transect extended up on to the bank) above the bankfull width on each side of the stream. The location should be as permanent and stable as possible (e.g., try and avoid areas where it is obvious a recent torrent has re-worked the channel); move away from the active channel if you have to but try and keep the discharge transect visible.
6) In non-wadeable streams it may not be efficient to access both banks. In this case, monument only the side where the first shoreline plot is measured.
7) Drive the rebar into the ground using a hammer or large rock. The top of the rebar should be just below (~1/2 inch) below the surface.
8) Attach the cap to the stake (be sure it is securely attached).
9) Verify that the stake (with cap) does not extend above the normal soil surface. If it protrudes, sink the stake and cap ~1/2 inch deeper.
10) An oblique photograph of each monument should be captured by standing approximately 1 meter orthogonal to the channel with a crew member with the site placard correctly marked for the photo type and pointing at the monument. The precise location used should be clearly described and documented. The photos should show the location of the monument in the center of the photo, and as much of the surrounding area as is possible based on the capabilities of the camera. Make sure to check off (and erase previous) the photo type designation on the placard.
11) Average (minimum of 120) a waypoint at the monument location. Record the GPS waypoint number (not the error or number of points in this case).
12) Take a compass bearing and measure the distance <u>from</u> the monument <u>to</u> the nearest wetted width on the discharge transect (have one crew member stand on this location to help see it from the monument).
13) Enter a description of the site marker location, using nearby permanent features like, "1 meter, 270 degree bearing from large larch with burl at 1.5 m."

Site Verification and Reach Layout Procedure: Establishing a Permanent Sample Reach at Sentinel Sites (SEI FORM #1, #3a)

1) Review information from previous events (often on a SEI Form #10). This will include a wetted width, reach length etc. to use in setting up the permanent sample reach (data from the time of sample is NOT used to establish a permanent reach).
2) Make sure a GPS is available with the X site locations for the site and enough space for at least 22 new waypoints.
3) Travel to X site and follow the procedures above for verification of site status and reach layout. Note that because the site is a sentinel site many steps will not be relevant. While a mean wetted

width will not be used to set up new transect spacing and reach lengths, still take these measurements and record on the appropriate form.

4) If the site has changed to a significant degree (a wetted width that is more than 2x different than default or a very different channel morphology, i.e., an avulsed channel) or the default reach would result in an permanently unsafe of out of compliance sample reach, use the a new wetted width and set up a new reach, explain this well on SEI Form # 1.
5) Locate X site monuments or GPS waypoints. If no physical monuments can be found or exist, do your best to locate the X site based on photos or previous experience or notes.
    a) As needed, re-monument the site at the X (or discharge) location using ROMN SEI monuments.
6) Use the reach length provided and reach spacing as on SEI Form #10 and establish the reach and transects.
7) SEI Form#10 will explain if the reach has an X site in the middle, bottom or in another location in the sample reach.
8) If a crew member has previous experience at the site and can recall where transects are located and these are within 1 m of where the default spacing would place them, the transects can be slid a bit.
9) As the reach is established or during sampling, waypoints should be set at each transect on each side of the stream.
10) The default waypoint numbers generated by the GPS can be used, but be sure to make a table of these on the back side of SEI Form #1.
11) As the reach is established or during sampling, photos should be taken from the middle of the channel looking towards each bank at each transect. Place a tall pin flag of flagging where the transect intersects the shore to aid in seeing where the transect is located in the photo.
12) The default photo numbers generated by the camera can be used, but be sure to make a table of these on the back side of SEI Form #1 (add it to the GPS number table as above).

Site Verification and Reach Layout Procedure: Site Photos and Sketch (SEI FORM #1)

1) Take four digital photos at the ***de facto* X site location**: looking upstream, downstream to river right and to river left. Photos should be taken from a perspective that includes the channel center (X site) and a view of the channel; this is often from within the channel (why photos are taken after sampling). Try and get both banks in the photo. For smaller streams stand back from the X site location at a distance of 3 meters. For larger streams (> 8 meters wide) stand back at the best distance to assure you can see both banks. Hold the camera 1.5 meters from the ground. Always take the photo without using the zoom, in landscape mode and with the resolution on "better."
2) Use a survey rod or marked meter stick held by the other crew member in the X site photos. The site placard can be attached to the depth rod with a clip or simply held in place such that is it visible in the picture frame.

3) Photos and waypoints of the monument(s) will be taken after they are established (probably at the end of the sample event as well).
4) Other photos may be taken of useful identifying or interesting features, sample activities, etc. Record and take notes about these photos as needed.
5) A detailed sketch of the stream reach will be completed after all sampling has been done or at an appropriate time during sampling. Figure 4-5 shows an example of a good site sketch. The reach sketch or map is drawn to describe the reach and help relocate the site in the future. Draw the reach map to scale (relatively) and strive for clean and simple drawings. Show the stream channel extending at least 10 m above and below the reach boundaries, the site monuments, locations of shrubs and trees, large wood, bars, islands, and beaver ponds, location of the hill slopes, roads, fences, side channels, tributaries, etc. In addition, show any distinct feature that will help in relocating the site, especially the location of the monuments at the discharge transect. Space for the sketch is on the last page of the form.

Literature Cited

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SEI SOP 5: *In Situ* Water Physiochemistry

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents pre-field (calibration, etc.) and field methods for collecting *in situ* water physiochemistry at SEI sites. We include four core NPS Water Resource Division monitoring indicators: temperature, specific conductance (SC), pH, and dissolved oxygen (DO). We also include *in situ* measurement of turbidity at select sites/times. These parameters will be measured at every sample event for all stream types using a multiparameter instrument (also known as a multiprobe or sonde). Finally, we include methods for deploying small continuous loggers of temperature at a subset of SEI sites (usually sentinel sites). Methods are provided for both wadeable and non-wadeable streams.

Some of the narrative that follows and several ROMN SEI *in situ* procedures are modified from the NPS Water Resource Division (Penoyer 2003), the EPA EMAP program (Peck et al. 2006) and USGS (Wagner et al 2006).

All *in situ* data are recorded on SEI Form #0: All Stream Types Calibration and Error Check and SEI Form #3a: All Stream Types SHORT FORM InSitu/WaterChem/Q.

In Situ Physiochemistry

All *in situ* measures are done with a multiprobe sonde. A variety of multiprobe instruments are available. This SOP provides only generic guidelines for sampling with a multiprobe, equipment use and maintenance. At a minimum, the instrument selected must meet the specifications shown in Table 5-1.

Choice of Sonde and Manufacturer SOPs

Several types of sondes are available and while ROMN attempts to limit the number of types of instruments deployed, there has been and will be some variance across time. For example, in 2013 an In Situ Troll 9500, a YSI ProPlus, and a Hach DS5 were all used depending on park and site. We

attempt to use different types of sondes in tandem when possible to assess differences due to instrument.

Table 5-1. Multiprobe reporting units and performance specifications[1].

Sensor	Reporting Units	Range	Accuracy	Resolution
Temperature	°C or Celsius, round to nearest degree or tenth of a degree as warranted by instrument	-5 to 45°C	±0.15°C	0.01°C
Specific Conductance	microsiemens per centimeter (µS/cm) rounded to two or three significant figures (corrected for temperature by the sonde)	0 to 100000 µS/cm	±0.5% of reading +1.0 µS/cm	10 to 100 µS/cm (range dependent)
pH	standard pH units (su) rounded to nearest 0.1 pH unit; pH is reported as a temperature-compensated value	1 to 14 units	±0.2 units	0.01 unit
DO	mg/L rounded to one decimal place unless otherwise justified; DO is reported as a temperature and pressure compensated value	0 to 50 mg/L	0 to 20 mg/L; ±0.2 mg/L; 20 to 50 mg/L:±0.6 mg/L	0.01 mg/L
Turbidity	NTU; Turbidity is reported as a temperature-compensated value	0 to 1000 NTU	±5% of reading or 2 NTU (whichever is greater; depth limit of 200 ft)	0.1 NTU

[1] Accuracy specifications reflect the uncertainty in measurement of the instrument and sensor in combination only and not other factors that can affect accuracy, such as environmental factors (field) and field personnel's ability to calibrate and operate the instrument using good measurement protocols. In the case of field probes, accuracy is typically a "best case" maximum deviation from known correct values (typically based on comparisons with known NIST certified reference materials or standards). True accuracy is a combination of high precision and low bias. Resolution/Sensitivity is a data quality indicator related to detection limits but typically handled differently for field probes than for laboratory parameters. For more information, see (http://science.nature.nps.gov/im/monitor/protocols/wqPartB.doc).

We do not provide detailed SOPs for each sonde used. ROMN SOPs for sonde operation and *in situ* data collection are design to be general guidance to be used with manufacturer SOPs as needed. Manufacturer's instruction manuals for the multiprobe(s) being used in any given park and/or year of monitoring are available on the internet or from the ROMN data manager.

Multiprobe Calibration and Error Check

Calibration and error check procedures are conducted episodically during the season (Penoyer 2003); and sometimes are referred to as "pre-mobilization." The default ROMN protocol is, at a minimum for pre-mobilization, to be done at the start of a week or set of survey site sample events.

Calibrations use the manufacturer's suggested routine for a multiprobe and certified traceable standards (unexpired, w/stock #). Pre-mobilization calibration resets the instrument or removes electronic drift that has occurred since the last calibration. By recording pre-calibration readings immediately prior to a calibration and then again immediately after calibration (while the sensor is

still in the standard) a check for gross errors that might indicate sensor failure is performed. This also ensures the calibration "sticks."

Error checks just after a calibration determine how accurately the calibrated instrument is performing. Error checks use a certified standard or an uncertified prepared solution. *Do not adjust the instrument (using calibration controls) during error check procedures. If the error check values are not within the acceptance criteria in Table 5-2 the calibration should be redone.* Error checks are ideally conducted in the field just prior to sample events to confirm any drift in the instruments. Error checking should be done with a solution that is as similar as possible to the stream you will be sampling. These methods should be simple enough to not be prohibitively time consuming in the field; however, they may be optional under severe time constraints. All calibration and error check data are recorded on SEI Form #0 and directly in a calibration report stored on the instrument.

As of publication, development of detailed procedures for long term sonde deployment and incorporation of QAQC data were being developed largely following (Penoyer 2003) and USGS (Wagner et al 2006).

Equilibration or Sensor Stabilization

All *in situ* error checks and data collection (see below) require a period of probe equilibration to settle the readings within an allowable range. This is typically reached after the probe has been in place for about 2 to 5 minutes unless temperature extremes are involved. Table 5-2 presents ROMN criteria for equilibration. The natural variability inherent in surface water at the time of sampling generally falls within these stability criteria and reflects the accuracy that should be attainable with a calibrated instrument (Table 5-3).

Table 5-2. Stabilization criteria for equilibration[1].

Parameter	Stabilization Criteria for Measurements (variability/repeatability should be within the value shown)
Temperature	±0.5°C (liquid-in-glass thermometer) ±0.2°C (thermistor thermometer)
Specific Conductance	When ≤100 µS/cm: ±5% When >100 µS/cm: ±3%
pH	±0.1 unit
Dissolved Oxygen	±0.3 mg/L
Turbidity	±10 percent

[1]Resolution/sensitivity is a data quality indicator related to detection limits but typically handled differently for field probes than for laboratory parameters. For more information, see Irwin (2004). In the case of field probes, accuracy is typically a "best case" maximum deviation from known correct values (typically based on comparisons with known NIST traceable reference materials or standards). True accuracy is a combination of high precision and low bias.

Table 5-3. Summary of multiprobe calibration and error check methods with acceptance criteria for core parameters (plus turbidity).

Parameter	Calibration Method Summary	Error Check Method Summary	Frequency	Error Check Acceptance Criteria	Optimal Acceptance Criteria
Temperature	No calibration is performed; calibration of thermistor is done by manufacturer	2-point temperature error check with thermometer referenced to NIST standards (i.e. at least NIST-traceable), with a range from at least ˉ1ºC to 45ºC with 0.1ºC divisions. Temperature points should bracket expected range in sites.	NA	±0.3ºC	±0.2ºC
pH	Perform a 2-point calibration with pH standards that bracket the anticipated water of environmental interest (e.g., using pH buffers of 4 & 10 std. units).	Error check with a third buffer (7) not used in the 2-point calibration and record pH readings.	Annually, prior to field season and monthly thereafter	±0.3 S.U.	±0.2 S.U.
Specific Conductance	2-point calibration using air and a 1413 µS/cm standard	Error check with standards 100 and 10000 µS/cm. Do lower one first.	Annually, prior to field season and monthly thereafter	±5 µS/cm or ±3%	±5 µS/cm or ±3%
Dissolved Oxygen	Single point water-saturated air calibration or oxygen saturated water	Error check with zero DO water as per Penoyer (2003)	Annually, prior to field season and monthly thereafter	±0.4 mg/L, ±5% saturation	±0.3 mg/L, ±3% saturation
Turbidity (not a core parameter)	2-point calibration using <0.01 and 100 NTU standard	Error check using a 20 NTU standard	Annually, prior to field season and monthly thereafter	5% of reading or ±2 NTU	5% of reading or ±2 NTU

Field Methods

Procedures for collecting *in situ* data are given below. Data collection occurs after an error check of each parameter. While at the *de facto* X site (discharge location), at least seven measures at a thalweg mid-depth location are taken. As possible, the sonde is then taken to the top of the sample reach and a continuous deployment with data collected every 5 minutes is run as other sample activities are completed.

Data Management

Procedures for downloading and managing data from sondes data are given in SEI SOP 14: Processing *In Situ* Water Physiochemistry Logger.

Continuous *In Situ* Temperature

At select SEI sites, small inexpensive temperature loggers are left deployed year round. These loggers collect stream water temperatures every 30 minutes. As with sondes, several models are available and we only provide general procedures here; methods from manufacturers should also be used. Loggers should have an accuracy of at least ±0.5^{o}C. As of 2013, the ROMN used Onset HOBO Pendant Loggers Model UA-001-64.

Loggers are deployed on Teflon-lined cables securely anchored to permanent objects on the bank such as substantial trees, boulders, etc. Loggers are positioned in "rock caves" constructed on the stream bed that serve to protect the logger and also keep it isolated from hyporeheic (often colder) waters. Loggers may be installed in PVC housings that help shade them from incident sunlight. Loggers are deployed in duplicate to help ensure at least one log is obtained over a sample interval.

Data Management

Procedures for downloading and managing data from temperature loggers are given in SEI SOP 15: Processing HOBO Water Temperature Loggers.

Lab and Field Equipment for *In Situ* Samples

Table 5-4. A checklist of items needed in the lab and field to conduct *in situ* water sampling.

Category	Item	Quantity
Premobilization	SEI Protocol Document and/or laminated sheets of SOPs	1
	SEI Form #2: Calibration and Error Check	1
	Soft lead (#2) pencils	Many
	In situ probe and accessories	1
	In situ data logger	1
Standards	Room temperature water bath	1
	Ice water bath	1
	1413 and 147 us/cm Sc standards	1
	pH 4, 7, and 10 standards	1
	Air-saturated water (may be created by a sponge soaked in water)	1
	Zero DO water	1
Lab Based Supplies	Lab stand	1
	Deionized water	1
	Simple Green cleaner	1
	Clean, soft, nonabrasive, lint-free cloth or Kimwipes	1
	Small soft-bristle brush	1
	Allen wrench, screwdrivers	1
Field Calibration	SEI Protocol Document and/or laminated sheets of SOPs	1
	SEI Form#2: Calibration and Error Check	1
	Soft lead (#2) pencils	Many
	In situ probe and accessories	1
	In situ probe and accessories	1
	In situ data logger or field notebook	1
Standards	147 us/cm Sc standard	1
	pH 7 and 4 or 10 standards	1
	Air saturated water	1
	Deionized water	1
	Small bottle of simple green cleaner	1
	Clean, soft, nonabrasive, lint-free cloth or Kimwipes	1
	Small soft-bristle brush	1
	Allen wrench, screwdrivers	1

In Situ Procedure: Generalized Calibration (SEI FORM #0)

Detailed procedures for using a sonde are in manufacturer's manuals. The following methods are only general and directed at the In Situ 9500 and Rugged Reader data logger. ROMN uses the programs Pocket Situ 4 or HydroPlus CE for calibrating and error checking sondes. The notes below describe calibration using HydroPlus CE on the Rugged Reader.

1) Fill in the header information and standards metadata on SEI Form #0.
2) Connect rugged reader to sonde and open Hydroplus program.
3) Go to Menus – Setup – Connect/disconnect sonde.
4) If you get "connect.dll failed" error message, try replacing the batteries.
5) Set the date and time if incorrect.
6) Triple rinse sample tube and sonde sensors, once with sink water, then with DI water and then 3 times with the fluid you're calibrating or error checking. (Do this step whenever you change calibration fluid.)
7) To calibrate a sensor, go to Menu – Utilities – Sonde direct access. Select the parameter you are going to calibrate. Type in the standard used to calibrate. When the sensor is in the solution, press "calibrate." Repeat with a different standard if doing a 2-point calibration. Press "Save and exit" to save the calibration. It will make a report.
8) To error check, put the sensor into the standard and allow time to equalize. Record a log by going to "Log session." It's easiest to grab an existing log and then edit it to make a new log. Grab "ROMN Lab" "Test" and then change site to the default naming method, "Site_EC_date [as yyyymmdd]." Click on "Line log" and it will create one record. Once clicked, you can unclick "log session."
9) Note, when calibrating and error checking, always triple rinse calibration cup and sensors, spray with DI water, and dry with kimwipes before using a new standard.
10) Error check (calibration is only done by the manufacturer) temperature with 2 water baths as possible.
11) Calibrate pH via 2-point method.
    a) First calibrate with pH 7.
    b) Then calibrate with pH 4 or 10.
    c) Then error check with standard not used in calibration (either 4 or 10).
12) Calibrate conductivity with 1413 us/cm standard solution.
    a) Error check with 147 us/cm standard solution.
13) Calibrate dissolved oxygen (DO) via 2-point method using water saturated air or air saturated water (LDO water) and a solution of zero DO water.

a) Calibrate saturation by placing a wet sponge or paper towel in the bottom of the calibration cup. Add a little water to the bottom. Place the sonde into the calibration cup, making sure the sensors do not touch any water.

b) Calibrate no dissolved oxygen using zero DO. Make sure the DO sensor is completely dry first.

c) Error check with 100% saturation.

14) Calibrate turbidity using a 2-point method.

a) First calibrate with 0 NTU standard.

b) Then calibrate with a 100 NTU standard.

c) Error check with a 20 NTU standard.

15) Do not adjust the instrument (using calibration controls) during error check procedures.

16) This should be done prior to the field season and at least monthly thereafter.

In Situ Procedure: Calibrating the In Situ SmarTroll (SEI FORM #0)

The In Situ SmarTroll multiparameter handheld uses an iPod touch to record data via Bluetooth.

1) Fill in the header information and standards metadata on SEI Form #0.

2) Put instrument together. Turn on the battery pack and iPod. Open the iSitu app on the iPod.

a) Under "Sites," create a site name (use the same name as the data file name on Form #0) under "Site Details" using the site name and EC (error check) + date [as yyyymmdd]. For example, "ROMO 0032 EC 20140913" or "LIBI lab EC 20150427."

3) Select camera and take photo to aid in site identification. Often this is a picture of the data collector or the sample site. Save site details.

4) Find that event in the list of other folders and press "set." Now everything you record will be in this folder. (Note: there is no way to distinguish which fluid you were error checking after the fact, so make sure to go in order so data management can figure out whether you were testing pH, conductivity, etc.)

5) Triple rinse sample tube and sonde sensors, once with sink water, then with DI water and then 3 times with the fluid you're calibrating or error checking. (Do this step whenever you change calibration fluid.)

6) Fill sample tube with calibration fluid to fill line and insert sonde. Be sure to leave opening at top of seal to allow air to flow in and out of the calibration cup.

7) To calibrate using the iSitu app, click on the beaker icon at the bottom. Choose the sensor you are going to calibrate and whether you are doing a 1-point or 2-point calibration.

8) Follow the on-screen instructions to finish calibration. There will be no calibration report, so make sure to write down the temperature reading and the pre-calibrating reading **before** clicking "Accept." The SmarTroll does not easily return to the screen with the post calibration readings, so you can leave the "calibrated value" box blank.

9) To error check, press the "home" icon on the ipod to return to the screen that shows the measurements the sonde is reading. If needed, select the correct Site code EC + [date as yyyymmdd] and push "Set." Place probe in clean calibration solution, let equilibrate and record value by selecting "RECORD," allow to record for 1-2 seconds and then stop. Write down value on Form #0.

10) Follow steps 5-9 above to calibrate pH, conductivity, and DO. (The SmarTroll does not measure turbidity.) Note: the SmarTroll only allows a 1-point conductivity calibration.

11) Note: when calibrating DO, you will first calibrate to 100% oxygen saturation. Put a water saturated sponge (or similar) into the bottom of the calibration cup and fill with about an inch of water. When placing the DO sensor into the cup, make sure the sensor does not actually come in contact with the water. Proceed with calibrating to 0% oxygen saturation using the zero DO solution. Make sure you are still wearing gloves.

In Situ Procedure: Field Error Check (SEI FORM #3a) and *In Situ* Samples with an In Situ Troll 9500 Sonde (SEI FORM #3a)

Detailed procedures for using a multiprobe are in the manufacturer's manual. The following methods are directed at the **In Situ 9500 using the Rugged Reader data logger; for YSI sondes see below.**

1) Pre-sample sonde set up; follow the sonde manual to connect sonde to the data logger.
   a) Open HydroPlus CE on the RuggedReader, connect sonde, enable it in the software.
   b) Remove pH storage cup, calibration cup if present and re-install sample cup.
   c) Select parameters to be logged (usually just accept the default).
   d) Set stable data settings (usually just accept the default; see Table 5-2).
   e) Start a log session.
   f) Create or select a Location (use the SiteID) and create or select Sites as follows for specific tasks as below:
      i) **XT + [date as yyyymmdd]** for *de facto* X site thalweg 7 samples.
      ii) **KC + [date as yyyymmdd]** for top of reach continuous log.
      iii) **EC + [date as yyyymmdd]** for error check.
2) Conduct error check as described below and in the In Situ manual. Use the Location and Site code EC + [date as yyyymmdd].
3) Note that because this is not a calibration, it can be done as if it is just a grab sample with the line log button. Do this in order (pH, SC, DO) with a single line log after each parameter is placed in the sample cup.
4) Fill in the header information on SEI Form #0.
5) Optional: Cool standards to ambient water temperature by immersing in stream for 15 minutes (this can be done when first arriving at the site).
6) Error check conductivity with 100 us/cm or similar. Place probe in clean calibration solution, let equilibrate and line log a reading. Write down value on SEI Form #0.

7) Error check pH with pH 7 or similar. Place probe in clean calibration solution, let equilibrate and line log a reading. Write down value on SEI Form #0.
8) Error check DO with zero DO water. Place probe in clean calibration solution, let equilibrate and line log a reading. Write down value on SEI Form #0.

Seven Thalweg Samples at de facto X Site

1) Record the time for the collection of the core sample, sonde type(s), type of measurement, whether an error check was done, number of spot measurements and file names.
2) Take after the water quality grab samples.
3) Use Site code XT + [date as yyyymmdd].
4) Wadeable streams. The thalweg *in situ* measurements can usually be done by one crew member, if it is safe. The measurer moves to the thalweg on the cross-channel transect and immerses the multiprobe instrument to mid depth.
5) Be sure to stand downstream of the probe. Do not disturb the substrate with the probe. Single point data is captured by pressing the Line Log button.
6) Collect 7 readings at this location.
7) Non-wadeable streams. The thalweg *in situ* measurements can usually be done by one crew member, if it is safe off of a stationary boat or if shallow enough on foot. The boat/measurer moves to the thalweg on the cross-channel transect and immerses the multiprobe instrument to mid depth.
8) Be sure to stand or have the boat downstream of the probe. Do not disturb the substrate with the probe. Single point data is captured by pressing the Line Log button.
9) Collect 7 readings at this location. In fast water this will not likely be possible. Options in order include using an anchor, collecting < 7 readings, taking the reading from the shore.
10) After all measurements are done, uncheck the Log Session button**.**
11) The start and stop time and date of data collection is automatically added to the file, distinguishing these data from other sample events at the site.

Optional: Continuous Sample at Top of Reach (wadeable streams) or Near Transect A (non-wadeable streams)

1) Carry the probe upstream.
2) Start a log session.
3) Select Location (use SiteID) and Site KC + [date as yyyymmdd] for top of reach continuous log.
4) Select Timed Log.
5) Set Time log interval in seconds. The default is set to 5 minutes (300 seconds) - usually just accept this.
6) Place the RR in a secure spot on shoreline ideally allowing the sonde to be in a secure spot mid-channel. If this is not possible, place the sonde on the shoreline with the sensors in the water column. Note this location on SEI Form #3.

7) Let the sonde collect data until other sample activities return the crew to this location when the sonde is then retrieved.
8) Uncheck the Log Session button.

In Situ Procedure: Field Error Check (SEI FORM #3a) and *In Situ* Samples with a YSI Proplus Sonde (SEI FORM #3a)

Detailed procedures for using a multiprobe are in the manufacturer's manual. The following methods are directed at the **YSI ProPlus; for In Situ sondes see previous procedure; for full calibrations contact the ROMN ecologist.**

1) Pre-sample sonde set up: follow the sonde manual to connect sonde to the data logger.
   a) Turn on logger.
   b) Remove calibration cup and install sample cup.
   c) Select parameters to be logged (usually just accept the default).
   d) Set stable data settings (usually just accept the default).
   e) Select Log One Sample.
   f) Create or select a Site (use the SiteID) and create or select a Folder as follows for specific tasks as below:
      i) **XT + [date as yyyymmdd]** for *de facto* X site thalweg 7 samples.
      ii) **KC + [date as yyyymmdd]** for top of reach continuous log.
      iii) **EC + [date as yyyymmdd]** for error check.
2) Conduct error check as described below and in the YSI manual. Use the correct Site and Folder code EC + [date as yyyymmdd].
3) Note that because this is not a calibration, it can be done as if it is just a grab sample with the line log button. Do this in order (pH, SC, DO) with a single line log after each parameter is placed in the sample cup.
4) Fill in the header information on SEI Form #0.
5) Optional: Cool standards to ambient water temperature by immersing in stream for 15 minutes (this can be done when first arriving at the site).
6) Error check conductivity with 100 µs/cm or similar. Place probe in clean calibration solution, let equilibrate and line log a reading. Write down value on SEI Form #0.
7) Error check pH with pH 7 or similar. Place probe in clean calibration solution, let equilibrate and line log a reading. Write down value on SEI Form #0.
8) Error check DO with zero DO water. Place probe in clean calibration solution, let equilibrate and line log a reading. Write down value on SEI Form #0.

Seven Thalweg Samples at de facto X Site

1) Record the time for the collection of the core sample, sonde type(s), type of measurement, whether an error check was done, number of spot measurements and file names.
2) Take after the water quality grab samples.
3) Use the correct Site and Folder code XT + [date as yyyymmdd].
4) Wadeable streams. The thalweg *in situ* measurements can usually be done by one crew member, if it is safe. The measurer moves to the thalweg on the cross-channel transect and immerses the multiprobe instrument to mid depth.
    a) Be sure to stand downstream of the probe. Do not disturb the substrate with the probe. Single point data is captured by pressing the Enter button while Log One Sample is highlighted.
    b) Collect 7 readings at this location.
5) Non-wadeable streams. The thalweg *in situ* measurements can usually be done by one crew member, if it is safe off of a stationary boat or if shallow enough on foot. The boat/measurer moves to the thalweg on the cross-channel transect and immerses the multiprobe instrument to mid depth.
    a) Be sure to stand or have the boat downstream of the probe. Do not disturb the substrate with the probe. Single point data is captured by pressing the Line Log button.
    b) Collect 7 readings at this location. In fast water this will not likely be possible. Options in order include using an anchor, collecting < 7 readings, taking the reading from the shore.
6) The start and stop time and date of data collection is automatically added to the file, distinguishing these data from other sample events at the site.

Optional: Continuous Sample at Top of Reach (wadeable streams) or Near Transect A (non-wadeable streams)

1) Carry the probe upstream.
2) Press the System button and scroll to Logging and select.
3) Switch to Continuous Mode (the interval should be 00:05:00 or 5 minutes).
4) When you return to the main screen you should see that xxx has switched to Start Logging.
5) Place the RR in a secure spot on shoreline ideally allowing the sonde to be in a secure spot mid-channel. If this is not possible, place the sonde on the shoreline with the sensors in the water column. Note this location on SEI Form #3.
6) Select Start Logging and the correct Site and Folder code KC + [date as yyyymmdd].
7) Let the sonde collect data until other sample activities return the crew to this location when the sonde is then retrieved.
8) Switch the sonde back to Log One Sample Mode**.**

In Situ Procedure: Continuous Temperature Loggers (SEI FORM #3a)

1) Detailed procedures for programming and downloading temperature loggers are in the manufacturer's manual and in SEI SOP 15: Processing HOBO Water Temperature Loggers. Key items are:
   a) Loggers should be programmed to collect data every 30 minutes.
   b) Data files are tracked based on Site ID and deployment date so logger file names are not fixed. They should have the stream name and the sample period in them.
2) Locate a large, permanent tree or boulder or similar near the *de facto* X site and as safely accessible as possible.
3) Cut a length of Teflon-lined stainless steel cable such that it may be looped around the object and will extend into the stream to a mid-water depth.
4) Loop the cable through a heavy gauge key chain ring that has also the logger and affix with aluminum ferrules.
5) Optionally construct a housing from 2" PVC with a cap on one end and a bolt/wing nut on the other and insert the logger inside the housing. This should be done in very high-energy water or where the logger might be exposed to direct sunlight.
6) Build a large rock cave with rock from around where the logger will be deployed and place the logger inside this cave. The logger should not be on the stream bed, rather about mid-water column in depth.
   a) If the stream is not rocky and/or is low gradient a cave may not be needed (but should be done if possible).
7) Repeat above steps for a second logger.
8) Fill in SEI Form #3a: serial numbers for old/new loggers, deployment or removal date/time and the number of loggers deployed or seen at each sample event. The location of the loggers should be described as a note with photos of where they were installed.

Literature Cited

Irwin, R.J. 2004. Draft part B of aquatic habitat Park Service guidance for Park Service vital signs monitoring. Planning process steps: Issues to consider and then to document in a detailed study plan that includes a quality assurance project plan (QAPP) And monitoring "protocols" (standard operating procedures), Available at: http://science.nature.nps.gov/im/monitor/protocols/wqPartB.doc.

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SEI SOP 6: Water and Sediment Physiochemistry

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents methods for collecting grab samples of stream water and surficial mineral sediments for analyses in a laboratory. Water and sediment samples are collected during all sample events at all site and stream types. The specific field protocol used is based on the known, measured, or expected mixing status of the stream. Methods are identical at wadeable and non-wadeable streams, although large rivers present special challenges and safety is always a concern.

Some of the narrative and methods that follows is modified from the NPS Water Resource Division (Penoyer 2003), the EPA (Peck et al. 2006), and the USGS (Moulton et al. 2002).

All water grab sample data are recorded SEI Form #3a.

Field Methods

Water

The ROMN SEI default grab sample method collects all water samples at the *de facto* X site (where stream flow is also collected). We assume that most of the parameters analyzed (Table 6-1) are fairly conservative and are thus representative of the sampled reach (or even its upstream catchment) when measured with the simple thalweg methods as presented here. If the size or structure of the sample reach suggests the site may not have well-mixed water, an optional method for grab samples based on an approximation to the USGS Equal Width Increment (EWI) method (Edwards and Glysson 1999) is employed. Best professional judgment or guidance from the ROMN ecologist should be used to make this decision. Note that in some cases it will not be safe to conduct an EWI method.

Table 6-1. Water and sediment parameters.

Class	Parameters
Major ions	Alkalinity (dissolved); Calcium (dissolved); Chloride (dissolved); Fluoride (dissolved); Hardness (dissolved); Magnesium (dissolved); Potassium (dissolved); Silica (dissolved); Sodium (dissolved); Sulfate (dissolved); Total Suspended Solids *(new in 2014)*
Nutrients	Ammonia (dissolved); Nitrite + Nitrate (dissolved); Nitrite (dissolved); Nitrate (dissolved); Nitrogen (total); Orthophosphate (dissolved); Phosphorous (total); Carbon, organic (dissolved); Carbon, organic (total)
Metals in water, dissolved and total	Aluminum, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Selenium, Zinc
Metals in sediment	Aluminum (total); Arsenic (total); Barium (total); Beryllium (total); Cadmium (total); Chromium (total); Copper (total); Lead (total); Iron (total); Mercury (total); Selenium (total); Silver (total); Zinc (total)

The default ROMN SEI water sampling approach is likely appropriate for most streams in ROMN parks. It approximates an isokinetic technique, but will not use specific isokinetic samplers (rather we use standard water sample bottles). The complete USGS EWI methods (Figure 6-1) are given in Edwards and Glysson (1999). USGS recommends the EWI method should be used during any sampling condition where a discharge measurement is not made before sampling, where the period of discharge record is insufficient to develop stage-discharge rating curves, where the streambed material is mobile (resulting in a poor stage-discharge relationship), or where inflow from a tributary is not well mixed in the sampling section. *Our approximation to the optional EWI methods is required given the remote location of many sites and the time required for completing a sample event. We do not use churn/cone samplers and we constrain the number of increments sampled; however, our approach will likely give a better vertically and horizontally integrated sample in streams that are not well mixed.*

Sediment

Sediment samples are taken using two similar approaches. Because there is likely meaningful small scale spatial variation in metals (Table 6-1) within the surficial sediments of most ROMN streams, both approaches involve preparing a single composit from 11 subsamples collected from depositional areas in the stream. During partial sample events (usually at sentinel sites during non-base flow) an ad hoc array of representative subsample locations are located near where water was collected using best professional judgment as to microhabitats typical of the site. Safety is also a paramount concern as often these events are during high flows or snowy/icy conditions. During full or base flow events sediment subsamples are taken in littoral or bank locations on each of the 11 cross sections.

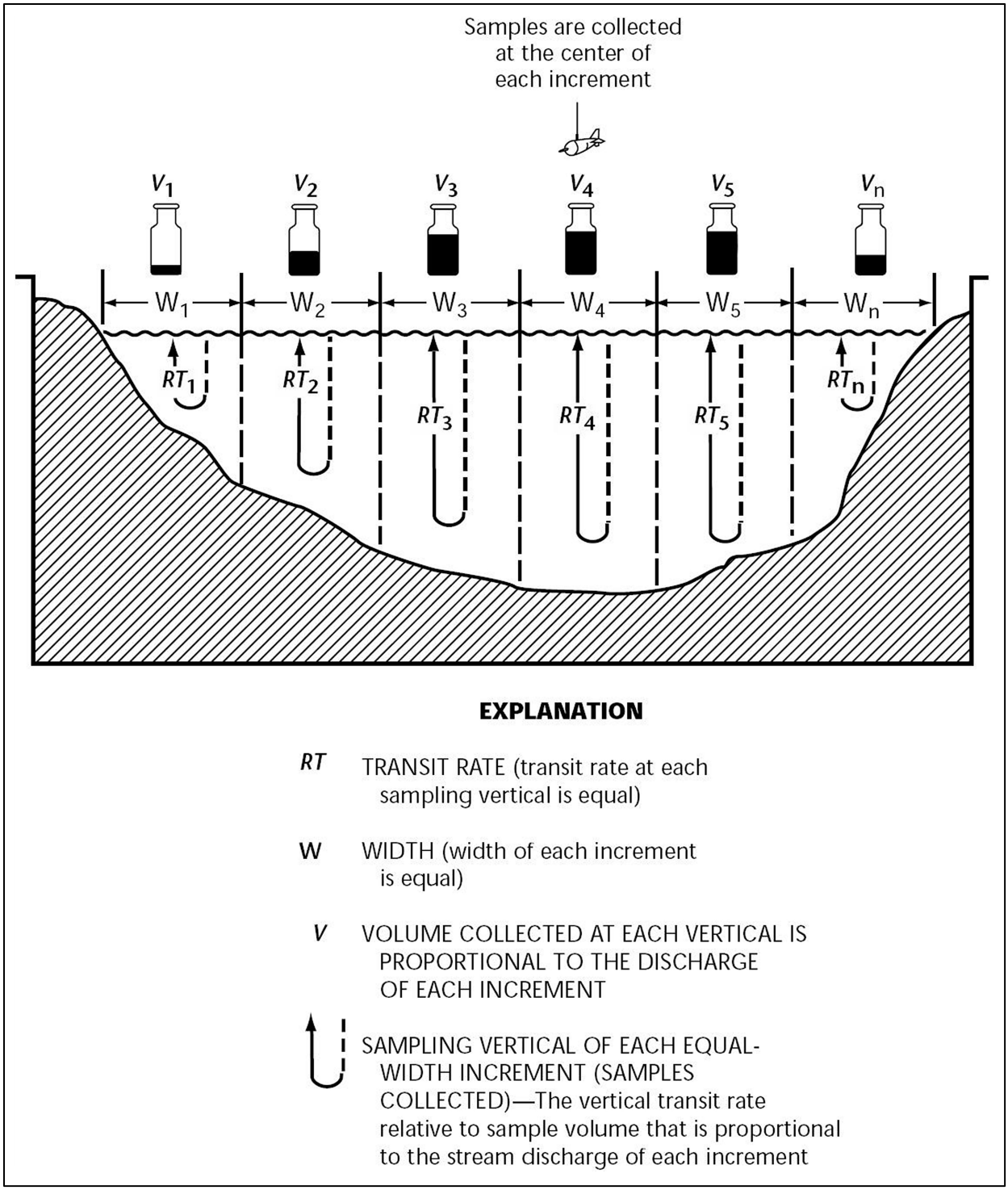


Figure 6-1. Equal-width-increment method for collection of water samples (modified from Edwards and Glysson 1999). River left (increment #1) is on the reader's left.

Sample Bottle Labels

Each bottle used to collect grab samples in the field, or created at the base station from an aliquot from a field bottle, will have a detailed label attached to the bottle (see SEI SOP 3: Sample Tracking). An example of sample labels is shown in Figure 6-2. The sample date and sampler's initials must be filled in at the time of the sample.



Figure 6-2. Examples of labels for water and sediment samples.

Quality Assurance and Quality Control Samples

Rigorous Quality Assurance and Quality Control (QAQC) procedures are followed within the ROMN SEI protocol. Duplicate water and sediment samples will be generated at 10% of total samples to be collected within an index period. Samples are true duplicates, not splits from a single sample. During larger sample size surveys a minimum of 7-10 QC samples are collected allowing statistical analyses. During years with only sentinel sites QA samples are only compared qualitatively to regular samples.

At the time of publication, a detailed Quality Assurance Performance Plan (QAPP) was under review by the US Environmental Protection Agency (Schweiger, In Review). The QAPP details all elements of QAQC for the SEI protocol including plans for incorporation of QAQC data into ROMN SEI data management and analyses.

Three types of quality control (QC) water samples play a key role in QAQC. Water quality monitoring programs commonly use QC samples at two points in the data generating process. First, laboratories routinely use duplicates and spikes to establish limits for precision and accuracy for each measurement parameter. All laboratories used to analyze ROMN SEI data have internal QAQC protocols for such objectives. The second point in the monitoring process where QC samples are commonly used is in documenting quality control associated with the collection of samples in the field. Like their lab counterparts, field blanks, duplicates, and spikes ("mickeys") also validate the precision and accuracy of data and determine the adequacy of preservation techniques, equipment cleaning and preparation, and sampling procedures.

Lab and Field Equipment for Water and Sediment Samples

Table 6-2. A complete checklist of items needed in the lab and field to conduct grab water samples.

Category	Item	Quantity
Equipment For Pre-event Grab Sample Preparation	SEI Protocol Document and/or laminated sheets of SOPs	1
	SEI Form #3a	2
	Soft lead (#2) pencils	Many
	Water Chemistry Labels (see Figure SOP 6-2)	9
	Deionized water	Lots
	Packing materials	Enough
	Gloves	Many
Equipment for Water and Sediment Samples	SEI Protocol Document and/or laminated sheets of SOPs	1
	All field labels applied to bottles plus loose blank labels	9
	SEI Form #3a	2
	Soft lead (#2) pencils	Many
	25 or 50 m tape	2
	Bottles as shown in SOP	5
	The filled from aliquots at base station can be left at base station	3
	For easily accessible sites a backup of each bottle type should be available If there is room in packs, backups should also be taken in remote sites	-
	Powderless gloves	Many
	Cooler with 4 to 6 plastic bags (1-gallon size) of ice (if site is vehicle accessible)	Enough
	Frozen ice bottles in portable coolers if site is remote	Many
Equipment for Processing Samples	SEI Protocol Document and/or laminated sheets of SOPs	1
	All field labels	9
	Filter assembly with filters	1
	Bottle of concentrated Nitric Acid	1
	Acid safe gloves, eyeware and smock	Enough
	Hood/vent if possible	1
	SEI Form #3: Water Physiochemistry	2
	Soft lead (#2) pencils	Many
	Cooler(s) and Ziploc plastic bags and frozen ice bottles	3
	Freezer or refrigerator	1

Water and Sediment Physiochemistry Procedure: Pre-Event Grab Sample Preparation

1) Before leaving the base location, package the sample bottles carefully to prevent contamination. Do not open the cleaned bottles unless necessary and always use gloves. Note that there should be a larger field bag (**6** bottles plus nitrile gloves) and a lab bag (**3** bottles and **1** syringe).

2) Each sample event requires a total of 9 bottles, with 6 taken into the field and 3 filled from filtered aliquots at a base station (these lab bottles can be left at the base site):
    a) The 6 field bottles include:
        i) one 250 ml clear Nalgene (K1.W_C)
        ii) one 60ml clear Nalgene (K4.W_Z)
        iii) one 250 ml clear Nalgene (E3.W_WAC)
        iv) one 60 ml clear Nalgene (E7.S_C)
        v) one 1000 ml clear Nalgene (G5.W_C)
        vi) one 1000 ml clear Nalgene (T8.W_C).
    b) The 3 base station bottles are:
        i) one 125 ml clear Nalgene (K2.F_C)
        ii) one 60 ml clear Nalgene (K3.F_Z)
        iii) one 250 ml clear Nalgene (E6.W_FAC)
    c) Each bottle is pre labeled with ROMN labels. Bottles E3, E6 and E7 will need additional EPA provided labels before being sent to the lab.
    d) *Optional:* Depending on the weight to be carried in packs and remoteness of site, carry at least one back up for each bottle taken to the field.

Water and Sediment Physiochemistry Procedure: Default Grab Samples (SEI FORM #3a)

1) The crew will be at the location in the sample reach where the Q measurement and *in situ* cross-channel transect has been done. The *in situ* transect results or previous experience suggest that the default ROMN approach can be used (isokinetic depth integrated, thalweg grab samples).
2) Record the time for the collection of the grab samples on SEI Form #3a.
3) **Assess the safety of accessing the channel** in larger rivers or with high flows. If the channel cannot be accessed, it is acceptable to collect samples from near the shore in the littoral zone. Flag these data and comment on the collection location.
4) Move just upstream from where all previous activities have occurred. Locate the thalweg based on the Q measurement or other cues (e.g., from previous physical habitat transect depth measurements). Stand downstream from where the grab sample bottles will be placed into the stream.
5) Put on powderless nitrile gloves.
6) Make sure that the labels all have the same sample ID number, that the correct code is on each bottle and that the labels are securely attached.
    a) Bottles filled in the field include: K1, K4, G5, T8, and E7 (sediment, see below).
    b) Bottle E3 is taken to and filled in the field but is done so from bottle G5 as E3 has a small amount if nitric acid in it.

7) Rinse each bottle (except E3) three times with stream water. Discard the rinse downstream.
8) For isokinetic sampling, the transit rate must be kept constant during sampler descent through a vertical and also during sampler ascent through a vertical. Although not necessary, usually the same transit rate is used for raising the sampler as was used for lowering the sampler through a given vertical.
9) Lower the bottle, with the mouth pointed upstream, until slight contact is made with the streambed (if not too deep). ***Bottle T8 must not come in contact with the streambed.*** Do not pause upon contacting the streambed. Raise the sampler immediately at a constant transit rate to complete the vertical traverse. The descending transit rate does not have to equal the ascending transit rate, but each rate must be unidirectional and constant, until the sampler bottle is full. Time the rate of moving through the water column so that at least one pass up and one pass down are accomplished before the bottle is full.
10) Take care not to disturb the streambed with the sampler. Disturbing the streambed could cause bed material to enter the bottle, resulting in erroneous data.
11) Fill bottles to the rim unless they are frozen bottles (K4.W_Z), fill these only to the bottles shoulder (this may be adjusted later).
12) **Fill bottle E3 from bottle G5, being careful to not spill and of the acid in bottle E3**.
    a) **Refill bottle G5 after E3 has been filled**.
13) Fill bottle T8 to right below the shoulder. The head space allows lab technicians to shake the sample to mix well before analyzing.
14) When a bottle is full and passes muster, make sure the label is correct, fill in the date, time, and initials of sampler, and place it in a cooler (on ice) and shut the lid. If a cooler is not available, place the bottle in a mesh bag and immerse it in the stream in shade.
15) Inspect each sample, looking for overfilling and (or) the presence of anomalously large amounts of particulates that might have been captured because of excessive streambed disturbance during sample collection. If you note either or both of these conditions, discard the sample, making sure there are no residual particulates left in the container, and resample.
16) Record the SampleNum, the nearest transect (default is A), the method used, and any comments for each bottle.

Non-wadeable Sites

1) If the default method is to be used for non-wadeable sites, the only difference is in how the crew position themselves in the thalweg to fill each bottle. If from a boat anchored on station or moving in the channel, an isokinetic technique is likely not possible with the simple gear used by the SEI protocol (no churner or splitter). Do the best you can at getting samples from the complete vertical below the boat. If only surface samples are possible, be sure to note this.

Very Shallow and/or Slow Velocity

1) Use the hand-dip method if stream depth **(10 cm)** or velocity is not sufficient to use depth-integrated sampling **(1.5 ft/sec or 0.3048 meter/second)**. The procedure minimizes the collection of surface films and avoids contact with the streambed.

2) For bottle samples: open the bottle; grasp the bottle near the base, with hand and arm on the downstream side of the bottle.
3) *Without rinsing* (as it would disturb the stream too much), plunge the bottle opening downward below the water surface. Allow the bottle to fill with the opening pointed slightly upward into the current.
4) For syringe samples the shallow depth and slow velocity is less of an issue. Fill the syringe carefully at mid depth pointing the tip of the syringe upstream. Filter as normal into the sample bottle, etc.
5) Inspect each sample, looking for overfilling and (or) the presence of large amounts of particulates that might have been captured due to excessive streambed disturbance during sample collection. If you note either or both of these conditions, discard the sample, making sure there are no residual particulates left in the container, and resample.
6) When each bottle is full, place it in a cooler (on ice or stream water) and shut the lid. If a cooler is not available, place the bottle in an opaque garbage bag and immerse it in the stream.
7) Procedures for processing the aliquots created at the base station are given below.

Water and Sediment Physiochemistry Procedure: Sediment Samples (SEI FORM #3a)

1) For a sentinel event, the crew will be at the location in the sample reach where the Q measurement and *in situ* cross-channel transect has been done. All sample composites are collected in a small area around this site.
2) For a base flow event, the crew will collect 11 sub samples from each transect location (or the extra bio sites). The final composite sample, placed into bottle E7, is prepared from these 11 subsamples.
3) Move upstream from where all previous activities have occurred. Locate a depositional area in shallow slow moving water.
4) If there is no obvious depositional area, just find the smallest mineral substrates you can.
5) Rinse the stainless steel spoon three times in stream water.
6) Scoop a small amount of mineral sediment up from the substrate using the stainless steel spoon. Move very slowly so as to not lose sediment. Sample material should be fines only. Avoid sand, algae, or gravel materials.
7) Place in bottle.
8) Repeat steps 3-7 at 10 additional locations. For a full sample event sample at each transect. Combine all samples into a single bottle to create a composite sample.
9) Cap bottle, label and place on ice.
10) Record the number of subsamples collected.

Water and Sediment Physiochemistry Procedure: Sample Filtration, Acidification, and Storage (SEI FORM #3a)

1) See Tables 6-3 and 6-4 and Figures 6-3 and 6-4 at the end of this section for more information on the following procedures.
2) Upon returning to a base station, place all sample bottles in a refrigerator (*_C samples) or freezer (*_Z samples) immediately.
3) Ensure that bottle labels are completed with the date, time, site ID, SampleNum, initials of field personnel, sample types, etc.
4) Create filter samples E6.FAC, K2.F_C and K3.F_Z as follows:
   a) Wear nitrile gloves to avoid unnecessary contamination.
   b) Place paper towels or lab cloth on the counter.
   c) Triple rinse the filter holder, syringe, and forceps with deionized water. Ensure the filter has an o-ring correctly installed.
   d) Place the smooth side of a new filter upward into the filter holder.
   e) Rinse the filtering apparatus (syringe + filter holder) with ~ 60 ml deionized water, repeat. Squirt this into K2 and K3 bottles, shake these well and discard. **Do not pre-rinse E6 bottle as this has a small amount of nitric acid inside.**
   f) **Be sure to switch from the DI syringe to the sample syringe for the sample.** ***If doing more than one site, do not mix sample syringes***.
   g) Rinse pre-rinsed filter and K2 and K3 sample bottles with 20 mL each of well mixed sample from the 250 mL K1 sample bottle, shake K2 and K3 well and discard. The G bottle may also be used for the source for this rinsing water, especially in "clean" sites.
   h) Filter 125 mL of sample from K1 into labeled K2 sample bottle (this will take 1+ full syringes).
   i) Filter 60 mL of sample from K1 into labeled K3 sample bottle.
   j) Filter 250 mL of sample from G5 into labeled E6 sample bottle (this will take 2+ full syringes). This bottle is NOT pre-rinsed.
5) If filtering more than 1 sample, rinse the filtering apparatus with 60 mL deionized water and proceed to step 7.
6) When sample filtration is complete, rinse syringe and reusable filter holder with deionized water. Place supplies in a closed Tupperware container.
7) Store E6, K2, K1 (remainder), G5 (remainder), E3, and E7 sample bottles at 2-8°C.
8) Store K3 and K4 sample bottles frozen at or below 0°C.
9) Perform any data management workflow items as needed after processing each sample.
10) Ship water chemistry samples as soon as possible after collection in order to meet holding time requirements (especially nutrients).

Table 6-3. EPA water and sediment grab sample parameters and analysis summary.

LAB	Sample Type Code[1]	Parameters	Bottle Size/Type	Sample Method	Preservative	Storage	Notes
EPA	**E3.WAC**	TOTAL IN WATER: Al, Ag, As, Ba, Be, Cd, Cr, Cu, Fe, Ni, Pb, Se, Zn, Silica and Mn	250ml HDPE/LDPE	Unfiltered grab sample	0.5 ml conc. nitric acid to pH<2.0 within 24 hrs	Ice	6 month hold time
EPA	**E6.FAC**	DISSOLVED IN WATER: Al, As, Ba, Be, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Se, Ag, Zn, Hardness Ca, K, Mg, Mn, Na	125ml HDPE/LDPE	Filtered in the field or within 24 hours with a 0.45 µm millipore filter	0.5 ml conc. nitric acid to pH<2.0 within 24 hrs	Ice	6 month hold time
EPA	**E7.S_C**	IN SEDIMENT: Al, As, Ba, Be, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Se, Ag, Zn	60 ml HDPE/LDPE	Composited fines sample	-	Ice	Hg analysis on a subsample from this bottle 28 day hold time for Hg 6 month hold time for others
EPA	**G5.W_C**	Bulk sample used to create E6 and as backup	1000 ml HPDE	Unfiltered grab sample	-	Ice	Not delivered to the EPA lab

[1]Lab (E, G), Bottle number, Whole/Filter/Sediment (W, F, S), Acid (A), Cold(Ice)/freeze (C)

Table 6-4. Kiowa water grab sample parameters and analysis summary.

LAB	Sample Type Code[2]	Parameters	Bottle Size/Type	Sample Method	Preservative	Storage	Notes
KIOWA	**K1.W_C**	ANC, pH, Cond (and all those in K2 and K3)	250 ml New triple DI rinsed clear HDPE	Unfiltered grab sample	-	Ice	Two aliquots created from this bottle, but remaining sample is also sent to KIOWA
KIOWA	**K2.F_C**	DOC, Mg, Na, K, Mn, NH4 (if sample less than 2 weeks old), Ca, Cl, NO2 (if sample less than 2 weeks old), NO3, SO4, PO4, Si	125 ml New triple DI rinsed clear HDPE	Syringe filtered at base station with a 1.0 µm millipore or Whatman filter	-	Ice	Created from K1.W_C
KIOWA	**K3.F_Z**	NH4 (if sample more than 2 weeks old), NO2 (if sample more than 2 weeks old), TDN, TDP	60 ml New triple DI rinsed clear HDPE	Syringe filtered at base station with a 1.0 µm millipore or Whatman filter	-	Freeze	Created from K1.W_C
KIOWA	**K4.W_Z**	TN, TP	60 ml New triple DI rinsed clear HDPE	Unfiltered grab sample	-	Freeze	
KIOWA	**T8.W_C**	TSS	1000 ml DI rinsed clear HDPE	Unfiltered grab sample	-	Ice	

[2]Lab (K, T), Bottle number, Whole/Filter/Sediment (W, F, S), Acid (A), Cold(Ice)/freeze (C, Z)

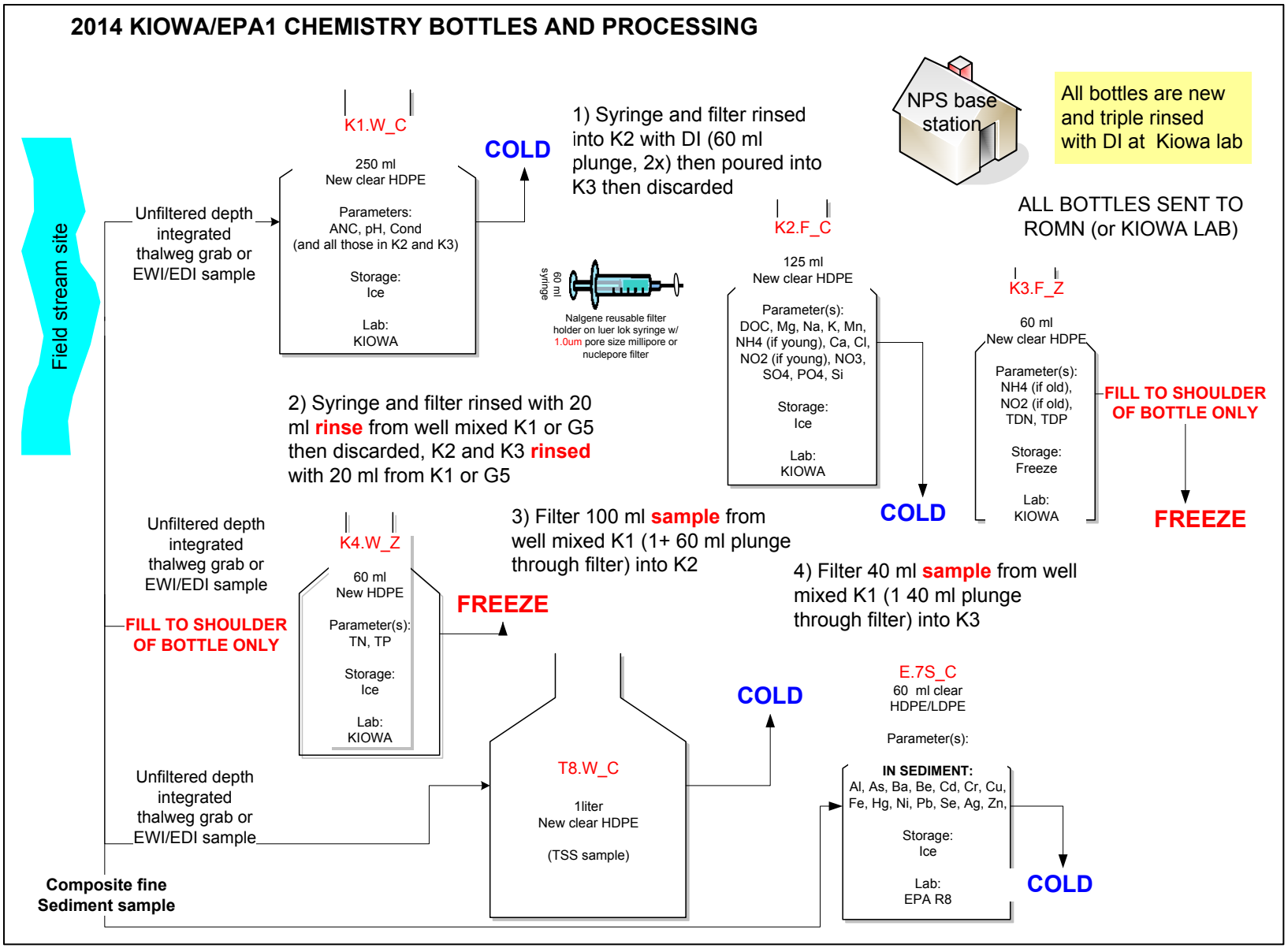


Figure 6-3. Workflow for sampling and processing water and sediment chemistry samples, part 1.

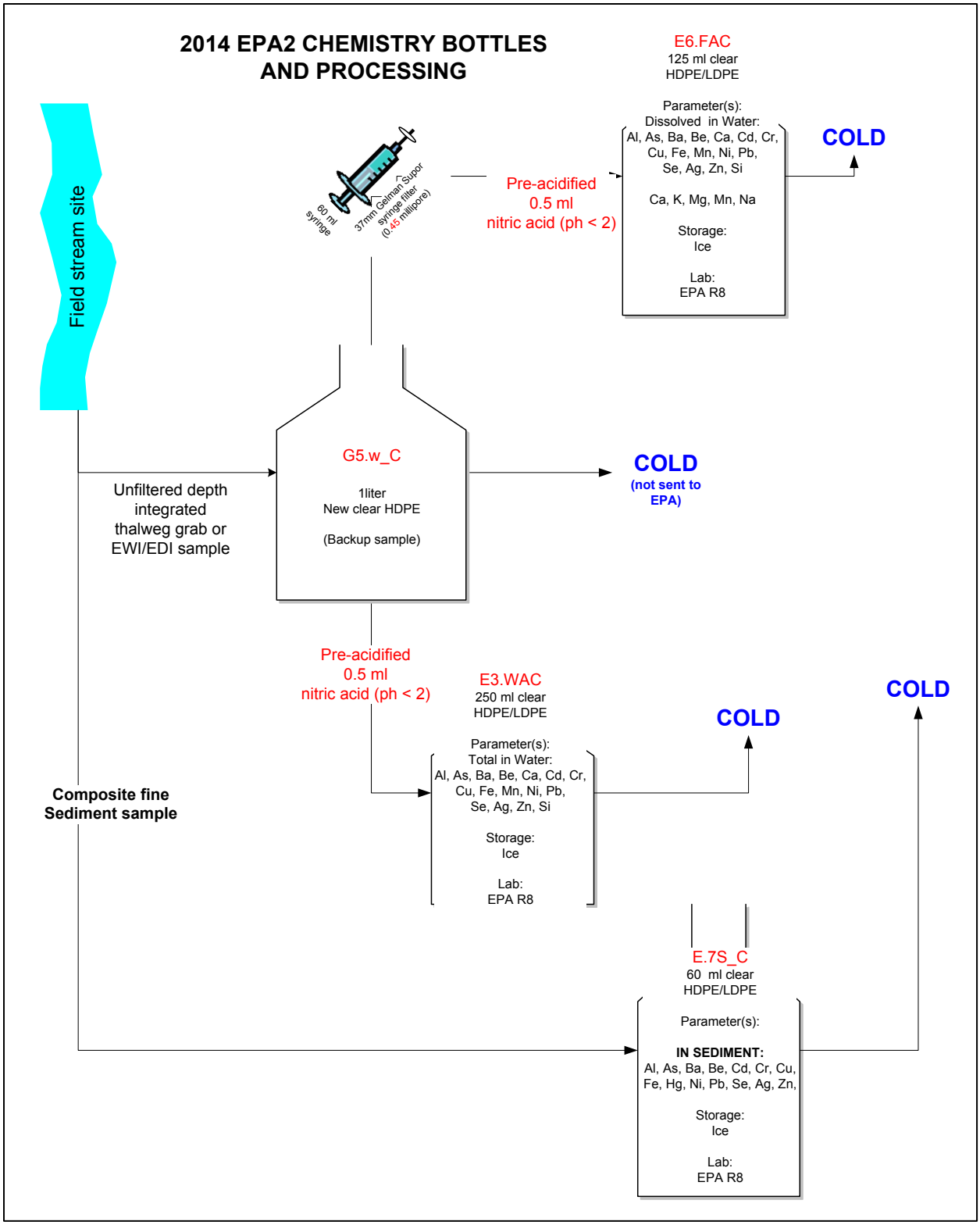


Figure 6-4. Workflow for sampling and processing water and sediment chemistry samples, part 2.

Water and Sediment Physiochemistry Procedure (Optional): ROMN EWI Grab Samples (SEI FORM #3a)

1) The crew will be at the ***de facto* X site** (where Q measurement in wadeable streams and *in situ* cross-channel transect have been done in all stream types). The *in situ* transect results or best professional judgment suggest that the ROMN EWI approach should be used.
2) All data are entered on SEI Form #3a. ROMN EWI details should be entered as notes on the back side of the form.
3) Move to the first location of the five equal increments created across the transect for the *in situ* measures.
4) If more increments are needed, use the space under the area for the first 5 on the data form. In this case the descriptions of the default locations (e.g., RR Shore) are no longer relevant.
5) Measure the distance from the RL wetted width and record this distance.
6) Stand or position the boat downstream from where the grab sample bottles will be placed into the stream.
7) Put on powderless gloves.
8) Make sure that the labels all have the same and correct sample ID number, that the correct sample code is on each bottle and that the labels are securely attached.
9) Rinse a 1000 ml sampling bottle three times with stream water at the interval location. Discard the rinse downstream. This bottle will be used to collect all samples at each increment.
10) Rinse the first bottle three times with stream water. Discard the rinse downstream.
11) Lower the sampling bottle until slight contact is made with the streambed. Do not pause upon contacting the streambed. Raise the sampler immediately at a constant transit rate to complete the vertical traverse. The descending transit rate does not have to equal the ascending transit rate, but each rate must be unidirectional and constant.
    a) Take care not to disturb the streambed with the sampler. Disturbing the streambed could cause bed material to enter the bottle, resulting in erroneous data.
12) Fill the first sample bottle so that the bottle is filled with an approximate amount of water that is equal to the proportion of the channel represented by the increment.
13) Be sure to rinse the sample bottles 3 times before actually filling them with the proportional sample from the increment.
14) Repeat steps 10-13 for the remaining bottles for the current increment.
15) After all bottles are complete at the current increment, move to successive increments and repeat all steps.
16) After all increments are complete, inspect each sample looking for overfilling and (or) the presence of anomalously large amounts of particulates that might have been captured because of excessive streambed disturbance during sample collection. If you note either or both of these conditions, discard the sample, making sure there are no residual particulates left in the container, and resample.

17) When each bottle in full and passes muster, place it in a cooler (on ice or stream water) and shut the lid. If a cooler is not available, place the bottle in an opaque garbage bag and immerse it in the stream.

18) The SampleNum for the sample bottles is recorded on the front of SEI Form #3a.

Water and Sediment Physiochemistry Procedure: QC Field Samples (SEI FORM #3a)

Field Blanks (deionized water)

1) Field blanks require 2.75 to 3 liters of laboratory reagent-grade water. Create a set of the bottles (ideally 3, well rinsed 1-liter bottles) with this amount at the base station using this deionized water.
2) Take these bottles to the field and use them as if they were extracted from the field, transfer to the appropriate container, filter, etc.
3) Fill in a label and the QC section of SEI Form #3a. The same SampleNum is used for these samples as the samples from the site, but the appropriate QC sample type is circled on the label.
4) Send these to the lab as a normal sample.

Equipment Blank

5) At the beginning of the field season as follows:
6) Clean all equipment used to collect, store, and process water samples (e.g., bottles, syringes, filters).
7) Rinse the equipment used to collect and store water samples (bottles and syringes) with laboratory reagent grade water three times and discard.
8) Fill a set of bottles with deionized water and handle and process this aliquot as if it were a stream sample to be analyzed.
9) Fill in a label and the QC section of Form 3. The same SampleNum is used for these samples as the samples from the site, but the appropriate QC sample type is circled on the label.
10) Send these to the lab as a normal sample.

Field Splits and Duplicates

1) Field duplicates are ideally splits of homogeneous samples to estimate measurement precision in the context of repeatability. If sufficiently large bottles and time are available create a field duplicate using bottles twice as large as the set described in Table 6-3.
2) Take these bottles to the field and fill them using the methods described above.
3) Fill in a label and the QC section of SEI Form #3a. The same SampleNum is used for these samples as the samples from the site, but the appropriate QC sample type is circled on the label. Note that these samples are actual homogeneous splits.
4) Send these to the lab as a normal sample.

5) If this is not possible, take a duplicate set of bottles into the field and create a duplicate from the same exact location immediately after the first sample is done. Use the same methods as described above.
6) Fill in a label and the QC section of SEI Form #3a. The same SampleNum is used for these samples as the samples from the site, but the appropriate QC sample type is circled on the label. Note that these samples are actual duplicates.
7) Send these to the lab as a normal sample.

Spiked Samples

1) Field spikes require several standard reference samples from the USGS (https://bqs.usgs.gov/srs/). Each USGS spiked sample includes one to several parameters and expected concentrations. Not all ROMN parameters may be available.
2) The ROMN Field Coordinator and SEI Protocol Lead will provide a set of spiked samples to field crews and directions for which sample is to be used for each ROMN bottle (this varies with the samples available from USGS in any given year and so must be handled on a year by year basis).
3) Crews fill spiked samples in a lab or clean work space based on directions from the Field Coordinator and SEI Protocol Lead on which spiked bottle fills a ROMN sample bottle and how it should be stored, etc.
4) Fill in a label and the QC section of SEI Form #3a. A SampleNum from a real site may be used for these samples, but the appropriate QC sample type is noted on the form.
5) Send these to the lab as a normal sample. Some labs request that spiked samples be blind and some do not.

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SEI SOP 7: Discharge

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents methods for collecting instantaneous discharge (Q) at survey, gradient, and base flow sentinel site sample events in wadeable streams (rarely in non-wadeable).

Some of the narrative and methods that follow are modified from the NPS Water Resource Division (Penoyer 2003), the EPA (Peck et al. 2006), and the USGS (Moulton et al. 2002).

All discharge data are recorded on SEI Form #3a and, optionally, SEI Form #4.

Instrument Choice: Flowtracker

A variety of instruments are available to measure instantaneous discharge. The ROMN piloted using a Flowtracker Acoustic Doppler Velocity (ADV) meter from 2007 to 2009 and feels this tool is ideal for the SEI protocol. If a particular site requires other instruments or more complex methods, USGS, NPS Water Resources Division, or other sources should be consulted.

Stream Gauges

The use of an established stream gauge is a preferred method of obtaining flow data; however, this may be uncommon for ROMN survey sites that are long distances from existing gauges. Gauges are preferred because the time investment in the field is minimal and the accuracy is high. Gauges provide the additional benefit of permitting an examination of the hydrograph before and after sample collection. Gauges are typically constructed on rivers with base flows of about 1 cfs or greater. Some caution should be used for flows below 5-10 cfs, where very minor changes in channel geometry can lead to inaccuracies in the measurement. Note that it is useful to collect gauge discharge values for any site where it is possible even if a meter or another method is used for an instantaneous Q.

For larger rivers, such as the North Fork and Middle Fork of the Flathead in Glacier National Park, taking instantaneous flow measurements at other than very low flow is beyond the capability of ROMN staff, so stream gauges may provide the only quantitative measure of flow. Even direct base flow measurements may be unsafe depending on the water year and channel conditions at some sites.

In order to be useful, the stream gauge should be located near the sample site, without significant inflow or withdrawal of water occurring between the sample site and gauge, or where these do occur they are predictable or measurable so the gauged flow can be adjusted with some reliability. It may be necessary to take several instantaneous measurements to establish a relationship between flow at the gauge and flow at the sample site.

Estimating Discharge from Distant Gauges

In cases where making a reliable discharge measurement on site is not practical, such as large rivers, an estimate of the discharge can be made using gauge data from several miles upstream if inputs on the intervening distance are minimal. Flow from the gauge will take into consideration the travel time from the gauge, and will be corrected for known significant inputs or depletions that occur in the intervening distance. The estimated discharge will be recorded along with a comment that it is based on the gauge, and a descriptor of its reliability. Reliability can be high under relatively constant flow conditions and lower when complicated by flow fluctuations and tributary inputs.

The USGS also has a well-documented program (StreamStats: http://water.usgs.gov/osw/streamstats/) for estimating discharge at ungauged sites. While there are some key assumptions that must be included and it is not quite in place for Montana it is a useful source for remote SEI sites.

Accessing Gauge Data

Where real-time gauge data exist, they can be accessed at:

- http://waterdata.usgs.gov/co/nwis/current/?type=flow&group_key=huc_cd for Colorado
- http://waterdata.usgs.gov/mt/nwis/current/?type=flow&group_key=huc_cd for Montana

Where gauge real-time data are not available, contact the USGS office responsible for the gauge to obtain provisional data. Depending on the type of data logger at the gauge and communication with it, it may take several weeks before data are downloaded and available.

The travel time of water between the gauge and the site should always be taken into consideration when selecting flow data from the gauge. Measured travel times are desirable if they are available from the river segment. If not, an estimate of 5 mph is reasonable for short distances.

Other gauges may also be available (e.g., state run gauges or flumes, long term academic research project gauges etc.). As sites are established in each ROMN park, part of the metadata developed for each site will be connections to these gauges.

Flowtracker Velocity Area Method

The methods presented here are generalized (but are somewhat specific to the Flowtracker ADV meter used in the ROMN SEI pilot). Because velocity and depth typically vary greatly across a

stream, accuracy in field measurements is achieved by measuring the mean velocity and flow cross-sectional area of many increments across a channel (Figure 7-1). Each increment gives a subtotal of the stream discharge, and the whole is calculated as the sum of these parts. Discharge measurements are made **at only one carefully chosen channel cross section within the sampling reach**. It is important to choose a channel cross section that is as much like a canal as possible. A glide area with a U-shaped channel cross section that is free of obstructions provides the best conditions for measuring discharge by the velocity area method. Crews may remove rocks and other obstructions to improve the cross section before any measurements are made; however, because removing obstacles from one part of a cross-section affects adjacent water velocities, the cross section must not be changed once crews start collecting the set of velocity and depth measurements. Moreover, these channel modifications and the discharge procedure itself must not be done if there are any remaining downstream or nearby measurements to be done.

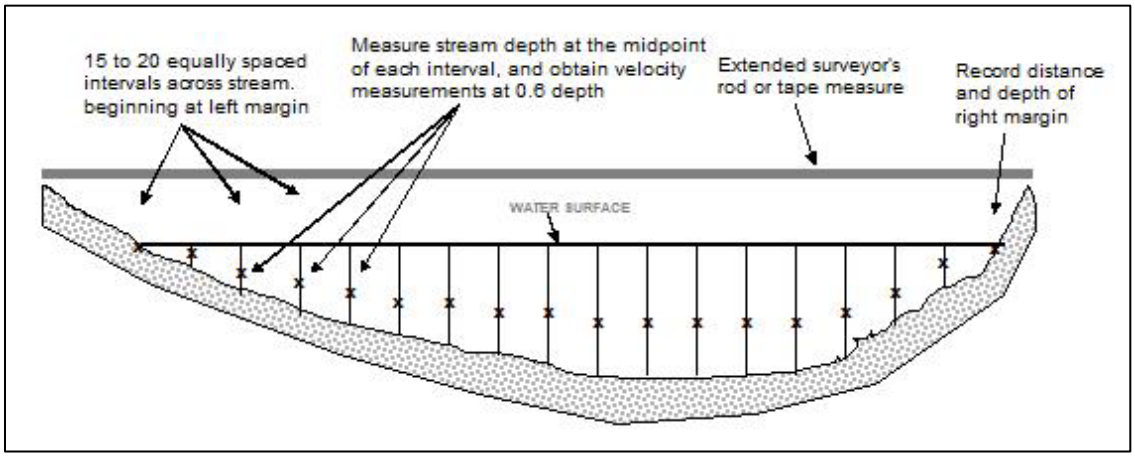


Figure 7-1. Layout of a channel cross-section for obtaining discharge data by the velocity-area procedure. Note the figure does not include any increments with sample points at two depths.

Qualitative Methods

Visual

This method is only recommended as a last resort when other methods are ineffective or unsafe; **however, it should always be done to facilitate calibration to more quantitative techniques.** The following are four exceptions to the requirement for obtaining flow measurements:

1) *Site conditions*, such as dense vegetation cover, a steep or flat slope, or diffuse discharge into a marshy area sometimes do not allow for a direct measurement of discharge by the techniques listed above.
2) *No flow and pools*. If there is no flow at a stream site, and accessible, isolated pools remain in the stream bed, collect and report the required field data and laboratory samples and report instantaneous flow as zero.
3) *Dry*. If the stream bed holds no water, no sampling is required. Report that the stream was "non-perennial" on Field Form #1: Site Verification.

4) *Unsafe Conditions*. Do not attempt to wade a stream for which values of depth multiplied by velocity equal or exceed 10 ft^2/s. For example, a stream only 2 ft. deep but with velocities of 5 ft/s or more can be dangerous to wade. When flow cannot be measured, the reason should be noted on the field form.

Although visual estimation is imprecise, it may be the only method possible for some springs.

Categories: Flow Severity and Hydrograph Limb

Placing a stream's discharge into flow severity and hydrograph limb classes is useful for later analysis of water quality data. This should be done even in cases where a quantitative measurement is possible. Tables 7-1 and 7-2 provide a description of the codes used for flow severity and position on the hydrograph. Use best professional judgment or knowledge of a give streams hydrograph to evaluate the flow severity.

Table 7-1. Flow severity.

Code	Description	Old STORET Code
Dry	No visible water in stream (typical of dry period for an ephemeral/intermittent stream).	1
No Flow	Discrete pools of water with no apparent connecting flow (at surface).	No old code
Low	Base flow for a stream or flow within roughly 10% to 20% of base flow condition.	2
Normal	When stream flow is considered normal (greatest time that stream is characterized by this in terms of flow quantity, level, or general range of flow during a falling or rising hydroperiod, but above base flow).	3
Above Normal	Bank full flow or approaching bank full (generally within upper 20% of bank full flow condition).	4
Flood	Flow extends outside normal bank full condition or spreads across floodplain.	5

Table 7-2. Hydrograph limb.

Code	Description	Old STORET Code
BASE	End of summer flow, typically ground water supported	1
RISING	Spring runoff begins	2
PEAK	Maximum flow, peak of runoff	3
FALLING	Flow falling off and returning to base	4

Field Equipment for Discharge Measurement

Table 7-3. A complete checklist of items needed for the discharge methods..

Category	Item	Quantity
Office	SEI Protocol Document and/or laminated sheets of SOPs	1
	SEI Form #4: Discharge	1
	Soft lead (#2) pencils	Many
	Internet connection or other way of accessing gauge station data	-
Field	SEI Protocol Document and/or laminated sheets of SOPs	1
	SEI Form #4: Discharge	1
	Soft lead (#2) pencils	Many
	Flow Meter (Flowtracker)	1
	Top set wading rod	1
	Spare parts and tools for meter and rod	Many
	Batteries	Many
	Surveyor's telescoping leveling rod, 2.4 m for small streams, 7.5m for large streams	1
	"Pocket" surveyors rods	2
	25 m to 50 m fiberglass measuring tape and reel	1
	Safety gear	-
	Personal gear	-

Discharge Procedure: Instantaneous Measurement with a Flowtracker (SEI FORM #3a or #4)

Detailed procedures for using the Flowtracker are in the manufacturer's manual. The following methods are somewhat general and may also apply to other meter types except where noted; see Figure 7-2 for a diagram and photo of the Flowtracker and top-set wading rod.

1) Crews will be downstream of the location chosen for the Q measurement.
2) Circle Meter on the form and fill in the type used.
3) A cross-section of the stream channel for discharge determination that has most of the following qualities (based on Rantz et al. 1982) should be located within or just beyond the 40x sampled reach. This location should be identified in the site verification process for most sites (see SEI SOP 4: Verification of Site Status and Sample Reach Layout).
    a) Segment of stream above and below cross section is straight.
    b) Depths mostly greater than 15 cm, and velocities mostly greater than 0.15 m/s. Do not measure discharge in a pool.
    c) U-shaped, with a uniform streambed free of large boulders, woody debris or brush, and dense aquatic vegetation.
    d) Flow is relatively uniform, with no eddies, backwaters, or excessive turbulence.

e) Note that this location will also be used for a series of cross-channel *in situ* readings and a set of water grab samples. Some of the locations along the Q transect will be the same as those used for these two methods. The discharge reading is the first procedure done of these three. The other two follow and are located slightly upstream of the discharge transect. Biological samples may also be taken in this area.

4) Record the Start Time for the Q measurement.

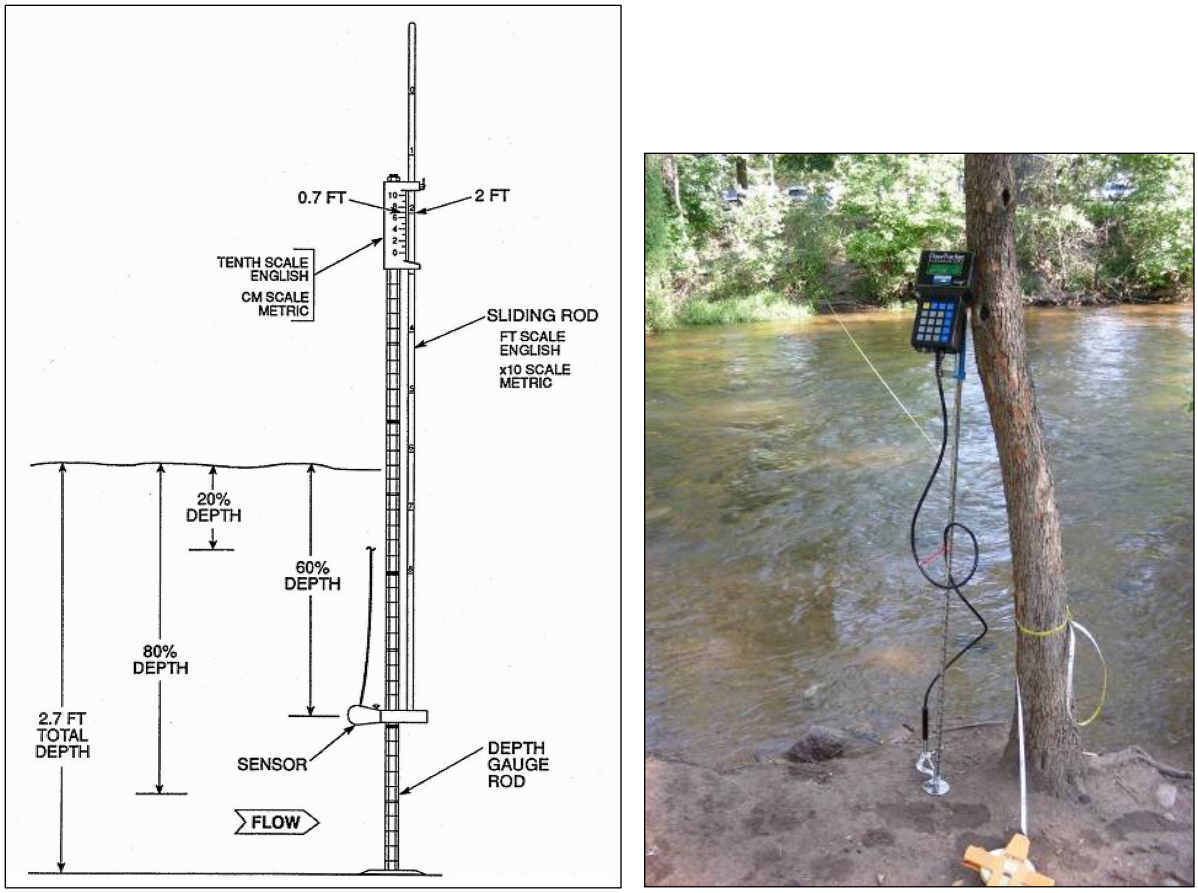


Figure 7-2. Top-set wading rod diagram (left), Flowtracker on wading rod (right).

Establish Q Transect

1) Lay the surveyor's rod (or stretch a meter tape) across the stream perpendicular to its flow, with the zero end of the rod or tape on the left bank, as viewed when looking downstream. Leave the tape tightly suspended across the stream, approximately 30 cm above water level.

2) Divide the total wetted stream width into 15 to 20 equal-sized intervals. To determine interval width, divide the width by 20 and round up to a convenient number. Intervals should not be less than 10 cm wide, even if this results in less than 15 intervals. The first interval is located at the river-left margin of the stream (left when looking downstream), and the last interval is located at the river-right margin of the stream (right when looking downstream).

3) If more than 20 increments are needed, use a second SEI Form #4 (note that this was done in the page x of y field). Cross out the current increment numbers (0-20), and replace with 21-last increment number).
4) *Optional:* Record the transect length, number of increments and increment width on SEI Form #4. when using the Flowtracker, it is optional to record the actual velocity and depth readings from the Q transect as described below (given that they are stored in the Flowtracker); however, the basic data about transect positions will be useful when collecting the discharge data.

Pre-measurement, Meter Set-up (Flowtracker)

1) Attach the velocity meter probe to a calibrated wading rod and power up the unit.
2) Place the velocity probe in the channel downstream of where the Q readings will be taken. It can be near the left wetted edge, but in an area with no obstructions and some flow.
3) Flowtracker: Select the Setup Parameters Menu**.** Set or confirm system parameters (these will not usually be changed and are saved in the data logger) from the default [ROMN SEI settings given in brackets]:
    a) Units system [Metric].
    b) Averaging time [40 seconds; default Flowtracker settings (see Manual)].
    c) Mode [Discharge; use default Flowtracker settings (see Manual)].
    d) QC Settings [*many settings are included here;* use default Flowtracker settings (see Manual)].
    e) Discharge Settings [*many settings are included here*; use default Flowtracker settings (see Manual)].
    f) Salinity [0.00; default Flowtracker settings (see Manual)].
    g) Language [English].
4) Flowtracker: Select the System Functions Menu:
    a) *View Data File* – to make sure there is room for the data file about to be made (see SEI SOP 2: Pre- and Post-Season Sample Event Activities data management). This is also where a previously created data file is reviewed.
    b) *Recorder status* – to make sure there is room for the data file about to be made (see SEI SOP 2: Pre- and Post-Season Sample Event Activities data management).
    c) *Format recorder* – ONLY if all data are to be erased.
    d) *Temperature Data* – to be sure it is reasonable for the environment (it should be close to that measured at the site by the *in situ* multiprobe).
    e) *Battery Data* – to be sure the estimate of remaining capacity (as a percent of total) is sufficient (total battery time is alkaline: ~5 hours, NiMH: ~15 hours, NiCad: ~7 hours, NOTE: the Flowtracker does not know what kind of battery is being used. **The ROMN SEI protocol requires high performance alkaline batteries**).

f) *Raw Velocity Data* – to check that SNR is ideally **above 10 dB (but measurements can be made as low as 3-4 dB)**. The velocity data should appear reasonable for the environment.

g) *Auto QC Test* – place the probe in moving water well away from any underwater obstacles; follow the on-screen instructions for the test. These test results are recorded with the data file. If a result comes back as no good, **see the Flowtracker Manual.**

h) *Show Config* – this is not typically needed in the field.

i) *Set System Clock* – verify that this is correctly set before each data collection run.

5) Flowtracker: Select Start Data Run from the main menu screen. This initiates a Discharge Mode data collection procedure after the file name, site and operator name are entered:

   a) Specify file name (required):

      i) A maximum of eight characters (letters or numbers) are allowed.

      ii) The ROMN SEI filename for a discharge reading is SiteIDQ (e.g., 001Q)

      iii) The extension given to the file is WAD

      iv) Press accept name when ready to start data collection.

   b) Enter site name:

      i) No site name within the Flowtracker data logger is needed for ROMN SEI Q measures (the SiteID is used in the file name and this is sufficient).

   c) Enter site and operator name:

      i) Enter the operator's name. This is the individual running the Flowtracker. Initials may be used.

   d) Press start to begin data collection.

6) Flowtracker: Before beginning the data measurements the operator is prompted to modify the QC settings. This would allow entry of any known starting and ending gauge height values, etc. **Most ROMN SEI Q measurements do not need to modify any of the default QC settings. See the Flowtracker manual for any needed changes in these settings.** If this is skipped data collection will (finally) begin.

Q Measurement (Flowtracker)

1) The first screen displayed is the Starting Edge screen. To enter data in this screen the keys with yellow text above the large numbers are used as follows:

   a) Press Set Location to set the starting edge location. Note that ROMN SEI starting edge location is always at the left water edge (LEW) and should be the default location that appears when starting a measurement (a "LEW" will be below the "Loc"). Its location should be 0.00 (distance from the LEW). Note that this establishes the transect and a reading will not be taken here.

   b) Often the tape measurement is not zero at the water's edge. Use the actual tape reading to simplify finding each increment distance.

c) If the starting edge is not river left, press LEW/REW to toggle the starting edge of water, left or right.

d) Press Set Depth to set starting-edge water depth. This may often be 0.00 meters (no depth), but may not be if it is a steep bank. Enter the depth in meters.

e) Press Corr. Factor to set any required correction factor (CF). The CF is a user-supplied parameter used to scale the mean station velocity. The CF is most commonly used at edges, islands, or bars in the channel. The default CF value is 1.00. Any value from -1.00 to 1.00, except 0.0, is allowed. The CF can be entered for any station and mean velocity will be multiplied by the CF. *One possible use is near the edges in very narrow streams. In these cases, the orientation of the Flowtracker probe can be reversed 180° to allow measurement closer to the edge. A CF of -1.00 should be entered to correct the Flowtracker X-velocity.* Be careful when entering the CF, as mean velocity is always scaled by this value. Incorrect use of this parameter will affect the final discharge measurement. **The CF is fully explained in the Flowtracker manual.**

2) Move to the first interval location. Stand downstream of the rod or tape and to the side of the first interval point.

3) When using the midpoint method (ROMN SEI default), the first interval distance will be half of the actual increment distance. Thereafter the increment distance is equal to the increment width until the last station (just prior to the REW when the distance is again half of the increment width.

4) Place the wading rod in the stream at the interval point and read the depth. Be sure to read depth from the downstream side of the rod.

5) Press Next Station to bring up the screen for the <u>first station</u>. Station information for "Stn 1" where the first measurement will be taken will be displayed. Modify all values as needed from this screen.

6) Press Set Location to set distance from the LEW or the station location. This will be automatically incremented based on previous location distances. It is displayed next to Loc on the screen. For example, if the increment widths are 0.20 m, the mid-increment distance will be 0.10.

7) Use Method+ and Method– to select the method used for velocity at that station. Methods are fully defined in the Flowtracker manual. Summaries of common methods used in the ROMN SEI protocol are as follows:

a) **0.60**: For depths less than 75 cm or ~2.5 ft. Default, and most common method used within the ROMN SEI protocol. A single measure is taken at 0.6 times the tream depth.

b) **0.2/0.8**: For depths greater than 75 cm or ~2.f ft. Two measures are taken at 20% and 80% of the total depth. The average of the two velocity measurements is used in the flow calculation.

c) **0.8/0.2**: Same as above, just reversed order of measurements.

d) **None**: Used in two different situations:

i) When no measurement is possible (perhaps due to weed growth) and velocity will be estimated based on velocity from the adjacent station(s).

ii) To specify the banks of an internal island (for a multiple channel river). If *one* method None station is recorded, it is assumed that no measurement was possible. Velocity for this station is based on the mean station velocity from the adjacent station(s) with velocity measurements multiplied by the user-specified correction (CF) factor for this station. The default CF is 1.00. If *two* method None stations are recorded together, they are assumed to represent an internal island and discharge is calculated accordingly.

e) Other methods are defined in the Flowtracker manual.

8) Press Set Depth to set the water depth at the station. This is displayed next to Dep on the screen. The measurement depth (where the probe should be set on the wading rod) will be in parentheses next to the method (e.g., if the depth was 0.45 m and the method is 0.6 the measurement depth will be displayed as "0.18" which is 60% of the depth from the surface. Set the wading rod to this depth as follows.

   a) For a 0.60 method (see above), slide the adjustable rod to the point where the first digit from the depth measurement (4) on the adjustable rod is lined up with the second digit (5) on the rods handle. This will place the sensor at 0.18 m or 60% from the surface (40% from the bottom).

   b) If the depth is greater than 75 cm a two point method (0.2/0.8) should be used (see above). For the first depth (0.2) the depth setting at twice the measured depth is used (0.45x2=0.9). Slide the adjustable rod until 9 is lined up with 0 on the fixed handle. This sets the probe at 0.36 m or 20% from the surface. For the second depth (0.8) halve the measured depth (0.225). Slide the adjustable rod until 2 is lined up with "2" (or just above 2) on the fixed handle.

   c) If needed press Corr. Factor to set the correction factor (CF), this is displayed only if the value is something other than **1.00**.

9) When all values are correctly set and the probe is located as desired, press Measure to start data collection. Stand downstream of the probe to avoid disrupting the stream flow. **Make sure you keep the probe's X direction perpendicular to the tag line being used to define the stream cross section (see Figure 7-3).**

10) If measure is mistakenly pressed before being ready, press Abort to terminate and 2 to repeat the setup for the station.

11) When the station is complete, a summary of velocity and quality control data is shown.

12) Prior to the summary screen, the data are reviewed using a variety of quality control criteria. If any data are outside expected values, a warning is issued.

13) All error and warning measures are detailed in the Flowtracker manual. The ROMN SEI protocol follows the recommendations given by the Flowtracker for any given measurement. **It is usually easy to repeat a measurement**.

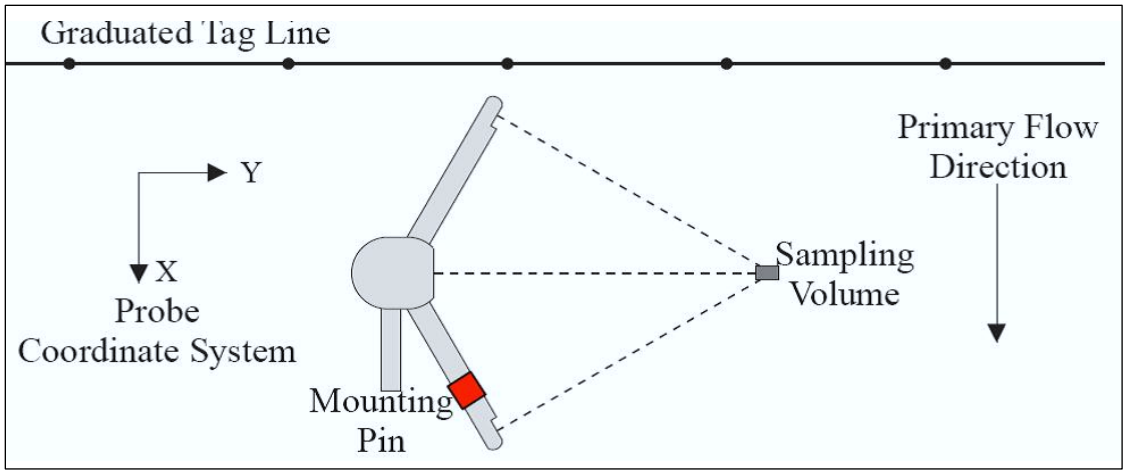


Figure 7-3. Overhead view of Flowtracker probe orientation relative to stream flow.

14) Accept the measurement and move on to the next depth measurement (or to the next station if this is the last measurement for this station). Press 2 to repeat the measurement (using the same station number). If there is more than one measurement at a station (e.g., 0.2 and 0.8 times the water depth), the system will proceed to the next measurement in the series.

15) When a station is accepted, the Flowtracker displays the next station. Location, depth, and method data for new stations are predicted using previous stations. If a multiple measurement method was used (e.g., 0.2 and 0.8 times water depth), the next station will use the same method in the opposite order (i.e.; 0.8 then 0.2 times depth).

16) Repeat steps 15-30 at the next station. Continue this until the last station (prior to the REW) is reached.

17) Note that Previous Station and Next Station keys scroll through the completed station(s).

18) You can edit station information using Set Location, Set Depth, Corr.Factor, etc.

19) It is possible to delete or repeat a station if desired:

   a) To delete an existing (completed) station (all measurements at that station will be deleted; you cannot delete only one measurement at a station), use Next Station and Previous Station to scroll to the desired station and press Delete. When prompted, enter 123 to confirm; any other entry keeps the station intact. The station is deleted, and the display returns to the current station.

   b) To repeat a station, first Delete the desired station. Move to the location of the station and enter the location, depth, and measurement method of the station to be repeated. Follow standard measurement procedures for that station. The new station data will automatically be sorted into the correct position so that discharge calculations are accurate.

20) When all stations are completed, press End Section. The Flowtracker reviews all data using several quality control criteria. If any stations/measurements are outside expected values, a warning is issued and these measurements are displayed. You can review data and repeat or add measurements to ensure optimal data quality. Next Station and Previous Station can be used to

view/edit other stations. To add new measurements, press the Measure key and confirm when prompted that you wish to re-open the file and add measurements.

21) When the review is complete, the ending-edge screen is shown. This screen works just like the starting-edge screen to enter the ending-edge information (depth, etc.). The distance will typically be automatically set to what the increment distance would have been had this not been the end of the transect, so this will need to be changed to the actual transect length.

22) When all values are correctly set, press Calc Disch to complete discharge calculations and close the file. **IMPORTANT**: Always return to the Main Menu before turning the system off to ensure all data have been saved.

23) The Total Q will be displayed. Record the Q and its uncertainty this on SEI Form #4.

24) Record the stop time.

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SEI SOP 8: Physical Habitat

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents methods for collecting detailed information on channel dimensions, channel gradient, channel substrate size and type, habitat complexity and cover, riparian vegetation cover and structure, anthropogenic alterations and channel-riparian interaction. Aquatic macrophytes, riparian vegetation, and large woody debris are also included as habitat features because of their role in modifying habitat structure and light inputs, even though they are actually biological measures. Habitat data discussed in this SOP is collected at all survey, gradient, and base flow sentinel site sample events for all stream types.

Most narrative that follows and most ROMN SEI physical habitat procedures are modified from the EPA EMAP program (Peck et al. 2006, Kaufmann et al. 1999) and National River and Streams Assessment (EPA 2007) programs. Some changes to EMAP procedures are derived from U.S. Forest Service (Heitke et al. 2011), USGS (Moulton et al. 2002), Montana Department of Environmental Quality (MT DEQ 2011, 2012a,b) and Colorado Department of Public Health and Environment (CDPHE 2005, 2010, 2011, 2012).

We are especially grateful to Phil Kaufmann from the EPA for his research behind these methods and for his permission to modify and use text and figures from EMAP manuals.

All data are recorded on a series of SEI Forms. For a "normal" wadeable site, 11 copies of SEI Form #5: Channel/Riparian Cross Section, 10 copies of SEI Form #6: Thalweg Profile and Woody Debris, 1 copy of SEI Form #7: Slope and Bearing, and 1 copy of SEI Form # 8 Constraint/Torrent are needed. Note that if "Xtra" cross sections are encountered, additional copies of SEI Form #5 will be needed.

For a normal non-wadeable site, 11 copies of SEI Form: Phab Channel Riparian Transect Form-Boatable, 10 copies of Phab Thalweg Profile SEI Form-Boatable, and 1 copy of SEI Form # 8 Constraint/Torrent are needed.

Components of Habitat Characterization

There are four different major components of the physical habitat characterization in wadeable and non-wadeable streams (Tables 8.1 and 8.2). The first component, a **channel and riparian characterization**, includes measures and/or visual estimates of channel dimensions, substrate, fish cover, bank characteristics, riparian vegetation structure, nonnative invasive plants, and evidence of human disturbances. These data are obtained at each of the 11 equally spaced transects established within the sampling reach. In addition, measurements of the stream slope and compass bearing between stations are obtained (for non-wadeable streams, these are done in a GIS), providing information necessary for calculating reach gradient, residual pool volume, and channel sinuosity. The second component is a **thalweg profile** or a longitudinal survey of depth, habitat class, presence of soft/small sediment deposits, and presence of off-channel habitats at 100 equally spaced intervals (150 in streams less than 2.5 m wide) along the centerline between the two ends of the sampling reach. Wetted width is measured and substrate size is evaluated at 21 equally spaced cross-sections (at 11 regular transects [A through K], and 10 to 20 supplemental cross-sections spaced midway between each of these). The third component collects data on **woody debris**, at each of 10 segments of stream (wadeable) or plots (non-wadeable) located between the 11 regular transects. The fourth component, **assessment of channel constraint, debris torrents, and major floods**, is an overall assessment of these characteristics for the whole reach, and is undertaken after the other components are completed.

Time Commitment

The time commitment to gain repeatability and precision is greater than that required for more qualitative methods. In EPA EMAP field trials (Kaufmann et al. 1999), two people typically complete the specified channel, riparian, and discharge measurements in about 3.5 hours of field time; however, the time required can vary considerably with channel characteristics. On streams up to about 4 meters wide with sparse woody debris, measurements can be completed in about two hours. The ROMN SEI protocol, requiring 21 wetted width measurements, should require less than 4.5 hours for a well-practiced crew of two, even in large (> 10 m wide), complex streams with abundant woody debris and deep water.

Table 8-1. Wadeable channel unit and pool-forming element categories.

Channel Unit Habitat Class (Code)	Description
Pool	Still water, low velocity, smooth, glassy surface; usually deep compared to other parts of the channel:
Plunge Pool (PP)	Pool at base of plunging cascade or falls
Trench Pool (PT)	Pool-like trench in the center of the stream
Lateral Scour Pool (PL)	Pool scoured along a bank
Backwater Pool (PB)	Pool separated from main flow off the side of the channel
Impoundment Pool (PD)	Pool formed by impoundment above dam or constriction
Pool (P)	Pool (unspecified type)
Glide (GL)	Water moving slowly, with a smooth, unbroken surface. Low turbulence.
Riffle (RI)	Water moving, with small ripples, waves and eddies; waves not breaking, surface tension not broken. Sound: "babbling" or "gurgling"
Rapid (RA)	Water movement rapid and turbulent; surface with intermittent whitewater with breaking waves. Sound: continuous rushing, but not as loud as cascade
Cascade (CA)	Water movement rapid and very turbulent over steep channel bottom. Most of the water surface is broken in short, irregular plunges, mostly whitewater. Sound: roaring
Falls (FA)	Free falling water over a vertical or near-vertical drop; water turbulent and white over high falls. Sound: from splash to roar
Dry Channel (DR)	No water in the channel.

Table 8-2. Non-wadeable channel unit categories.

Class (Code)[a]	Description
Pools (PO):	Still water, low velocity, smooth surface, deep compared to other parts of channel.
Glide (GL)	Water moving slowly, with a smooth, unbroken surface. Low turbulence.
Riffle (RI)	Water moving, with small ripples, waves and eddies; waves not breaking, surface tension not broken. Sound: "babbling" or "gurgling"
Rapid (RA)	Water movement rapid and turbulent, surface with intermittent whitewater with breaking waves. Sound: continuous rushing, but not as loud as cascade
Cascade (CA)	Water movement rapid and very turbulent over steep channel bottom. Most of the water surface is broken in short, irregular plunges, mostly whitewater. Sound: roaring
Falls (FA)	Free falling water over vertical or near-vertical drop, water turbulent and white over high falls. Sound: splash to roar
Dry channel (DR)	No water in the channel.
Off-channel	Side-channels, sloughs, backwaters, and alcoves separated from the main channel.

Wadeable

Overview of Workflow

Because the habitat protocols are the most time intensive elements of the SEI protocol they tend to control the work flow of an entire sample event. The following summarizes this at a "normal" wadeable site (Figure 8-1).

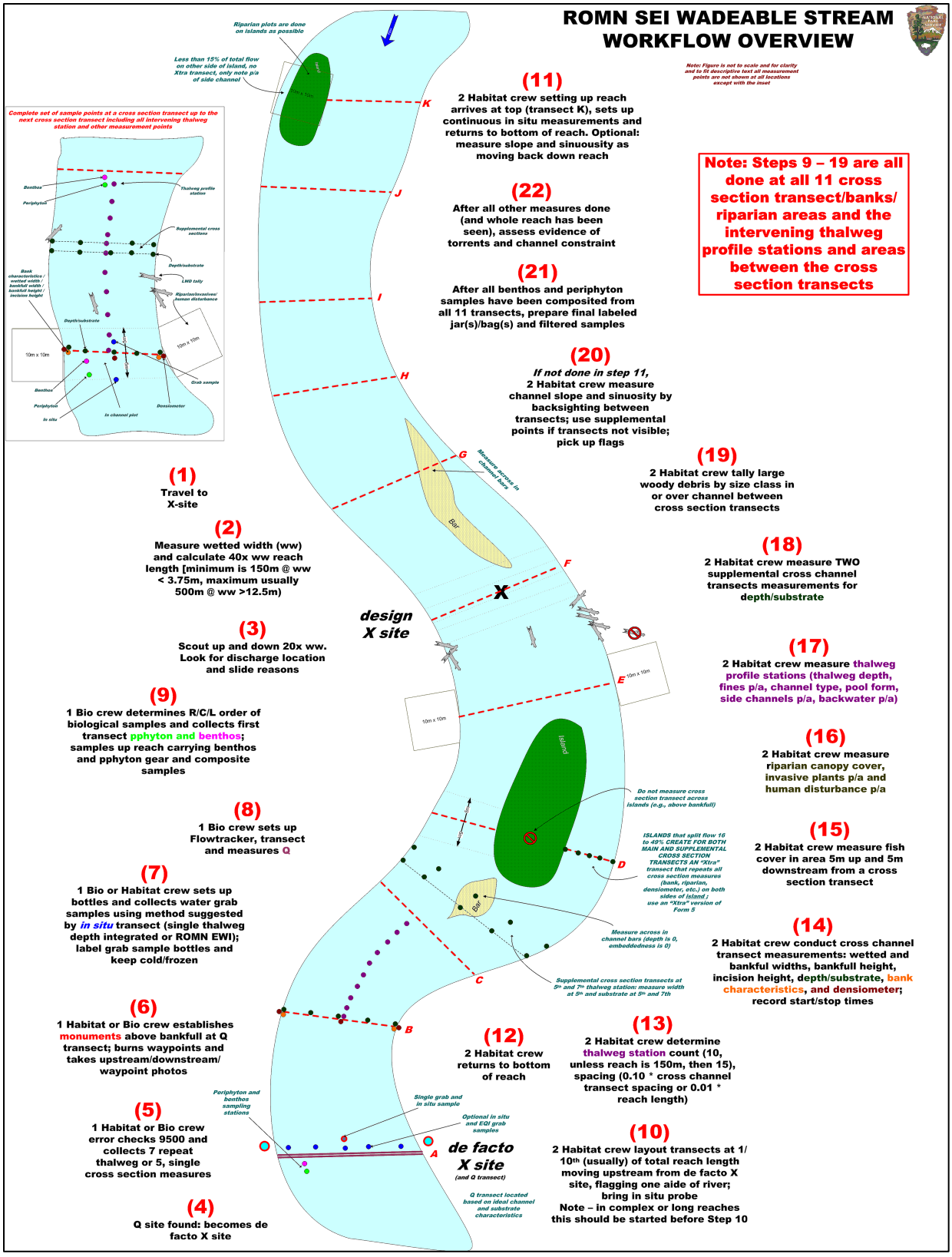


Figure 8-1. Generalized diagram of ROMN SEI sample locations within a "normal" wadeable reach (all replicates of all sample locations are only shown in the inset and the figure is not to scale).

Prior to initiating sampling of habitat, crews have verified and documented the site location, determined the length of stream reach to be sampled, and established the required transects, taken site photos, and conducted the *in situ* water quality and grab samples at the bottom (and top for *in situ*) of the reach. The crews will then move to the bottom of the reach to the ***de facto* X site** and begin collection of periphyton and macroinvertebrates before any other channel disturbing activities are done. The discharge reading will also be underway as well as monuments and site photos.

After the water quality and biological measures are complete below a transect, the crew conducts the first set of channel/riparian cross-section measures along the transect. One person conducts the channel cross-section dimension, substrate, bank, and canopy cover measurement. The second person records those measurements on the first copy of SEI Form #5: Channel/Riparian Cross Section while making visual estimates of riparian vegetation structure, in-stream fish cover, and human disturbance specified on that form. They also make observations to complete the invasive taxa portion of the form for the adjacent riparian plot, finish processing the biological samples, and/or prep for the next round of biological and *in situ* water samples.

The crew then proceeds upstream from the downstream end of the sampling reach making observations and measurements at the chosen increment spacing along the thalweg. One person is in the channel making width and depth measurements, and determining whether soft/small sediment deposits are present under his/her surveyor's rod or staff. The other person records these measurements, classifies the channel habitat, records presence/absence of side channels and off-channel habitats (e.g., backwater pools, sloughs, alcoves), and tallies large woody debris on SEI Form #6: Thalweg Profile and Woody Debris. When the crew member in the water makes a width measurement at the **two** channel locations midway between regular transects, s/he also locates and estimates the size class of the substrate articles on the left channel margin and at positions 25%, 50%, 75%, and 100% of the distance across the wetted channel. Procedures for this substrate tally are the same as for those at regular cross sections, and data are recorded on the Thalweg Profile side of the field form.

As the crew nears the next regular cross-section transect, they should estimate when they should do the next set of (optional) *in situ* measures, and the benthos and periphyton samples. Offsets must be maintained between these sample locations and the thalweg profile sites such that disturbance from the kick samples does not disturb the substrate being quantified. In very small streams this may be difficult, especially when the biological samples are being done at the center station. If necessary, allow the stream to settle after the *in situ* and biological sampling before completing the few remaining thalweg profile points and the next cross section transect. After completing the biological and *in situ* measures, complete the remaining thalweg points prior to the next cross-section transect.

Slope and bearing are then determined together by backsighting to the previous transect (one crew member will need to move back downstream to the previous transect). Optionally, the slope and bearing may be done when the crew returns from setting up the reach. Supplementary points may need to be located and flagged (using a different color) if the stream is extremely brushy, sinuous, or steep to the point that you cannot site for slope and bearing measures between two adjacent transects. Slope and bearing are recorded on SEI Form #7: Slope and Bearing. Crews could tally woody debris

while doing the backsight, rather than during the thalweg profile measurements. *Alternatively, the slope and sinuosity readings can be done all together as crews move back down the reach after completing all habitat measures.*

After completing observations and measurements along the thalweg and at all 11 transects, the field crew completes the overall reach assessments of channel constraint and evidence of debris torrents and major floods. These data are recorded on SEI Form #8: Torrent/Channel Constraint. Final activities include cleaning up the reach and preparing gear for the hike out.

Habitat Sampling Locations within the Reach

Measurements are made at two scales of resolution along the length of the reach; the results are later aggregated and expressed for the entire reach, a third level of resolution. Figure 8-1 illustrates the locations within the sampling reach where data are obtained. For new and most revisits to sites, habitat is assessed over stream reach lengths that are 40x their average wetted width at base flow, but not less than 150 m or more than 500 m long. This allows the sample reach length to be adjusted to accommodate varying sizes of streams. For revisits to sentinel sites, sample locations are fixed as detailed in SEI SOP 4: Verification of Site Status and Sample Reach Layout.

Many of the channel and riparian features are characterized on 11 cross-sections and pairs of riparian plots spaced at 4 channel-width intervals (i.e., transect spacing=1/10th the total reach length). The thalweg profile measurements must be spaced evenly over the entire sampling reach. In addition, they must be sufficiently close together that they do not "miss" deep areas and habitat units that are in a size range of about 1 to 2 average channel widths.

The following guidelines are used for choosing the interval between wadeable thalweg profile measurements:

- Channel Width < 3.75m; interval = 1.5 m
- Channel Width 3.75-12.5 m; interval = 0.01 x reach length
- Channel Width > 12.5 m; interval = 5 m

Following these guidelines, crews will make 150 evenly spaced thalweg profile measurements in the smallest category of streams, 15 between each detailed channel cross section. In larger stream sizes, crews will make 100 measurements, 10 between each cross section. We specify width measurements only at the 11 regular transect cross-sections and 10 supplemental cross sections at the thalweg measurement points midway between each pair of regular transects (a total of 21 wetted widths). If more resolution is desired, width measurements may be made at all 100 or 150 thalweg profile locations. Substrate measurements are also done at the 20 supplemental cross sections in addition to those at the 11 regular transects, for a systematic pebble count of 155 particles (rather than 55 as in Kaufmann et al. 1999).

Channel and Riparian Measurements at Cross-section Transects

Substrate size and channel geomorphology are some of the most important determinants of habitat character in streams. Along with bedform (e.g., riffles and pools), substrate influences the hydraulic

roughness, and consequently, the range of water velocities in the channel. It also influences the size range of interstices that provide living space and cover for macroinvertebrate. Substrate characteristics are often sensitive indicators of the effects of human activities on streams. Decreases in the mean substrate size and increases in the percentage of fine sediments, for example, may destabilize channels and indicate changes in the rates of upland erosion and sediment supply (Dietrich et al. 1989, Wilcock 1998). The character of stream substrates is important to both physical and biological stream functions. Physically, as stream substrates become more embedded, the interstitial space between particles is reduced, thus effectively reducing streambed roughness and altering channel bedform and hydraulics. Streambed and substrate mobility can be substantially affected by the quantity and characteristics of the fine material (Wilcock 1998). In addition, without periodic mobilization of fine sediments from the coarse bed material, deposited fines eventually clog interstitial voids (Osmundson and Scheer 1998).

In wadeable streams, substrate size and embeddedness are evaluated at each of the 11 cross-section transects using a combination of methods adapted from those described by Wolman (1954), Bain et al. (1985), Platts et al. (1983), and Plafkin et al. (1989). Substrate size is evaluated also at 20 additional cross-sections located midway (5th and 7th thalweg station) between each of the 11 regular transects (A-K). In the process of measuring substrate particle sizes at each channel cross section, crews also measure the wetted width of the channel and the water depth at each substrate sample point (at the 10 midway cross sections, only substrate size and wetted width are recorded). The procedure for obtaining substrate size, embeddedness, and channel dimension measurements is presented below.

Wetted widths and bankfull widths are measured at each of the 11 main cross section transects along the reach. Wetted widths are also measured at the 20 intervening supplemental transects. Note that bankfull heights and incision heights are also measured at each main cross-section transect. These methods are covered below.

Mid-channel bars, islands, and side channels pose some problems for the sampler measuring widths. *Bars* are defined here as mid-channel features *below* the bankfull flow mark that are dry during base flow conditions. *Islands* are mid-channel features that are *above* bankfull flow (dry even when the stream is experiencing a bankfull flow). Both bars and islands cause the stream to split into side channels.

When a *mid-channel bar* is encountered along a cross-section transect (or the thalweg profile) the active channel is considered to include the bar. Therefore, the wetted width is measured as the distance between wetted left and right banks. It is measured across and over mid-channel bars and boulders. If mid-channel bars are present, record the bar width in the space provided. The five substrate points are centered between the wetted width boundaries regardless of the mid-channel bar in between. *Consequently, substrate particles selected in some cross-sections may be "high and dry." For cross-sections with dry channels, however, only take measurements across the unvegetated portion of the channel.*

If a mid-channel feature is as high as the surrounding flood plain, it is considered an *island*. Treat side channels resulting from islands different from mid-channel bars. Handle the ensuing side channel based on visual estimates of the percent of total flow within the side channel as follows. When a side channel occurs due to an island, its length is reflected with continuous entries in the Side Channel field on SEI Form #6:

- **Less than 15%:** Indicate the presence of the side channel with a comment on SEI Form #5 (on SEI Form #6 there is a p/a field for the side channel.
- **16 to 49%:** Establish a secondary transect across the side channel designated as "X" plus the primary transect letter; (e.g., XA), by checking boxes for both X and the appropriate transect letter (e.g., A through K) on a separate copy of the field data form.

Substrate Size

The core of the protocol is a systematic selection of five substrate particles from each of 21 cross-section transects (both the main and the supplemental transects; Figure 8-1 and Figure 8-2). The substrate sampling points along a cross-section are located at 0, 25, 50, 75, and 100% of the measured wetted width, with the first and last points located at the water's edge just within the left and right banks. For the main cross-section transects these are recorded in the Substrate section of the Form. Note that for the **two** supplemental cross-sections midway between regular transects, substrate size (and wetted width) data are recorded on SEI Form #6 (Thalweg).

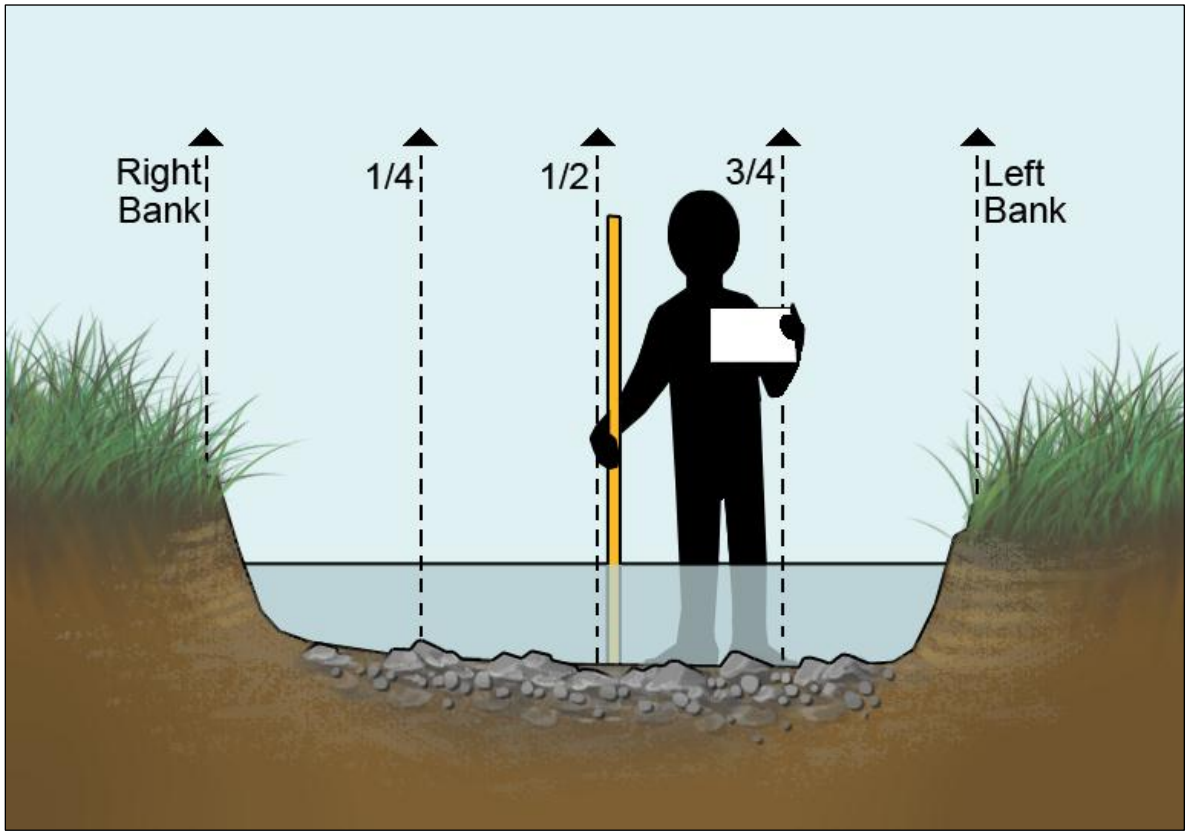


Figure 8-2. Substrate sampling cross section locations.

The distance of each measurement station (0, 25, 50, 75, and 100% from the left bank) is also recorded as well as the depth at each station (these are only done for the main cross section substrate measurements, not the supplemental transects).

To minimize bias in selecting a substrate particle for size classification, it is important to concentrate on correct placement of the measuring stick along the cross section, and to select the particle right at the bottom of the stick (not, for example, a more noticeable large particle that is just to the side of the stick). Classify the particle into one of the size classes listed based on the middle dimension of its length, width, and depth. This median dimension determines the sieve size through which the particle can pass. *Always distinguish hardpan from fines, coding hardpan as HP.* Similarly, always distinguish concrete or asphalt from bedrock; denote these artificial substrates as RC and record their size class in the comments section of the field data form. Code and describe other artificial substrates (including metal, tires, car bodies, etc.) as OT on the field form. When you record the size class as OT (other), assign an F-series flag on the field data form and describe the substrate type in the comments section of Form #5.

Embeddedness

The ROMN SEI protocol includes estimates of embeddedness at substrate sampling locations on the 11 regular transects (A-K). Embeddedness is estimated as the fraction of larger particle's surface (boulder, cobble, pebble, gravel) that is surrounded by (embedded in) sand or finer sediments on the stream bottom. Crews examine the substrate in the 10-cm diameter circle around the substrate sampling point by examining particles larger than sand for surface stains, markings, and algal coatings to estimate embeddedness of all particles. The portion of a particle that is not algal covered or is lighter in coloration approximates the percent of that particle that was embedded (Figure 8-3).

The following can also be used as a guide to estimate percent embeddedness for the stream bottom as a whole (Simonson et al. 1994). It may be useful for gestalt estimation of the embeddedness of the 10-cm area, but should not replace continuous estimates (e.g., not classes) of the amount of discoloration of specific particles:

- 100% embeddedness = Rocks are completely surrounded or covered by sediment. By definition, if there is any sand or finer present embeddedness is not zero. If it is all sand or fines (silt, clay, and muck) record it as as 100 percent.
- 75% embeddedness = Rocks are completely surrounded by sediment and half covered by sediment.
- 50% embeddedness = Rocks are completely surrounded by sediment, but are not covered by sediment.
- 25% embeddedness = Rocks are half surrounded by sediment and are not covered by sediment.
- 0% embeddedness = No fine sediments on substrate. By definition, record the embeddedness of hardpan and bedrock as 0 percent.

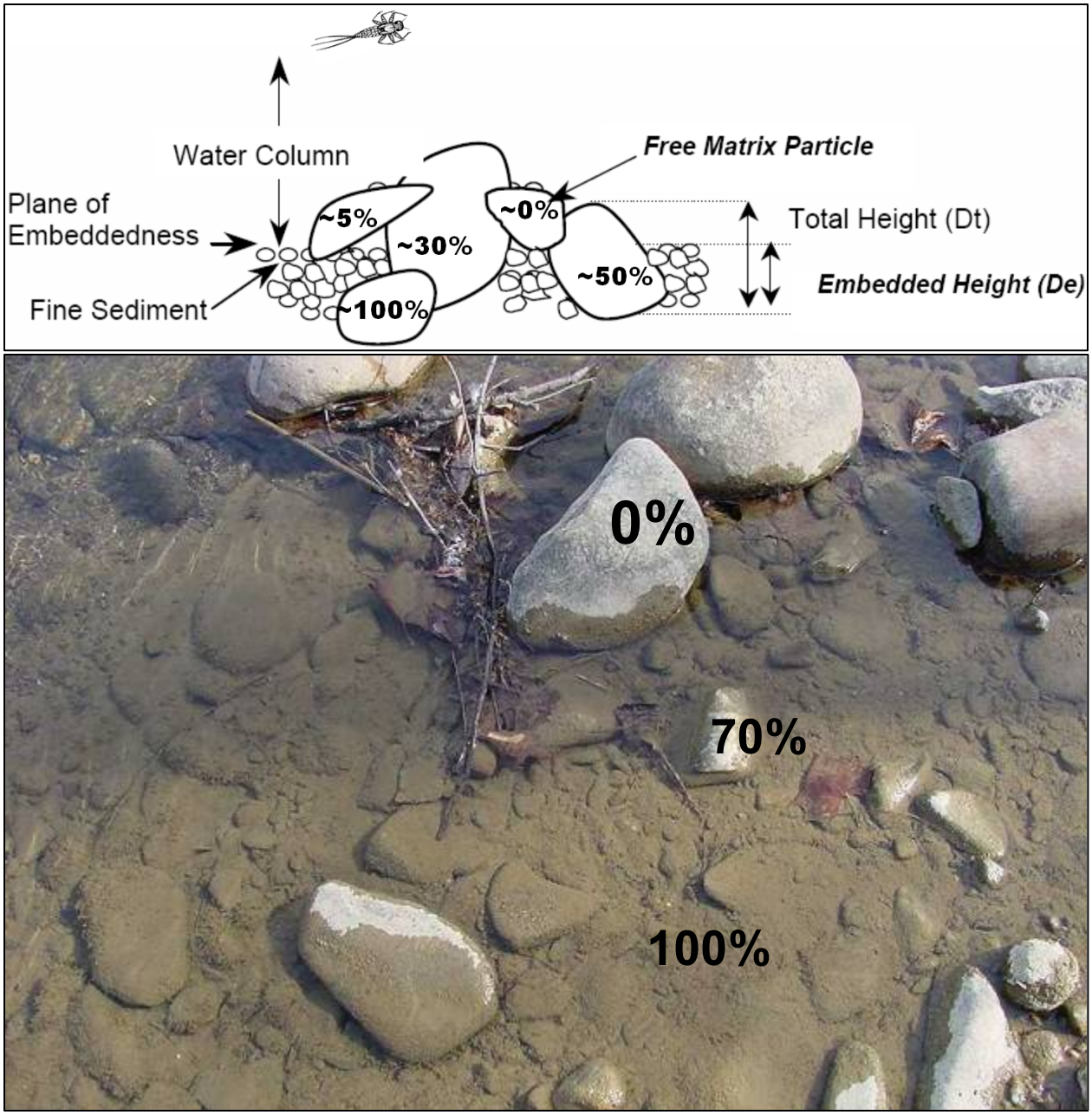


Figure 8-3. Schematic representation of embeddedness (top). Photograph of typical classes (bottom). The numbers represent the % of each particle that lies under the plane of embeddedness.

Bank Characteristics

Bank Angle

Bank angle and bank undercut distance are determined on the left and right banks at each cross-section transect. Other features measured include the wetted width of the channel, the width of exposed mid-channel bars of gravel or sand, estimated incision height, and the estimated height and width of the channel at bankfull. Bankfull height and incised height are both measured relative to the present water surface. In other words, both are measured up from the level of the wetted edge of the

stream. Figure 8-4 illustrates how bank angle is determined in several different situations. Undercut bank angles and distances are also measured following these guidelines. The upstream/downstream distance at which bank angle is characterized is approximately 0.5 m (only consider the bank over this distance). A 1-m long measuring pole and clinometer are used to determine bank angle. The angle is determined based on the pole resting on the approximate 0.5 m above wetted width with the clinometer placed on the middle of the pole.

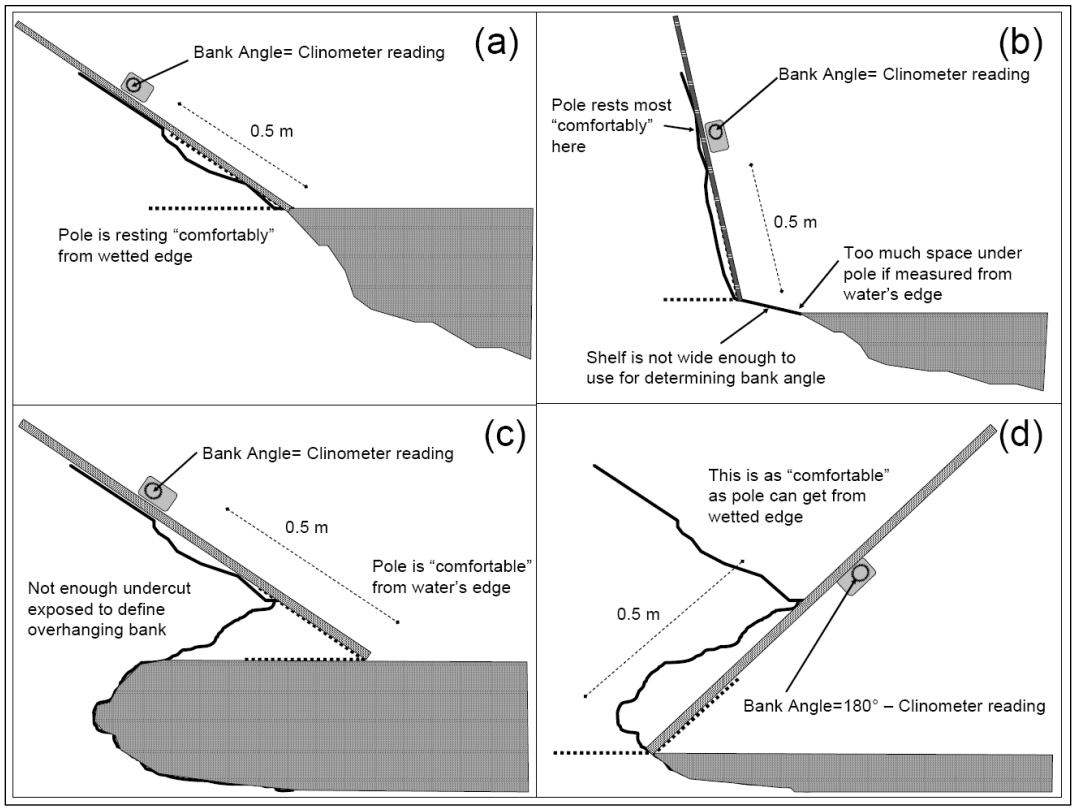


Figure 8-4. Determining bank angle under different types of bank conditions: (a) typical, (b) incised channel, (c) undercut bank, and (d) overhanging bank. Figure is from Peck et al. (2006).

Bankfull and Incision Heights

The bankfull or active channel (Figure 8-5) is defined as the channel that is filled by moderate-sized flood events that typically occur every one or two years. Such flows do not generally overtop the channel banks to inundate the valley floodplain, and are believed to control channel dimensions in most streams. Spotting the level of bankfull flow during base flow conditions requires judgment and practice; even then it remains somewhat subjective. In many cases there is an obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel. Because scouring and inundation from bankfull flows is typically frequent enough to inhibit the growth of terrestrial vegetation, the bankfull channel may be evident by a transition from exposed stream sediments to terrestrial vegetation. Similarly, it may be identified by noting moss growth on rocks along the banks. Bankfull flow level may also be seen by the presence of drift material caught on overhanging vegetation. In years with large floods, however, this material may be much higher

than other bankfull indicators. In these cases, record the lower value, flag it, and also record the height of drift material in the comments section of the field data form.

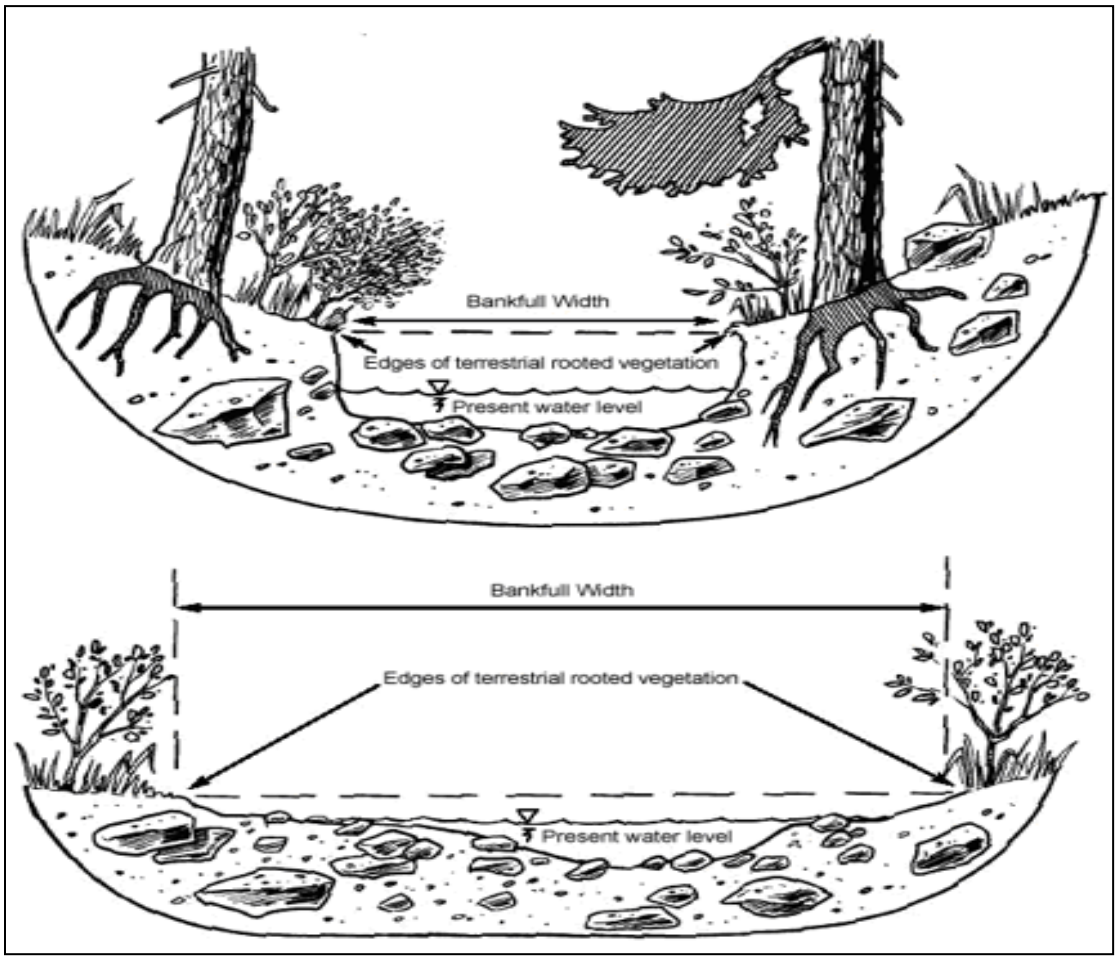


Figure 8-5. Examples of bankfull widths (Heitke et al. 2011).

Crews use the vertical distance (height) from the observed water surface up to the level of the first valley terrace as a measure of the degree of incision or downcutting of the stream below the general level of its valley (Figure 8-6 and Figure 8-7). These data are recorded in the space for Incised Height. (Note: In analyzing these data, we actually add the mean thalweg depth to incision heights to yield a flow-independent measure B; we do the same thing for bankfull heights).

Streams incise when their rate of sediment transport exceeds the supply of new sediment from upstream and from their banks. Conversely, aggradation occurs when sediment supplies exceed the capacity of the stream to transport sediment. Human activities can change the balance between sediment transport and supply in a number of ways. The power of the stream to transport sediment may be increased by human activities that increase flood flows (e.g., increases in the impervious area of a watershed), or remove large roughness elements, like woody debris that dissipate stream power that might otherwise transport sediment.

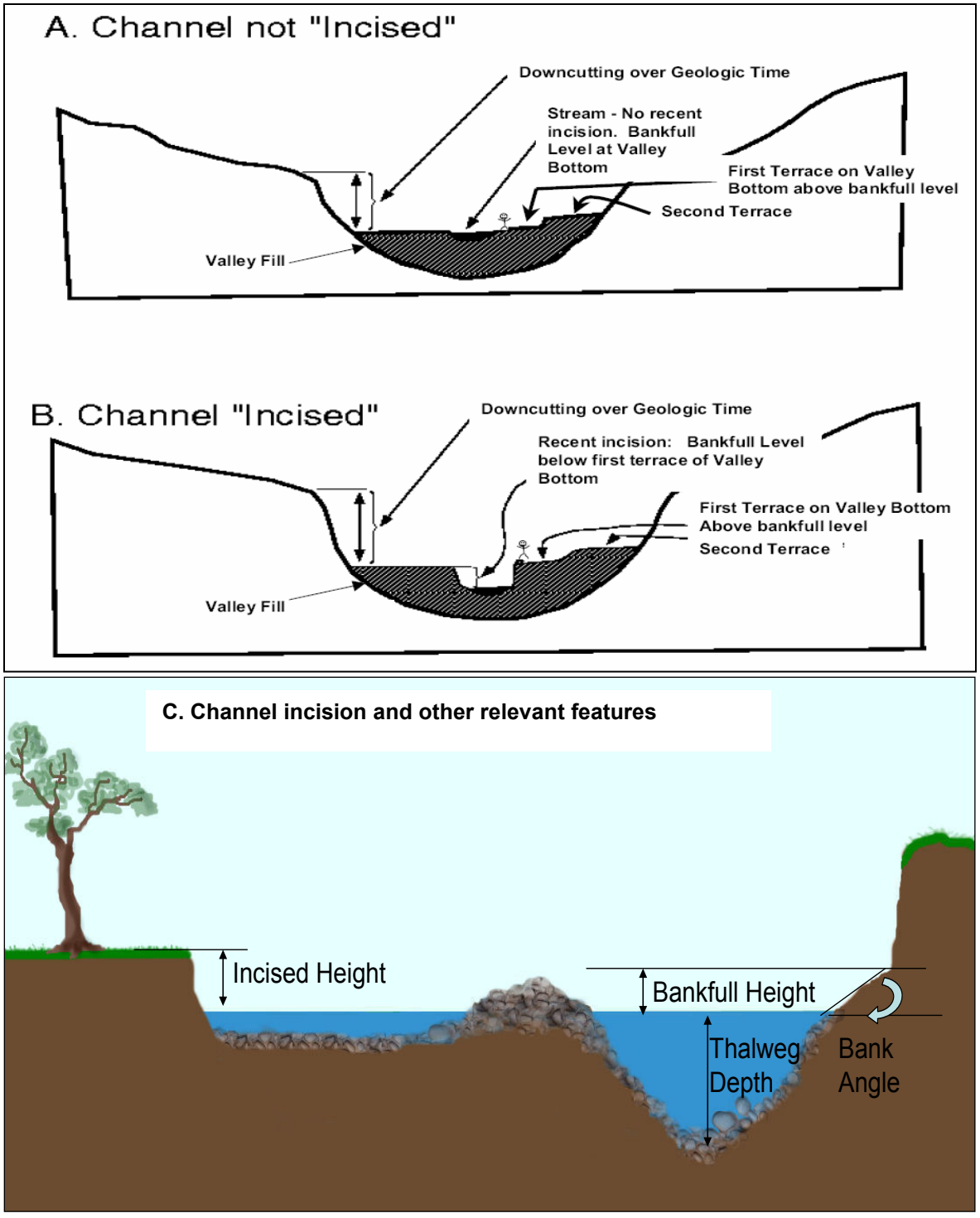


Figure 8-6. Schematic showing bankfull channel and incision for channels. (A) not recently incised, and (B, C) recently incised into valley bottom. Note level of bankfull stage relative to elevation of first terrace on valley bottom (from Peck et al. 2006).

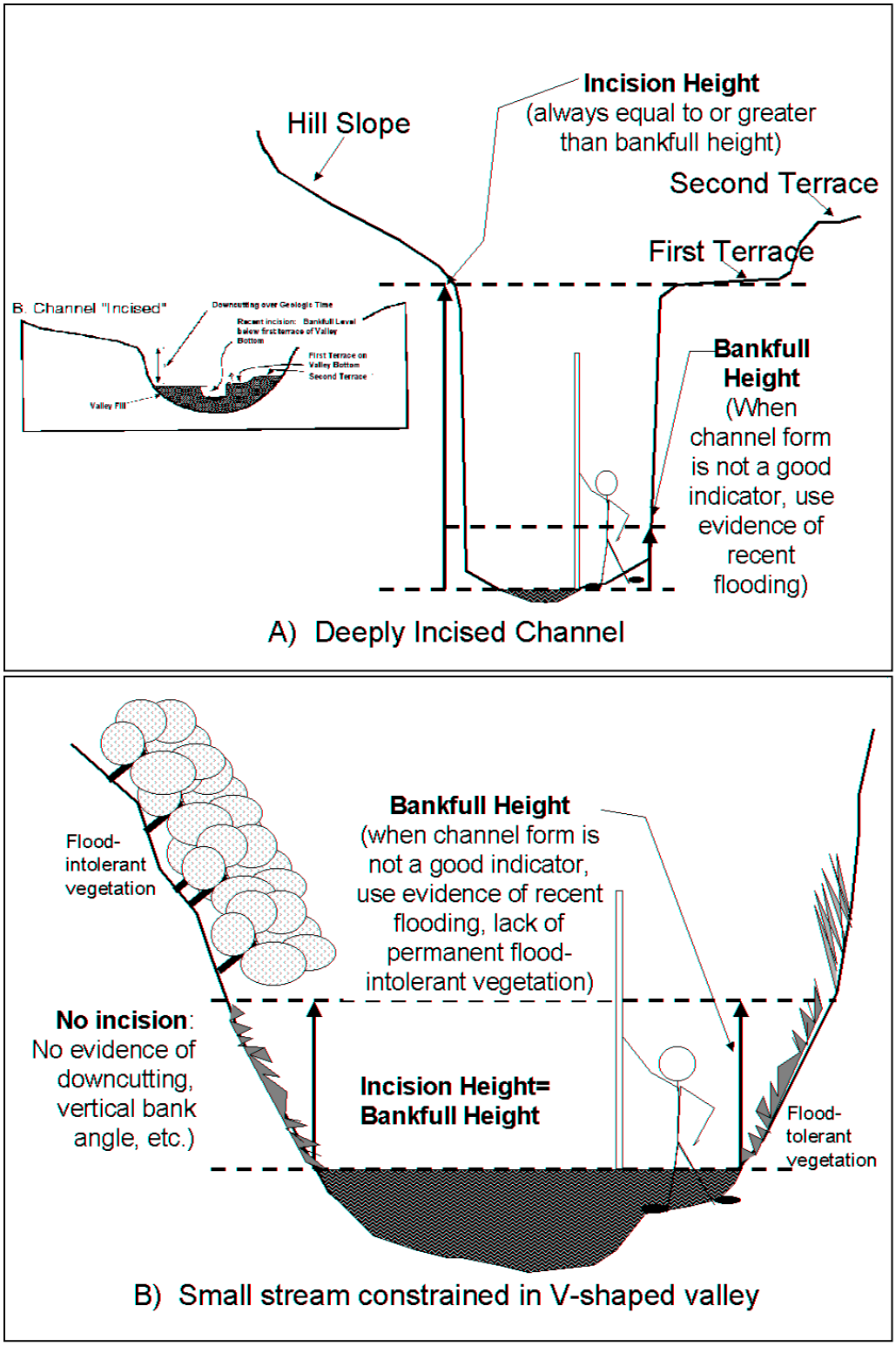


Figure 8-7. Determining bankfull and incision heights for (A) deeply incised channels, and (B) streams in deep V-shaped valleys (from Peck et al. 2006).

The supply of sediment may be increased by upslope erosion, or decreased when, for example, upstream impoundments trap bedload sediments. It may not be evident at the time of sampling whether the channel is downcutting, stable, or aggrading (raising its bed by depositing sediment); however, by recording incision heights measured in this way and monitoring them over time, we will be able to tell if streams are incising or aggrading. If the channel is not greatly incised, bankfull channel height and incision height will be the same. If the channel is incised greatly, the bankfull level will be below the level of the first terrace of the valley floodplain, making bankfull channel height less than incision height. **Bankfull height is never greater than incision height**. Crews may need to look for evidence of recent flows (within about one year) to distinguish bankfull and incision heights. In cases where the channel is cutting a valley sideslope and has over-steepened and destabilized that slope, the bare "cutbank" against the steep hillside at the edge of the valley is not necessarily an indication of recent incision. In such a case, the opposite bank may be lower, with a more obvious terrace above bankfull height; choose that bank for your measurement of incised height. Examine both banks to more accurately determine incision height and bankfull height. Remember that incision height is measured as **the vertical distance to the first terrace above bankfull; if terrace heights differ on left and right banks (both are above bankfull), choose the lower of the two terraces.**

In many cases the sample reach may be in a V-shaped valley or gorge formed over eons, and the slope of the channel banks simply extends uphill indefinitely, not reaching a terrace before reaching the top of a ridge. In such cases, record incision height values equal to bankfull values and make appropriate comment that no terrace is evident. Similarly, when the stream has extremely incised a very ancient terrace, (e.g., the Colorado River in the Grand Canyon), you may crudely estimate the terrace height if it is the first one above bankfull level. If you cannot estimate the terrace height, make appropriate comments describing the situation.

Canopy Cover Measurements

Riparian canopy cover over a stream is important not only in its role in moderating stream temperatures through shading, but also as an indicator of conditions that control bank stability and the potential for inputs of coarse and fine particulate organic material. Organic inputs from riparian vegetation become food for stream organisms and structure to create and maintain complex channel habitat.

Canopy cover over the stream is determined at each of the 11 cross-section transects. A spherical densiometer (model A-convex type) is used (Lemmon 1957). Mark the densiometer with a permanent marker or tape exactly as shown in to limit the number of square grid intersections read to 17. Densiometer readings can range from 0 (no canopy cover) to 17 (maximum canopy cover). Six measurements are obtained at each cross-section transect (four measurements in four directions at mid-channel and one at each bank). The mid-channel measurements are used to estimate canopy cover over the channel. The two bank measurements complement your visual estimates of vegetation structure and cover within the riparian zone itself, and are particularly important in wide streams, where the riparian canopy may not be detected by the densiometer when standing midstream.

Densiometer measurements are taken at 0.3 m (1 ft) above the water surface, rather than at waist level, to (1) avoid errors because people differ in height; (2) avoid errors from standing in water of varying depths; and (3) include low overhanging vegetation more consistently in the estimates of cover. Hold the densiometer level (using the bubble level) 0.3 m above the water surface with your face reflected just below the apex of the taped V as shown in Figure 8-8. Concentrate on the 17 points of grid intersection on the densiometer that lie within the taped V. If the reflection of a tree or high branch or leaf overlies any of the intersection points, that particular intersection is counted as having cover. For each of the six measurement points, record the number of intersection points (maximum = 17) that have vegetation covering them in the Canopy Cover Measurement section of the Channel/Riparian Cross-section SEI Form #5.

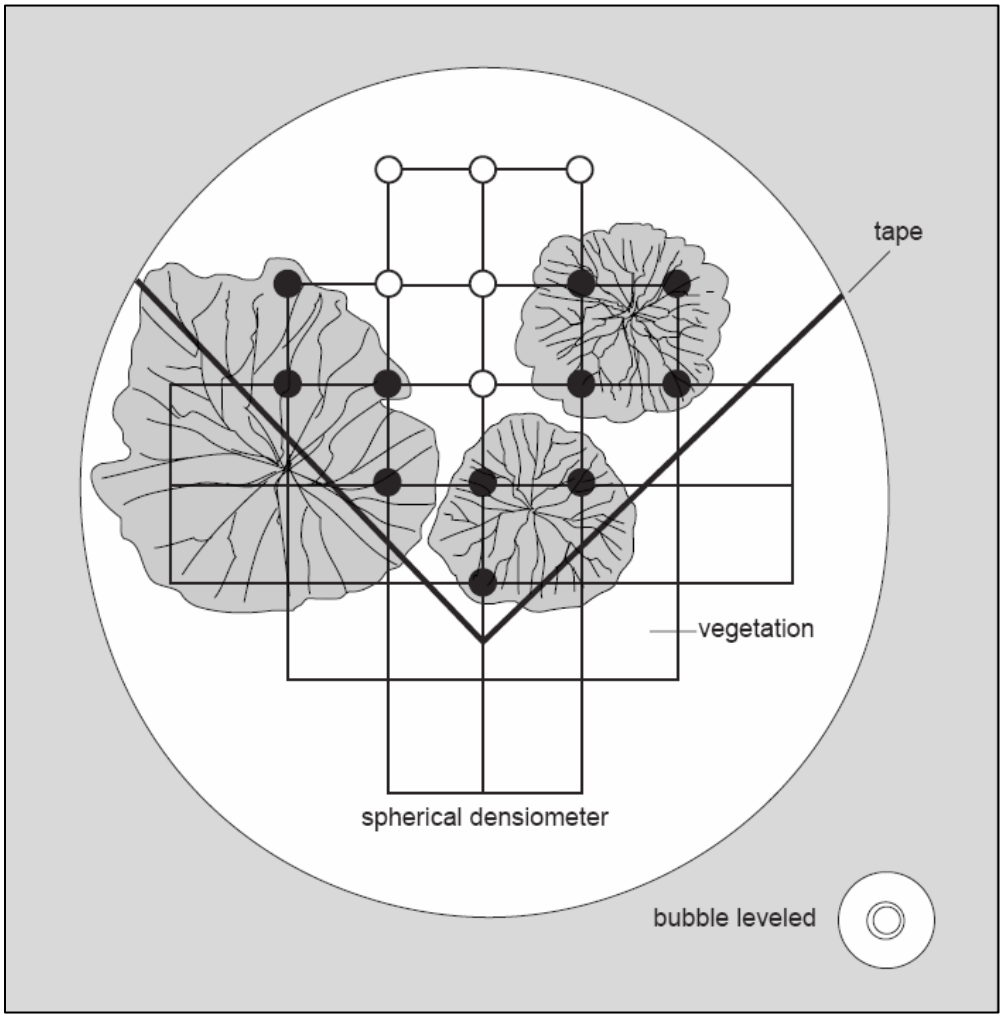


Figure 8-8. A concave spherical densiometer with bubble level, tape, and 17 points of observation. Line of intersections at both open and closed circles are examined. Closed circles represent line intersections counted in measurement of canopy closure (11 out of 17 points; Fitzpatrick et al. 1998).

Riparian Vegetation Structure

The previous section described methods for quantifying the cover of canopy over the stream channel. The following visual estimation procedures supplement those measurements with a semi-quantitative evaluation of the type and amount of various types of riparian vegetation. These data are used to evaluate the health and level of disturbance of the stream corridor. They also provide an indication of the present and future potential for various types of organic inputs and shading.

Riparian vegetation observations apply to the riparian area upstream 5 m and downstream 5 m from each of the 11 cross-section transects. They include the visible area from bankfull back a distance of 10 m (30 ft) shoreward from both the left and right banks, creating a 10 x 10 m riparian plot on each side of the stream. *The riparian plot dimensions are estimated, not measured*. On steeply sloping channel margins, the 10 x 10 m plot boundaries are defined as if they were projected down from an aerial view. If the wetted channel is split by a mid-channel bar, the bank and riparian measurements are made at each side of the channel, not the bar.

Conceptually divide the riparian vegetation into three layers: a *canopy layer* (> 5 m high), an *understory* (0.5 to 5 m high), and a *ground cover* layer (< 0.5 m high). Note that several vegetation types (e.g., grasses or woody shrubs) can potentially occur in more than one layer. Similarly, note that some things other than vegetation are possible entries for the Ground Cover layer (e.g., barren ground).

Before estimating the areal coverage of the vegetation layers, record the type of **woody** vegetation (Deciduous, Coniferous, broadleaf Evergreen, Mixed, or None) in each of the two taller layers (Canopy and Understory). Consider the layer "Mixed" if more than 10% of the areal coverage is made up of the alternate vegetation type. If there is no woody vegetation in the understory layer, record the type as "None."

Estimate the areal cover separately in each of the three vegetation layers. Note that the areal cover can be thought of as the amount of shadow cast by a particular layer alone when the sun is directly overhead. The maximum cover in each layer is 100%, so the sum of the areal covers for the combined three layers could add up to 300%. The four areal cover classes are absent, sparse (< 10%), moderate (10 to 40%), heavy (40 to 75%), and very heavy (> 75%). These cover classes and their corresponding codes are shown on Form #5. When rating vegetation cover types, mixtures of two or more subdominant classes might all be given sparse (1), moderate (2), or heavy (3) ratings. One very heavy cover class with no clear subdominant class might be rated (4) with all the remaining classes rated as either moderate (2), sparse (1), or absent (0). Two heavy classes with 40-75% cover can both be rated (3).

Instream Fish Cover, Algae, and Aquatic Macrophytes

This portion of the ROMN SEI physical habitat protocol is a visual estimation procedure that semi-quantitatively evaluates the type and amount of important types of cover for fish and macroinvertebrates. Alone and in combination with other metrics, this information is used to assess habitat complexity, fish cover, and channel disturbance.

Estimate the areal cover of all of the fish cover and other listed features that are in the water and on the banks 5 m upstream and downstream of the cross-section. The entire channel within this 10-m area forms the in-channel assessment area The areal cover classes of fish concealment and other features are the same as those described for riparian vegetation.

Filamentous algae refers to long, streaming algae that often occur in slow-moving waters. Aquatic macrophytes are water-loving plants, including mosses, in the stream that could provide cover for fish or macroinvertebrates. If the stream channel contains live stream grasses, include these as macrophytes. Woody debris is the larger pieces of wood that can influence cover and stream morphology (i.e., those pieces that would be included in the large woody debris tally). Brush/woody debris refers to smaller wood pieces that primarily affect cover, but not morphology. Live Trees or Roots are living trees that are within the channel; estimate the areal cover provided by the parts of these trees or roots that are inundated. Overhanging vegetation includes tree branches, brush, twigs, or other small debris that is not in the water, but is close to the stream (*within 1 m of the surface*) and provides potential cover. Boulders are typically basketball- to car-sized particles. Artificial structures include those designed for fish habitat enhancement, as well as in-channel structures discarded (e.g., concrete, asphalt, cars, or tires) or purposefully placed for diversion, impoundment, channel stabilization, or other purposes.

Human Influence

The field evaluation of the presence and proximity of various important types of human land-use activities in the stream riparian area is used in combination with mapped watershed land-use information to assess the potential degree of disturbance of the sample stream reaches.

For the left and right banks at each of the 11 cross-section transects, crews evaluate the presence/absence and the proximity of 12 categories of human influences. The area examined is the same used for riparian vegetation and the in-stream fish cover. Four proximity classes are used: (1) In the stream or on the bank within 5 m upstream or downstream of the cross-section transect, (2) present within the 10 x 10 m riparian plot, but not in the stream or on the bank, (3) present outside of the riparian plot, and (4) absent. If a disturbance is within more than one proximity class, record the one that is closest to the stream.

A particular influence may be observed outside of more than one riparian observation plot (e.g., at both transects D and E. Record it as present at every transect where you can see it without having to sight through another transect or its riparian plot.

Invasive Plants

A trend of increasing concern along streams in many parts of the western U.S. is the invasion of alien (non-native) tree, shrub, and grass species. The plant assemblages that result from such invasions can substantially alter stream ecosystems and/or negatively impact the economic value of the land they occupy (Pimentel et al. 2000). Riparian areas are particularly susceptible to invasion because of both natural and human-induced disturbance regimes, and the connectivity of the stream network (Nilsson and Svedmark 2002).

Twelve to fifteen taxa were selected for survey along stream sites in each ROMN park unit (Table 8-3). Selection of these plants was based on ease of field identification by non-botanists, degree of economic or ecological impact at the park scale, preference for the riparian habitat, and ecological variety within the list of target species.

Table 8-3. Draft ROMN park SEI invasive plant target list. (Note this is not a complete list of all invasive plants in a park.)

Species	ROMN Parks[1]
Canada Thistle (*Cirsium arvense*)	GLAC, GRKO, LIBI, ROMO, GRSA
Cheatgrass (*Bromus tectorum*)	GRSA
Common Tansy (*Tanacetum vulgare*)	GLAC, GRKO, LIBI, GRSA
Dalmatian Toadflax (*Linaria dalmatica*)	GLAC, GRKO, LIBI, ROMO, GRSA
Diffuse Knapweed (*Centaurea diffusa)*	ROMO, GRSA
Houndstongue (*Cynoglossum officinale*)	GLAC, GRKO, LIBI, ROMO, GRSA
Japanese Knotweed (*Polygonium cuspidatum*)	GLAC, GRKO, LIBI, GRSA
Leafy Spurge (*Euphorbia esula*)	GLAC, GRKO, LIBI, GRSA
Meadow Hawkweed complex (*Hieracium pratense, H. floribundum, H. piloselloides*)	GLAC, GRKO, LIBI, ROMO, GRSA
Orange Hawkweed (*Hieracium aurantiacum*)	GLAC, GRKO, LIBI, ROMO, GRSA
Ox-eye Daisy (*Chrysanthemum leucanthemum*)	GLAC, GRKO, LIBI, ROMO, GRSA
Purple Loosestrife (*Lythrum salicaria, L. virgatum*, and any hybrid crosses)	GLAC, GRKO, LIBI, GRSA
Quackgrass *(Elymus repens*)	ROMO, GRSA
Smooth Brome (*Bromus inermis)*	GRSA
St. Johnswort (*Hypericum perforatum*)	GLAC, GRKO, LIBI, ROMO, GRSA
Tall Buttercup (*Ranunculus acris*)	GLAC, GRKO, LIBI, GRSA
Tamarix (*Tamarix* ssp.)	GRSA
Tansy Ragwort (*Senecio jacobea*)	GLAC, GRKO, LIBI, ROMO, GRSA
Yellow Toadflax (*Linaria vulgaris*)	GLAC, GRKO, LIBI, ROMO, GRSA

[1]GLAC=Glacier National Park, GRKO=Grant-Kohrs Ranch National Historic Site, LIBI=Little Bighorn Battlefield National Monument, GRSA=Great Sand Dunes National Park, ROMO=Rocky Mountain National Park.

At each transect, examine the area within the 10 x 10 m riparian plots on either bank. Record the presence of any listed plant species. Figure 8-9 shows an example species ID sheet given to crews with color photographs and text descriptions of all target species. *Record only the presence of plant species which are targets in a given park, even though you may observe other invasive species*. These additional sightings can be recorded in the comments section of the form. If no listed species for your state are present within the plot, mark the "None" box on the form.

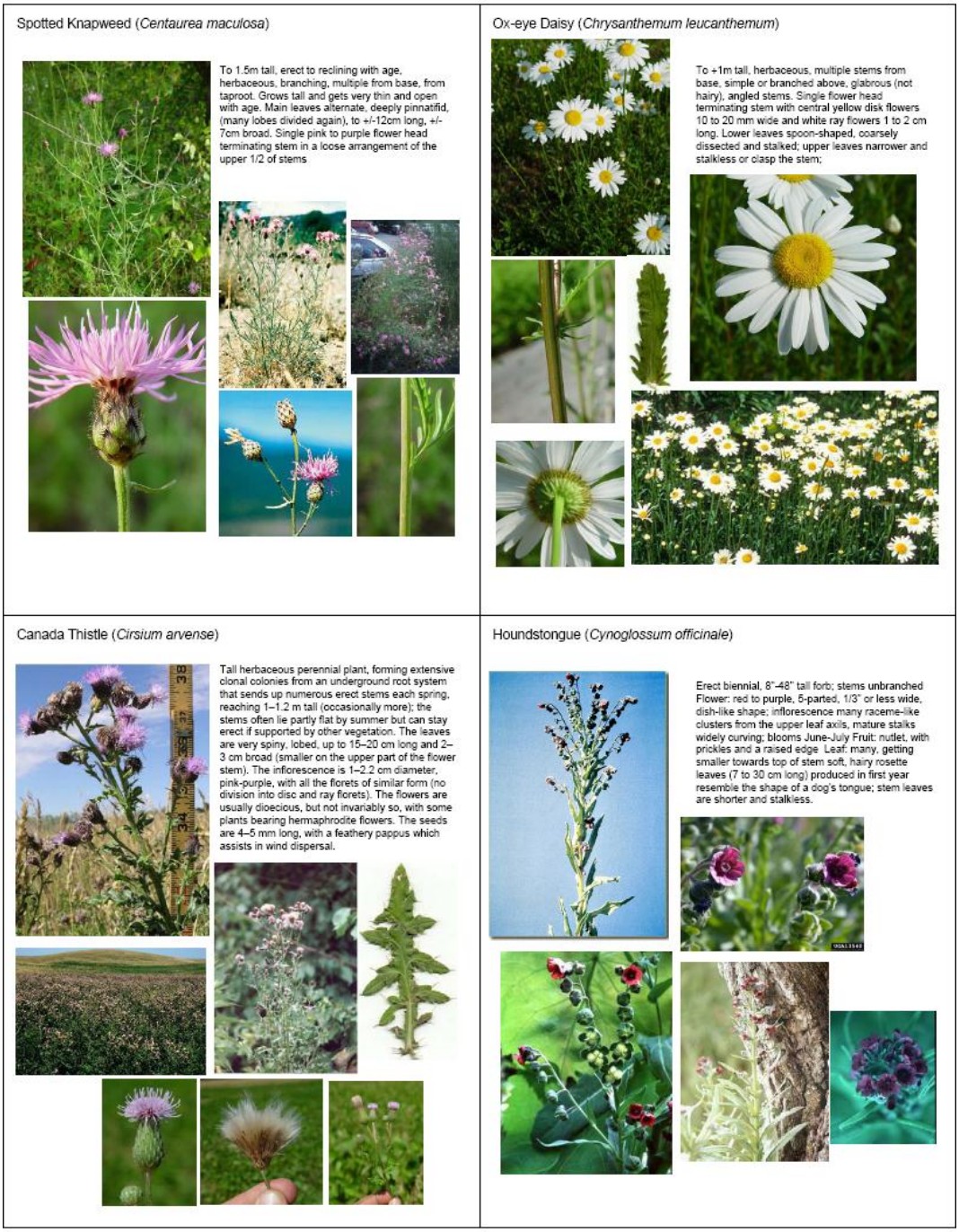


Figure 8-9. Example invasive taxa field guide from GLAC.

Thalweg Profile, Large Woody Debris Tally, and Slope/Bearing

After all measures are completed at one of the main cross-channel transects (A-K) and the associated riparian and in-channel cover plots, the crew begins to move up the channel, conducting a thalweg profile (note that some measures bundled with the cross-section transect may be done by the crew member recording data as the other crew conducts the following procedures). The thalweg profile is a longitudinal survey of maximum depth and several other selected characteristics at 100 or 150

equally spaced points along the centerline of the stream between the two ends of the stream reach. Operationally, it is partitioned into the 10 sections between the 11 main cross-section transects.

Methods also included in this section describe classifying and counting large woody debris between cross-section transects. Finally, a set of procedures that quantify the slope and sinuosity of the channel are detailed below.

Thalweg Profile

Thalweg refers to the flow path of the deepest water in a stream channel. Data from the thalweg profile allows calculation of indices of residual pool volume, stream size, channel complexity, and the relative proportions of habitat types, such as riffles and pools. The ROMN SEI habitat assessment modifies traditional methods by proceeding upstream in the middle of the channel, rather than along the thalweg itself (though each thalweg depth measurement is taken at the deepest point at each incremental position). One field person walks upstream (wearing studded-soled waders or other appropriate footwear) carrying a fiberglass telescoping (1.5 to 7.5 m) surveyor's rod and a 1-m metric ruler (or a calibrated rod or pole, such as a benthos net handle or a walking stick/pole). A second person on the bank or in the stream carries a clipboard with 11 copies of the field data form. Remember to record start and stop times. The stop time should be prior to the first method on the next upstream cross-channel transect SEI Form #5.

The procedure for obtaining thalweg profile measurements are presented below. Record data on SEI Form #6: Thalweg Profile and Woody Debris. Use the surveyor's rod and a metric ruler or calibrated rod or pole to make the required depth and width measurements and to measure the distance between measurement points as you proceed upstream. Ideally, every tenth thalweg measurement will bring you one increment spacing from the flag marking a new cross-section profile. The flag will have been set previously by carefully measuring along the channel, making the same bends that you do while measuring the thalweg profile; however, you may still need to make minor adjustments to align each 10th measurement to be one thalweg increment short of the cross section. In streams with average widths smaller than 2.5 m, make thalweg measurements at 1-meter increments. Because the minimum reach length is set at 150 m, there will be 15 measurements between each cross section. Use the 5 extra lines on the thalweg profile portion of the data form to record these measurements.

It is very important that thalweg depths are obtained from all measurement points. Missing depths at the ends of the sampling reach (e.g., due to the stream flowing into or out of a culvert or under a large pile of debris) can be tolerated, but those occurring in the middle of the sampling reach are more difficult to deal with. Flag these missing measurements using an F code and explain the reason for the missing measurements in the comments section of the field data form. At points where a direct depth measurement cannot be obtained, make your best estimate of the depth, record it on the field form, and flag the value using an F code, explaining that it is an estimated value in the comments section of the field data form. **Where the thalweg points are too deep for wading**, measure the depth by extending the surveyors rod at an angle to reach the thalweg point. Record the water level on the rod, and the rod angle, as determined using the external scale on the clinometer (vertical = 90°). In analyzing these data, we calculate the thalweg depth as the length of the rod under water multiplied by the trigonometric *sin* of the rod angle. For example, if 3 meters of the rod are

under water when the rod held at 30 degrees (*sin* = 0.5), the actual thalweg depth is 1.5 meters. These calculations are done after field forms are returned for data analysis. On the field form, crews are required only to record the wetted length of the rod under the water, an F code in the flag field, and a comment with the angle in degrees. If a direct measurement of the thalweg depth is not possible, make the best estimate you can of the depth, record it, and use a flag and comments to note it is an estimated value.

At every thalweg measurement increment, determine by sight or feel whether deposits of soft/small sediment are present on the channel bottom. These particles are defined as substrate equal to or smaller than fine gravel (< 16 mm diameter). These **soft/small sediments are NOT the same as fines described when determining the substrate particle sizes at the cross-section transects**. For the thalweg profile, determine if soft/small sediment deposits are readily obvious by feeling the bottom with your boot, the surveyor's rod, or the calibrated rod or pole. (Note that **a very thin coating of silt or algae on a cobble bottom substrate does not qualify as soft/small sediment**.

Wetted width is measured at each transect ("station 0" within the Cross Section/Riparian set of Procedures), and midway between transects (station 5 and station 7) within the Thalweg Profile set of procedures. The wetted width boundary is the point at which substrate particles are no longer surrounded by free water. Substrate size is estimated for 5 particles evenly spaced across each midway cross-section using procedures identical to those described for substrate at regular cross-sections, but at the supplemental cross sections, only the size class (not the distance and depth) data are recorded in spaces provided on the Thalweg Profile side of the field form.

While recording the width and depth measurements and the presence of soft/small sediments, the second person chooses and records the habitat class and the pool forming element codes applicable to each of the 100 (or 150) measurement points along the length of the reach. These channel-unit habitat classifications and pool-forming elements are modified from those of Bisson et al. (1982) and Frissell et al. (1986). The resulting database of traditional visual habitat classifications will provide a bridge of common understanding with other studies. Channel-unit scale habitat classifications are to be made at the thalweg of the cross section. The habitat unit itself must meet a minimum size criteria. **Before being considered large enough to be identified as a channel-unit scale habitat feature, the unit should be at least as long as the channel is wide.** For instance, if there is a small, deep, pool-like area at the thalweg within a large riffle area, don't record it as a pool unless it occupies an area about as wide or long as the channel is wide. If a backwater pool dominates the channel, record PB as the dominant habitat unit class. If the backwater is a pool that does not dominate the main channel, or if it is an off-channel alcove or slough, circle Y to indicate presence of a backwater in the Backwater column of the field form, but classify the main channel habitat unit type according to characteristics of the main channel.

Mid-channel bars, islands, and side channels pose some problems for the sampler conducting a thalweg profile and necessitate some guidance. Bars are defined here as mid-channel features **below the bankfull flow** mark that are dry during base flow conditions. Islands are mid-channel features that are dry even when the stream is experiencing a bankfull flow. Both bars and islands cause the stream to split into side channels. When a mid-channel bar is encountered along the thalweg profile,

it is noted on the field form and the active channel is considered to include the bar. Therefore, the wetted width is measured as the distance between wetted left and right banks. It is measured across and over mid-channel bars and boulders. If mid-channel bars are present, record the bar width in the space provided.

If a mid-channel feature is as high as the surrounding flood plain, it is considered an island. Treat side channels resulting from islands different from mid-channel bars. Handle the ensuing side channel based on visual estimates of the percent of total flow within the side channel as follows:

- **Less than 15%:** Indicate the presence of a side channel on the field data form.
- **16 to 49%:** Indicate the presence of a side channel on the field data form. Establish a secondary transect across the side channel designated as X plus the primary transect letter; (e.g., XA), by checking boxes for both X and the appropriate transect letter (e.g., A through K) on a separate copy of the field data form. Complete the detailed channel and riparian cross section measurements for the side channel on this form.

When a side channel occurs due to an island, reflect its presence with continuous entries on Form #6. In addition, note the points of divergence and confluence of the side channel in the comments section of the thalweg profile form. Begin entries at the point where the side channel converges with the main channel; note the side channel presence continuously until the upstream point where it diverges. When doing width measures with a side channel separated by an island, include only the width of the main channel in the measures at the time and then measure the side channel width separately.

For streams with interrupted flow, where no water is in the channel at a thalweg station, record zeros for depth and wetted width. Record the habitat type as dry channel (DR).

Large Woody Debris

This component of the ROMN SEI physical habitat characterization allows quantitative estimates of the number, size, total volume and distribution of wood within the stream reach. LWD is defined here as woody material with a small-end diameter of at least 10 cm (4 in) and a length of at least 1.5 m (5 ft). Methods for large woody debris (LWD) measurements are a simplified adaptation of those described by Robison and Beschta (1990). These methods are further modified with select components from Heitke et al. (2006).

The procedure for tallying LWD is presented below. Record data on SEI Form #6: The tally includes all pieces of LWD that are at least partially in the base flow channel, the “active channel” (flood channel up to bankfull stage), or spanning above the active channel. The active bankfull channel is defined as the channel that is filled by moderate-sized flood events that typically recur every one to two years. LWD in the active channel is tallied over the entire length of the reach, including the area between the channel cross-section transects. SEI Form #6 has a section for tallying with hash marks then a box for entry of the sum for a section by size class and position within the channel. Pieces of LWD that are not at least partially within Zones 1, 2, or 3 are not tallied.

Include LWD from island side channels with 16-49% of the flow in the tally for a section. LWD in side channels with <15% are not counted.

For each LWD piece, first visually estimate its length and its large and small end diameters in order to place it in one of the diameter and length categories. The diameter class on the field form refers to the large-end diameter. Sometimes LWD is not cylindrical, so it has no clear "diameter." In these cases, visually estimate what the diameter would be for a piece of wood with circular cross section that would have the same volume. When evaluating length, include only the part of the LWD piece that has a diameter greater than 10 cm (4 in). Count each of the LWD pieces as one tally entry and include the whole piece when assessing dimensions, even if part of it is in Zone 4 (outside of the bankfull channel). For both the Zone 1-2 wood and the Zone 3 LWD, the field form provides 12 entry boxes for tallying debris pieces visually estimated within three length and four diameter class combinations. **Each LWD piece is tallied in only one box**. There are 12 size classes for wood at least partially in Zones 1 and 2, and 12 for wood partially within Zone 3. Wood that is not at least partially within those zones is not tallied.

Slope and Bearing

The slope, or gradient, of the stream reach is useful in three different ways. First, the overall stream gradient is one of the major stream classification variables, giving an indication of potential water velocities and stream power, which are in turn important controls on aquatic habitat and sediment transport within the reach. Second, the spatial variability of stream gradient is a measure of habitat complexity, as reflected in the diversity of water velocities and sediment sizes within the stream reach. Lastly, using methods described by Stack (1989) and Robison and Kaufmann (1994), the water surface slope, in conjunction with the multiple depth and width measurements taken in the thalweg profile, is used to compute residual pool depths, volumes, and numbers. Compass bearing between cross-section transects, along with the distance between transects, is used to estimate the sinuosity of the channel (ratio of the length of the reach divided by the straight line distance between the two reach ends).

Follow the procedure for obtaining slope and bearing measurements. Record slope and bearing data on SEI Form #7: Slope and Bearing. Slope and bearing measurements are done after the last thalweg station and before the next cross-channel transect. Measure slope and bearing by "backsighting" downstream between transects (e.g., transect B to A, C to B, etc.). The required time for slope and bearing is *only done for two intervals* (largely because of the single form used for this and limited space on it). Note the interval times and attempt to select representative sections from the whole reach. Slope is typically measured by two people, each having a pole that is marked at the same height. Alternatively (but less precise), one person can be flagged at the eye level of the person doing the backsighting. Be sure that the mark is made on the other person or on the pole while standing on level ground. Site to this eye level when backsighting from one crew member to the other. Particularly in streams with slopes less than 3%, we recommend that field crews use poles marked at exactly the same height for sighting slope. When two poles are used, sight from the mark on one pole to the mark on the other. Also, be sure that the second person is standing (or holding the marked pole) at the water's edge or in the same depth of water as the crew member doing the backsighting.

The intent is to get a measure of the water surface slope, which may not necessarily be the same as the bottom slope.

The clinometer reads both percent slope and degrees of the slope angle; be careful to read and record percent slope. Percent slope is the scale on the right-hand side when looking through most clinometers. If using an Abney Level, ensure that the scale marked PERCENT is the one being read. With the clinometer or the Abney level, verify this by comparing the two scales. Percent slope is always a higher number than degrees of slope angle (e.g., 100% slope = 45° angle). For slopes > 2%, read the clinometer to the nearest 0.5%. For slopes < 2%, read to the nearest 0.25%. If the clinometer reading is 0%, but water is moving, record the slope as 0.1%. If the clinometer reading is 0% and water is not moving, record the slope as 0%.

For bearing measurements, the compass is NOT adjusted for magnetic declination. Also, guard against recording "reciprocal" bearings (erroneous bearings 180 degrees from what they should be). The best way to do this is to know where the primary (cardinal) directions are in the field: (north [0 degrees], east [90 degrees], south [180 degrees], and west [270 degrees]), and ensure that recorded bearings make sense.

As stated earlier, it may be necessary to set up intermediate (supplementary slope and bearing points) between a pair of cross-section transects if there is no direct line-of-sight along (and within) the channel between stations. This can happen if brush is too heavy or if there are sharp slope breaks or tight meander bends. If a sighting would occur across land to measure slope or bearing between two transects, then supplementary measurements are needed (i.e., do not short-circuit a meander bend). Mark these intermediate station locations with a different color of plastic flagging than used for the cross-section transects to avoid confusion. Record these supplemental slope and bearing measurements, along with the proportion of the stream segment between transects included in each supplemental measurement, in the appropriate sections of the Slope and Bearing Form. Note that the main slope and bearing observations are always downstream of supplemental observations. Similarly, first supplemental observations are always downstream of second supplemental observations (e.g., work upstream from the downstream transect).

Torrents/Recent Floods and Channel Constraint - Wadeable

Debris Torrents and Recent Major Floods

Major floods are those that substantially overtop the banks of streams and occur with an average frequency of less than once every five years. Major floods may scour away or damage riparian vegetation on banks and gravel bars that are not frequently inundated. They typically cause movement of large woody debris, transport of bedload sediment, and changes in the streambed and banks through scouring and deposition. While they may kill aquatic organisms and temporarily suppress their populations, floods are an important natural resetting mechanism that maintains habitat volume, clean substrates, and riparian productivity.

Debris torrents, or lahars, differ from conventional floods in that they are flood waves of higher magnitude and shorter duration, and their flow consists of a dense mixture of water and debris. Their high flows of dense material exert tremendous scouring forces on streambeds. In temperate regions,

debris torrents occur primarily in steep drainages and are relatively infrequent, occurring typically less than once in several centuries. They are usually set into motion by the sudden release of large volumes of water upon the breaching of a natural or human-constructed impoundment, a process often initiated by mass hillslope failures (landslides) during high-intensity rainfall or snowmelt. Debris torrents course downstream until the slope of the stream channel can no longer keep their viscous sediment suspension in motion (typically < 3% for small streams); at this point they set up, depositing large amounts of sediment, boulders, logs, and whatever else they were transporting (Figure 8-10). Upstream, the torrent track is severely scoured, often reduced in channel complexity and devoid of near-bank riparian vegetation. As with floods, the massive disruption of the stream channel and its biota are transient, and these intense, infrequent events will often lead to a high-quality complex habitat within years or decades, as long as natural delivery of large wood and sediment from riparian and upland areas remains intact.



Figure 8-10. Stream in Glacier National Park with evidence of a recent torrent.

In arid areas with high runoff potential, debris torrents can occur in conjunction with flash flooding from extremely high-intensity rainfall. They may be nearly annual events in some steep ephemeral channels where drainage area is sufficient to guarantee isolated thunderstorms somewhere within

their boundaries, but small enough that the effect of such storms is not dampened out by the portion of the watershed not receiving rainfall during a given storm.

Because they may alter habitat and biota substantially, infrequent major floods and torrents can confuse the interpretation of measurements of stream biota and habitat in regional surveys and monitoring programs. Therefore, it is important to determine if a debris torrent or major flood has occurred within the recent past. After completing the complete suite of physical habitat measures at a site, examine the stream channel along the entire sample reach, including its substrate, banks, and riparian corridor, checking the presence of features described on the Torrent Evidence Assessment section of SEI Form #8. It may be advantageous to look at the channel upstream and downstream of the actual sample reach to look for areas of torrent scour and massive deposition to answer some of the questions on the field form. For example, you may more clearly recognize the sample reach as a torrent deposition area if you find extensive channel scouring upstream. Conversely, you may more clearly recognize the sample reach as a torrent scour reach if you see massive deposits of sediment, logs, and other debris downstream.

Channel Constraint

Whether natural or the result of human activities, the presence of immovable or difficult-to-move river margins constrains the degree to which the stream can form its own channel and banks through scour and deposition. The degree of channel constraint can strongly influence the quantity and quality of habitat for aquatic organisms. Constraint also influences the type and degree of stream channel adjustment to anthropogenic alterations in flow and sediment supply, or to direct channel manipulations (e.g., dredging, revetments, impoundment). Rivers patterns (fluvial styles) have been classified in the classical paper by Leopold et al (1964) as braided, meandering, and straight. This classification is essentially based on the shape of the river channel, as it appears on aerial photographs. Later, Smith (1983) added anastomosed rivers as a distinct fluvial style.

After completing the complete suite of physical habitat measures at a site, envision the stream at bankfull flow and evaluate the degree, extent and type of channel constraint. Data are recorded on the Channel Constraint section of Form #8. Note that these activities are not timed.

First, classify the stream reach channel pattern as predominantly a **single** channel, an **anastomosing** channel, or a **braided** channel (Figure 8-11):

- **Anastomosing** channels have relatively long major and minor channels branching and rejoining in a complex network.
- **Braided** channels also have multiple branching and rejoining channels, but these sub-channels are generally smaller, shorter, and more numerous, often with no obvious dominant channel.

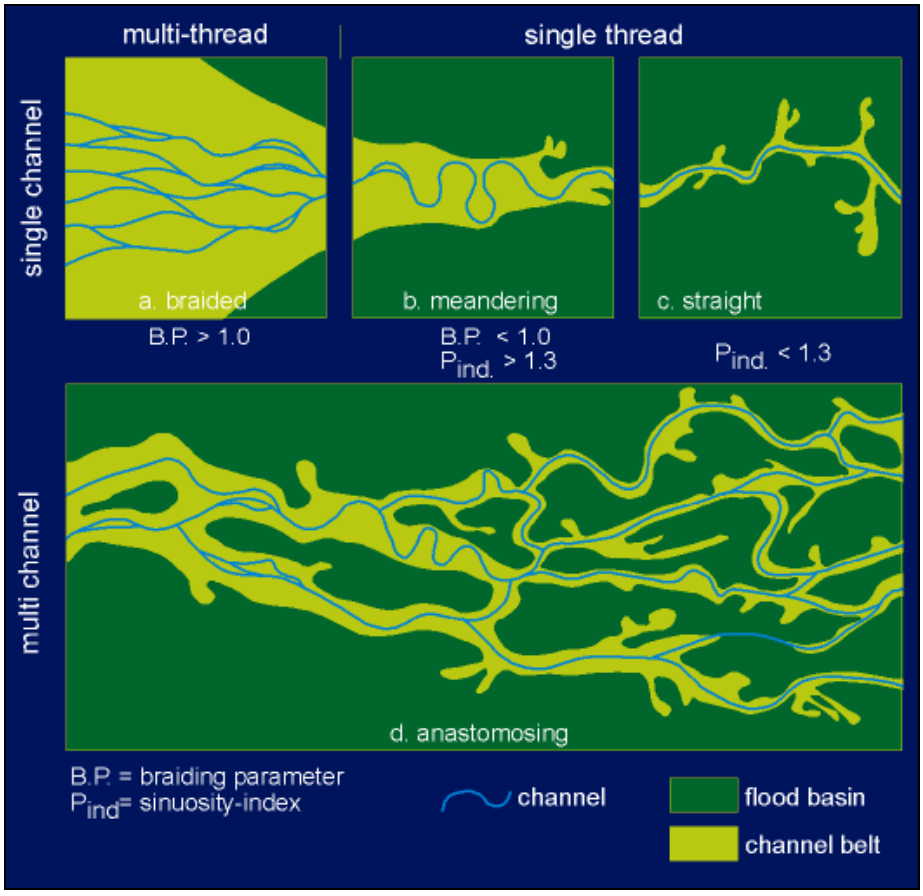


Figure 8-11. Classification of fluvial styles by Makaske (2001). Anastomosing channel patterns may consist of individual channels that can be braided, meandering, or straight. S = length of channel axis/length of meander belt axis. BP = braiding parameter.

After classifying the channel pattern, determine whether the channel is constrained within a narrow valley, constrained by local features within a broad valley, unconstrained and free to move about within a broad floodplain, or free to move about, but within a relatively narrow valley floor. Then examine the channel to ascertain the bank and valley features that constrain the stream. Entry choices for the type of constraining features are bedrock, hillslopes, terraces/alluvial fans, and human land use (e.g., a road, a dike, landfill, rip-rap, etc.). Estimate the percent of the channel margin in contact with constraining features (for unconstrained channels, this is 0%). To aid in this estimate, you may wish to refer to the individual transect assessments of incision and constraint. Finally, estimate the typical bankfull channel width and visually estimate the average width of the valley floor. If you cannot directly estimate the valley width (e.g., it is further than you can see, or if your view is blocked by vegetation), record the distance you can see and mark the appropriate box on the field form.

Non-wadeable

The SEI protocol for wadeable and non-wadeable stream types overlap in both conceptual background and in many methods. We limit the following text to major differences in the two sets of methods.

Overview of Work Flow

As with wadeable streams, physical habitat measures in non-wadeable systems tend to control the overall workflow of a sample event. The primary differences from smaller streams are (1) collection of most measures from a boat, (2) movement downstream from the *de facto* X site, (3) (ideally) the use of pre-assigned (in a GIS and on the crews GPS) locations for the top and bottom of the reach and shoreline plots, and (4) the speed and immediacy at which the measures sometimes must happen given the whims of rafting in high-flow and complex channel structures. The following summarizes the major steps of the work flow (also see Figure 8-12).

Safety is a special concern in non-wadeable streams and will always be the first consideration when working at put-in and take-out, shoreline locations, cross sections, etc. All crew must wear PFDs and boat operators must be experienced. Equipping the boat with a bow or stern anchor to stop at transect locations can greatly ease the shore marking operation and shoreline measurement activities, though such equipment can be dangerous in white-water rivers.

After put-in, the crew will raft downstream to transect A or the *de facto* X site. They will come to shore at the closest point to the pre-chosen shoreline plot. Next they will measure, average, and confirm the (GIS-assigned) wetted width and channel layout. If the field values are meaningfully different (> 10-20%) from the *a priori* ones, the reach layout should be redone (losing the use of the GPS coordinates). Record the actual GPS location of the shoreline plot.

After constructing monument(s), taking site photos, and conducting the biological measures in the shoreline plot, crews measure channel wetted width, bankfull channel dimensions, incision, GPS lat/long, and then assess near-shore, shoreline, and riparian physical habitat characteristics by measuring or observing littoral depths, riparian canopy cover, substrate, large woody debris, fish cover, bank characteristics, riparian vegetation structure, non-native riparian and aquatic species, and evidence of human activities. The crew then confirms the next downstream shoreline plot and "eyeballs" its location (or uses the rangefinder) if it is visible. Next, because the *de facto* X site also defines the transect where water chemistry measures are done, any near-shore grab and *in situ* water chemistry sampling is conducted during the littoral "loop" where habitat is quantified.

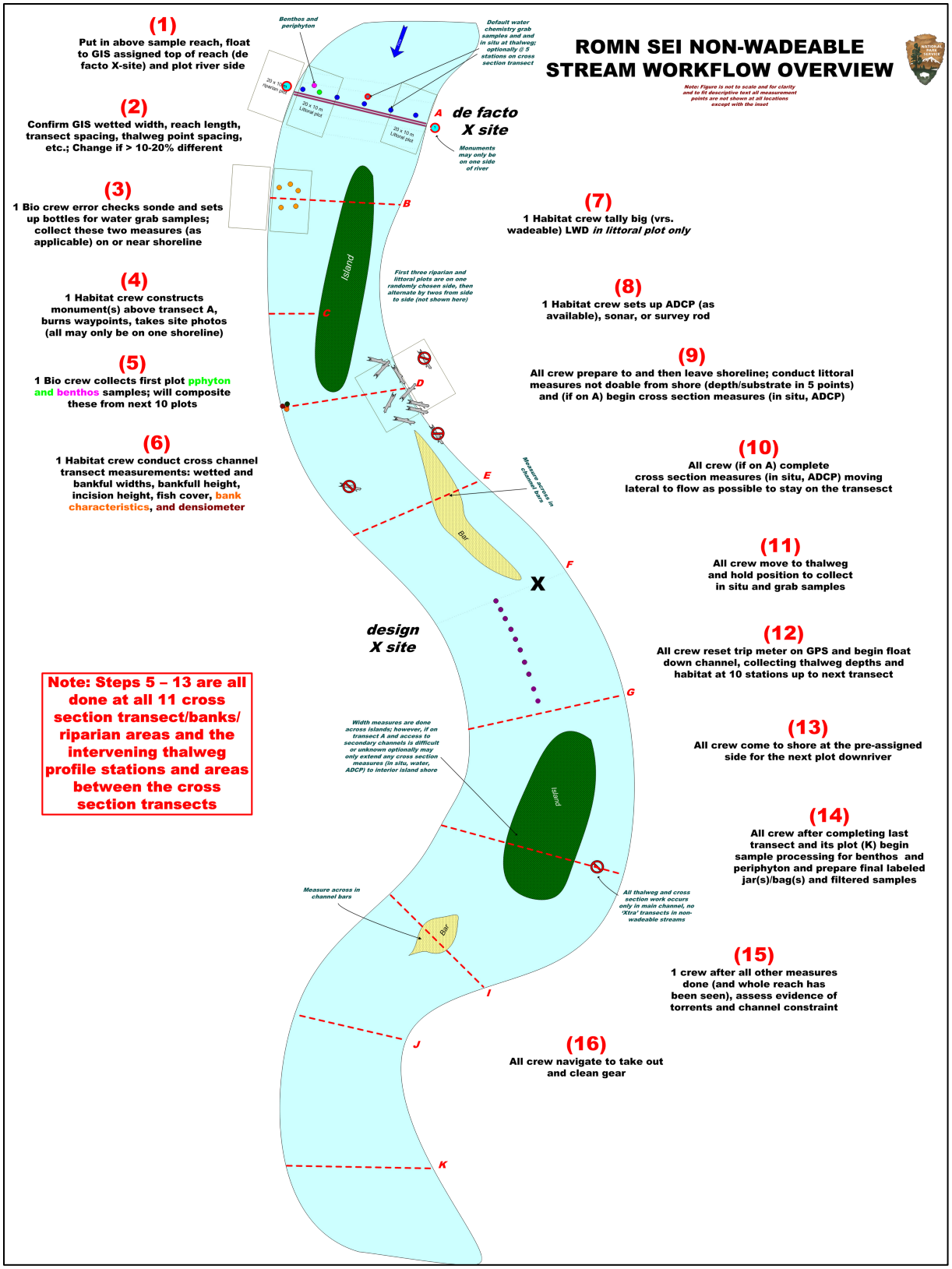


Figure 8-12. Generalized diagram of ROMN SEI sample locations within a “normal” non-wadeable reach. Not all replicates of all sample locations are shown and the figure is not to scale.

Once in the thalweg, in a single midstream float, the crew accomplishes a reconnaissance, a sonar/pole depth profile, and a pole-drag to tally snags and characterize mid-channel substrate moving down channel until the next shoreline plot (located using the pre-assigned GPS locations and the laser rangefinder). The mid-channel float to the new transect location collects thalweg profile measurements and observations at 10 evenly spaced increments along the way. **If a GPS unit also has course tracking, trip-meter (accumulated distance and bearing), and waypoint setting/navigation features,** we recommend using it to locate thalweg measurement points (use course tracking and trip meter). Each shoreline plot is located 4 channel-width's distance from the preceding transect immediately upstream.

When they reach the new downstream shoreline plot location, they stop to do cross-section, littoral, and riparian measurements, recording the actual GPS latitude/longitude of the transect position. In addition, while they are stopped at a cross-section station, the crew can fill out the habitat "typing" entries retrospectively and prospectively for the portion of the stream distance that is visible upstream and downstream. They will also collect biological samples. These steps are repeated until the bottom of the reach is reached.

After completing all observations and measurements along the thalweg and at all 11 transects, the field crew completes the overall reach assessments of channel constraint and evidence of debris torrents and major floods. Final activities include cleaning up and preparing gear for the float to the take out site.

Habitat Sampling Locations within the Reach

Measurements are made at two scales of resolution along the mid-channel length of the reach; the results are later aggregated and expressed for the entire reach, a third level of resolution. SEI SOP 4: Verification of Site Status and Sample Reach Layout describes the procedures for locating the X site(s), and the starting point of the sample reach. These sampling locations are marked on the maps provided to the field crews in the site dossiers prior to sampling or generated as part of site verification. SEI SOP 4: Verification of Site Status and Sample Reach Layout also describes the protocol for delineating a sample reach that is 40x its width. Those sections also describe the protocol for measuring out (with a laser range finder or GIS software) and locating the 11 littoral/riparian stations where many habitat measurements will be made. The distance between each of these transects is $1/10^{th}$ the total length of the sample reach. The plots at each transect measure 20 m along the length of the channel and 10 m into the riparian area above bankfull and 10 m into the channel itself. *If there is a large area between the wetted width and bankfull these two 20 x 10 m plots will be separated in space. Finally, because some bank measures are done on both sides of the river, the riparian plot is represented on both sides of the channel* (see Figure 8-13).

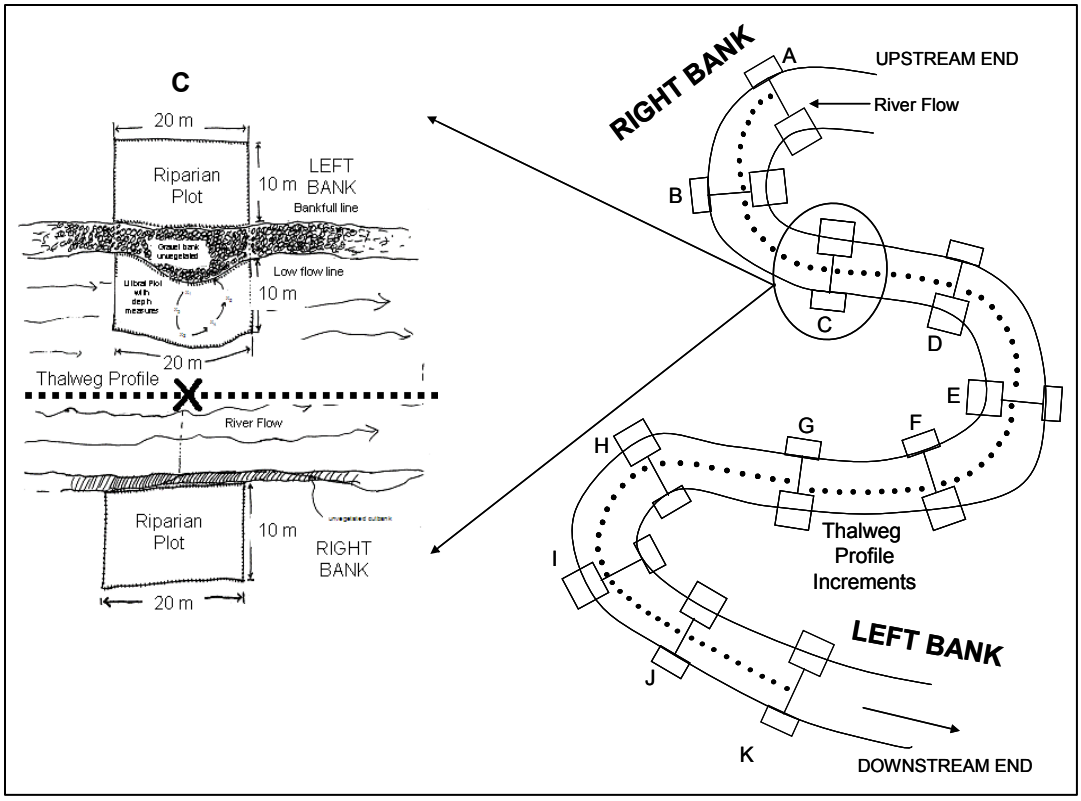


Figure 8-13. Generalized reach layout and sample locations within a non-wadeable reach (adapted from Lazorchak et al. 2000).

The thalweg profile measurements are spaced as evenly as practicable over the entire sample reach length. **Only the main channel is sampled.** In addition, they must be sufficiently close together to not miss deep areas and important habitat units. To set the interval between thalweg profile measurements, measure the wetted channel width with a laser rangefinder at 5 locations near the *de facto* X site and multiply the average width by 40 to set the river sample reach length. Then divide that reach length by 100 to set the thalweg increment distance. Following these guidelines, you will be making 100 evenly spaced thalweg profile measurements, 10 between each detailed channel cross section where littoral/riparian observations are made.

Channel and Riparian Measurements at Cross-Section Transects and Shoreline/Littoral Plots

Channel Margin Depth and Substrate

Channel margin depths are measured along the designated shoreline at each transect within the 10x20 m littoral plot that is centered on the transect. Depths may be collected by a survey rod, sonar, or ADCP. Dominant and sub-dominant bottom substrates are determined and recorded at 5 systematically spaced locations that are located by eye within the 10 x 20 m plot. The procedure for obtaining channel margin depth and substrate measurements is described in more detail below. Record these measurements on the Channel/Riparian Transect Form. Identify the dominant and subdominant substrate present along a shoreline swath 20 m long and 1 m back from the waterline. The substrate size class choices are as shown in Table 8-4.

Table 8-4. Substrate particle size classes – wadeable.

Code	Size Class	Size Range (mm)	Description
RS	Bedrock (Smooth)	> 4000	Smooth surface rock bigger than a car
RR	Bedrock (Rough)	>4000	Rough surface rock bigger than a car
HP	Hardpan	>4000	Firm, consolidated fine substrate
LB	Boulders (large)	>1000 to 4000	Yard/meter stick to car size
SB	Boulders (small)	>250 to 1000	Basketball to yard/meter stick size
CB	Cobbles	>64 to 250	Tennis ball to basketball size
GC	Gravel (Coarse)	>16 to 64	Marble to tennis ball size
GF	Gravel (Fine)	>2 to 16	Ladybug to marble size
SA	Sand	>0.06 to 2	Smaller than ladybug size, but visible as particles—gritty between fingers
FN	Fines	<0.06	Silt Clay Muck (not gritty between fingers)
WD	Wood	Regardless of Size	Wood and other organic particles
RC	Concrete	Regardless of size	Record size class in comment field
OT	Other	Regardless of Size	Metal, tires, car bodies etc. (describe in comments)

Large Woody Debris

Large Woody Debris (LWD) is defined as woody material with small end diameter of ≥ 30 cm (1 ft) and length of ≥ 5 m (15 ft). **These size criteria are larger than those used in wadeable streams** because of the lesser role that small wood plays in controlling velocity and morphology of larger rivers. The procedure for tallying LWD is presented below. For each tally of Wood All/Part in Wetted Channel and Dry, but All/Part in Bankfull Channel, the field form provides 12 entry boxes for tallying debris pieces visually estimated within three length and four diameter class combinations. Tally each LWD piece in only one box. Do not tally woody debris in the area between channel cross-sections, but the presence and location of large debris dams and accumulations should be mapped (sketched) and noted in the thalweg profile comments.

For each LWD piece, first visually estimate its length and its large and small end diameters and place it in one of the diameter and length categories. The diameter classes on the field form refer to the large-end diameter. Sometimes LWD is not cylindrical, so it has no clear "diameter;" in these cases visually estimate what the diameter would be for a piece of wood with circular cross section that would have the same volume. When evaluating length, include only the part of the LWD piece that has a diameter > 0.3m (1 ft). Count each of the LWD pieces as one tally entry and include the whole piece when assessing dimensions, even if part of it is outside of the bankfull channel. If you encounter massive, complex debris jams, estimate their length, width, and height. Also estimate the diameter and length of large "key" pieces and judge the average diameter and length of the other pieces making up the jam. Record this information in the comments section of the form.

Bank Angle and Channel Cross-Section Morphology

Bank angles of undercut, vertical, steep, and gradual are visually estimated as defined on the field form. Observations are made from the wetted channel margin up 5 m (a canoe's length) into the bankfull channel margin on the previously chosen side of the stream.

You will measure or estimate the wetted width, mid-channel bar width, bankfull height and width, the amount of incision, and the degree of channel constraint. These are assessed for the whole channel (left and right banks) at each of the 11 cross-section transects. Record each on the Channel/Riparian Transect Form.

Wetted width is the width of the channel containing free-standing water; if > 15 m, it can be measured with a laser rangefinder. Mid-channel bar width, the width of exposed mid-channel gravel or sand bars, is included within the wetted width, but is also recorded separately. In channel cross-section measurements, the wetted and bankfull channel boundaries include mid-channel bars. Therefore, the wetted width is measured as the distance between wetted left and right banks. Measure across and over mid-channel bars and boulders. If islands are present, treat them like bars, but flag these measurements and indicate in the comments that the "bar" is an island. If you are unable to see across the full width of the river when an island separates a side channel from the main channel, record the width of the main channel, flag the observation, and note in the comments section that the width pertains only to the main channel.

Canopy Cover (Densiometer)

Measure vegetative cover over the reach at the chosen bank at each of the 11 transects (A-K) with a Convex Spherical Densiometer. Four measurements are obtained at each cross-section transect (upriver, downriver, left, and right).

Riparian Vegetation Structure

Riparian vegetation observations apply to the riparian area upstream 10 m and downstream 10 m from each of the 11 transects. They include the visible area from the river bankfull margin back a distance of 10 m (30 ft) shoreward from both the left and right banks, creating a 10x20 m riparian plot on each side of the river. The riparian plot dimensions are estimated, not measured.

Fish Cover, Algae, and Aquatic Macrophytes

Crews will estimate the areal cover of all of fish cover and other listed features that are in the water and on the banks within a 10 x 20 m plot.

Human Influences

For the left and right banks at each of the 11 detailed Channel/Riparian Cross Sections, evaluate the presence/absence and the proximity of 11 categories of human influences outlined below. Record human influences on the Channel/Riparian Transect Form. You may mark "P" more than once for the same human influence observed outside of more than one riparian observation plot (e.g., at both Transect D and E). **The rule is that you count human disturbance items as often as you see them, BUT NOT IF you have to sight through a previously counted transect or it's 10 x 20 m riparian plot.**

Riparian Invasive Alien Species

At each littoral-riparian station (A-K) search in the 10 x 20 m riparian and littoral plots on both banks for the presence of any invasive for a ROMN park. If the river is too wide to effectively observe the far bank at a transect, record what you observe for the plot on the near bank, record a flag, and explain in the comments section of the form.

Thalweg Profile, Large Woody Debris Tally, and Slope/Bearing

Thalweg Profile

"Thalweg" refers to the flow path of the deepest water in a river channel. The thalweg profile is a longitudinal survey of maximum depth and several other selected characteristics at 100 near-equally spaced points along the centerline of the river between the two ends of the river reach. For practical reasons, field crews will approximate a thalweg profile by sounding along the river course that they judge is deepest, but also safely navigable. **Locations for observations and measurements along the path of this profile are determined using the GPS course-tracking and trip-meter features (recommended)**, or by visually estimating distances based upon the river width.

Thalweg Depth Profile

A thalweg depth profile of the entire 40 channel-width reach is approximated by a sonar, ADCP, or sounding rod depth profile while floating downstream along the deepest part of the channel (or closest navigable path). In the absence of a ADCP or recording fathometer (sonar depth sounder with strip-chart output or electronic data recorder), the crew records depths at frequent, relatively evenly spaced downstream intervals while optionally observing a sonar display and holding a surveyor's rod off the side of the boat. The sonar screen is mounted so that the crewmember can read depths on the sonar and the rod at the same time. The sonar sensor may need to be mounted at the opposite end of the boat to avoid mistaking the rod's echo for the bottom, though using a narrow beam (16 degree) sonar transducer minimizes this problem. It is easy to hold the sounding rod vertically if you are going at the same speed as the water.

Pole Drag for Snags and Substrate Characteristics

While floating downstream, one crew member holds a calibrated PVC sounding rod or surveying rod down vertically from the gunwale of the boat, dragging it lightly on the bottom to simultaneously "feel" the substrate, detect snags, and measure depth with the aid of sonar. The crew member shall record the dominant substrate type sensed by dragging the rod along the bottom (bedrock/hardpan, boulder, cobble, gravel, sand, silt, and finer) on the Thalweg Profile Form. Substrate characteristics are recorded at every thalweg depth measurement (e.g., 10 determinations between transects A and B). In shallow, fast-water situations, where pole-dragging might be hazardous, crews will estimate bottom conditions the best they can visually and by using paddles and oars. If unavoidable, suspend measurements until out of whitewater situations, but make notes and appropriately flag observations concerning best judgments of depth and substrate.

Channel Habitat Classification

Classify and record channel habitat types at a spatial resolution of about 0.5 channel-widths and check presence of off-channel and backwater habitat at every 0.4 channel-width increment.

Designate side channels, backwaters and other off-channel areas independent of the main-channel habitat type. **Main channel habitat units are at least half as long as the channel is wide** (e.g., if there is a small, deep, pool-like area at the thalweg within a large riffle area, don't record it as a pool unless it occupies an area about half as wide or long as the channel is wide).

Mid-channel bars, islands, and side channels within a thalweg profile require some guidance. Mid-channel bars are defined as channel features below the bankfull flow level that are dry during base flow conditions. Islands are channel features that are dry even when the river is at bankfull flow. If a mid-channel feature is as high as the surrounding flood plain, it is considered an island. Both mid-channel bars and islands cause the river to split into side channels. If a bar or island is encountered along the thalweg profile, navigate and survey the channel that carries the most flow.

When side channels are present, on the Thalweg Profile form check the Off-Channel column. These checkmarks will begin at the point of divergence from the main channel, continuing downstream to the point of convergence with the main channel. In the case of a slough or alcove, the "off-channel" checkmarks should continue from the point of divergence downstream to where the off-channel feature is no longer evident. When major side-channels occur, flag the "Off-Channel" checkmarks and indicate in the comments section that the feature is a side channel. For dry and intermittent rivers, record zeros for depth and wetted width in places where no water is in the channel. Record habitat type as dry channel (DR).

Torrents/Recent Floods and Channel Constraint

Channel Constraint Assessment

After completing the thalweg profile and littoral-riparian measurements and observations, envision the stream at bankfull flow and evaluate the degree, extent and type of channel constraint. Use SEI Form #8 (same as wadeable streams). Estimate the percent of the channel margin in contact with constraining features (for unconstrained channels, this is 0%). To aid in this estimate, you may wish to refer to the individual transect assessments of incision and constraint. Finally, estimate the "typical" bankfull channel width and visually estimate the average width of the valley floor (valley floor width can often be determined from 1:24,000-scale topographic maps).

Debris Torrents and Recent Major Floods

After completing the thalweg profile and channel/riparian measurements and observations, examine the stream channel along the entire sample reach including its substrate, banks, and riparian corridor, checking the presence of features described on SEI Form #8 (same as wadeable streams). It may be advantageous to look at the channel upstream and downstream of the actual sample reach to look for areas of torrent scour and massive deposition to answer some of the questions on the field form. For example, you may more clearly recognize the sample reach as a torrent deposition area if you find extensive channel scouring upstream. Conversely, you may more clearly recognize the sample reach as a torrent scour reach if you see massive deposits of sediment, logs, and other debris downstream.

Field Equipment for Physical Habitat Measurement

Table 8-5. a complete checklist of items needed for the physical habitat methods.

Item	Quantity
SEI Protocol Document and/or laminated sheets of SOPs	1
Form #5: Channel/Riparian Cross Section	11 copies
Form #6: Thalweg Profile and Woody Debris	10 copies
Form #7: Slope and Bearing	1 copy
Form # 8 Constraint/Torrent	1 copy
Soft lead (#2) pencils	Many
Surveyors telescoping leveling rod (round profile, metric scale, 7.5m extended) – big streams	1
Surveyors telescoping leveling rod (round profile, metric scale, 2.4m extended) – smaller streams	1
Sonar unit	1
ADCP and accessories (as available)	1
50-m fiberglass measuring tape & reel	1
30-m fiberglass measuring tape & reel	1
Clinometer (or Abney level) with percent and degree scales.	2
Meter stick. Alternatively, a short (1-2 m) rod or pole (e.g., a ski pole) with cm markings for thalweg measurements, or the PVC pipe described for slope determinations can be marked in cm and used.	2
Colored surveyors plastic flagging (2 colors) or flags	2
Convex spherical canopy densiometer (Lemmon Model A), modified with taped “V”	2
Bearing compass (backpacking type)	2
Fisherman’s vest with lots of pockets and snap fittings. Used at least by person conducting the in-channel measurements to hold the various measurement equipment (densiometer, clinometer, compass, etc.). Useful for both team members involved with physical habitat characterization.	2
Covered clipboard (lightweight, with strap or lanyard to hang around your neck)	1
Safety gear	-
Personal gear	-

Physical Habitat Procedure: Cross-Channel Transect, Substrate Size, Embeddedness, and Channel Dimensions (SEI FORM #5)

1) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5.
2) Record the start time before any activities occur on the transect. This should be done at every transect (A-K). Because some channel or riparian activities are not really on the transect *per se* and co-occur with the thalweg profile, there will be overlap in time stamps with the thalweg activities. The stop time will be with the last data collected on the current instance of SEI Form #5. Start-stop times should be done at every transect.
3) At the transect, extend the surveyor’s rod across the channel perpendicular to the flow, with the zero end at the left bank (facing downstream). If the channel is too wide for the rod, stretch the metric tape in the same manner.

4) Measure the wetted width. Wetted width is *measured across and over mid-channel bars* and boulders. This is the same width that is used for thalweg station 0 (see below). Record the width on the field data form in the Bank Measurements section. Measure to the nearest 0.1 m for widths up to about 3 meters, and to the nearest 5% for widths > 3 m. This is 0.2 m for widths of 4 to 6 m, 0.3 m for widths of 7 to 8 m, and 0.5 m for widths of 9 or 10 m, and so on. For dry and intermittent streams, where no water is in the channel, record zeros for wetted width.
   a) Optionally, or for larger channels, a higher-precision range finder may be used.
   b) Wetted width is the point where substrate is no longer surrounded on all sides by water.
5) NOTE: If an *island* and a side channel are present, **and the side channel contains between 16% and 49% of the total flow**, establish secondary cross-section transects as necessary (from 1 to many). Use separate field data forms to record data for the side channel, designating each secondary transect by checking or adding to the comment field "Xtra" and the associated primary transect letter (e.g., XA, XB, etc.). **Collect all channel and riparian cross-section measurements from the side channel**.
6) Divide the wetted channel width by 4 to locate substrate measurement points on the cross-section. In the DistLB fields of the form, record the distances corresponding to 0% (Lft-will be 0), 25% (LCtr), 50% (Ctr), 75% (RCtr), and 100% (Rgt should be the wetted width) of the measured wetted width.
7) Place the meter stick or calibrated pole at the Lft location (0 m). Measure the depth and record it on the field data form. (*Cross-section depths are measured only at regular transects A-K, not at the 10 midway cross section*s).
   a) Depth entries at the left and right banks may be 0 (zero) if the banks are gradual.
   b) If the bank is nearly vertical, let the base of the measuring stick fall to the bottom, rather than holding it suspended at the water surface.
   c) Depth on a mid-channel bar is zero.
8) NOTE the bank measurements at the left bank and right bank can be done when at these locations, although the methods are described in the next set of procedures.
9) NOTE the canopy cover densiometer measures at left bank, right bank, and channel center can be done when at these locations, although the methods are described in a following set of procedures.
10) NOTE the bankfull and incision height measurements at the left bank and right bank can be done when at these locations, although the methods are described in the following set of procedures.
11) Pick up the substrate particle *that is touching the front of the measuring stick or just underneath the front of the stick*, and visually estimate its particle size, according to the classes on SEI Form #5 and in the Table 8-4. Classify the particle according to its median diameter (the middle dimension of its length, width, and depth). Record the size class code on the SEI Form #5 for transects A-K (note that there are also entry boxes on SEI Form #6 Thalweg Profile for midway cross-sections).
12) The same methods apply to (dry) substrate on within channel bars.

13) Evaluate substrate embeddedness at each cross section point on the 11 main transects A-K. For particles larger than sand, examine the surface for stains, markings, and algae. Estimate the average percentage embeddedness (see Figure 8-3) of particles in the 10-cm circle around the measuring rod. Record this value on the field data form. By definition, an area with only sand or fines is embedded 100 % and bedrock and hardpan are embedded 0 percent.

14) Move successively to the next location along the cross section. Repeat Steps 7 through 11 at each location. Repeat Steps 4 through 11 at each new cross-section transect.

Physical Habitat Procedure: Cross-Channel Transect, Bank Characteristics (Angles and Depths) and Stream Width (SEI FORM #5)

1) These measurements can be done in combination with the substrate measurements described above.

2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5. Note that a different version of Form #5 is used for each transect.

Bank Angles

1) To measure bank angle, lay a meter ruler or a short rod (approximately 1 m long) down against the left bank (determined as you face downstream), with one end at the water's edge. At least 0.5 m of the ruler or rod should be resting comfortably on the ground to determine bank angle. Lay the clinometer on the rod, and read the bank angle in degrees from the external scale on the clinometer (see Figure 8-4).

2) Measure and record the angle in the field for the left bank in the Bank Measurement section of the Channel/Riparian Cross-section Form;

3) Several situations can complicate bank angle measures (Figures 8-14 to 8-16 demonstrate how to deal with those situations):

   a) A vertical bank is 90º, overhanging banks have angles > 90º approaching 180º, and more gradually sloped banks have angles < 90º. To measure bank angles > 90º, turn the clinometer (which only reads 0 to 90º) over and subtract the angle reading from 180º.

   b) If there is a large boulder or log present at the transect, measure bank angle at a nearby point where conditions are more representative.

   c) It is difficult to accurately measure the angle when the bank rises in a stair-step fashion. A stair-step bank is defined as 3 or more separate angles each > 10 cm in vertical height. This applies to concave, convex, and relatively straight banks. Measure the average angle by laying the depth rod along the outer corner of the steps (so it is resting comfortably across all steps).

   d) If the bank is undercut, measure the horizontal distance of the undercutting to the nearest 0.01º. The undercut distance is the distance from the water's edge out to the point where a vertical plumb line from the bank would hit the water's surface. Record the distance on the

field data form. Measure submerged undercuts by thrusting the rod into the undercut and reading the length of the rod that is hidden by the undercutting.

e) Overhanging bank angles and distances are measured from the deepest point of the undercut up to the ceiling of the overhang.

f) Occasionally, the back of the undercut will be a consistent depth, thereby lacking a deepest point. Place the depth rod at the highest elevation, resulting in the smallest angle.

g) In some situations, there will be an undercut with a ceiling below bankfull and a second undercut with a ceiling above bankfull. Measure the lower undercut and ignore the upper one.

4) Repeat the above steps on the right bank.

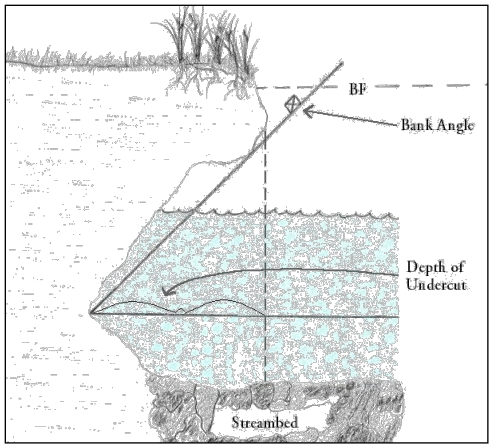


Figure 8-14. Measure undercut bank angle from the deepest point to the ceiling of the undercut; measure undercut depth from the deepest point to the outer edge of the bank in cm (Heitke et al. 2011).

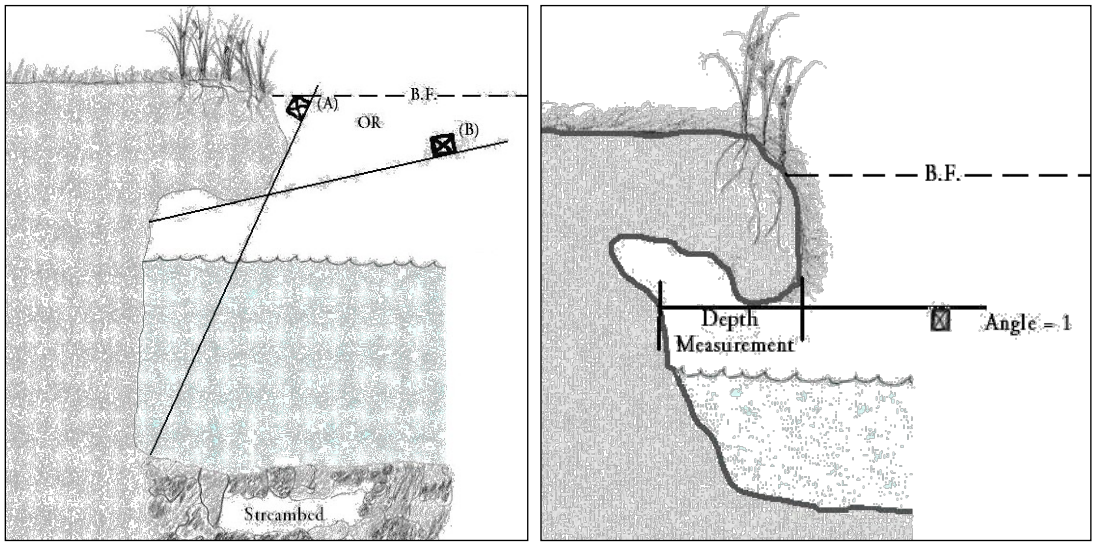


Figure 8-15. Undercut banks with a constant depth are measured with the base of the depth rod at the highest elevation (angle B, not angle A) (Heitke et al. 2011).

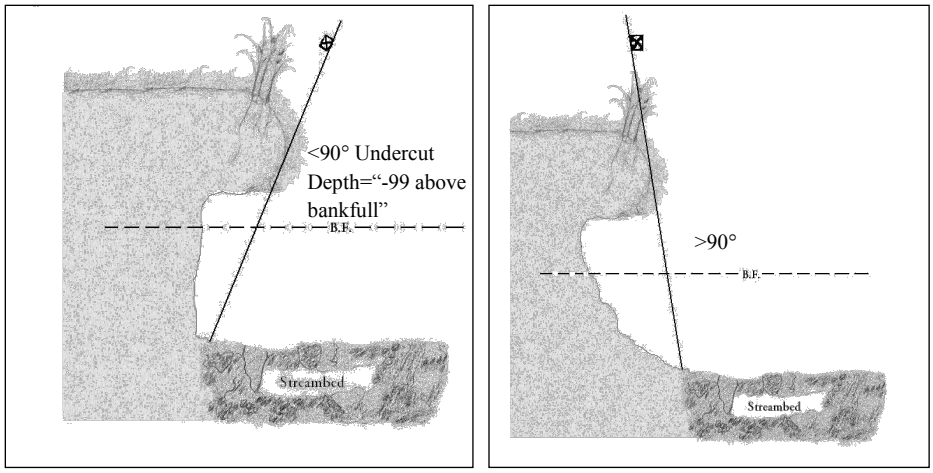


Figure 8-16. Undercut banks with the ceiling above bankfull are measured from where the streambed and bank meet to the outside edge of the undercut (Heitke et al. 2011).

Bankfull Widths

1) Wetted widths were probably measured and recorded when measuring substrate. If not, record these values in the Bank Measurement section of the field data form the wetted width value determined when locating substrate sampling points in the Wetted Width field in the bank measurement section of the field data form. Figure 8-5 illustrates examples of bankfull widths.
2) Include width of exposed mid-channel bars (if present).
3) Determine the bankfull channel width (see diagram above). Measure or estimate (note estimates with a flag) this and record. Look for:
    a) An obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel.
    b) A transition from exposed stream sediments to terrestrial vegetation.
    c) Transition from flood- and scour-tolerant vegetation to that which is relatively intolerant of these conditions.
    d) Moss growth on rocks along the banks.
    e) Presence of drift material caught on overhanging vegetation (but be careful this is not from an extreme flood event).
    f) Note that bankfull should be at the same elevation on each bank so use the most obvious cues from one bank and visualize this elevation on the other bank to help pinpoint searching.
    g) An obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel.

Bankfull and Incision Heights

1) Hold the surveyor's rod vertical, with its base planted at the water's edge. Examine both banks to estimate and record the height of bankfull flow above the present water level.

2) Still using the surveyor's rod as a guide while examining both banks, estimate (by eye) the channel incision (see Figure 8-6 and Figure 8-7) as the height up from the water surface to elevation of the first terrace of the valley floodplain (Note this is at or above the bankfull channel height). Record this value in the Incised Height field of the bank measurement section on the field data form. **Incision height is always equal to or greater than bankfull height**.
3) Repeat the above steps at each cross-section transect. Record data for each transect on a separate version of SEI Form #5.

Physical Habitat Procedure: Cross-Channel Transect, Instream Fish Cover, Algae, and Aquatic Macrophytes (SEI FORM #5)

1) At this point in the sampling workflow, the crew has done or is doing the substrate and bank measures. Fish cover estimates can be done by the data recorder as the other crew member makes substrate and bank measures, etc.
2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5.
3) Standing mid-channel at a cross-section transect, estimate a 5 m distance upstream and downstream (10 m total length). Include 10 m of the wetted area into the channel; if this is bigger than the whole stream, flag this, but assess this whole area.
4) Examine the water and the banks within this area of stream for the following features and types of fish cover: filamentous algae, aquatic macrophytes, large woody debris, brush and small woody debris, in-channel live trees or roots, overhanging vegetation, undercut banks, boulders, and artificial structures;
5) Because it is fish cover, all estimates are for the area over water.
6) For each cover type, estimate the areal cover. Record the appropriate cover class in the Fish Cover section of the Channel/Riparian Cross Section Form:
    a) 0 = absent: zero cover
    b) 1 = sparse: < 10%
    c) 2 = moderate: 10-40%
    d) 3 = heavy: 40-75%
    e) 4 = very heavy: > 75%
7) Repeat steps 1 through 3 at each cross-section transect, recording data from each transect on a separate field data form.

Physical Habitat Procedure: Cross-Channel Transect, Canopy Cover (Densiometer) (SEI FORM #5)

1) At this point in the sampling workflow, the crew has done or is doing the substrate and bank measures. The densiometer readings should be done by the crew member also conducting the bank and substrate measures.

2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5.
3) At each cross-section transect, stand in the stream at mid-channel and face upstream.
4) Hold the densiometer 0.3 m (1 ft) above the surface of the stream. Level the densiometer using the bubble level. Move the densiometer in front of you so your face is just below the apex of the taped V (see Figure 8-8).
5) Count the number of grid intersection points within the V that are covered by either a tree, a leaf, or a high branch. Record the value (0 to 17) in the CenUp field of the canopy cover measurement section of the Channel/Riparian Cross-section and Thalweg Profile Form.
6) Repeat steps 4 and 5 for all three other directions (left, right, down).
7) Repeat steps 1 through 6 at each cross-section transect. Record data for each transect on a separate field data form.

Physical Habitat Procedure: Cross-Channel Transect, Riparian Vegetation Structure (SEI FORM #5)

1) At this point in the sampling workflow, the crew has done or is doing the substrate and bank measures. Riparian vegetation cover estimates can be done by the data recorder as the other crew member makes substrate and bank measures, etc.
2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5.
3) Standing in mid-channel at a cross-section transect, estimate a 5 m distance upstream and downstream (10 m total length).
4) Facing the left bank (left as you face downstream), estimate a distance of 10 m back into the riparian vegetation.
5) On steeply sloping channel margins, estimate the distance into the riparian zone as if it were projected down from an aerial view.
6) Within this 10x10 m-area, conceptually divide the riparian vegetation into three layers: a CANOPY LAYER (> 5 m high), an UNDERSTORY (0.5 to 5 m high), and a GROUND COVER layer (< 0.5 m high).
7) Within this 10x10 m area, determine the dominant vegetation type for the CANOPY LAYER (vegetation > 5 m high) as either Deciduous, Coniferous, broadleaf Evergreen, Mixed, or None. Consider the layer Mixed if more than 10% of the areal coverage is made up of the alternate vegetation type. Indicate the appropriate vegetation type in the Visual Riparian Estimates section of the Channel/Riparian Cross Section Form.
8) Determine separately the areal cover class of large trees (> 0.3 m [1 ft] diameter at breast height [DBH]) and small trees (< 0.3 m DBH) within the canopy layer. Estimate areal cover as the amount of shadow that would be cast by a particular layer alone if the sun were directly overhead. Record the appropriate cover class on the field data form (0 = absent: zero cover; 1 = sparse: < 10%; 2 = moderate: 10-40%; 3 = heavy: 40-75%; or 4 = very heavy: > 75%).

9) Look at the UNDERSTORY layer (vegetation between 0.5 and 5 m high). Determine the dominant **woody** vegetation type for the understory layer as described in step 4 for the canopy layer. If there is no woody vegetation in the understory layer, record the type as **N**one.

10) Determine the areal cover class for woody shrubs and saplings separately from non-woody vegetation within the understory, as described in Step 8 for the canopy layer.

11) Look at the GROUND COVER layer (vegetation < 0.5 m high). Determine the areal cover class for woody shrubs and seedlings, non-woody vegetation, and the amount of bare ground present as described in step 8 for large canopy trees.

12) Repeat steps 3 through 11 for the right bank.

13) Repeat steps 1 through 9 for all cross-section transects, using a separate field data form for each transect.

Physical Habitat Procedure: Human Influence (SEI FORM #5)

1) At this point in the sampling workflow, the crew has done or is doing the substrate and bank measures. Human influence estimates can be done by the data recorder as the other crew member makes substrate and bank measures, etc.

2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5.

3) Standing mid-channel at a cross-section transect, look toward the left bank (left when facing downstream), and estimate a 5-m distance upstream and downstream (10 m total length). Also, estimate a distance of 10 m back into the riparian zone to define a riparian plot area.

4) Examine the channel, bank, and riparian plot area adjacent to the defined stream segment for the following human influences: (1) walls, dikes, revetments, riprap, and dams; (2) buildings; (3) pavement/cleared lots (e.g., paved, gravelled, dirt parking lot, foundation); (4) roads or railroads; (5) inlet or outlet pipes; (6) landfills or trash (e.g., cans, bottles, trash heaps); (7) parks or maintained lawns; (8) row crops; (9) pastures, rangeland, hay fields, or evidence of livestock; (10) logging; (11) mining (including gravel mining); and (12) park trails/campgrounds or other low-intensity facilities.

5) For each type of influence, determine if it is present and what its proximity is to the stream and riparian plot area. Consider human disturbance items as present if you can see them from the cross-section transect. Do not include them if you have to sight through another transect or its 10 x 10 m riparian plot.

6) For each type of influence, record the appropriate proximity class in the Human Influence part of the Visual Riparian Estimates section of the Channel/Riparian Cross Section Form. Proximity classes are:

   a) B (Bank) - Present within the defined 10-m stream segment and located in the stream or on the stream bank.

   b) C (Close) - Present within the 10 x 10 m riparian plot area, but away from the bank.

   c) P (Present) - Present, but outside the riparian plot area.

d) 0 (Absent) - Not present within or adjacent to the10-m stream segment or the riparian plot area at the transect.

7) Repeat steps 2 through 6 for the right bank.
8) Repeat steps 2 through 7 for each cross-section transect, recording data for each transect on a separate field form.

Physical Habitat Procedure: Invasive Plants (SEI FORM #5)

1) At this point in the sampling workflow, the crew has done or is doing the substrate and bank measures. Invasive plant presence/absence can be done by the data recorder as the other crew member makes substrate and bank measures, etc.
2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #5.
3) Examine the 10 x 10 m riparian plots on both banks for the presence of alien plant species. Look for those species from list of target species for a park.
4) Record the presence of any species listed for the park within the plot on either the left or right bank by marking the appropriate box(es) in the Invasive Plants section. If none of the species listed for your state is present in either of the plots at a given transect check the box labeled None for this transect.
5) Repeat steps 3 and 4 for each remaining transect (B through K).
6) This is probably the last channel/riparian activity so crews should record the stop time on the top of the current iteration of SEI Form #5. Note that some channel/riparian activities do not occur physically on a cross-channel transect.

Physical Habitat Procedure: Thalweg, Channel Profile and Substrate (SEI FORM #6)

1) Crews will have just completed the main cross-section transect (substrate, depths, covers, etc.). Usually they will be at or near the cross-section transect; if not, return to this location as this is where the first thalweg point is located. **Note: It is possible for the data recorder to tally pieces of large woody debris (LWD) within each segment of stream at the same time the thalweg profile is being determined. Include all pieces with the large end located within the segment in the tally**.
2) All header information including site ID, the date of sampling, and the section being evaluated (e.g., A-B for the area between transects A and B) should be filled out on SEI Form #6.
3) Record the start time before any activities occur along the profile. This should be done at the start of every interval between transects A-K. Because some channel or riparian activities are not really on the transect *per se* and co-occur with the thalweg profile, there will be overlap in time stamps with the thalweg activities. The stop time will be prior to the slope and bearing data collection and therefore include any non-habitat data collection such as the *in situ* or biological measures if the habitat crews are collecting these data. These will be timed as well and subtracted from the thalweg profile time.

4) Determine the interval between measurement stations based on the wetted width used to determine the length of the sampling reach:
   a) Channel Width < 3.75m; interval = 1.5 m
   b) Channel Width 3.75-12.5 m; interval = 0.01x reach length
   c) Channel Width > 12.5 m; interval = 5 m
5) Wetted Width > 12.5 m; interval = 5 m. This is by definition the maximum reach length allowed. Each cross-section transect will be 50 m apart; therefore, thalweg points are 5 m apart. In the rare cases where a reach is greater than 500 m long, set the thalweg point intervals at 0.01x reach length.
6) Record the interval distance determined in Step 1 in the Increment field on the field data form.
7) NOTE: If an island and side channel are present, and contains between 16 and 49% of the total flow secondary cross section transects will have been established for the cross section and riparian measures. ***However, the thalweg will be in the channel with > %50 of the flow and this is where the measures described here occur.***
8) Begin at the downstream end (station 0) of the first transect (transect A). This is on the cross-channel transect, but because the cross-section transect measures the middle of the channel and the thalweg profile finds the deepest point from the middle, the two methods are not necessarily duplicative.
9) Measure the wetted width if you are at station 0, station 5, or station 7. For the 0 station, this is the same measurement as done with the cross-section transect procedures and can be copied from SEI Form #5. Wetted width is measured across and over mid-channel bars and boulders. Record the width on the field data form to the nearest 0.1 m for widths up to about 3 m, and to the nearest 5% for widths > 3 m. This is 0.2 m for widths of 4 to 6 m, 0.3 m for widths of 7 to 8 m, and 0.5 m for widths of 9 or 10 m, and so on. For dry and intermittent streams, where no water is in the channel, record zeros for wetted width.
10) NOTE: If a *mid-channel bar* is present at a station where wetted width is measured, measure the bar width and record it on the field data form.
11) At each thalweg profile station, use a meter ruler or a calibrated pole or rod to locate the deepest point (the thalweg), which may not always be located at mid-channel. Measure the thalweg depth to the nearest cm, and record it on the thalweg profile form. Read the depth on the side of the ruler, rod, or pole to avoid inaccuracies due to the wave formed by the rod in moving water.
12) NOTE: For streams with interrupted flow, where no water is in the channel at a transect, record zeros for depth.
13) NOTE: **It is critical to obtain thalweg depths at all stations**. **At stations where the thalweg is too deep to measure directly**, stand in shallower water and extend the surveyor's rod or calibrated rod or pole at an angle to reach the thalweg. Determine the rod angle by resting the clinometer on the upper surface of the rod and reading the angle on the external scale of the clinometer. Leave the depth reading for the station blank, and record a flag. Record the water level on the rod and the rod angle in the comments section of the field data form. For even deeper

depths, it is possible to use the same procedure with a taut string as the measuring device. Tie a weight to one end of a length of string or fishing line, and then toss the weight into the deepest channel location. Draw the string up tight and measure the length of the line that is under water. Measure the string angle with the clinometer exactly as done for the surveyor's rod.

14) If a direct measurement cannot be obtained, make **the best estimate you can** of the thalweg depth, and use a flag to identify it as an estimated measurement.

15) At the point where the thalweg depth is determined, observe whether unconsolidated, loose (soft) deposits of small diameter (≤ 16 mm), sediments are present directly beneath your ruler, rod, or pole. Soft/small sediments are defined here as fine gravel, sand, silt, clay, or muck readily apparent by feeling the bottom with the staff. Record presence or absence in the Soft/Small Sediment field on the field data form. Note: A thin coating of fine sediment or silty algae coating the surface of cobbles should not be considered soft/small sediment for this assessment. Fine sediment coatings should be identified in the comments section of the field form when determining substrate size and type.

16) Determine the channel unit code and pool forming element codes (see Table 8-1and Table 8-6 for classifications and codes) for the station.

   a) Note that in order for a channel habitat unit to be distinguished, it must be at least as wide or long as the channel is wide.

   b) Note: Remember that most pools are formed at high flows, so you may need to look at features, such as large woody debris, that are dry at base flow, but still within the bankfull channel.

Table 8-6. Categories of pool-forming elements.

Code	Category
N	Not Applicable, Habitat Unit is not a pool
W	Large Woody Debris.
R	Rootwad
B	Boulder or Bedrock
F	Unknown cause (unseen fluvial processes)
WR, RW, RBW	Combinations
OT	Other (describe in the comments section of field form)

17) Record these on the field data form using the standard codes provided. For dry and intermittent streams, where no water is in the channel, record habitat type as dry channel (DR).

18) If the station cross-section intersects a mid-channel bar, indicate the presence of the bar in the Bar Width field on the field data form.

19) Record the presence or absence of a side channel at the station's cross section in the Side Channel field on the field data form.

20) Record the presence or absence of quiescent off-channel aquatic habitats, including sloughs, alcoves and backwater pools in the Backwater column of the field form.

21) Proceed upstream to the next station, and repeat steps 4 through 14.

22) At station **5** and **7** classify the substrate particle size at the tip of your depth measuring rod at the left wetted margin and at positions 25%, 50%, 75%, and 100% of the distance across the wetted width of the stream. This procedure is identical to the substrate size evaluation procedure described for regular channel cross sections A through K, except that for these midway supplemental cross sections, substrate size is entered on the Thalweg Profile side of the field form and distances and depths are not measured.

23) Repeat until you reach the next transect. At this point complete Channel/Riparian measurements at the new transect. Then prepare a new SEI Form #6 and repeat steps 4 through 17 for each of the reach segments, until you reach the upstream end of the sampling reach (transect K).

Physical Habitat Procedure: Thalweg, Large Woody Debris (SEI FORM #6)

1) Crews will have just completed the main cross-section transect (substrate, depths, covers, etc.). Usually they will be at or near the cross-section transect (if not, return to this location as this is where the first thalweg point is located). **Note: It is possible for the data recorder to tally pieces of large woody debris (LWD) within each segment of stream at the same time the thalweg profile is being determined. Include all pieces with the large end located within the segment in the tally**.

2) All header information including site ID, the date of sampling, and the section being evaluated (e.g., A-B for the area between transects A and B) should be filled out on Form #6.

3) Scan the stream segment between the two cross-section transects where thalweg profile measurements are being made.

4) Tally all LWD pieces within the segment that are at least partially within the bankfull channel (zones 1, 2 and 3; Figure 8-17 and Figure 8-18).

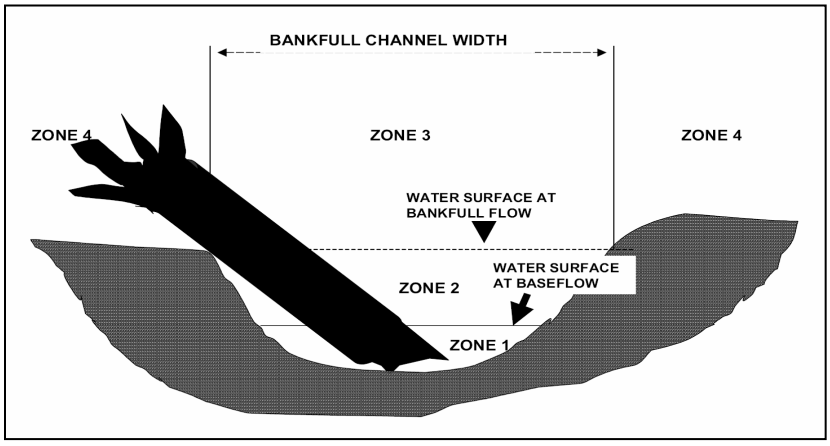


Figure 8-17. Large woody debris influence zones (Robison and Beschta 1990).

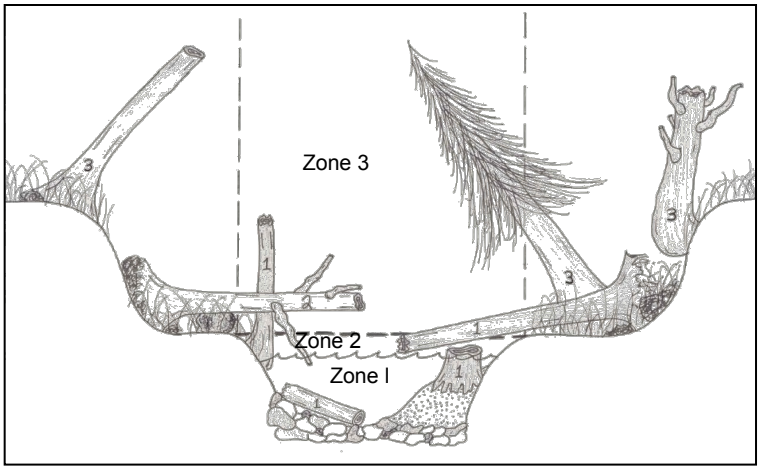


Figure 8-18. Illustration of large wood that is counted pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted. The large tree leaning in to zone 3 is not counted because it is alive (Heitke et al. 2011).

5) Include LWD from island side channels with 16-49% of the flow in the tally for a section that also meets all other criteria. **LWD in side channels with <15% are not counted**.
6) In order to be counted, each piece must meet the following criteria (See: Figure 8-19 through Figure 8-22):
    a) Each piece must be greater than 1.5 m in length and at least 10 cm in diameter on the small end. For pieces that are not evenly round, measure the widest axis.
    b) Only include standing trees that lean within the bankfull channel if they are dead. Dead trees are defined as being devoid of needles or leaves, or where all of the needles and leaves have turned brown. Consider it living if the leaves or needles are green.
    c) Wood that is imbedded within the streambank is counted if the exposed portion meets the length and width requirements.
    d) Do not count a piece if only the roots (but not the stem/bole) extend within the bankfull channel.
    e) Some pieces crack or break when they fall. Include the entire length when the two pieces are still touching at any point along the break. Treat them separately if they are no longer touching along the break.

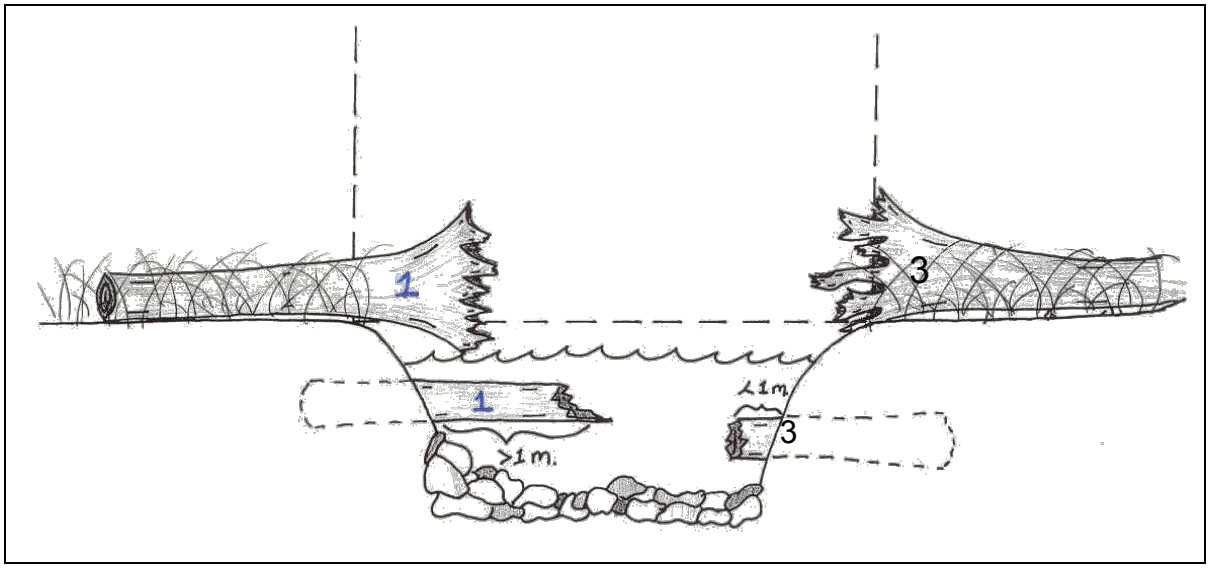


Figure 8-19. Examples of qualifying large wood (1). The pieces on the right side (3) are not counted, because only the roots extend over the bankfull channel (upper) and the exposed section is <1 m in length (lower). Figure is from Heitke et al. (2011).

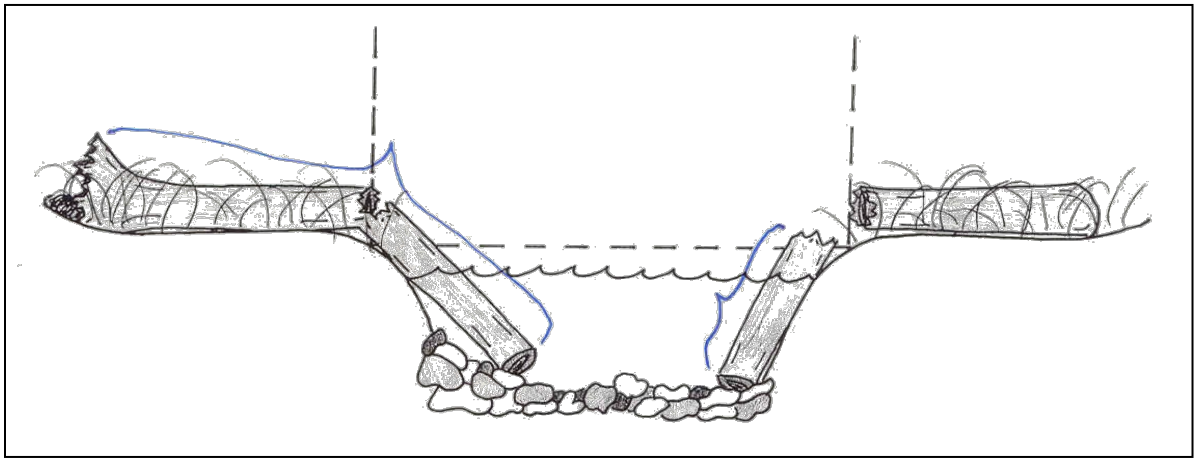


Figure 8-20. Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (the pieces are still connected and the part reposed on the bank is assumed greater than 10 cm in diameter). Only measure the piece within the bankfull channel on the right. Figure is from Heitke et al. (2011).

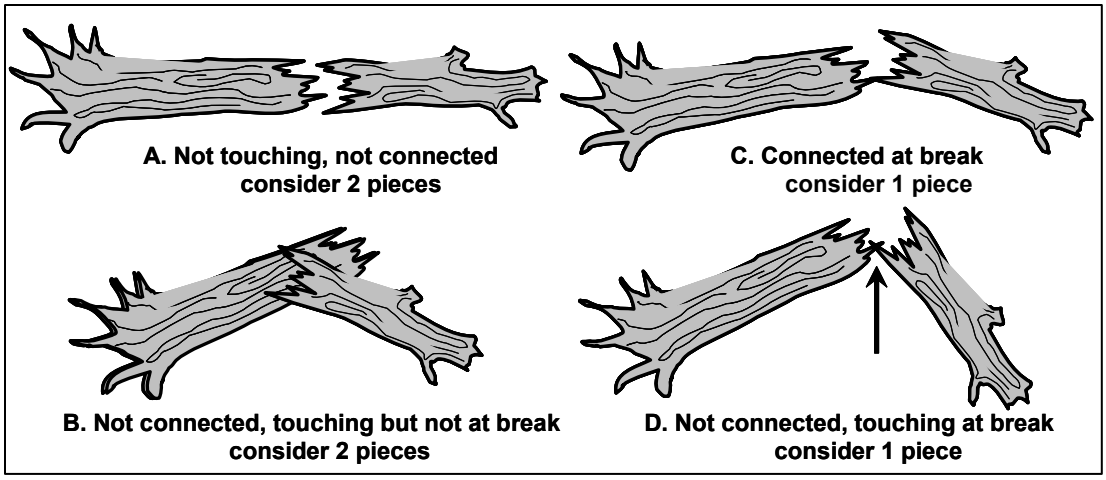


Figure 8-21. Variations of wood pieces touching vs. not touching along the break (Heitke et al. 2011).

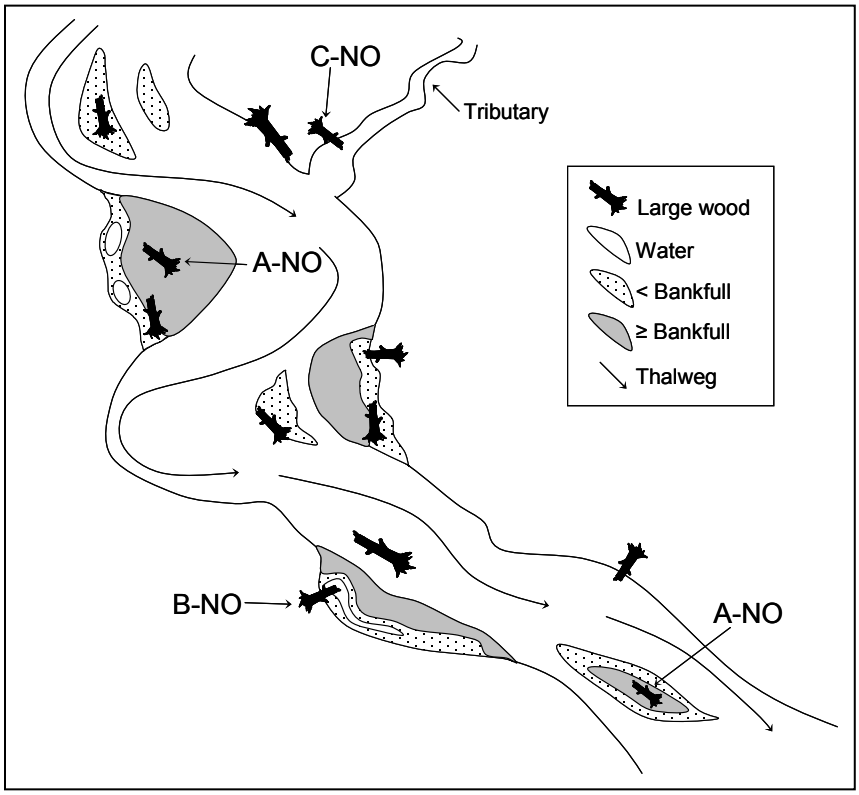


Figure 8-22. Depiction of qualifying and non-qualifying large wood. Unlabeled pieces qualify because they are within bankfull channel. Large wood on islands at or above bankfull elevation are not measured unless it spans into or over zones 1, 2, or 3. Large wood above bankfull is not measured (A). Large wood associated with isolated side channels, pools, and depressions does not qualify (B). Large wood in tributary streams is not measured (C). Figure is from Heitke et al. (2011).

7) For each piece of LWD, determine the class **based on the diameter of the large end** (0.1 m to < 0.3 m, 0.3 m to < 0.6 m, 0.6 m to < 0.8 m, or > 0.8 m, and the class based on the length of the piece (1.5 m to < 5.0 m, 5 m to < 15 m, or > 15m).

8) If the piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with circular cross section that would have the same volume.

9) When estimating length, include only the part of the LWD piece that has a diameter greater than 10 cm (4 in);

10) Place a tally mark in the appropriate diameter/length class box in the Pieces All/Part in Bankfull Channel section of the Thalweg Profile and Woody Debris Form.

11) Tally all LWD pieces within the segment that are not actually within the bankfull channel, but are at least partially spanning (bridging) the bankfull channel. For each piece, determine the class based on the diameter of the **large end** (0.1 m to < 0.3 m, 0.3 m to < 0.6 m, 0.6 m to < 0.8 m, or > 0.8 m), and the class based on the length of the piece (1.5 m to < 5.0 m, 5 m to < 15 m, or > 15 m).

12) Place a tally mark for each piece in the appropriate diameter/length class tally box in the Pieces Bridge Above Bankfull Channel section of the Thalweg Profile and Woody Debris Form.

13) After all pieces within the segment have been tallied, write the total number of pieces for each diameter and length class in the small box at the lower right-hand corner of each tally box.

14) Repeat steps 3 through 14 for the next stream segment, using a new Thalweg Profile and Woody Debris Form.

Physical Habitat Procedure: Slope and Bearing (SEI FORM #7)

1) Crews will have just completed the thalweg profile.

2) All header information including site ID and the date of sampling should be filled out on SEI Form #7.

3) One crew member stands in the center of the channel (or both on the same side of the channel) at the downstream cross-section transect. Determine if you can see the center (or same side) of the channel at the next cross-section transect upstream without sighting across land (i.e., do not short-circuit a meander bend). If not, you will have to take supplementary slope and bearing measurements (Figure 8-23).

4) Mark two measuring devices (rods, calibrated meter stick) at the same height. Use a piece of tape or a finger. If a shorter pole or ruler is used, measure the height from the ground to the opening of the clinometer when it is resting on top.

5) Have one person take the marked surveyor's rod to the downstream transect. Hold the rod vertical with the bottom at the same level as the water surface. If no suitable location is available at the stream margin, position the rod in the water and note the depth.

6) If you have determined in step 5 that supplemental measurements are required for this segment, the crew member doing the backsighting (from upstream) moves downstream from the downstream transect to the furthest point where you can still see the center of the channel at the downstream cross-section transect from the center of the channel. Mark this location with a different color flagging than that marking the cross-section transects.

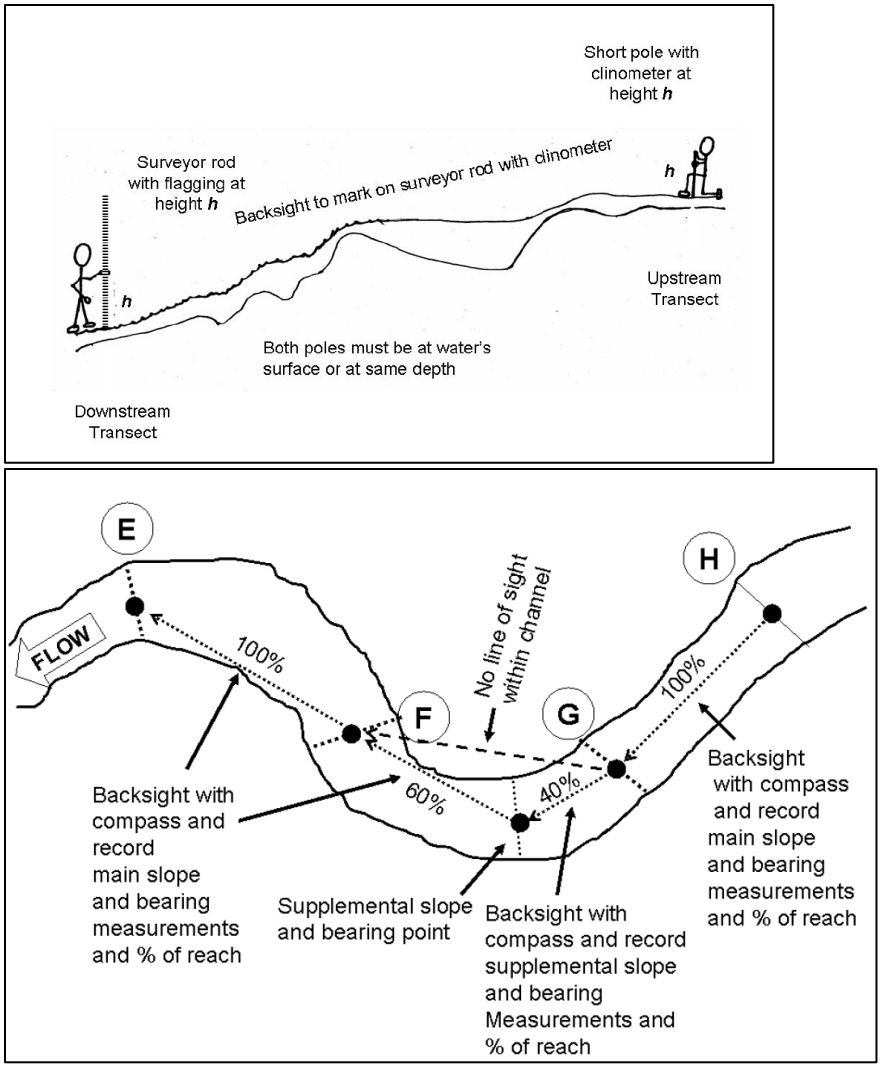


Figure 8-23. Channel slope and bearing procedures.

7) If there is no need for a supplemental point, simply backsight from the upstream transect to the downstream transect.

8) Place the clinometer on the calibrated rod at the height determined in step 6. With the clinometer, sight back downstream to the flagged height on the surveyor's rod being held by the second crew member at the downstream transect (or at the supplementary point). Read and record the **percent** slope in the Main section on the Slope and Bearing Form. Record the Proportion as 100% if there is no supplemental point involved.

9) If you are backsighting from a supplemental point, record the slope (%) and proportion (%) of the stream segment that is included in the measurement in the appropriate Supplemental section of the Slope and Bearing Form.

10) Stand in the middle of the channel at upstream transect (or at a supplemental point), and sight back with your compass to the middle of the channel at the downstream transect (or at a

supplemental point). Record the bearing (degrees) in the Main section of the Slope and Bearing Form.

11) If you are backsighting from a supplemental point, record the bearing in the appropriate Supplemental section of the Slope and Bearing Form.

12) Continue with cross section and thalweg measures until the next slope reading is done and repeat all steps above.

Physical Habitat Procedure: Debris Torrents and Recent Major Floods (SEI FORM #8)

1) These activities are conducted after completing the thalweg profile and littoral-riparian measurements and observations, and represent an evaluation of the entire stream reach.

2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #8.

3) Determine the degree, extent, and type of flood evidence for the entire reach. Select any of the following categories that apply:

   a) 01 - Stream channel has a recently devegetated corridor two or more times the width of the low-flow channel. This corridor lacks riparian vegetation with possible exception of fireweed, even-aged alder or cottonwood seedlings, grasses, or other herbaceous plants.

   b) 02 - Stream substrate cobbles or large gravel particles are NOT IMBRICATED. (*Imbricated* means flat sides horizontal and that they are stacked like roof shingles; imagine the upstream direction as the top of the "roof.") In a torrent scour or deposition channel, the stones are laying in unorganized patterns, lying "every which way." In addition, many of the substrate particles are angular (not "water-worn.")

   c) 03 - Channel has little evidence of pool-riffle structure. (For example, could you ride a mountain bike down the channel?)

   d) 04 - The stream channel is scoured down to bedrock for substantial portion of reach.

   e) 05 - There are gravel or cobble berms (little levees) above bankfull level.

   f) 06 - Downstream of the scoured reach (possibly several miles), there are massive deposits of sediment, logs, and other debris.

   g) 07 - Riparian trees have fresh bark scars at many points along the stream at seemingly unbelievable heights above the channel bed.

   h) 08 - Riparian trees have fallen into the channel as a result of scouring near their roots.

   i) 09 - There are massive deposits of sediment, logs, and other debris in the reach. They may contain wood and boulders that, in your judgment, could not have been moved by the stream at even extreme flood stage.

   j) 10 - If the stream has begun to erode newly laid deposits, it is evident that these deposits are Matrix Supported. This means that the large particles, are often not touching each other, but have silt, sand, and other fine particles between them (their weight is supported by these fine particles, in contrast to a normal stream deposit, where fines, if present, normally "fill-in" the interstices between coarser particles).

k) 11 - No evidence of torrent scouring or torrent deposits.

Physical Habitat Procedure: Thalweg, Channel Constraint (SEI FORM #8)

1) These activities are conducted after completing the thalweg profile and littoral-riparian measurements and observations, and represent an evaluation of the entire stream reach.
2) All header information including site ID, the date of sampling, and the transect being evaluated (e.g., A) should be filled out on SEI Form #8.
3) Channel Constraint**:** Determine the degree, extent, and type of channel constraint based on envisioning the stream at bankfull flow.
4) Classify the stream reach channel pattern as predominantly a **single** channel, an **anastomosing** channel, or a **braided** channel (see Figure 8-11).
   a) Anastomosing channels have relatively long major and minor channels branching and rejoining in a complex network.
   b) **Braided channels also have multiple branching and rejoining channels**, but these subchannels are generally smaller, shorter, and more numerous, often with no obvious dominant channel.
5) After classifying the channel pattern, determine whether the channel is constrained within a narrow valley, constrained by local features within a broad valley, unconstrained and free to move about within a broad floodplain, or free to move about, but within a relatively narrow valley floor.
6) Then examine the channel to ascertain the bank and valley features that constrain the stream. Entry choices for the type of constraining features are bedrock, hillslopes, terraces/alluvial fans, and human land use (e.g., a road, a dike, landfill, rip-rap, etc.).
7) Based on your determinations from Steps 1 through 3, select and record one of the constraint classes shown on the Channel Constraint Form.
8) Estimate the percent of the channel margin in contact with constraining features (for unconstrained channels, this is 0%). Record this value on the Channel Constraint Form.
9) Finally, estimate the typical bankfull channel width, and visually estimate the average width of the valley floor. Record these values on the Channel Constraint Form.
10) NOTE: To aid in this estimate, you may wish to refer to the individual transect assessments of incision and constraint that were recorded on the Channel/Riparian Cross Section Forms.
11) NOTE: If the valley is wider than you can directly estimate, record the distance you can see and mark the box on the field form.

Non-wadeable Physical Habitat Procedure: Channel Margin Depth and Substrate Procedure (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - FRONT)

1) Fill in the header information on page 1 of a Channel/Riparian Transect Form. Be sure to indicate the letter designating the transect location.

2) Measure depth and observe bottom substrates within the 10 x 20 m littoral plot that is centered on each transect location.
3) A survey rod, sonar or ADCP may be used. If ADCP, record the file name.
4) Determine and record the depth and the dominant and subdominant substrate size class (see Table 8-4) at 5 systematically spaced locations estimated by eye within this 10 x 20m plot and 1 m back from the waterline. Dominant substrate is the type with the greatest areal coverage, within a 1 x 1 m assessment area at each point. This may be small sediments in the interstitial spaces among larger size classes.
    a) If the substrate particle is artificial (e.g., concrete, asphalt), choose the appropriate size class, flag the observation, and note that it is artificial in the comment space.
5) Circle the appropriate shore and bottom substrate type, the depth measurements, and the method used to get depths (SONAR or POLE).
6) Repeat steps 1 through 4 at each new cross-section transect.

Non-wadeable Physical Habitat Procedure: Bank Angle, Bank Characteristics, and Channel Cross-Section (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - FRONT)

1) Visually estimate the bank angle (undercut, vertical, steep, gradual), as defined on the field form. Bank angle observations refer to the area from the wetted channel margin up 5 m (canoe's length) into the bankfull channel margin on the previously chosen side of the river. Circle the angle in the Bank Angles section of the Channel/Riparian Transect Form.
2) Hold the surveyor's rod vertically, with its base planted at the water's edge. Examine both banks, then determine channel *incision* as the *height up from the water surface to elevation of the **first terrace** of the valley floodplain* (Note this is at or above the bankfull channel height). Whenever possible, use the clinometer as a level (positioned so it reads 0% slope) to measure this height by transferring (backsighting) it onto the surveyor's rod. Record this value in the Incised Height field of the bank characteristics section on the field data form.
3) While still holding the surveyor's rod as a guide, and sighting with the clinometer as a level, examine both banks to measure and record the *height of bankfull flow above the present water level*. Look for evidence on one or both banks such as:
    a) An obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel.
    b) A transition from exposed stream sediments to terrestrial vegetation.
    c) Moss growth on rocks along the banks.
    d) Presence of drift material caught on overhanging vegetation.
    e) A transition from flood- and scour-tolerant vegetation to that which is relatively intolerant of these conditions.

4) Record the *wetted width* value determined when locating substrate sampling points in the Bank Characteristics section of the field data form. Also determine the *bankfull channel width* and the *width of exposed mid-channel bars* (if present).
5) Repeat steps 1 through 5 at each cross-section transect, (including any additional side-channel transects established when islands are present). Record data for each transect on a separate field data form.

Non-wadeable Physical Habitat Procedure: Tallying Large Woody Debris (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - FRONT)

Note: Tally pieces of large woody debris (LWD) within the 11 littoral and riparian plots (if the piece sticks in) of the river reach at the same time the shoreline measurements are being determined. Include all pieces for which the large end is located within the transect plot in the tally. Tally wood that is at least partially within the wetted channel separately from that that is not presently wetted, but still within or directly above (bridging) the bankfull channel.

1) LWD is tallied in 11 plots systematically spaced over the entire length of the stream reach. **Only the main channel is sampled.** These plots are each 20 m long in the upstream-downstream direction (10 m up, 10 m down). They are positioned along the chosen bank and extend from the shore in 10 m towards mid-channel and then all the way to the bankfull margin.
2) Tally all LWD pieces within the plot that are at least partially within the presently wetted (base flow) channel. First, determine if a piece is large enough to be classified as LWD (**small end diameter 30 cm [1 ft.]; length 5 m [15 ft.]**).
3) For each piece of LWD, determine its diameter class **based on the diameter of the large end** (0.3 m to < 0.6 m, 0.6 m to < 0.8 m, 0.8 m to < 1.0 m, or > 1.0 m), and the **length class of the LWD pieces based on the part of its length that has diameter ≥ 30 cm.** Length classes are 5 m to < 15 m, 15 m to < 30 m, or > 30 m.
4) If the piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with circular cross section that would have the same volume.
5) When estimating length, include only the part of the LWD piece that has a diameter > 0.3 m (1 ft).
6) Place a tally mark in the appropriate diameter x length class tally box in the WOOD All/Part in WETTED Channel section of the Channel/Riparian Transect Form.
7) Tally all shoreline LWD pieces along the littoral plot that are at least partially within or above (bridging) the bankfull channel, but not in the wetted channel. For each piece, determine the diameter class based on the diameter of the **large end** (0.3 m to < 0.6 m, 0.6 m to < 0.8 m, 0.8 m to < 1.0 m, or > 1.0 m), and the **length class based on the length of the piece that has diameter ≥ 30 cm.** Length classes are 5 m to < 15 m, 15 m to < 30 m, or > 30 m.
8) Place a tally mark for each piece in the appropriate diameter x length class tally box in the Dry But All/Part In Bankfull Channel section of the Channel/Riparian Transect Form.

9) After all pieces within the segment have been tallied, write the total number of pieces for each diameter x length class in the small box at the lower right-hand corner of each tally box.
10) Repeat steps 1 through 9 for the next river transect, using a new Channel/Riparian Transect Form.

Non-wadeable Physical Habitat Procedure: Estimating Fish Cover (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - BACK)

1) Stop at the designated shoreline at a cross-section transect and estimate a 10-m distance upstream and downstream (20 m total length), and a 10-m distance out from the banks to define a 20 x 10 m littoral plot.
2) Examine the water and the banks within the 20 x 10 m littoral plot for the following features and types of fish cover: filamentous algae, aquatic macrophytes, large woody debris, in-channel live trees or roots, brush and small woody debris, overhanging vegetation, undercut banks, boulders, and artificial structures.
3) For each cover type, estimate its areal cover by eye or by sounding with a pole. Record the appropriate cover class in the Fish Cover/Other section of the Channel/Riparian Transect Form (0 = absent: zero cover; 1 = sparse: < 10%; 2 = moderate: 10-40%; 3 = heavy: 40-75%; or 4 = very heavy: > 75%).
4) Repeat steps 1 through 3 at each cross-section transect, recording data from each transect on a separate field data form.

Non-wadeable Physical Habitat Procedure: Canopy Cover Measurements (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - BACK)

1) Take densiometer readings at a cross-section transect while anchored or tied up at the river margin.
2) Hold the densiometer 0.3 m (1 ft) above the surface of the river. Holding the densiometer level using the bubble level, move it in front of you so your face is just below the apex of the taped V.
3) At the channel margin measurement locations, count the number of grid intersection points within the V that are covered by either a tree, a leaf, a high branch, or the bank itself.
4) Take 1 reading each facing upstream (UP), downstream (DOWN), left bank (LEFT), and right bank (RIGHT). Right and left banks are defined with reference to an observer facing downstream.
5) Record the UP, DOWN, LEFT, and RIGHT values (0 to 17) in the Canopy Cover at Bank section of the Channel/Riparian Transect Form.
6) Repeat steps 1 through 5 at each cross-section transect. Record data for each transect on a separate field data form.

Non-wadeable Physical Habitat Procedure: Characterizing Riparian Vegetation Structure (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - BACK)

1) Anchor or tie up at the river margin at a cross-section transect; then make the following observations to characterize riparian vegetation structure.
2) Estimate the distance from the shore to the edge of the riparian vegetation plot; record it just below the title Channel Constraint on the Channel/Riparian Transect Form, side 2.
3) Facing the left bank (left as you face downstream), estimate a distance of 10 m back into the riparian vegetation, beginning at the bankfull channel margin. Estimate the cover and structure of riparian vegetation within an estimated 10 x 20 m plot centered on the transect, and starting where perennial vegetation begins or at the bankfull river margin (whichever is closest to the river shoreline). On steeply sloping channel margins, estimate the riparian plot dimensions as if they were projected down from an aerial view.
4) Within this 10 x 20 m area, divide the riparian vegetation into 3 layers: a CANOPY (> 5m high), Understory (0.5 to 5 m), and Ground Cover layer (< 0.5 m).
5) Within this 10 x 20 m area, determine the dominant woody vegetation type for the Canopy Layer (vegetation > 5 m high) as either Deciduous, Coniferous, broadleaf Evergreen, Mixed, or None. Consider the layer Mixed if more than 10% of the areal coverage is made up of the alternate vegetation type. If the dominant vegetation type in the canopy layer is not woody, record the vegetation type as None. Indicate the appropriate vegetation type in the Visual Riparian Estimates section of the Channel/Riparian Cross-section and Thalweg Profile Form.
6) Determine separately the areal cover class of large trees (> 0.3 m [1 ft] diameter at breast height [DBH]) and small trees (< 0.3 m DBH) within the canopy layer. Estimate areal cover as the amount of shadow that would be cast by a particular layer alone if the sun were directly overhead. Record the appropriate cover class on the field data form (0 = absent, zero cover; 1 = sparse, < 10%; 2 = moderate, 10-40%; 3 = heavy, 40-75%; or 4 = very heavy, > 75%).
7) Look at the Understory layer (vegetation between 0.5 and 5 m high). Determine the dominant **woody** vegetation type for the understory layer as described in step 5 for the canopy layer. If the dominant vegetation type in the understory is not woody (e.g., herbaceous), record the vegetation type as None.
8) Determine the areal cover class for woody shrubs and saplings separately from non-woody vegetation within the understory, as described in Step 6 for the canopy layer.
9) Look at the Ground Cover layer (vegetation < 0.5 m high). Determine the areal cover class for woody shrubs and seedlings, non-woody vegetation, and the amount of bare ground or duff (dead organic material) present as described in step 6 for large canopy trees.
10) Repeat steps 1-9 for all transects, using a separate field data form for each transect.

Non-wadeable Physical Habitat Procedure: Estimating Human Influence (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - BACK)

1) Stop at the designated shoreline at a cross-section transect, look toward the left bank (left when facing downstream), and estimate a 10 m distance upstream and downstream (20 m total length). Also, estimate a distance of 10 m back into the riparian zone to define a riparian plot area.
2) Examine the channel, bank and riparian plot area adjacent to the defined river segment for the following human influences: (1) walls, dikes, revetments, riprap, and dams; (2) buildings; (3) cleared lot, pavement (e.g., paved, graveled, dirt parking lot, foundation); (4) roads or railroads; (5) inlet or outlet pipes; (6) landfills or trash (e.g., cans, bottles, trash heaps); (7) parks or maintained lawns; (8) row crops; (9) pastures, rangeland, or hay fields; (10) logging; and (11) mining (include gravel mining).
3) For each type of influence, determine if it is present and what its proximity is to the river and riparian plot area. Consider human disturbance items as present if you can see them from the cross-section transect. Do not include them if you have to site through another transect or its 10 x 20 m riparian plot.
4) For each type of influence, record the proximity class in the Human Influence part of the Visual Riparian Estimates section of the Channel/Riparian Transect Form. Proximity classes are:
    a) B (Bank) - Present within the defined 20 m river segment and located in the stream or on the wetted or bankfull bank.
    b) C (Close) - Present within the 10 x 20 m riparian plot area, but above the bankfull level.
    c) P (Present) - Present, but observed outside the riparian plot area.
    d) O (Absent) - Not present within or adjacent to the 20 m river segment or the riparian plot area at the transect.
5) Repeat steps 1 through 4 for the opposite bank.
6) Repeat steps 1 through 5 for each cross-section transect, recording data for each transect on a separate field form.

Non-wadeable Physical Habitat Procedure: Invasive Species (SEI/NRSA FORM: CHANNEL/RIPARIAN TRANSECT FORM - BACK)

1) Examine the 10 x 20 m riparian and littoral plots on both banks for the presence of alien species. (Species ID field guides will be provided). If opposite bank vegetation is too far to see, only collect data on the bank where anchored.
2) Circle the presence of any species listed within the plots on either the left or right bank. If none of the species listed are present in the plots at a given transect, fill in the circle indicating None for this transect.
3) Repeat for each remaining transect (B through K).

Non-wadeable Physical Habitat Procedure: Thalweg Profile (SEI/NRSA FORM: PHAB: THALWEG PROFILE FORM - BOATABLE)

1) Determine the interval between transects based on the mean wetted width used to determine the reach length. Transects are at 4 channel-width spacings; thalweg depth, snags, off-channel habitats and other downstream longitudinal profile observations are recorded at intervals of 0.4 channel width.
2) Complete header information on the Thalweg Profile Form, noting transect pair (upstream to downstream).
3) Begin at the upstream transect (station 1 of 10). Determine the locations to take measurements using the course-tracking and trip-meter functions of the GPS. Alternatively, estimate your position.

Thalweg Depth Profile

1) Recording Fathometer:
   a) While floating downstream along the thalweg, record depths at frequent, even-spaced intervals while observing a sonar display and holding a surveyor's rod off the side of the boat.
   b) A depth recording every 0.4 channel-width distance is required, yielding 10 measurements between channel/riparian cross-section transects.
   c) If the depth is > 0.5 meters, or contains a lot of air bubbles, the sonar fathometer will not give reliable depth estimates. In this case, record depths using a calibrated sounding rod. In shallow, fast-water situations, depths may have to be visually estimated to the nearest 0.5 m.
   d) Measure depths to nearest 0.1 m and record in the Sonar column.
2) GPS and pole/sonar:
   a) While floating downstream along the thalweg, record depths at frequent, even-spaced intervals using the GPS distance measuring function. Measure depths with a pole or a hand held sonar. Write each distance down in the margin of the form before beginning.
   b) A depth recording every 0.4 channel-width distance is required, yielding 10 measurements between channel/riparian cross-section transects.
   c) In shallow, fast-water situations, depths may have to be visually estimated to the nearest 0.5 m as the intervals will come up too quick.
   d) Measure depths to nearest 0.1 m and record in the Sonar or Pole column.

Pole Drag for Snags and Substrate Characteristics

1) If using a GPS and pole, this will be the same tool used to measure depths.
2) From the gunwale of the boat, hold a surveying rod or calibrated PVC sounding rod down vertically into the water. (CAUTION: Hold the rod over the side or stern of the raft; otherwise it could be jerked out of your hands if it catches on an obstruction in fast water.)
3) Lightly drag the rod on the river bottom to "feel" the substrate and detect snags.

4) Record the presence of snags hit by the rod or seen visually, plus the dominant substrate type sensed by dragging the rod along the bottom.
5) Circle the appropriate Substrate type and record the presence/absence of Snags.

Channel Habitat Classification

1) Classify and record the channel habitat type (see Table 8-2) at increments of every 0.4 channel width.
2) Check for off-channel and backwater habitat at increments of every 0.4 channel width.
3) If channel is split by a bar or island, navigate and survey the channel with the most flow.
4) When a side channel is encountered, circle Y in the Off-Channel column beginning with the point of divergence from the main channel, continuing downriver until the side channel converges with the main channel.
5) Circle the Channel Habitat and record side channels as described above.
6) Proceed downriver to the next station, and repeat the above procedures.
7) Record GPS waypoint (Lat/Long) midstream and at shoreline location on each transect.
8) Repeat the above procedures until you reach next transect. Set a waypoint location for the transect location midstream and at the adjacent bank. Record waypoints that you set for channel bends, transect midstream, and transect shoreline locations on the Channel-Riparian Transect Form corresponding to the downstream end of the thalweg sub-reach you just traversed.
9) After completing activities at the shoreline, prepare a new Thalweg Profile Form, then repeat the above procedures for each of the reach segments, until you reach the downriver end of the reach (Transect K).

Non-wadeable Physical Habitat Procedure: Channel Constraint (SEI FORM #8)

NOTE: These activities are conducted after completing the thalweg profile and littoral-riparian measurements and observations and represent an evaluation of the entire stream reach. Record this information on the Channel Constraint Form.

1) Determine the degree, extent, and type of channel constraint based on envisioning the stream at bankfull flow.
2) Classify the stream reach channel pattern as predominantly **one** channel, an **anastomosing** channel, or a **braided** channel (see Figure 8-11).
    a) **One channel** may have occasional in-channel bars or islands with side channels, but feature a predominant single channel, or a dominant main channel with a subordinate side channel.
    b) **Anastomosing channels** have relatively long major and minor channels branching and rejoining in a complex network separated by vegetated islands, with no obvious dominant channel.
    c) **Braided channels** also have multiple branching and rejoining channels, separated by unvegetated bars. Subchannels are generally small, short, and numerous, often with no obvious dominant channel.

3) After classifying the channel pattern, determine whether the channel is constrained within a narrow valley, constrained by local features within a broad valley, unconstrained and free to move about within a broad floodplain, or free to move about, but within a relatively narrow valley floor.
4) Then examine the channel to ascertain the bank and valley features that constrain the stream. Entry choices for the type of constraining features are bedrock, hillslopes, terraces/alluvial fans, and human land use (e.g., a road, a dike, landfill, rip-rap, etc.).
5) Estimate the percent of the channel margin in contact with constraining features (for unconstrained channels, this is 0%).
6) Finally, estimate the typical bankfull channel width. To aid in this estimate, you may wish to refer to the individual transect assessments of incision and constraint that were recorded on the Channel/Riparian Cross-Section Forms.
7) Visually estimate the average width of the valley floor. If the valley is wider than you can directly estimate, record the distance you can see and mark the box on the field form.

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SEI SOP 9: Periphyton

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents methods for collecting samples of periphyton from stream substrates. Periphyton samples are collected during all base- or full-sample events at all site and stream types. Periphyton samples are used for two purposes: (1) as an indicator of the relative biomass or productivity in the stream, and (2) as an indicator of the ecological integrity of the site via models that assess periphyton species composition. Biomass and productivity are characterized by chlorophyll a and ash-free dry mass (Stevenson 1996). Periphyton assemblage composition is assessed via an enumeration of taxa within the sample. We also include methods for qualitative estimation of *Didymosphenia geminata* ("didymo") abundance.

Some of the narrative that follows, and most ROMN SEI periphyton procedures, are modified from the EPA EMAP (Peck et al. 2006) and National River and Streams Assessment (EPA 2007) programs. We also derive some methods, and in particular analytical tools, from MT DEQ (2011).

All data are recorded on a SEI Form #9: Periphyton and Benthos.

Field Methods

Wadeable

Overview of Work Flow

Prior to initiating sampling of periphyton, crews have verified and documented the site, determined the length of stream reach to be sampled, and established the required transects. The bio crew (usually 1 person) is then at the bottom of the reach (*de facto* X site, transect A) and begins collection of periphyton and macroinvertebrates before any other channel-disturbing activities are done. Samples are collected at each transect and composited into a single sample jar for further processing. At the completion of the day's sampling activities, but before leaving the site, three types of laboratory samples are prepared: an ID/enumeration sample to determine taxonomic composition and relative abundances, a chlorophyll sample, and a biomass sample (for ash-free dry mass; AFDM).

Transect Samples

The general scheme for collecting periphyton samples from the sampling reach is illustrated in Figure 9-1 and Figure 9-2 . Table 9-1 provides a summary of each sample type collected.

At each transect, the crew collects a sample from a randomly assigned sampling point (left [L], center [C], or right [R]). **Locate the sampling point just downstream of the transect to avoid disturbing substrates that are enumerated and classified as part of the physical habitat characterization or sampled as part of the macroinvertebrate procedures**. Sampling points (L, C, R) at each transect are assigned at transect A at random using a digital watch or other suitable means. Once the first sampling point is determined, *collect either an erosional or depositional sample, depending on whether the dominant habitat at the sampling point is flowing water (e.g., a riffle or run) or slack water (e.g., a pool).* Alternate sample positions serially as each successive transect is sampled. Combine the individual transect samples into a single bottle to create a composite sample for the reach. Record the type of substrate the sample was taken in and when all sampling is done, the total volume of the final composite sample on SEI Form #9. Note that this same composite sample is used to create the chlorophyll and biomass samples.

The total volume of composite sample removed from a site is recorded and should not exceed 500 ml. **Crews should adjust the amount of sample material taken from a site as subsamples are added to not exceed this amount**.



Figure 9-1. Periphyton sample collection. Left: After removing all periphyton outside of the delimiter and prior to scraping this known area into the composited sample bottle. This method is often easier than attempting to clean off the area only inside the delimiter and may deal with irregular-shaped rocks better than the razor blade scrape method. Right: Sucking up sample from 1 cm deep in depositional area.

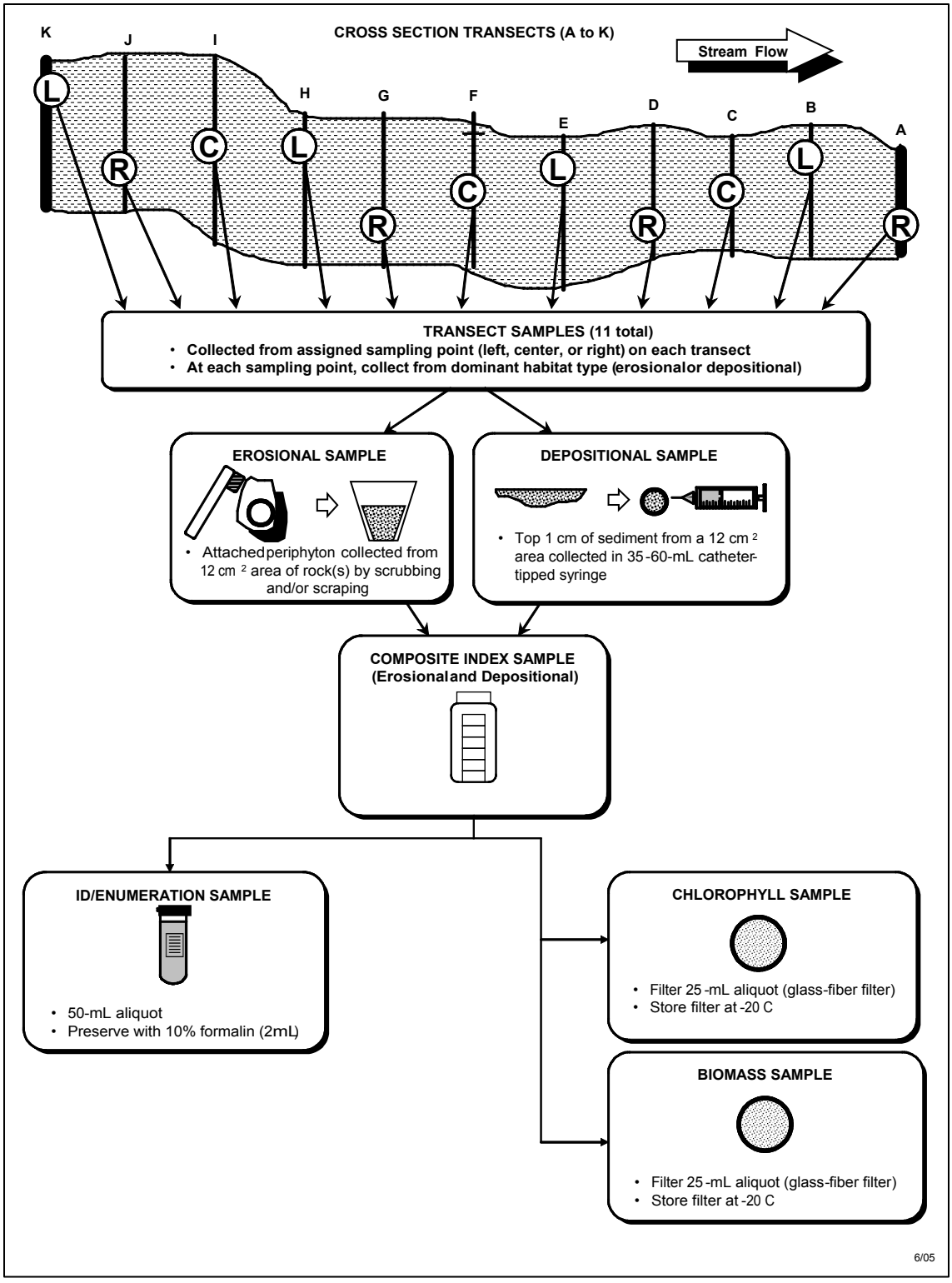


Figure 9-2. Generalized diagram of periphyton sample locations, processing, and final sample types (Peck et al. 2006).

Table 9-1. ROMN SEI biological samples with sample names, parameters, sample type, preservative, and storage.

Sample Type Code	Parameters	Bottle Size/Type	Sample Method	Preservative	Storage
R.BS	Benthos ID soft sample	1-liter Ziploc bag Triple bagged	Composite kick sample; elutriated "soft" portion	95% ETOH[1]	Ice
R.BH	Benthos ID hard sample	1-liter Ziploc bag Triple bagged	Composite kick sample "hard" remainder from elutriated sample	95% ETOH[1]	Ice
H.P	Periphyton – ID sample	50 ml vial	Aliquot from composite sample from known area of erosional or depositional substrate	M-fixative	Ice
R.CZ	Periphyton-based Chlorophyll a	Foil wrapped GF/F[2] filter paper in 35 or 50 ml vials	Aliquot from composite sample from known area of erosional or depositional substrate	-	Freeze
R.AZ	Periphyton-based Ash-Free Dry Mass	Foil-wrapped GF/C[2] filter paper in 35 or 50 ml vials	Composite sample	-	Freeze

[1]ETOH: Ethanol

[2]GF/F or C: glass fiber filter, fine or course

Non-wadeable

Overview of Work Flow

Prior to initiating sampling of periphyton, crews have verified the site and confirmed the length of stream reach to be sampled from the GIS-derived metadata. The bio crew (usually 1 person) is then at the top of the reach (*de facto* X site, transect A) and begins collection of periphyton and macroinvertebrates before or as other habitat activities are done. Samples are collected in each littoral plot and combined into a single sample jar (composite sample) for further processing. At the completion of the day's sampling activities, but before leaving the site, three types of laboratory samples are prepared: an ID/enumeration sample to determine taxonomic composition and relative abundances, a chlorophyll sample, and a biomass sample (for ash-free dry mass; AFDM).

Safety is a special concern in non-wadeable streams and will always be the first consideration when working at put-in and take-out, shoreline locations, cross sections, etc. All crew members must wear PFDs and boat operators must be experienced. Equipping the boat with a bow or stern anchor to stop at transect locations can greatly ease the shore marking operation and shoreline measurement activities, though such equipment can be dangerous in white-water rivers.

Littoral Plot Samples

The general scheme for collecting periphyton samples in non-wadeable streams is similar to wadeable streams (see Figure 9-1 and 9-2 above), with the exception that samples come from the 11 littoral plots along the sample reach. Table 9-1 above provides a summary of each sample type collected.

At each of the 11 littoral plots, crews collect a sample from the dominant substrate (erosional or depositional). As non-wadeable shorelines are often deep, collect the substrate selected for sampling from a depth no deeper than 0.5 m. If you cannot collect a sample because the location is too deep, skip the plot.

Combine the individual samples into a single bottle to create a **composite sample** for the reach. Record the type of substrate the sample was taken in and when all sampling is done, the total volume of the final composite sample on SEI Form #9. Note that this same composite sample is used to create the chlorophyll and biomass samples.

The total volume of composited sample removed from a site is recorded and should not exceed 500 ml. **Crews should adjust the amount of sample material taken from a site as subsamples are added to avoid exceeding this amount.**

Processing Samples

Methods for sample preparation are identical across wadeable and non-wadeable streams so they are presented together in the following sections.

Three laboratory samples are prepared from the composite index sample: an ID or enumeration sample (to determine taxonomic composition and relative abundances), a chlorophyll sample, a

biomass sample (for ash-free dry mass). Keep all the sample containers required for an individual stream in sealed in plastic bags until use to avoid external sources of contamination (e.g., dust, dirt, or mud) that are present at streamside.

Identification and Enumeration Sample

Prepare the ID/enumeration sample as a 50 mL aliquot from the composite index sample. **Be sure to mix the composite sample very well before pouring it off.** Preserve each sample with 2 mL of Lugols solution; this may be done in the lab if on the same day as the sample and the sample is kept cold. Record the SampleNum from the sample container label and the total volume of the sample (50 mL) in the appropriate fields on Form #9. Attach labels to the container and cover in foil. Explain any deviations from the target volumes in the comments field of the collection form.

Chlorophyll Sample

Prepare a chlorophyll sample by filtering a 25 mL aliquot of the composite index sample through a glass fiber filter (Figure 9-3; Whatman GF/F 47 mm diameter, 0.7 µm pore size). *Chlorophyll can degrade rapidly when exposed to bright light, so filter the samples in subdued light (or shade) as quickly as possible after collection to minimize degradation.* Rinse the filtration chamber with deionized water each day at the base site and seal it in a plastic bag until use at the stream. Keep the glass fiber filters in a dispenser inside a sealed plastic bag until use.

It is important to measure the volume of the sample being filtered accurately (±1 mL) with a graduated cylinder. During filtration, do not exceed 7 pounds per square inch (psi) to avoid rupturing cells. If the vacuum pressure exceeds 7 psi, prepare a new sample. If the filter clogs completely before the volume of sample in the chamber has been filtered, discard the sample and filter, and prepare a new sample using a smaller volume of sample. After filtering the sample, fold the filter paper in half and place it in a 50-mL centrifuge tube. Complete a sample label and check it to ensure that all written information is complete and legible. Affix the label to the centrifuge tube and cover it completely with a strip of clear tape. Record the SampleNum printed on the label and the volume filtered on SEI Form #9. Make sure the information recorded on the sample label matches the corresponding information recorded on the form. Record a flag and provide comments on the Sample Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity. Wrap the centrifuge tube in aluminum foil and store it in a self-sealing plastic bag in darkness. Store the sample frozen until shipment to the laboratory.

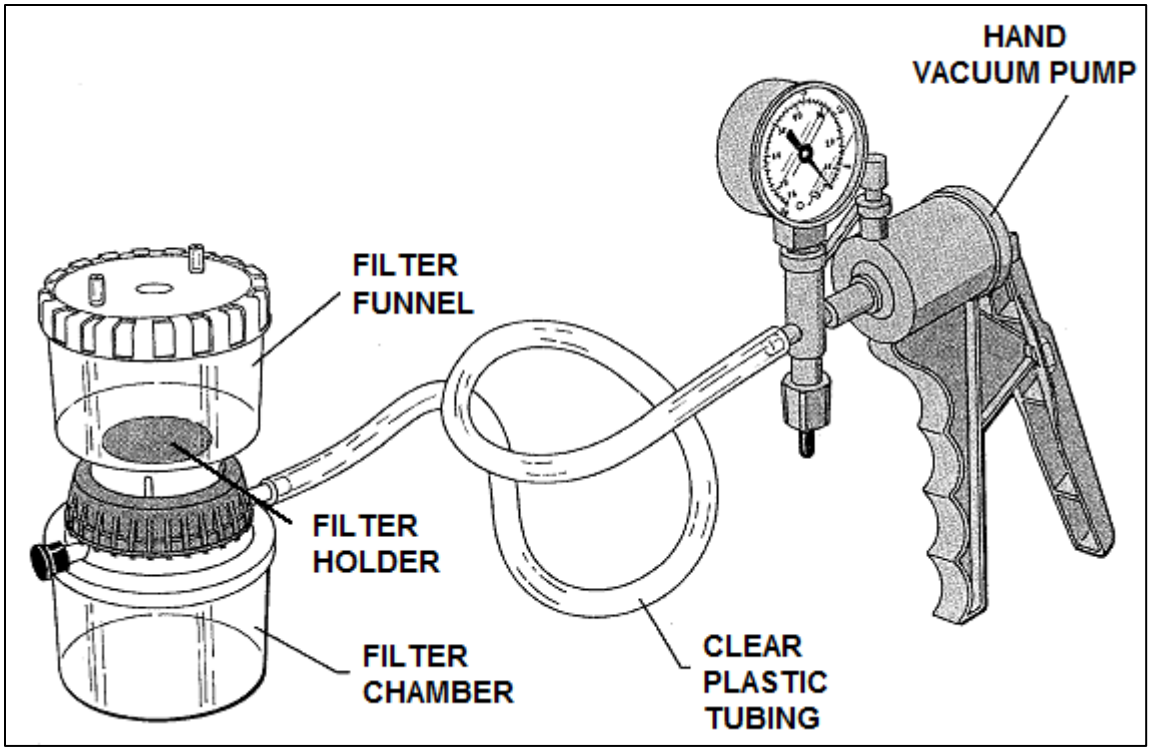


Figure 9-3. Filtration apparatus for preparing chlorophyll and biomass subsamples for periphyton (modified from Chaloud et al. 1989).

Biomass Sample

Prepare the biomass sample from a 25 mL aliquot of the composite index sample. Use a Whatman GF/C 47 mm diameter, 0.7 µm pore size filter. As with the chlorophyll sample, measure the volume to be filtered accurately (±1 mL). Rinse the filter chamber components and the graduated cylinder thoroughly between the chlorophyll and biomass samples with deionized water.

After filtering the sample, complete a biomass sample label as shown in Figure 9-4. Check the sample label to ensure that all written information is complete and legible. Affix the label to the 50-mL centrifuge tube and cover it completely with clear tape. Record the SampleNum printed on the label and the volume filtered on Form 9. Make sure the information recorded on the sample label matches the corresponding information recorded on the form. Record a flag and provide comments on the form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity. Wrap the centrifuge tube in aluminum foil and store it in a self-sealing plastic bag in darkness. Store the sample frozen until shipment to the laboratory.

Labels

Periphyton sample labels are shown in Figure 9-4. All labels for a set of the three sample types have the same SampleNum. Crew should fill in dates and initials on each bottle. The total composite volume (usually 500 ml) and the subsample volume or amount filtered must be recorded on SEI Form #9 and then entered into the database after each field event; these are key data. Attach completed labels to the appropriate containers and cover with clear tape.

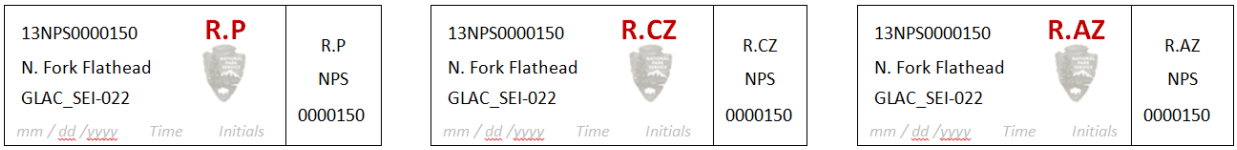


Figure 9-4. Periphyton sample labels. Each vial or filter paper from a site will have a label on the outside. The sample date and crew initials must be filled in prior to being attached to the sample. The SampleNum is a pre-generated sample that is unique to each sample. If the label is for a field duplicate it will have "duplicate" on it.

Didymosphenia geminata ("didymo") Abundance

Didymosphenia geminata ("didymo") is an aggressive, opportunistic invader that forms conspicuous growths on stream bottoms. Growths of didymo have been known to alter food web structure and stream ecosystem function, degrade water supplies, modify stream hydraulics, and strain regional and national economies through impacts on fisheries, tourism, and hydropower (EPA 2007).

To enhance the detection of this diatom, a simple set of additional qualitative measures are done at each transect in both wadeable and non-wadeable streams. These are in addition to augmented laboratory processing procedures (and the whole slide search that is necessary because of the large size of didymo valves).

Field Guide for Identification of D. geminata

The macroscopic appearance of *D. geminata* can be divided into four stages of colony growth and appearance:

- **Initial colony growth** – As the diatom cells attach to a rocky (or other) substrate and begin to produce stalks, the colonies appear as small, circular clumps that range from 2-10 mm. The growths are visible to the naked eye, and are light tan to brown in color. The clumps are soft and feel like a cotton ball when they are pulled apart. They are not slimy or slippery. This stage is common during the late winter or following periods of high flow, but can occur at any time of year, depending on the region.
- **Colony expansion** – As the colonies grow, they merge together and may cover the substrate completely. Colonies attached to plant stems from rope-like strands. As several small colonies coalesce and stalk production increases, the clumps become thicker. The colonies are frequently 1-2 cm in thickness, but may be thicker. The coverage on the streambed may be patchy, or the substrate across a transect may be completely covered.
- **Stalk proliferation** – Under periods of low flow or with favorable growth conditions, the colonies have the opportunity to form blooms. The cells produce excessive amounts of stalks many times the lengths of the microscopic cells. As the stalks lengthen, they form ropy strands and are white in color. Some reports describe the strands as tissue, fiberglass, toilet paper, or sheepskins.
- **Colony senescence** – Although the cells may die, the stalks persist on the stream substrate or stranded above the stream wetted zone. The stalks may persist for 2 months, or more. Stalks may

change in color as they trap fine sediment and dry. The microscopic cells may no longer be living, or present, in the aging stalk masses.

In the field, *D. geminata* can be confused with other stalk-forming diatom species. In particular, the visual appearance of *D. geminata* is very similar to its closest relatives, *Cymbella mexicana* and *C. mexicana* var. *janischii*; however, *D. geminata* is distinctive to the touch. When *D. geminata* stalks are pulled apart, there is some resistance and the stalks feel like wet cotton balls. Other diatom species have no such resistance, and they are slimy and slippery when the stalks are pulled apart.

Ideal didymo habitat includes moderate-velocity waters and backwaters of rivers (out of direct flow, but subject to constant water movement). Because didymo requires good light exposure, it generally is not in deep waters, though the alga may occur on the margins of faster-flowing, deeper areas. It requires stable substrates generally cobble-size or larger (> 150 mm diameter). After high flows didymo may still be found in protected patches on the downstream side of large rocks. Figures 9-5 and 9-6 show typical didymo cover and blooms.



Figure 9-5. Didymo at Swiftcurrent Creek, Glacier National Park, 2010 (left); didymo bloom on McDonald Creek, Glacier National Park, 2009 (right). Photos by B. Schweiger, NPS.





Figure 9-6. Early didymo growth (top left); **NOT** didymo (red algae; top right); more advanced didymo (lower left); infestation (lower right).

Quality Assurance and Quality Control Samples

Rigorous Quality Assurance and Quality Control (QAQC) procedures are followed within the ROMN SEI protocol. Duplicate periphyton samples will be generated at 10% of total samples to be collected within an index period. Samples are true duplicates, not splits from a single sample. During larger sample size surveys a minimum of 7-10 QC samples are collected allowing statistical analyses. During years with only sentinel sites QA samples are only compared qualitatively to regular samples. QC samples are analyzed for all three components (ID, biomass, and chlorophyll). Periphyton QC samples are all handled with the second page of SEI Form #9.

At the time of publication, a detailed Quality Assurance Performance Plan (QAPP) was under review by the US Environmental Protection Agency (Schweiger, In Review). The QAPP details all elements of QAQC for the SEI protocol including plans for incorporation of QAQC data into ROMN SEI data management and analyses.

Field and Lab Equipment for Periphyton

Table 9-2. A complete checklist of items needed for the periphyton field and lab methods.

Item	Quantity
SEI Protocol Document and/or laminated sheets of SOPs	1 copy
Form #9: Periphyton and Benthos	1 copy
Soft lead (#2) pencils	Many
Large funnel (15-20 cm diameter)	1
12 cm^2 area delimiter (3.8 cm [1.5 in] diameter PVC pipe, 3 cm tall)	2
Stiff-bristle toothbrush with handle bent at 90º angle	2
1-L wash bottle labeled “STREAM WATER”	1
1-L wash bottle labeled for and containing deionized water	1
500-mL plastic bottle (with volume markings) for composite index samples, labeled “PERIPHYTON COMPOSITE SAMPLE”	1
35-60 mL catheter-tipped plastic syringe	1
50-mL screw-top centrifuge tubes	3
Glass-fiber filters for chlorophyll (GF/F) and biomass (GF/C) samples	1 box
Forceps for filter handling.	1
25-mL or 50-mL graduated cylinder	1
Filtration unit, including filter funnel, cap, filter holder, and receiving chamber	1
Hand-operated vacuum pump and clear plastic tubing	1
Aluminum foil for wrapping containers holding chlorophyll and biomass filters	Several sheets
Self-sealing plastic bags for chlorophyll and biomass samples	3
10% formalin solution for ID/enumeration samples (20 mL if using diluted formalin)	Small bottle
Small syringe or bulb pipette for dispensing Lugol’s solution	1
Safety glasses and chemical-resistant gloves for handling formalin	1
Sample labels (3 per set) with the same barcode ID number	1 set
Covered clipboard (lightweight, with strap or lanyard to hang around your neck)	1
Safety gear	-
Personal gear	-

Periphyton Procedure: Collecting Composite Index Samples of Periphyton from a Wadeable Stream (SEI FORM #9)

1) Bio crew(s) will be at the bottom of the reach.
2) If the sampling points were not assigned previously when laying out the sampling reach, proceed to below the transect. Randomly determine if it is a left (L), center (C), or right (R) sampling point for collecting periphyton and benthic macroinvertebrate samples. For example, use a digital wristwatch and glance at the last digit (1-3 = L, 4-6 = C, 7-9 = R). Mark L, C, or R on the transect flagging. Assign sampling points at each successive transect in order as L, C, R after the first random selection.

3) Standing below the transect, determine if the assigned sampling point (L, C, or R) is located in an erosional (riffle) habitat or a slack water (pool) habitat. Collect a single sample at the point using the appropriate procedure below. **NOTE: to avoid disturbing the substrate on a transect, locate each sampling point 1-2 m downstream of the actual transect.**
4) Left, Center, or Right as you face downstream is at 25%, 50%, and 75% of the wetted width, respectively. If you cannot collect a sample at the designated point because of deep water or unsafe conditions, relocate the point on the same lateral plane at the closest safe sample location that will not interfere with other sample collection.
5) **Be sure to conduct the qualitative didymo measures described below**.

Erosional Habitats

1) Collect a sample of substrate (rock or wood) that is small enough (< 15 cm diameter) and can be easily removed from the stream. The selected piece should not be deeper than light penetration in the channel. Place the substrate in a plastic funnel which drains into a 500 mL plastic bottle with volume graduations marked on it and labeled Periphyton.
2) Use the area delimiter to define a 12 cm^2 area on the **upper** surface of the substrate. Dislodge attached periphyton from the substrate within the delimiter into the funnel by brushing with a stiff-bristled toothbrush for 30 seconds.
3) OR the area outside the area delimiter can be cleaned first, making sure to rinse this back into the channel. This leaves a non-cleaned area that is then cleaned off into the funnel.
4) Take care to ensure that the upper surface of the substrate is the surface that is being scrubbed.
5) Fill a wash bottle with stream water. Using a minimal volume of water from this bottle, wash the dislodged periphyton from the rock, delimiter, and funnel into the 500 mL bottle.

Depositional Habitats

1) Use the area delimiter to confine a 12 cm^2 area of soft sediments.
2) Vacuum the top 1 cm of sediments from within the delimited area into a catheter-tipped syringe (35-60 mL size).
3) Empty the syringe into the 500 mL PERIPHYTON bottle (combining it with samples collected from erosional habitats).
4) **Put the bottle in a cooler on ice or keep shaded and as cool as possible while you travel between transects and collect the subsequent samples (The samples need to be kept cool and dark because a chlorophyll sample will be filtered from the composite).**
5) Repeat step 1 for transects B through K. Place the sample collected at each sampling site into the single 500 mL bottle to produce the composite index sample.
6) After samples have been collected from all 11 transects**, thoroughly mix the 500 mL bottle regardless of substrate type**. Record the total estimated volume of the composite sample in the periphyton section of the Form #9.

Periphyton Procedure: Collecting Composite Index Samples of Periphyton from a Non-wadeable Stream (SEI FORM #9)

1) Starting with transect A, collect a single sample from the assigned sampling station using the procedure below.
2) Evaluate the littoral plot and determine the dominant habitat type (erosional or depositional). Record on SEI Form #9. Follow the relevant methods below.
3) **Be sure to conduct the qualitative didymo measures described below**.

Erosional Habitats

1) Collect a sample of substrate (rock or wood) that is small enough (< 15 cm diameter) and can be easily removed from the stream. The selected piece should not be deeper than light penetration in the channel. Place the substrate in a plastic funnel which drains into a 500 mL plastic bottle with volume graduations marked on it and labeled PERIPHYTON.
2) Use the area delimiter to define a 12 cm^2 area on the **upper** surface of the substrate. Dislodge attached periphyton from the substrate within the delimiter into the funnel by brushing with a stiff-bristled toothbrush for 30 seconds.
3) OR the area outside the area delimiter can be cleaned first, making sure to rinse this back into the channel. This leaves a non-cleaned area that is then cleaned off into the funnel.
4) Take care to ensure that the upper surface of the substrate is the surface that is being scrubbed.
5) Fill a wash bottle with stream water. Using a minimal volume of water from this bottle, wash the dislodged periphyton from the rock, delimiter, and funnel into the 500 mL bottle.

Depositional Habitats

1) Use the area delimiter to confine a 12 cm^2 area of soft sediments.
2) Vacuum the top 1 cm of sediments from within the delimited area into a catheter-tipped syringe (35-60 mL size).
3) Empty the syringe into the 500 mL PERIPHYTON bottle (combining it with samples collected from erosional habitats).
4) Repeat these steps for transects all other transects as the crew moves up the channel to produce the composite index sample for the stream reach. Use the same 500 ml bottle for each sample. *Keep the collection bottle out of direct sunlight as much as possible to minimize degradation of chlorophyll.*
5) **Put the bottle in a cooler on ice while you travel between transects and collect the subsequent samples. (The sample needs to be kept cool and dark because a chlorophyll sample will be filtered from the composite sample.)**
6) Repeat Step 1 for transects B through K. Place the sample collected at each sampling site into the single 500 mL bottle to produce the composite index sample.

7) After samples have been collected from all 11 transects**, thoroughly mix the 500 mL bottle regardless of substrate type**. Record the total estimated volume of the composite sample in the periphyton section of the Sample Collection Form.

Periphyton Procedure: Qualitative Didymo Abundance (SEI FORM #9)

1) At each cross-section transect (wadeable) or shoreline littoral plot (non-wadeable), scan area **1 m in** from the wetted width upstream and downstream **5 m (wadeable) or 10 m (non-wadeable)** for didymo.
2) Record the areal cover of didymo to nearest 5% in this 1 x 5 or 1 m plot.
3) Estimate the average thickness of didymo.
4) If didymo is seen outside of these search areas, but within the sampled reach, record its categorical abundance:
   a) 0 = not visible
   b) L = minor cover, not exceeding 10% of available substrate
   c) M = medium cover, 10-50% of available substrate
   d) H = high cover, exceeding 50% of available substrate
5) Take any notes on the extent and severity of cover of didymo.

Periphyton Procedure: Preparing Identification/Enumeration Sample (SEI FORM #9)

1) Record the volume of the composite sample (typically 500 mL) on SEI Form #9. Double check the volume recorded on form.
2) Thoroughly mix the bottle containing the composite index sample.
3) **Quickly, before the swirling mix has settled**, pour 50 mL of the composite index sample into a 50 mL centrifuge tube.
4) Wear gloves and safety glasses. Use a syringe or bulb pipette to add 2 mL of Lugol's solution (or formalin, see below) to the sample. Cap the tube tightly and seal with plastic electrical tape. Shake gently to distribute the preservative. This may be done at the base station if done that evening and the sample can be kept cool and in the dark.
5) NOTE: If using previously diluted formalin (e.g., 10-12%) as a preservative, **adjust the subsample volume to 40 mL and add 10 mL of preservative solution.** Note the use of diluted preservative in the comments. Double check that the volume recorded on the collection form matches the total volume recorded on the corresponding sample label, especially if you are using diluted formalin as a preservative. This may be done at the base station if done that evening and the sample can be kept cool and in the dark.
6) Record the SampleNum of the label on SEI Form #9.
7) Record the volume of the subsample (typically 50 mL; exclude the 2 ml volume of preservative added to the ID sample) on SEI Form #9. Double check the volume recorded on form.

8) Confirm that the label is correct: The Site ID, sample date, and code for each sample must be correct (CL = chlorophyll, AF = biomass, and PR = identification).

9) Cover in tape and then in foil. Place the centrifuge tube into a self-sealing plastic bag. Place the plastic bag into a portable freezer, a cooler containing dry ice, or between two sealed plastic bags of ice in a cooler.

10) Do not discard composite sample until other two samples have been processed.

Periphyton Procedure: Preparing Chlorophyll and AFDM (Biomass) Samples (SEI FORM #9)

1) If not done already, record the composite sample volume on SEI Form #9.
2) Using clean forceps, place a **GF/F** glass fiber filter on the filter holder. Use a small amount of deionized water from a wash bottle to help settle the filter properly. Attach the filter funnel to the filter holder and filter chamber, then attach the hand vacuum pump to the chamber.
3) Rinse the sides of the filter funnel and the filter with a small volume of deionized water.
4) Rinse a 25 mL or 50 mL graduated cylinder (or a centrifuge tube with volume markings) three times with small volumes of deionized water.
5) Thoroughly mix the bottle containing the composite index sample.
6) Quickly, before the swirling mix has settled, pour 25 mL (±1 mL) of sample into the graduated cylinder. *The filtered volume is very important to measure and record carefully.*
7) Pour the 25 mL aliquot from the graduated cylinder into the filter funnel, and pump the sample through the filter using the hand pump. **NOTE: Do not exceed 7 psi of vacuum pressure to avoid rupturing fragile algal cells.** NOTE: For hard-to-filter samples, try tilting the filter apparatus to the side.
8) If 25 mL of sample will not pass through the filter, discard the filter and rinse the chamber thoroughly with deionized water. Repeat steps 1 through 6, but use a smaller volume of sample in the filter apparatus, measured to ±1 mL. ***Be sure to record the actual volume filtered on the sample label and SEI Form #9.***
9) Remove both plugs from the filtration chamber and pour out the filtered water in the chamber. Remove the filter funnel from the filter holder. **Remove the filter from the holder with clean forceps. Avoid touching the colored portion of the filter. Fold the filter in half, with the colored side folded in on itself.** Place the folded filter paper into a 50 mL centrifuge tube.
10) If not done already, record the SampleNum of the label on SEI Form #9.
11) Record the volume filtered (typically 25 mL) on SEI Form #9. Double check the volume recorded on form.
12) Confirm that the label is correct: The Site ID, sample date, and code for each sample must correct (CL = chlorophyll, AF = biomass, and PR = identification).
13) Cover the label in tape and then wrap the centrifuge tube in foil. Place the centrifuge tube into a self-sealing plastic bag. Place the plastic bag into a portable freezer, a cooler containing dry ice, or between two sealed plastic bags of ice in a cooler.

14) Do not discard composite sample until other two samples have been processed.

15) Rinse the filter funnel, filter holder, filter chamber, and graduated cylinder thoroughly with deionized water. **Do not forget to do this.**

16) Repeat steps 1 through 13 to prepare the biomass sample, completing a periphyton sample label for biomass and recording sample information in the biomass section of SEI Form #9.

   a) **Be sure to use a GF/C filter (not a GF/F) for the biomass sample. You cannot tell the two types apart once you remove them from the box**.

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SEI SOP 10: Macroinvertebrates

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents methods for collecting samples of macroinvertebrates from stream substrates. Macroinvertebrates samples are collected during all base- or full-sample events at all site and stream types. ROMN SEI monitoring uses macroinvertebrates as an indicator of the ecological integrity of a site via models that assess species composition or various functional attributes relative to reference conditions.

Some of the narrative that follows and most ROMN SEI macroinvertebrates procedures are modified from the EPA EMAP (Peck et al. 2006) and National River and Streams Assessment (EPA 2007) programs. We also derive some methods, and in particular analytical tools, from MT DEQ (2012).

All data are recorded on a SEI Form #9: Periphyton and Benthos.

Field Methods

Wadeable

Overview of Work Flow

Prior to initiating benthic sampling, crews have verified and documented the site, determined the length of stream reach to be sampled, and established the required transects. The bio crew (usually 1 person) is then at the bottom of the reach (*de facto* X site, transect A) and begins collection of periphyton and macroinvertebrates before any other channel-disturbing activities are done. These are done successively upstream of one another; therefore, a downstream offset from the actual location of a transect is needed. Offsets must be maintained between these sample locations, and the thalweg profile sites such that disturbance from the kick samples and other activities does not impact the substrate being quantified. After all measures are completed, eleven samples of macroinvertebrates will have been collected from a "normal" stream site. After the last sample, crews will prepare one composite sample for the site. At the completion of the day's sampling activities, but before leaving

the site, a laboratory sample (an ID/enumeration sample to determine taxonomic composition and relative abundances) is elutriated from the composite sample.

Transect Samples

The general scheme for collecting a composited sample of macroinvertebrate across the entire reach is illustrated in Figure 10-1. Table 10-1 provides a summary of each sample type collected.

At each transect, collect a sample from an assigned sampling point (left [L], center [C], or right [R]). Locate the sampling point 0.5 to 1 m downstream of the cross-channel transect, but 0.5 to 1 m upstream of where the periphyton has just been sampled to avoid disturbing substrates that are enumerated and classified as part of the physical habitat characterization or sampling disturbed areas that are part of the periphyton procedures. Sampling points (L, C, R) at each transect may have been assigned when the sampling reach was laid out. If not, assign the sampling point at transect A at random using a digital watch or other suitable means. Once the first sampling point is determined, the rest alternate (L then R then C). At transects assigned a Center sampling point where the stream width is between one and two net-widths wide, pick either the Left or Right sampling point instead. If the stream is only one net-width wide at a transect, place the net across the entire stream width and consider the sampling point to be Center. If a sampling point is located in water that is too deep or otherwise unsafe to wade, select an alternate nearby sampling point.

At each sampling point, record the gear type used and if the habitat is a pool, glide, riffle/run rapid, or some other type. Any area where there is not sufficient current to extend the net is operationally defined as a pool or glide habitat. Also record the dominant substrate type fine/sand, gravel, coarse substrate (gravel or larger), or other (e.g., bedrock, hardpan, wood, aquatic vegetation, etc.) for each sample. Note that all samples are combined into a single container regardless of how they were collected or their habitat type.

Choosing the Correct Gear Set

The default gear set for ROMN SEI macroinvertebrate sampling is a modified D-net with 500 µm mesh and a detachable dolphin bucket also with 500 µm mesh (Figure 10-2 and Figure 10-3). The default method is a one-person timed kick sample with the net held tight to the substrate. This should work in the majority of sampling situations in ROMN streams. The D-net can also be used with other methods, such as in slack water or in vegetation-choked sampling points where a 1 ft^2 (0.09 m^2) sample area is delineated and the net is swept through the water column or vegetation for 30 seconds.

When a stream is over 3x deeper than the D net and/or most substrates are bigger than cobbles (or around 30 cm in diameter), but the stream is still safely wadeable, a Stanford-Hauer net should be used (Figure 10-4; also called FLBS net). The ROMN SEI version of this net is also constructed with 500 µm mesh throughout. Results are corrected for any differences in sample area between the two net types

Finally, if it is impossible to sample at the sampling point with either the modified kick net or the FLBS net, samples may be hand-picked from a delineated area, but this is the method of last choice.

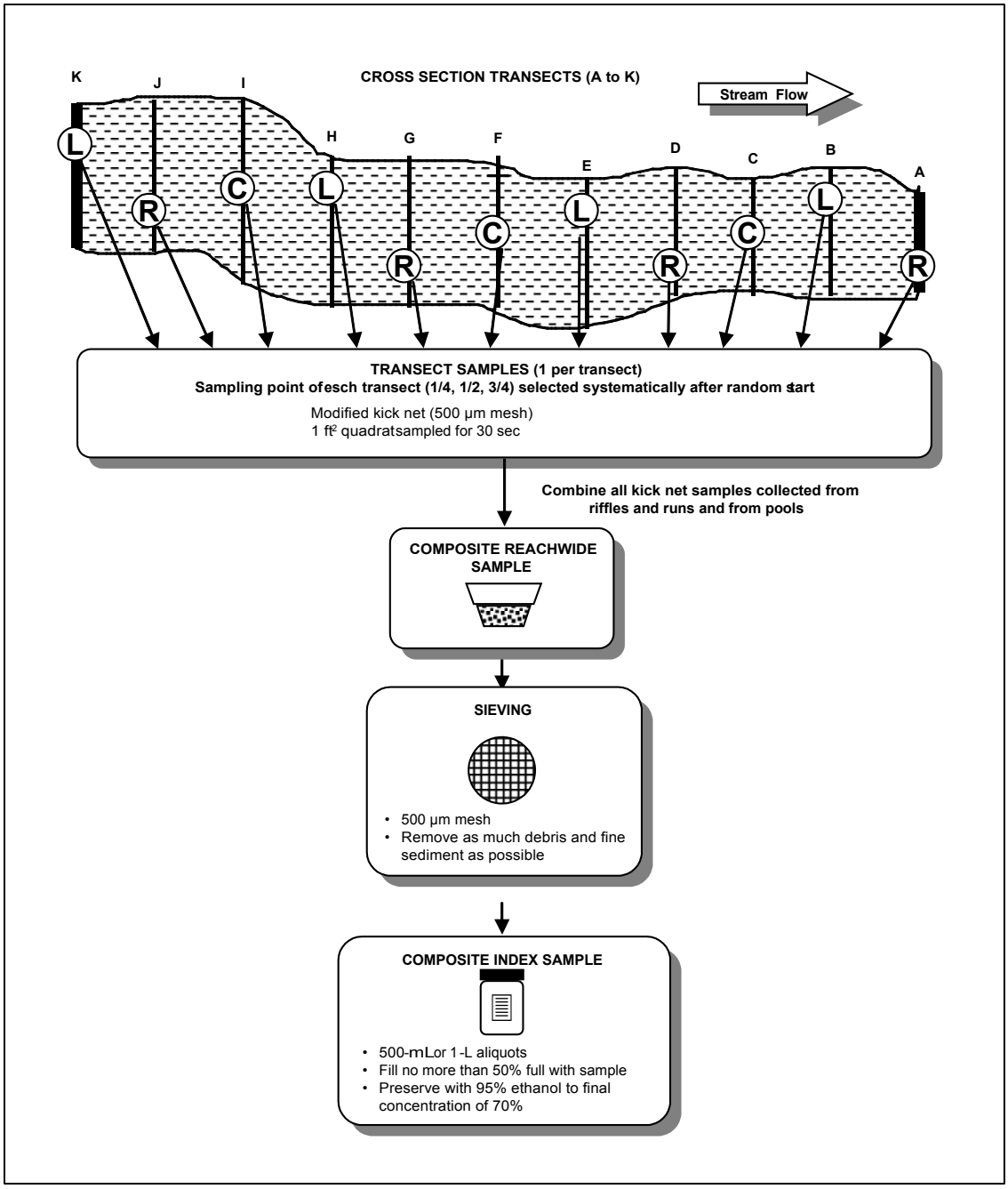


Figure 10-1. Generalized diagram of macroinvertebrate sample locations, processing and final sample types (modified from Peck et al. 2006).

Table 10-1. ROMN SEI biological samples with sample names, parameters, sample type, preservative, and storage.

Sample Type Code	Parameters	Bottle Size/Type	Sample Method	Preservative	Storage
R.BS	Benthos ID soft sample	1-liter Ziploc bag Triple bagged	Composite kick sample; elutriated "soft" portion	95% ETOH[1]	Ice
R.BH	Benthos ID hard sample	1-liter Ziploc bag Triple bagged	Composite kick sample "hard" remainder from elutriated sample	95% ETOH[1]	Ice
H.P	Periphyton – ID sample	50 ml vial	Aliquot from composite sample from known area of erosional or depositional substrate	M-fixative	Ice
R.CZ	Periphyton-based Chlorophyll-a	Foil wrapped GF/F[2] filter paper in 35 or 50 ml vials	Aliquot from composite sample from known area of erosional or depositional substrate	-	Freeze
R.AZ	Periphyton-based Ash-Free Dry Mass	Foil-wrapped GF/C[2] filter paper in 35 or 50 ml vials	Composite sample	-	Freeze

[1]ETOH: Ethanol

[2]GF/ F or C: glass fiber filter, fine or course

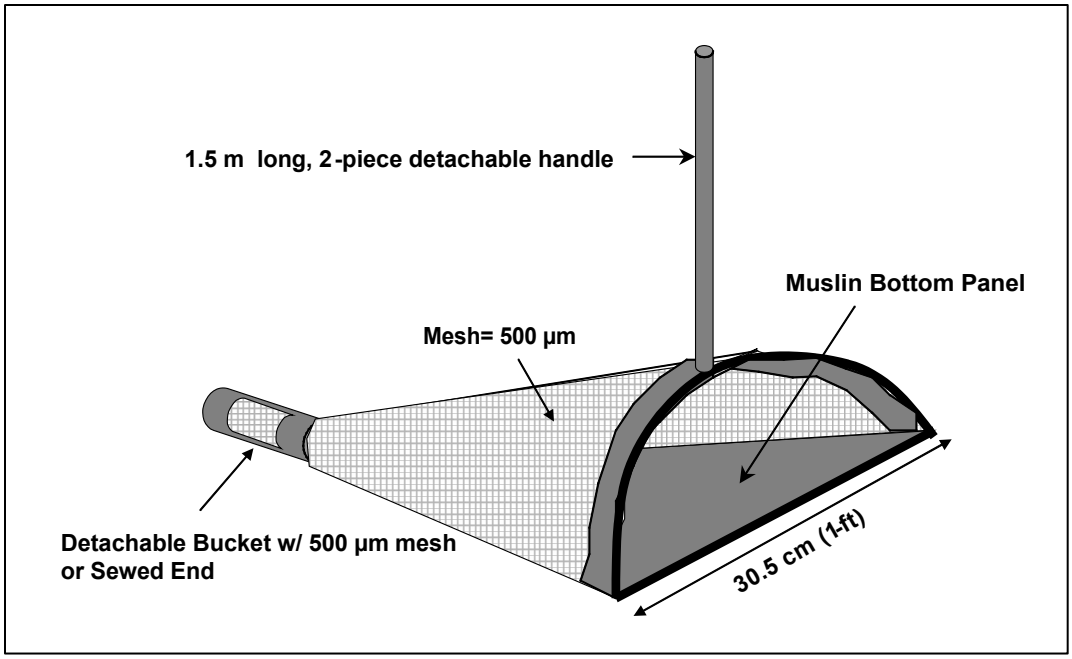


Figure 10-2. Diagram of modified D-frame kick net (Peck et al. 2006).



Figure 10-3. Modified D-frame kick net being deployed by one person. Photo by B. Schweiger, NPS.



Figure 10-4. Standford-Hauer (FLBS) net being deployed by two people (A) and one person (B). Photos by R. Hauer, FLBS (A) and B. Schweiger, NPS (B).

Non-wadeable

Overview of Work Flow

Prior to initiating sampling of benthos, crews will be at transect A or the *de facto* X site (top of the reach). They will have measured and confirmed the (GIS-assigned) wetted width and channel layout, constructed monument(s), taken site photos, and conducted any littoral water chemistry sampling (as applicable). The bio crew then collects benthos from the near-shore shallows in the littoral plot using the most appropriate gear. After all other activities, the crew will travel to the next shoreline plot where the relevant methods are repeated. This is done at sampling stations located on the 11 cross-section transects (A through K) established within the sampling reach. After all measures are completed, eleven samples of macroinvertebrates will have been collected from a "normal" stream site. After the last sample, crews will prepare one composite sample for the site. At the completion of the day's sampling activities, but before leaving the site, a laboratory sample (an ID/enumeration sample to determine taxonomic composition and relative abundances) is elutriated from the composite sample.

Safety is a special concern in non-wadeable streams and will always be the first consideration when working at put-in and take-out, shoreline locations, cross sections, etc. All crew must wear PFDs, and boat operators must be experienced. Equipping the boat with a bow or stern anchor to stop at transect locations can greatly ease the shore marking operation and shoreline measurement activities, though such equipment can be dangerous in white-water rivers.

Littoral Plot Samples

The general scheme for collecting a composite sample of macroinvertebrates across the entire reach is similar to that used in wadeable streams (Figure 10-5). Table 10-1 above provides a summary of each sample type collected.

Gear choices for sampling are described above. At each of the 11 littoral plots, crews collect a 30-second timed kick sample from the dominant habitat type within the 10 x 15 m littoral plot. In deep water areas, samples are collected with a 1-linear-meter D-net sweep within the dominant habitat type from the boat. At each sampling point, record the gear type used and if the habitat is a pool, glide, riffle/run rapid, or some other type. Any area where there is not sufficient current to extend the net is operationally defined as a pool or glide habitat. Also record the dominant substrate type (fine/sand, gravel, coarse substrate [gravel or larger] or other [e.g., bedrock, hardpan, wood, aquatic vegetation, etc.]) for each sample. Note that all samples are combined into a single container regardless of how they were collected or their habitat type.

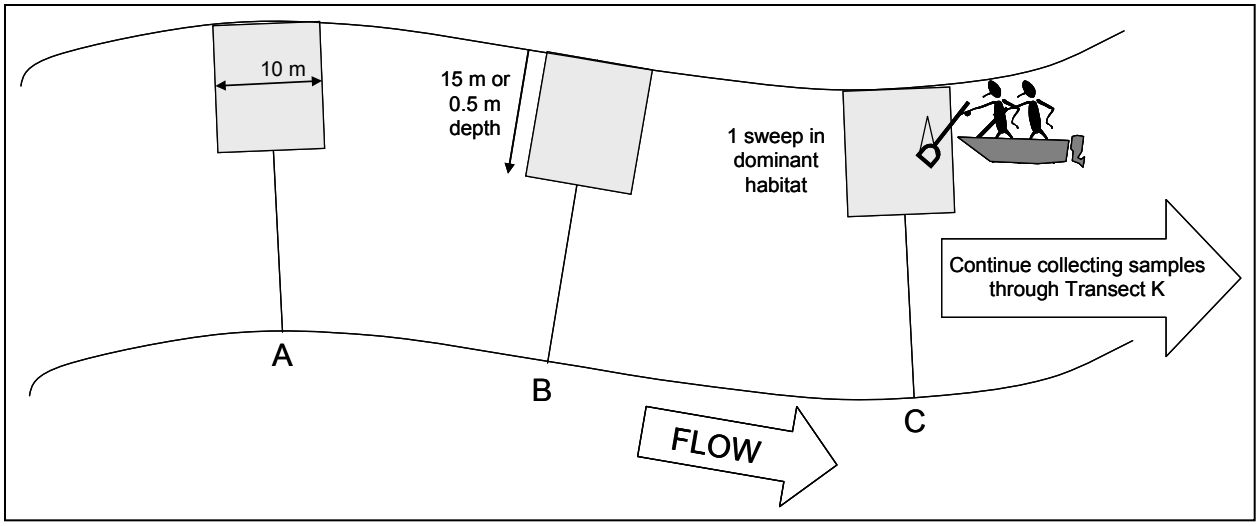


Figure 10-5. Littoral plots for collecting benthic macroinvertebrates at non-wadeable sites (Lazorchak et al. 2000).

Processing Samples

Methods for sample preparation are identical for both wadeable and non-wadeable streams, so they are presented together in the following sections.

One laboratory sample is prepared from the composite sample: an ID or enumeration sample (to determine taxonomic composition and relative abundances). Keep all the sample containers required for an individual stream sealed in plastic bags until use to avoid external sources of contamination (e.g., dust, dirt, or mud) that are present at streamside.

The ID/enumeration sample is created by elutriating the composite sample into a "soft" (most macroinvertebrates and other softer organic material) and "hard" portion (the remaining harder substrates). Record the SampleNum from the sample container label in the appropriate fields on SEI Form #9. Attach labels to all bags.

Labels

Macroinvertebrate sample labels are shown in Figure 10-6. The sample name is given in large type along with various codes for the bottle type, etc. Crew should fill in dates and initials on each bottle. The total number of bags (1 of 2, 2 of 2) should be noted on the label and on SEI Form #9. Attach completed labels to the appropriate containers and cover with clear tape.

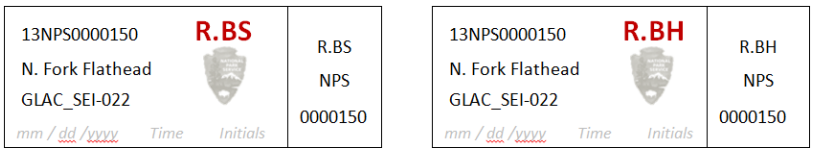


Figure 10-6. Benthos sample labels. The sample date and crew initials must be filled in prior to being attached to the sample. The SampleNum is a pre-generated sample that is unique to each sample.

Quality Assurance and Quality Control Samples

Rigorous Quality Assurance and Quality Control (QAQC) procedures are followed within the ROMN SEI protocol. Duplicate macroinvertebrate samples will be generated at 10% of total samples to be collected within an index period. Samples are true duplicates, not splits from a single sample. During larger sample size surveys, a minimum of 7-10 QC samples are collected allowing statistical analyses. During years with only sentinel sites, QA samples are only compared qualitatively to regular samples. Macroinvertebrate QC samples are all handled with the second page of SEI Form #9.

At the time of publication, a detailed Quality Assurance Performance Plan (QAPP) was under review by the US Environmental Protection Agency (Schweiger, In Review). The QAPP details all elements of QAQC for the SEI protocol including plans for incorporation of QAQC data into ROMN SEI data management and analyses.

Field and Lab Equipment for Macroinvertebrate

Table 10-2. A complete checklist of items needed for the macroinvertebrate field and lab methods.

Item	Quantity
SEI Protocol Document and/or laminated sheets of SOPs	1 copy
Form #9: Periphyton and Benthos	1 copy
Soft lead (#2) pencils	Many
Modified kick net (D-frame with 500 µm mesh)	1
Stanford-Hauer or FLBS-style net with 500 µm mesh	1
Poles for FLBS-style net (use the measuring sticks, survey rod, etc. as possible)	2
Hand held bolos nets with 100 µm mesh	2
Sieve with 500 µm mesh openings or sieve-bottomed bucket, 500 µm mesh openings	1
Spare net(s) and/or spare bucket assembly for end of net (optional)	1
Watch with timer or a stopwatch	1
Plastic buckets, 8- to 10-qt capacity (2 if rockbasket sample is done, otherwise 1)	1 or 2
Watchmakers' forceps (straight and curved)	1
Wash bottle, 1 L capacity labeled STREAM WATER	1
Small spatula, spoon, or scoop to transfer sample	1
Funnel, with large bore spout	1
Sample jars, HDPE plastic with leak-proof screw caps, 500-mL and/or 1-L capacity, suitable for use with ethanol	1-many
Sample bags, thick mil, 500-mL and/or 1-L capacity, suitable for use with ethanol	1-many
95% ethanol, in a proper container	1
Rubber gloves suitable for use with ethanol	1
Cooler (with suitable absorbent material) for transporting ethanol and samples	1
Preprinted benthic sample labels with sample ID numbers	Many
Preprinted benthic sample labels without sample ID numbers	Many
Blank labels on waterproof paper for inside of jars	Many

Table 10. A complete checklist of items needed for the macroinvertebrate field and lab methods, cont.

Item	Quantity
Clear tape strips	1
Plastic electrical tape	1
Knife, pocket, with at least two blades	1
Scissors	1
Pocket-sized field notebook (optional)	1
Kim wipes in small self-sealing plastic bag	Many
Safety gear	-
Personal gear	-

Macroinvertebrate Procedure: Sampling at Wadeable Sites (SEI FORM #9)

1) Crews will be at the bottom of the reach and have completed the periphyton sampling for that transect.
2) If the sampling points were not assigned previously when laying out the sampling reach, proceed to below the transect. Randomly determine if it is a left (L), center (C), or right (R) sampling point for collecting periphyton and benthic macroinvertebrate samples. For example, use a digital wristwatch and glance at the last digit (1-3 = L, 4-6 = C, 7-9 = R). Mark L, C, or R on the transect flagging. Assign sampling points at each successive transect in order as L, C, R after the first random selection.
3) Standing below the transect, determine the gear and method to be used at the site (L, C or R site; record these on Form #9. Assessing the substrate and habitat will help with this. For example, if the substrate is coarse and the water deep, the FLBS may be needed. Or, if there is not sufficient current in the area at the sampling point to fully extend a net (either the D or FLBS net), a sweep procedure may be needed. Use best judgment, but remember the D-net kick sample is the default method. NOTE: to avoid disturbing the substrate, locate each sampling point 0.5 to 1 m downstream of the actual transect.
4) Left, Center, or Right as you face downstream is at 25%, 50%, and 75% of the wetted width, respectively. If you cannot collect a sample at the designated point because of deep water or unsafe conditions, relocate the point on the same lateral plane at the closest safe sample location that will not interfere with other sample collection.
5) Assess the substrate and habitat type <u>where the sample is taken</u>; record these on Form #9. NOTE: This habitat type may be different from that recorded during the thalweg profile (SEI SOP 8: Physical Habitat), which is based on a channel-width scale, rather than a quadrat scale. It also may be easier to classify the substrate type after the sample is taken as you will have more contact with it during the sampling. If there are co-dominant substrate types (more or less equal proportions), you may circle more than one type; note the co-dominants in the comments section of the form.
6) Substrate types are:
    a) FS: Fine/Sand (ladybug or smaller; < 2 mm)

b) GR: Gravel (ladybug to tennis ball; 2 to 64 mm)

c) CO: Coarse (tennis ball to car sized; 64 to 4,000 mm)

d) OT: Other (bedrock, hardpan, wood, etc., explain)

7) Habitat types are:

a) PL: Pool - Still water; low velocity with smooth, glassy surface; usually deep compared to other parts of the channel

b) GL: Glide - Water moving slowly, with smooth, unbroken surface; low turbulence

c) RF: Riffle/run - Water moving, with small ripples, waves, and eddies; waves not breaking, and surface tension is not broken; "babbling" or "gurgling" sound

d) RP: Rapid - Water movement is rapid and turbulent; surface with intermittent "white water" with breaking waves; continuous rushing sound

e) OT: Other (explain)

8) Collect a single sample at the point using the appropriate procedure below.

D-Net, Kick Sample

1) Attach the handle to the kick net. Make sure that the handle is on tight or the net may become twisted in a strong current, causing the loss of part of the sample. Attach the dolphin bucket and make sure it is secure and that the netting in the window is in place.

2) Riffle/Run Habitats:

a) Record the start time before the following methods are done.

b) With the net opening upstream, position the net quickly and securely on the stream bottom to eliminate gaps under the frame. Avoid large rocks that prevent the sampler from seating properly on the stream bottom.

c) NOTE: If there is too little water to collect the sample with the kick net, see the hand-picked procedure below (that will still use a net).

d) Holding the net in position on the substrate, visually define a rectangular quadrat that is one net-width wide and one net-width long upstream of the net opening. The area within this quadrat is 30 cm^2 or 0.09 m^2 (1 ft^2). Alternatively, place a wire frame of the correct dimensions in front of the net to help delineate the quadrat to be sampled.

e) Hold the net in place with your knees. Check the quadrat for heavy organisms, such as mussels and snails. Remove these organisms from the substrate by hand and place them into the net. Pick up any loose rocks or other larger substrate particles in the quadrat. Use your hands or a small scrub brush to dislodge organisms so that they are washed into the net. Scrub all rocks that are golf ball sized or larger and which are over halfway into the quadrat. Large rocks that are less than halfway into the sampling area are pushed aside. After scrubbing, place the substrate particles outside of the quadrat. This is not part of the time limit applied to the sample collection; however, it should be standardized as much as possible across sample collections.

f) Keep holding the sampler securely in position. Start at the upstream end of the quadrat, vigorously kick the remaining finer substrate within the quadrat for **30** seconds (use a stopwatch).

g) For samples located within dense beds of long, filamentous aquatic vegetation (e.g., algae or moss), kicking within the quadrat may not be sufficient to dislodge organisms in the vegetation. Usually these types of vegetation are lying flat against the substrate due to current. Use a knife or scissors to remove **only the vegetation that lies within the quadrat** (i.e., not entire strands that are rooted within the quadrat) and place it into the net. This is not part of the time limit applied to the sample collection; however, it should be standardized as much as possible across sample collections.

h) Pull the net up out of the water. Immerse the net in the stream several times to remove fine sediments and to concentrate organisms at the end of the net. Avoid having any water or material enter the mouth of the net during this operation.

i) Go to Composite Sample Creation.

3) Pool/Glide Habitats:

a) Record the start time before the following methods are done.

b) Visually define a rectangular quadrat that is one net-width wide and one net-width long at the sampling point. The area within this quadrat is 30 cm^2 or 0.09 m^2 (1 ft^2). Alternatively, lay a wire frame of the correct dimensions in front of the net at the sampling point to help delineate the quadrat.

c) Inspect the stream bottom within the quadrat for any heavy organisms, such as mussels and snails. Remove these organisms by hand and place them into the net or into the bottle labeled REACHWIDE. Pick up any loose rocks or other larger substrate particles within the quadrat and hold them in front of the net. Use your hands (or a scrub brush) to rub any clinging organisms off of rocks or other pieces of larger substrate (especially those covered with algae or other debris) into the net. After scrubbing, place the larger substrate particles outside of the quadrat. This is not part of the time limit applied to the sample collection; however, it should be standardized as much as possible across sample collections.

d) Vigorously kick the remaining finer substrate within the quadrat with your feet while dragging the net repeatedly through the disturbed area just above the bottom. Keep moving the net all the time so that the organisms trapped in the net will not escape. Continue kicking the substrate and moving the net for **30** seconds. NOTE: If there is too little water to use the kick net, stir up the substrate with your gloved hands and use a sieve with 500 µm mesh size to collect the organisms from the water in the same way the net is used in larger pools.

e) After 30 seconds, remove the net from the water with a quick upstream motion to wash the organisms to the bottom of the net.

f) NOTE: If there is too little water to collect the sample with the kick net, see the hand-picked procedure below (that will still use a net).

g) Go to Composite Sample Creation.

4) Very Vegetation Clogged Habitats:
   a) Record the start time before the following methods are done.
   b) Visually define a rectangular quadrat *as possible within the vegetation* that is one net-width wide and one net-width long at the sampling point. The area within this quadrat is 30 cm^2 or 0.09 m^2 (1 ft^2).
   c) Sweep the net through the vegetation within the delineated area for 30 seconds.
   d) After 30 seconds, remove the net from the water with a quick upstream motion to wash the organisms to the bottom of the net.
   e) NOTE: If there is too little water to collect the sample with the kick net, see the hand-picked procedure below (that will still use a net).
   f) Go to Composite Sample Creation.

FLBS Net, Kick Sample

1) Place the handles in the net.
2) Riffle/Run Habitats:
   a) Record the start time before the following methods are done.
   b) Align the net opening so it is perpendicular to the flow.
   c) Visually define a rectangular quadrat that is one net width wide and one net width long at the sampling point. The area within this quadrat is 30 cm^2 or 0.09 m^2 (1 ft^2). Alternatively, lay a wire frame of the correct dimensions in front of the net at the sampling point to help delineate the quadrat.
   d) Position the benthos net downstream of the delineated area so that the bottom of the net is flush with the river bottom and the net is curved to catch all benthos dislodged during the sampling process. You may place rocks on the bottom of the net to hold it down if those rocks come from within the delineated area.
   e) If two people are sampling (common for safety in habitats that require the FLBS net), one person should hold the net to avoid interrupting the flow of water through the net. If one person is sampling with the FLBS net, the following procedures can be done if the poles are crossed and held in one hand, but this takes practice.
   f) The second person, located upstream of the net, will pick up all the larger rocks in the delineated area, rubbing or washing the surfaces clean of clinging benthos. This is not part of the time limit applied to the sample collection; however, it should be standardized as much as possible across sample collections.
   g) Disturb the river bottom with your feet for **30** seconds using a twisting motion.
   h) When the time is up, each person should take hold of one of the wooden stakes on each side of the net and then together carefully raise the net from the water so that no organisms are lost over the top of the net (always keep the upper end of the net above the surface of the water).

i) Wash organisms down the net into the attached bucket by strongly splashing water on the sides of the net.

j) Go to Composite Sample Creation.

3) Pool/Glide Habitats:

a) It is unlikely that the FLBS net can be used in a true pool habitat unless there is enough flow to extend the rear of the net. If so, the procedures are the same as if being used in a riffle or run.

4) Hand Picked, Either Net:

a) If there is too little water to collect the sample with the either net, hand pick a sample from about 0.09 m^2 (1 ft^2) of substrate at the sampling point. The net will still be used as a receptacle for the hand picking. The D-net will work better for this purpose.

b) This procedure is not timed given the variability in the situations that will lead to this. Instead it is limited to **10 rocks or other pieces of substrate**.

c) Check the quadrat for heavy organisms, such as mussels and snails. Remove these organisms from the substrate by hand and place them into the net. Randomly pick up 10 rocks or other larger substrate particles in the quadrat. Use your hands or a small scrub brush to dislodge organisms so that they are washed into the net. Scrub all rocks that are golf ball-sized or larger and which are over halfway into the quadrat. Large rocks that are less than halfway into the sampling area are pushed aside. After scrubbing, place the substrate particles outside of the quadrat. Use a wash bottle with stream water to help wash each hand-picked rock into the net.

d) After complete, wash any organisms to the bottom of the net using a stream water wash bottle.

e) Go to Composite Sample Creation.

Creation of the Composite Sample at Each Transect (this is not the Final Sample Preparation)

1) This occurs after each sample at a transect and is relatively consistent across methods used to collect the sample. The final processing of the composite sample after all transects are sampled is discussed below.

2) On land, transfer the contents from the D-net or FLBS dolphin bucket to a large plastic bucket. Use a squirt bottle filled with stream water and watchmakers' forceps if necessary to remove organisms from the net. Carefully inspect any large objects (such as rocks, sticks, and leaves) in the bucket and wash off any organisms found on the objects into the bucket before discarding the object.

3) Add water to the plastic bucket and swirl in order to separate the bugs from the sediment and rocks that settle to the bottom of the bucket.

4) Pour the decanted contents from the plastic bucket into a small bolos net with 100 µm mesh or traditional seive, removing all water from the sample.

5) Repeat at least 3 times or more until all organisms are transferred out of the bucket into the bolos net. Be sure to check the sediments at the bottom of the bucket for any caddisflies, as their cases may weigh them down.
6) Transfer the sample from the sieve or bolos net to the Reach-wide benthos jar or bag.
7) This jar or bag is used repeatedly until it is about ¾ full of sample. After this, a second, third, etc. reach-wide jar is used.
8) Thoroughly rinse the net before use at the next sampling location.
9) Record the stop time for the benthos sampling at the current transect.
10) Procedures for the final sample preparation (filtration, labeling, etc.) after all transects have been sampled are provided separately.

Macroinvertebrate Procedure: Sampling at Non-wadeable Sites (SEI FORM #9)

1) After locating the sampling station site according to procedures described in the physical habitat section, identify the dominant and secondary habitat type within the plot. Indicate this on Form #9 by clearly writing a "1" for dominant or a "2" for secondary over the type:
   a) PL: Pool - Still water; low velocity; smooth, glassy surface; usually deep compared to other parts of the channel
   b) GL: Glide - Water moving slowly, with smooth, unbroken surface; low turbulence
   c) RF: Riffle/run - Water moving, with small ripples, waves, and eddies; waves not breaking, and surface tension is not broken; "babbling" or "gurgling" sound
   d) RP: Rapid - Water movement is rapid and turbulent; surface with intermittent "white water" with breaking waves; continuous rushing sound
   e) OT: Other (explain)
2) Use the appropriate gear to collect a habitat-appropriate sample (see methods for wadeable streams).
3) If the sample must come from the boat, sweep through 1 linear meter of the most dominant habitat type within the 10 x 15 m sampling station, making sure to disturb the substrate enough to dislodge organisms.
4) Because a dip-net or a FLBS net is being used for sampling, the maximum depth for sampling will be approximately 0.5 m; therefore, in cases in which the depth of the river quickly drops off, it may be necessary to sample in the nearest several meters to the shore.
5) After completing the sample, remove all organisms and debris from net and place them in a bucket following sample processing procedures described in the following section.
6) Record the sampled habitat type on the Sample Collection Form. Indicate this on Form #9 by clearly writing a "1" for dominant or a "2" for secondary over the type:
   a) FS: Fine/Sand (ladybug or smaller; < 2 mm)
   b) GR: Gravel (ladybug to tennis ball; 2 to 64 mm)

c) CO: Coarse (tennis ball to car sized; 64 to 4000 mm)

d) OT: Other (bedrock, hardpan, wood, etc., explain)

7) Proceed to the next sampling station and repeat steps 1-6. The organisms and detritus collected at each station on the river should be combined in a single bucket to create a single composite sample for the river. After sampling at all 11 stations is completed, process the composite sample in the bucket according to procedures described in the following section.

Macroinvertebrate Procedure: Processing Final Composite Macroinvertebrate Samples (SEI FORM #9)

1) At this point all transect samples will have been combined into one or more jars or bag. The following steps are usually done at the end of a sample event.
2) Pour the entire contents of the composite sample container (or all of them if you had to use more than one) through a sieve or bolos net (100 μm mesh). Remove any remaining large debris after carefully dislodging any clinging organisms.
3) Estimate the total volume of the sample in the sieve and determine the number of bag sets (each sample is at least triple bagged) that will be needed for the sample. Avoid using more than one bag set for a composite sample, if possible (but don't overfill with sample either).
4) Wash the contents of the sieve or bolos net to one side by gently agitating the sieve in the water. Wash the sample into a bag using ethanol. A bag should not be more than **¼ full of sample material**. Use additional bags for the remaining sample. Carefully examine the sieve or bolos net for any remaining organisms and use watchmakers' forceps to place them into the sample jar or bag.
5) Completely fill the bag with 95% ethanol (no headspace) so that the final concentration of ethanol is between 75 and 90%. It is very important that sufficient ethanol be used, or the organisms will not be properly preserved.
6) Place the small separate label in the bag with the sample.
7) Triple bag each sample.
8) Repeat steps 2-7 for the "hard" remainder sample.
9) Each bag or bottle from a site will have a label on the outside and in the sample. The sample date and initials of the final sample jar preparer must be added. Fill in "____ of ____" for sample x of y (e.g., for extra bags or jars for a single sample).
10) Attach the completed label to the jar or bag and cover it with a strip of clear tape.
11) Record the SampleNum, number of jars/bags and number of transects on SEI Form #9. Make sure the form matches the label. Do not record an ID number on the form until you have collected the sample!

Literature Cited

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SEI SOP 11: Sentinel Sample Events

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change description	Reason

Introduction

This SOP presents a set of condensed methods for sampling SEI sentinel sites. It includes a summary of the overall workflow, sonde preparation, sonde calibration and error check, *in situ* sampling using the sonde, water grab sampling, sediment grab sampling, temperature loggers, sample processing, and sample shipment. Many of these procedures are also done in full or base flow events but they are included here as well such that a crew can just reference a single SOP when doing a sentinel event.

These methods use two SEI Forms, #0: All Stream Types Calibration and #3a: All Stream Types InSitu/WaterChem/Q. Other data are recorded within the various instruments used in these procedures. Methods are provided for both wadeable and non-wadeable streams.

Overall Workflow Summary

Sentinel sample events occur up to three times a season. These are on the rising limb of the hydrograph, at peak flow and during winter flow. A base-flow sample event is also conducted that includes all of the sentinel event methods (and many others) but is treated in a suite of separate SOPs.

The workflow for an event first consists of determining when to safely sample in consultation with ROMN ecologists given hydrology, the schedule of park staff, etc. On the day of sampling (or, if needed, on a previous day within 3-5 days) all gear should be assembled and the sonde error checked and calibrated, if needed. For small parks, this can occur in the office. For large parks, it should be at the stream site (calibration can occur in the lab), but can be done at the trailhead if needed. Next, travel to the site and locate the sampling location using GPS, photos, and other guides. Once on site, safely wade into the channel as much into the thalweg as possible and collect *in situ* measurements. Reprogram the sonde for continuous data collection and place securely on the shore (upstream) to collect a data stream while other methods are completed. After any disturbance to the channel has subsided, return to the thalweg and collect all water grab samples. Next, select 7-11 sites along the

shoreline (downstream of the sonde) and collect a composite mineral sediment sample. Locate the temperature logger to make sure it is still in place and download (if needed) or replace. Take any (optional) site photos. Return to the sonde and stop the continuous data collection. Return to the lab and begin sample processing such as filtering, freezing, etc. Review all forms for completeness and legibility. Finally (after frozen samples have frozen), package samples for shipping and send to ROMN along with the forms and any other items.

Sentinel Sample Event Procedure: Summary of Sonde Calibration (SEI FORM #0)

Detailed procedures for using sondes are in the manufacturer's manual and in SOP 5: *In Situ* Water Physiochemistry. The following methods are only a summary.

1) Fill in the header information on SEI Form #0. All subsequent data is recorded on Form #0 (and in the loggers memory).
2) Error check temperature (calibration is only done by the manufacturer) with 2 water baths as possible.
3) Calibrate pH via 2-point method using pH 7 and 10 or 4.
    a) Error check pH with standard not used in calibration (10 or 4).
4) Calibrate conductivity via 1-point method using 1413.
    a) Error check using 147.
5) Calibrate DO via 1-point method using water saturated air or air saturated water (LDO water).
    a) Error check with zero DO water.
6) Do not adjust the instrument (using calibration controls) during error check procedures.
7) This should be done prior to the field season and at least monthly thereafter.

Sentinel Sample Event Procedure: Error Check In Situ 9500 (SEI FORM #0)

Detailed procedures for using sondes are in the manufacturer's manual and in SOP 5: *In Situ* Water Physiochemistry. The following methods are only a summary; for more detailed procedures see the *In Situ* or YSI manuals or the ROMN ecologist.

1) Fill in the header information on SEI Form #0.
2) On or prior to the day of sampling be sure that the sonde has good batteries, that all cables are intact and secure, that all needed calibration/error-check standards are in place, and that the sensors are securely in the sonde and have the proper storage media (pH 4) in place. Additional and detailed procedures for using sondes are in the manufacturer's manual.
3) Fill in the header information on SEI Form #0.
4) All subsequent data is recorded on SEI Form #0 (and in the logger's memory).
5) Open HydroPlus CE on the RuggedReader, connect sonde, and enable it in the software using Setup–Connect Sonde.
6) Remove the small pH storage cup–don't lose it!

7) Create a log session by clicking the Log Session button on the main screen.
8) Add or select the Location. This is the Site ID (e.g., GLAC-SEI-022 or lab ROMN HDQTRS).
9) Add or select the Site. Use an EC code (for error check) plus the date using yyyymmdd (EC 20110511).
10) Once the log session is active using the Location and Site EC+date code, all data are recorded by clicking the Line Log button AND on SEI Form #0 (redundancy is your friend when you forget to do one or the other on a cold stream side).
11) Clean the sonde using DI and kimwipes. Rinse the sonde with the standard you are about to error check.
12) Fill the calibration cup to the fill line with the standard. Tap away any air bubbles. Put sonde in filled calibration cup, making sure the sensor you are testing is well covered.
13) Allow the sonde to stabilize (all data boxes will be green).
14) Record the temperature, standard being used, and the current sonde reading of the standard on SEI Form #0.
15) Press line log ONCE (be sure you hear a beep and see the screen flash/flicker).
16) Dump standard into the waste bottle.
17) Repeat steps 8-17 using in order: specific conductance standard 147 and then zero DO. Be careful handling the zero DO solution; wear gloves and goggles (or sunglasses) and do not inhale the fumes.
18) Zero DO may be reused for a week or up to a month or so. Return it to the bottle and top off any that was lost with fresh zero DO (or if a small amount just tap water) leaving no or little airspace in the bottle.
19) Do not adjust the instrument during error-check procedures.
20) Please note any irregularities to the EC process on SEI Form #0.
21) End the log session by unclicking the log session box.
22) Disconnect from the sonde using Setup–Disconnect Sonde (this turns the sonde off).
23) Regardless of the actual values seen in the EC you will use the sonde in the field. If values are really poor we will choose to use the data or not or adjust it later.
24) Note that there is no easy way to record the actual data file name on SEI Form #0. You can view the file just created to make sure there are 3 data lines (one for pH, SC, and DO).

Sentinel Sample Event Procedure: Error Check In Situ SmarTroll (SEI FORM #0)

Additional and detailed procedures for using sondes are in the manufacturer's manual.

1) Fill in the header information on SEI Form #0.
   a) All subsequent data are recorded on Form #0 (and in the logger's memory).
2) Put instrument together. Turn on the battery pack and iPod. Open the iSitu app on the iPod.

3) Under “Sites,” create a site name (record this name as the data file name on Form #0) under “Site Details” using the site name and EC (error check) + date [as yyyymmdd]. For example, “ROMO 0032 EC 20140913” or “LIBI lab EC 20150427.”
4) Select camera and take photo to aid in site identification. Often this is a picture of the data collector. Save site details.
5) Find that event in the list of other folders and press “set.” Now everything you record will be in this folder. (Note: there is no way to distinguish which fluid you were error checking after the fact, so make sure to go in order so data management can figure out whether you were testing pH, conductivity, etc.)
6) Remove the calibration cup and save the pH 4 storage solution.
7) Clean the sonde using DI and kimwipes. Rinse the sonde with the standard. **Error checks will be done in order using pH 7, SC 147, and Zero DO.** If another standard is used, this is acceptable if it is carefully recorded on SEI Form #0.
8) Fill the calibration cup about 2/3rd full with the standard. Tap away any air bubbles.
9) Press the “home” icon on the iPod to return to the screen that shows the measurements the sonde is reading. Let the sonde equilibrate.
10) Record the temperature, standard being used, and the current sonde reading of the standard on SEI Form #0.
11) Record the measured value by selecting “RECORD.” Allow to record for 1-2 seconds and then stop.
12) Dump standard into the waste bottle.
13) Repeat steps 7-12 for each standard.
    a) Be careful handling the zero DO solution. Always wear gloves and goggles (or sunglasses).
    b) Zero DO may be reused for a week or up to a month or so. Return it to the bottle and top off any that was lost with fresh zero DO (or if a small amount just tap water) leaving no or little airspace in the bottle.
14) Do not adjust the instrument during error check procedures.
15) Please note any irregularities to the EC process on SEI Form #0.
16) Regardless of the actual values seen in the EC, use the sonde in the field. If values are really poor we will choose to use the data or not or adjust it later.

Sentinel Sample Event Procedure: Error Check YSI ProPlus (SEI FORM #0)

Additional and detailed procedures for using sondes are in the manufacturer’s manual.

1) Fill in the header information on SEI Form #0.
    a) All subsequent data are recorded on Form #0 (and in the loggers memory).

b) Record the actual EC data file name on Form #0 (the Site-Folder combination as shown below in steps 7-8). You can view the file just created to make sure there are 3 data lines (one for pH, SC, and DO).

2) Connect sensor cable to sonde and turn on the handheld. The instrument defaults to "Run" mode with all the current parameter values displayed on the screen.

3) Remove the calibration cup and save the pH 4 storage solution (if possible).

4) Clean the sonde using DI and kimwipes. Rinse the sonde with the standard. **Error checks will be done in order using pH 7, SC 147, and Zero DO.** If another standard is used, this is acceptable if it is carefully recorded on SEI Form #0.

5) Fill the calibration cup about 2/3rd full with the standard. Tap away any air bubbles.

6) Press Log One Sample and move into the Sites/Folders submenu.

7) Select from the Site List based on your Site ID or general location (e.g., GRKO-SEI-S01 or LIBI LAB).

8) Add or select a Folder. Use an EC code (for error check) plus the date using yyyymmdd (EC 20110511).

   a) All data will be saved into this Site-Folder AND you will also record it on SEI Form #0 (redundancy is your friend when you forget to do one or the other on a cold stream side).

9) Allow the sonde to stabilize (the AS symbol will appear solid next to the parameter).

10) Record the temperature, standard being used, and the current sonde reading of the standard on SEI Form #0.

11) Press the Log Now button once and make sure you hear the beep or see the screen flash/flicker.

12) Dump standard into the waste bottle.

13) Repeat steps 4-12 for each standard.

   a) Be careful handling the zero DO solution. Always wear gloves and goggles (or sunglasses).

   b) The Site and Folder should default to the previously used one, but double check as you do each parameter.

   c) Zero DO may be reused for a week or up to a month or so. Return it to the bottle and top off any that was lost with fresh zero DO (or if a small amount just tap water) leaving no or little airspace in the bottle.

14) Do not adjust the instrument during error check procedures.

15) Please note any irregularities to the EC process on SEI Form #0.

16) End the data log session by escaping to the main Run screen (you can reselect the Site-Folder following the same steps above).

   a) Turn handheld off.

17) Regardless of the actual values seen in the EC, use the sonde in the field. If values are really poor we will choose to use the data or not or adjust it later.

Sentinel Sample Event Procedure: *In Situ* Sampling, In Situ 9500 and YSI ProPlus (SEI FORM #3a)

1) Additional and detailed procedures for using sondes are in the manufacturer's manual. We include both sondes in one method as almost all steps are the same and users who have conducted the required EC will be familiar enough with each particular sonde model. These methods include the required instantaneous samples taken in the thalweg and optional (but useful) continuous measurement over the duration of the sample event.
2) Fill in the header information on SEI Form #3a.
3) If needed, connect the sonde to the data logger and open relevant software following the manufacturer's manual (or as in the EC methods above).
4) Note that all sondes are preset with the required parameters, sensitivity, etc., but if you feel these are not right, contact the ROMN ecologist.

Core/Required 7 Measures in the Thalweg

1) On the In Situ 9500, start a log session and select the Location (e.g., GLAC-SEI-022) and Site (see below). On the YSI ProPlus, from the Run screen select Log One Sample and select the Site (e.g., LIBI-SEI-S01) and Folder (see below). Use the following codes for the Site or Folder:
   a) **XT** [date] (yyyymmdd) for the required 7 thalweg measurements (e.g., XT 20110617).
2) Record the time for the collection of the core sample on SEI Form #3a.
3) Circle the type of sample for the core sample on SEI Form #3a (currently we are only doing the Thalweg sample type).
4) The thalweg *in situ* measurements can usually be done by one crew member, if it is safe. The measurer moves to the thalweg and immerses the sonde instrument to mid depth. Be sure to stand downstream of the probe. Do not disturb the substrate with the probe.
5) On the In situ 9500, data are captured by pressing the Line Log button. On the YSI ProPlus, data are captured by pressing the Log Now button. Collect a minimum of 7 readings. **BE SURE to get at least 7**.
6) On the In Situ 9500, it is not possible to record the correct data file name on SEI Form #3a (it is machine code stored internally), but enter the code used for the Site (XT yyyymmdd). On the YSI ProPlus, the actual data file is called the Folder name, so record this on SEI Form #3a (XT yyyymmdd).

Optional Continuous Measure

1) Carry the sonde upstream from where other activities are occurring.
2) On the In situ 9500, start a log session and select the Location (e.g., GLAC-SEI-022) and Site (see below). On the YSI ProPlus, from the Run screen select Log One Sample and select the Site (e.g., LIBI-SEI-S01) and Folder (see below). Use the following codes for the Site or Folder:
   a) KC [date] (yyyymmdd) for the optional, but good to have, continuous log (e.g., KC 20110401).

3) On the In Situ 9500, select Timed Log on the main screen.
4) On the YSI ProPlus, you must press the System key, highlight Logging, and then Continuous Mode. Return to the Run screen (with the left arrow) and the option to log will change from Log One Sample to Start Logging.
5) Place the sonde sensor as far in the channel **as safe for you and the instrument**. Place the hand held logger safely on the shore.
6) Let the sonde collect data until all other sample activities are complete.
7) When all else is done, return to this location and uncheck the Log Session on the *In Situ* or press the Stop Logging button on the YSI.
8) On the In Situ 9500, it is not possible to record the correct data file name on SEI Form #3a (it is machine code stored internally), but enter the code used for the Site (KC yyyymmdd). On the YSI ProPlus the actual data file is called the Folder name so record this on SEI Form #3a (KC yyyymmdd).

Sentinel Sample Event Procedure: *In Situ* Sampling, In Situ SmarTroll (SEI FORM #3a)

Additional and detailed procedures for using sondes are in the manufacturer's manual. These methods describe how to record continuous measurement over the duration of the sample event.

1) Fill in the header information on SEI Form #3a.
2) Carry the sonde upstream from where other activities are occurring.
3) Connect the sonde to the battery pack. Turn the battery pack on. On the iPod, open the i-Situ software.
4) Under "Sites" (upper left corner), press on "New Site" (lower right corner) to create a new site. A new screen should come up that says "Site Details" at the top. Fill in the name of the new site as: site name + KC + date [as yyyymmdd]. For example, "LIBI S01 KC 20150518."
5) Press "save" to save that site.
6) Make sure the protective metal cage is around the sensors on the sonde. Then place the sonde as far in the channel **as safe for you and the instrument**. Place the battery pack safely on the shore. (You can use the clip to secure it somewhere).
7) Press the "record" button to start recording. Let the sonde collect data until all other sample activities are complete. Place the iPod ***in the shade***. If no shade is available, place the ipod in the sonde bag to keep it out of the sun. It will stop recording if it overheats.
8) When all else is done, return to this location and stop the log.
9) Later that day or week when you are back to the office, offload the data from the iPod onto your computer using iTunes and send the files to ROMN (See SOP 14: Processing *In Situ* Water Physiochemistry Loggers for instructions.)

Sentinel Sample Event Procedure: Water and Sediment Grab Sampling (SEI FORM #3a)

1) Before leaving the base location, package the sample bottles carefully to prevent contamination. Do not open the cleaned bottles unless necessary and always use gloves.
2) In 2014, each sample event required a total of **9 bottles, with 6 taken into the field and 3 filled from aliquots at a base station** (these bottles can be left at the base site).
   a) The 6 field bottles include:
      i) one 250 ml clear Nalgene (K1.W_C)
      ii) one 60 ml clear Nalgene (K4.W_Z)
      iii) one 250 ml clear Nalgene (E3.W_WAC)
      iv) one 60 ml clear Nalgene (E7.S_C)
      v) one 1000 ml clear Nalgene (G5.W_C)
      vi) one 1000 ml clear Nalgene (T8.W_C).
   b) The 3 base station bottles are:
      i) one 125 ml clear Nalgene (K2.F_C)
      ii) one 60 ml clear Nalgene (K3.F_Z)
      iii) one 250 ml clear Nalgene (E6.W_FAC)
   c) Each bottle is pre labeled with ROMN labels.
   d) *Optional:* Depending on the weight to be carried in packs and remoteness of site, carry at least one back up for each bottle taken to the field.
3) Make sure that the bottle labels all have the same sample ID number, that the correct code is on each bottle, and that the labels are securely attached. **Fill in the date and sampler initials** on each label (this can be done earlier or later in the lab).

Water

1) Record the time for the collection of the water grab samples on SEI Form #3a.
2) Collect the samples after the *in situ* thalweg measures are done and the continuous measure is running. Wait for any disturbance caused be previous activities to subside.
3) Put on powderless nitrile gloves.
4) Move as far into the thalweg as safely possible. Stand downstream from where the grab sample bottles will be placed into the stream.
5) Make sure that the labels all have the same sample ID number, that the correct code is on each bottle and that the labels are securely attached.
   a) Bottles filled in the field include: K1, K4, G5, T8, and E7 (sediment, see SOP for sediment).
   b) Bottle E3 is taken to and filled in the field but is done so from bottle G5 as E3 has a small amount if nitric acid in it.

6) Rinse each bottle (except E3) three times with stream water. Discard the rinse downstream.
7) For isokinetic sampling, the transit rate must be kept constant during sampler descent through a vertical and also during sampler ascent through a vertical. Although not necessary, usually the same transit rate is used for raising the sampler as was used for lowering the sampler through a given vertical.
8) Lower the bottle until slight contact is made with the streambed (if not too deep). ***Bottle T8 must not come in contact with the streambed.*** Do not pause upon contacting the streambed. Raise the sampler immediately at a constant transit rate to complete the vertical traverse. The descending transit rate does not have to equal the ascending transit rate, but each rate must be unidirectional and constant, until the sampler bottle is full. Time the rate of moving through the water column so that at least one pass up and one pass down are accomplished before the bottle is full.
9) Take care not to disturb the streambed with the sampler. Disturbing the streambed could cause bed material to enter the bottle, resulting in erroneous data.
10) Fill bottles to the rim unless they are frozen bottles (K4.W_Z); fill these only to the bottles shoulder (this may be adjusted later).
11) **Fill bottle E3 from bottle G5, being careful to not spill and of the acid in bottle E3.**
    a) **Refill bottle G5 after E3 has been filled**.
12) When a bottle is full and passes muster, make sure the label is correct, place it in a cooler (on ice) and shut the lid. If a cooler is not available, place the bottle in a mesh bag and immerse it in the stream in shade.

Sediment

1) Move upstream from where all previous activities have occurred. Locate a depositional area in shallow, slow-moving water.
2) If there is no obvious depositional area, just find the smallest substrate you can.
3) Scoop a small amount of mineral sediment up from the substrate. Move very slowly so as to not loose sediment.
4) Place in E.7S_C bottle.
5) Repeat in 5-11 additional locations, compositing into the same bottle.
6) Cap bottle and place on ice.
7) Record the number of subsamples collected.
8) **Record the Sample Number on SEI Form #3a**.

Sentinel Sample Event Procedure: Temperature Loggers (SEI FORM #3a)

1) Each sentinel site should have two HOBO temperature loggers. Most sample events crews must simply re-locate the logger, make sure it is still well anchored, and improve its "cave" if possible.
    a) Be sure to record this on SEI Form #3a.
2) Loggers are replaced at the first sample of the year and then again at the base-flow sample event.

a) Be sure to record the old and new logger serial numbers.

3) If possible, simply put a new logger on the key chain ring attached to the cable.
   a) At some sites the logger will be in a PVC tube.
4) If necessary, cut the cable as close as possible to the old logger and reinstall a provided logger using a new ferule. Do not shorten the cable too much or you will have to start all over.
5) Loggers are downloaded in the ROMN office.

Water and Sediment Physiochemistry Procedure: Sample Filtration, Acidification, and Storage (SEI FORM #3a)

1) See Tables 6-3 and 6-4 and Figures 6-3 and 6-4 for more information on the following procedures.
2) Upon returning to a base station, place all sample bottle in a refrigerator (*_C samples) or freezer (*_Z samples) immediately.
3) Ensure that bottle labels are completed with the date, time, site ID, SampleNum, initials of field personnel, sample types, etc.
4) Create filter samples E6.FAC, K2.F_C and K3.F_Z as follows:
   a) Wear nitrile gloves to avoid unnecessary contamination.
   b) Place paper towels or lab cloth on the counter.
   c) Triple rinse the filter holder, syringe, and forceps with deionized water.
   d) Place the smooth side of a new filter upward into the filter holder.
   e) When the syringe is attached to the filter chamber, **never** pull up on the syringe plunger. This can break the filter. Instead, disconnect the syringe from the filter chamber first, and then pull up on the plunger.
   f) Rinse the filtering apparatus (syringe + filter holder) with ~ 60 ml deionized water, repeat. Squirt this into K2, K3, and E6 bottles, shake these well and discard.
   g) BE sure to switch from the DI syringe to the sample syringe for the sample. *If doing more than one site, do not mix sample syringes.*
   h) The E6 bottle is pre acidified and should not be rinsed.
   i) Rinse pre-rinsed filter and K2 and K3 sample bottles with 20 mL each of well mixed sample from the 250 mL K1 sample bottle, shake K2 and K3 well and discard. *The G bottle may also be used for the source for this rinsing water, especially in "clean" sites.*
   j) Filter 125 mL of sample from K1 into labeled K2 sample bottle (this will take 1+ full syringes).
   k) Filter 60 mL of sample from K1 into labeled K3 sample bottle.
   l) Filter 250 mL of sample from G5 into labeled E6 sample bottle (this will take 2+ full syringes).

5) If filtering more than 1 sample, rinse the filtering apparatus with 60 mL deionized water and proceed to step 7.
6) When sample filtration is complete, rinse syringe and reusable filter holder with deionized water. Place supplies in a closed Tupperware container.
7) Store E6, K2, K1 (remainder), G5 (remainder), E3, and E7 sample bottles at 2-8°C.
8) Store K3 and K4 sample bottles frozen at or below 0°C.
9) Perform any data management workflow items as needed after processing each sample.
10) Ship water chemistry samples as soon as possible after collection in order to meet holding time requirements (especially nutrients).

Sentinel Sample Event Procedure: Sample Packing and Shipping (No Form)

After a sample event is complete, please follow these steps. These include steps for base-sample events where other sample types are collected in addition to water and sediment.

Chain of Custody (COC) and Checking Samples

1) **If you are direct shipping to the Kiowa, Rhithron, or EPA Lab, you must complete a COC**. If you are shipping directly to a lab, samples will be grouped into cooler(s) by lab (i.e., all water chemistry to the Kiowa lab or all bio samples to the Rhithron lab).
2) **You do not need a COC if direct shipping to the ROMN Office, but you must still double check the samples, their sample numbers, etc. as below. You can combine sample types (water bottles and bio) into coolers as space allows, but often there will be enough benthos bags to have their own cooler**.
3) Select the correct COC version and fill out the header by hand, or these can be done electronically using the word versions.
4) Carefully cross-reference every bottle or bag to its SiteID and sample number on the COC. Make sure there are full sets of bottles; if not, determine if a bottle was missed or lost. **Do not forget any frozen bottles**.
5) IMPORTANT: Make sure each label on a bottle or bag is correct and has sample date, time, and initials. If you don't know what the label details should be, find another bottle from the sample event or call ROMN field coordinator or ecologist..
6) Fill in a COC sheet for all sets of bottles or bio samples to be shipped. Use separate COC(s) for each lab. Use 1 of 2, 2 of 2, etc. for multiple pages.
7) Sign and date the COC sheet in the top left most Released By space. If you are creating an electronic version, you can insert "Signed electronically by xxxx."
8) Make two hardcopies copies of the signed COC. Keep one hardcopy and send one to the ROMN field coordinator or ecologist.
9) If you have created electronic versions, print a hardcopy for yourself, but you can send ROMN field coordinator or ecologist an electronic (Word) version. Save the file as COC_[parkcode]_SampleEventDate (COC_GRKO_20100506.docx).

10) Place a signed COC in a Ziploc bag. **Be sure to add a copy of the methods table to the ziploc with the COC in it for each relevant cooler**. The COC in the Ziploc bag will go in the cooler with the samples.

Packing Coolers

1) Be sure all bottle caps are tight and Ziplocs sealed. Place all non-frozen bottles from a sample event in a Ziploc. Write the SampleNumber and SiteID on these external bags using a Sharpie marker.
2) Be sure all bottle caps are tight and Ziplocs sealed. Place all frozen bottles (and frozen filters, if done and you are shipping to ROMN, if you are direct shipping to labs, the frozen filters will be with the bio samples) in a shipment together in a single bag (so they stay frozen). Write the SampleNumbers and SiteIDs on these external bags using a Sharpie marker.
3) Benthos bags should be checked for leaking and double/triple/quad bagging should be added as needed. Benthos bags do not need the SampleNumber and SiteID in Sharpie as the labels on the bags have this information.
4) Place LOTS of frozen water bottles into their own Ziploc bags (isolating them from the samples even more) and then the coolers that will receive samples. Use multiple coolers as needed.
5) Pack the bag with the frozen K samples into the coldest part of the cooler. You can place non-frozen samples in the same cooler.
6) Coolers must be as packed as tightly as possible. There should be no open space. Fill in open space with frozen water bottles and packing materials.
7) The benthos do not need ice. The hard samples should be placed on the bottom of the cooler then the soft samples on top. Pack the cooler tightly with newspaper so the bags don't slosh around.
8) Tape the coolers closed well. Place shipping labels in FedEx bags stuck to the top of the coolers.
9) **Make absolutely sure coolers get picked up; if not, get samples into fridge/freezer and call FEDEX to reschedule. Make sure ROMN field coordinator or ecologist know about the change**.

Shipping

1) Keep bottles or bags in the fridge or freezer until they are shipped. See bottle/bag diagram to know where a type of sample is kept.
2) If ROMN staff are not participating on a sample event, you will usually ship bottles and bio to the ROMN offices in Fort Collins (see below for more detail on shipping).
3) If ROMN staff are participating in a sample event, they will take the lead on sample preparation and shipping.
4) **Do not ship on Fridays.**
5) To schedule a pickup and print labels a day or two before a sample event (or same day of a pickup if done very early am), log on to the FedEx site (https://www.fedex.com). Use a computer you can print from.

6) There are shipper profiles in this FedEx account for our offices (and each lab we ship to, if you ever do direct ship samples).
7) Select or create the ship from and to locations.
8) You should save as a new profile your ship from/to if you create one.
9) **Note that the Fedex site usually defaults to the incorrect pickup address**. **This must be changed to your location**.
10) Use fastest shipping method: overnight, if possible. Samples should go out the morning after they are collected, if possible, and the frozen ones have time to freeze.
11) Print labels for the coolers to be shipped.
12) Print off the shipping receipt it gives you. Keep a hardcopy receipt.
13) Save the receipt to a pdf and email to the ROMN field coordinator or ecologist.

SEI SOP 12: Field Sheet Scanning

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP presents the ROMN Data Management Team's scanning, renaming, and storing field sheets in PDF form for future reference.

Field Sheet Scanning Procedure: Preparing Field Sheets for Scanning

1) Divide the papers by *Site ID* and *Start Date*.
2) Make sure that they are ordered according to the numbers on the field sheets.

   Note: The exact position of page numbers varies by protocol (e.g., in SEI, the numbers are found in the upper left-hand corner or top of the papers (#3, #6, #8 etc.).

Field Sheet Scanning Procedure: Scanning the Field Sheets

1) Go to the printer in the copy/fax room.
2) If the screen is black, press the power button.
3) Enter *Department ID* if requested (obtain from other ROMN staff).
4) Press the *Access* button.
5) Press the *Fax/Scan* button.
6) From the *Address Book* tab, press the alpha tab range (ex. JKL) for the login of the person you want to send the PDFs to (ex. KHLong), navigate to that login, and click it.
7) Click *Scan Settings* and touch *Color*.
8) Click *File Type*, touch PDF, and then touch *Multi-page*.
9) Put all the datasheets from the first *Site ID* and *Start Date*, face up, into the machine.

10) Press the blue *Start* button on the printer.

11) Put all the datasheets from the next *Site ID* and *Start Date*, face up, into the machine.

12) Click the *Send* tab and then click the *Recall* button and then click the *1-Before* and *OK* buttons.

13) Press the green *Start* button on the printer.

14) Repeat the last three steps until you've scanned all the events.

Field Sheet Scanning Procedure: After Scanning

1) Go to your scans folder in your *H:* drive on your computer.
2) Double check that the file contains both sides of each piece of paper before continuing.
3) The scans will be there named with a date and time stamp (e.g., *20120702084924*).
4) Rename the scans using the *Site ID* and *Start Date* and the format: *Protocol_Park_SiteID_yyyymmdd* (e.g., SEI_ROMO_S01L_20120614)
5) Move the scans into the appropriate protocol folder on ROMN network drive at: *Z:\MONITORING\Streams\Data\DataGathering\Scans*.
6) When all SEI field forms have been scanned for that field season, move all scanned forms to the certified data folder for that year at: *Z:\MONITORING\Streams\Data\Certified\FY##\Scans*.

SEI SOP 13: Processing SEI Discreet Field and Laboratory Data

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP presents the ROMN Data Management Team's process of acquiring, entering, and conducting QAQC of data for the SEI protocol.

Note that the images of field forms in this SOP are current as of the 2013 field season. For any updated version see the ROMN Data Manager.

SEI Database Design

The ROMN SEI Database is based on the standard NRDS design, created by the NPS Inventory & Monitoring Program, and contains all monitoring data spanning back to 2007.

Multiple versions of the SEI MS Access database are maintained by ROMN.

1) The SEI Master Database, containing information for all sampling years, is stored at: *Z:\MONITORING\Streams\Data\Certified*.
2) Separate working copies are maintained for data entry and QAQC. The ROMN SEI Data Entry Database for the current field season can always be found at stored at: *Z:\MONITORING\Streams\Data\DataGathering\DataEntry*.
3) All versions of the SEI MS Access database share the same basic schema based on the NRDT model, as outlined in figures and tables in Appendix C.

Data Entry Procedure: Receiving Data

1) Discreet SEI data can be received as:
   a) Original datasheets

b) Copies of the original datasheets

c) Scanned PDFs

d) Laboratory data deliverables (as *.xlsx*, *.pdf*, and *.csv* files)

2) When SEI datasheets are received, they will go in the SEI Inbox. When PDFs are received, they will be emailed (zipped) to the Data Management Team.

3) If PDFs are received, put them at: *Z:\MONITORING\Streams\Data\DataGathering\Scans*.

4) Rename them using the Site ID and Start Date and the format:

a) *SEI_Park_ SiteID_yyyymmdd* (ex. SEI _ROMO _617_20120614)

5) If the datasheets are received and there are no PDF versions of them in existence, scan the datasheets before beginning the data entry process. Put the scanned PDFs in the same place as other PDFs. See the ROMN SOP: Scanning for detailed instructions.

6) Laboratory result files are placed in the file folder: *Z:\MONITORING\Streams\Data\DataGathering\Lab*.

Data Entry Procedure: Data Entry Overview

1) The SEI Data Entry Database for the current SEI field season is stored at: *Z:\MONITORING\Streams\Data\DataGathering\DataEntry*

a) The SEI data entry database is a smaller copy of the SEI master MS Access database.

b) For more information, see the SEI Database Design subchapter.

2) When beginning a new day of data entry/QAQC, create a copy of the latest version of the database and change the date to the current date.

3) To enter data pertaining to that sampling category/table into the database, click the checkbox to the left of the section name.

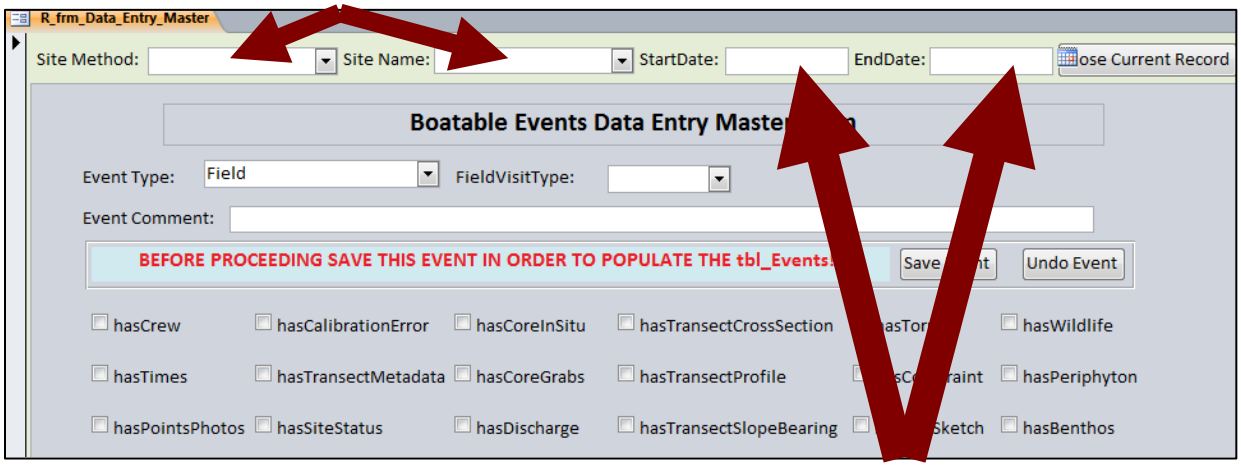
4) When finished entering data for that sampling category/table, save and exit the table to return to the main data entry form.

5) The ESC key can be used to escape any record, not saving any changes if need be.

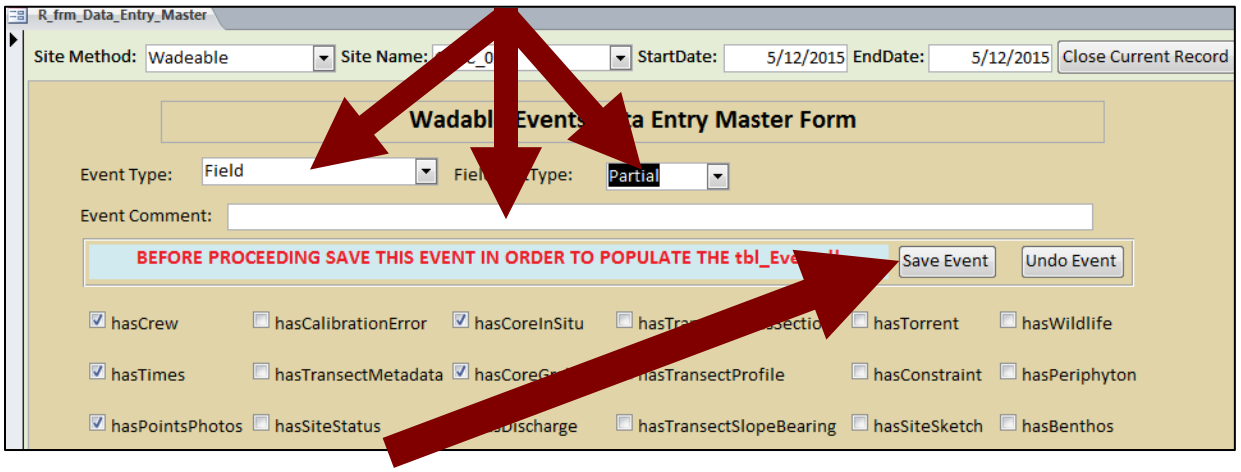
6) Partial events have only *SEI Form #3a*, whereas full events have more pages separated into boatable and wadeable versions.

Data Entry Procedure: Event/Insitu/Water Chem/Discharge (*SEI Form #3a*)

1) Complete one form per full or partial event.
2) Open the SEI Data Entry Database for the current SEI field season is stored at: *Z:\MONITORING\Streams\Data\DataGathering\DataEntry*.
3) At the top of the master data entry form (loads automatically):
   a) Use the drop-down menus to select the *Site Method* and *Site Name*.



   b) Enter the *StartDate* and change the *EndDate* as needed (*EndDate* will be automatically set to *StartDate*; if different, it can be manually edited).
   c) Enter the *EventType*, *FieldVisitType*, and any *Event Comments* about the event as a whole.

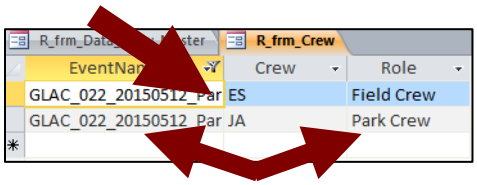


   d) Click the *Save Event* button to activate the checkboxes (mandatory step for entering all other data for that field sampling event).

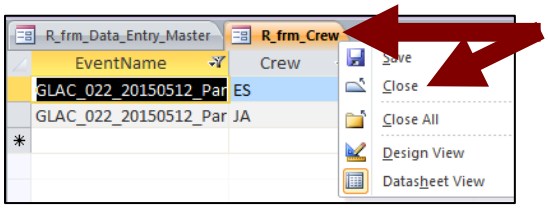
About Sampling Parameters Associated with hasSamplingCategory Checkboxes

- All sampling categories listed on SEI Data Entry Database data entry forms with *hasSamplingCategory* checkboxes follow the same basic data entry scheme outlined in more detail below for the *hasCrew* sampling category.
  - Clicking on a *hasSamplingCategory* checkbox opens a separate database entry form that was designed for data entry for that individual sampling category.
  - The data entry forms were set up to look like database tables or spreadsheets.
  - This arrangement allows trained office staff to enter data much more quickly and accurately than with other layout schemes.
  - Not all date-specific sampling events will include information for all of the *hasSamplingCategory* checkbox topics. Why?
  - Field forms for a full SEI sampling event range between 34-44 total pages (depends on event type and park), and with hundreds of potential data entry fields.
  - Not all sampling categories are sampled during a single, date-specific, sampling event.
- If the *hasSamplingCategory* checkbox remains unchecked, then no data were sampled for that sampling category during that date-specific sampling event. That is fine.

4) Click the *hasCrew* checkbox to begin entering the crew members found on the field forms.
   a) On the *R_frm_Crew* data entry form (this form looks like a table), enter the initials of each unique crew member listed at the top of ALL FIELD FORM PAGES into the *Crew* field. The *EventName* and *Role* fields on this form will automatically be filled-in for you.



   b) To close the *R_frm_Crew* form, right-click on the *R_frm_Crew* form tab, and on the resulting pop-up box, choose the *Close* option.



5) On the master data entry form, check ALL FIELD FORM PAGES for sampling times, if any of the field forms have sampling time information, click the *hasTimes* checkbox and:
   a) Enter all sampling times on the *Times* database entry form.

b) Be sure to enter both the date and time for HOBO logger files on *SEI Form #3a*.

c) Close the form when you are finished.

6) On the master data entry form, click on the *hasPhotoPoints* checkbox (this category includes mandatory GPS information found on *SEI Form #3a* for all SEI sampling events).

a) Enter each value in the corresponding space in the database entry form.

i) This form also lists information about any sampling event photographs taken.

ii) The photographs are managed using a completely separate database and related procedures from the ROMN SEI Database (SEI SOP 16).

b) Close the form when you are finished.

7) On the master data entry form, if any *Core Insitu* or *HOBO Temp Loggers* sections of *SEI Form #3a* were filled in, click on the *hasCoreInSitu* checkbox. On the *MetadataCoreInSitu* database entry form.

a) Enter each value in the corresponding space in the database entry form.

i) This form also lists the names of any InSitu (water physiochemistry) or HOBO (water temperature) station continuous data logger files that were uploaded/collected during that event visit.

ii) The continuous logger data files are managed using databases and procedures that are completely separate from the ROMN SEI Database system (SEI SOP 14, SEI SOP 15).

b) Close the form when you are finished.

8) On the master data entry form, if any of the *Core Grab Water and Sediment* section of *SEI Form #3a* was filled in, click on the *hasCoreGrabs* checkbox. On the *MetadataCoreGrabs* database entry form:

a) Enter each value in the corresponding space in the database entry form.

b) Close the form when you are finished.

9) On the master data entry form, if any of the *Discharge* section of *SEI Form #3a* was filled in, click on the *hasDischarge* checkbox. On the *MetadataDischarge* database entry form:

a) Enter each value in the corresponding space in the database entry form.

b) Close the form when you are finished.

10) Double-check the back of *SEI Form #3a* for any additional flags or notes, and enter them into the appropriate database form.

11) Enter all Event Checklist items found at the bottom of the first page of *SEI Form #3a* into the excel spreadsheet at:

Z:\MONITORING\Streams\Data\DataGathering\DataEntry.

Data Entry Procedure: Channel/Riparian Cross Section (Wadeable) (*SEI Form #5*)

1) Usually 11 forms per full event (one per transect), more if there are extra side channels.
2) For this field form, it is helpful to enter the same section for all transects (A-K) before moving onto the next section. It means more moving between pages, however, a rhythm can be generated for each section, increasing efficiency.
3) On the master data entry form, click the *hasTransectCrossSection* checkbox. On the *Cross_Section_Master* database entry form:
   a) Click the *hasSubstrate* checkbox. On the *Substrate* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   b) Click the *hasBankMeasure* checkbox. On the *Bank_Measure* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   c) Click the *hasVegCover* checkbox. On the *Veg_Cover* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   d) Click the *hasFishCover* checkbox. On the *Fish_Cover* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   e) Click the *hasHumanInfluence* checkbox. On the *Human_Influence* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   f) Click the *hasAlienPlant* checkbox. On the *Alien_Plant* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   g) Click the *hasCanopyCover* checkbox. On the *Canopy_Cover* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   h) Click the *hasFlags* checkbox. On the *Flags* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   i) When you are finished entering cross section wadeable data, close the *Cross_Section_Master* database entry form.

Data Entry Procedure: Thalweg Profile and Woody Debris (Wadeable) (*SEI Form #6*)

1) Usually 11 forms (10 filled out) per full event (one per space between transects) – there will be more blank forms if there are extra side channels.
2) Since *SEI Form #6* is always printed on the back of *SEI Form #5*, there will always be an equal number of *SEI Form #6*s and *SEI Form #5*s, but only 10 *SEI Forms #6* will ever be filled out.
3) For this field form, it is helpful to enter the same section for all transects (A-K) before moving onto the next section. It means more moving between pages, however, a rhythm can be generated for each section increasing efficiency.
4) On the master data entry form, click the *hasTransectProfile* checkbox. On the *R_frm_Transect_Profile* database entry form:
   a) Enter the appropriate values for the *TotalReach*, *DistanceBtwn*, and *IncrementBtwn* fields.
   b) Click the *hasProfile* checkbox. On the *R_frm_Transect_Profile_Wade* database entry form:
      i) Enter each value in the corresponding space in the database entry form.

         Note: The wetted width and bar width are only recorded at stations 0,5, and 7.
      ii) Close the form when you are finished.
   c) Click the *hasSubstrate(Wadeable)* checkbox. On the *R_frm_Transect_Profile_Sustrate_Wade* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   d) Click the *hasLargeWood(Wadeable)* checkbox. On the *R_frm_Transect_Profile_Large_Wood_Wade* database entry form:
      i) Enter each value in the corresponding space in the database entry form.

         Note: Make sure to check whether or not the *Check If Unmarked Boxes Are Zero* box on the field form was checked.
      ii) Close the form when you are finished.
   e) Click the *hasFlag* checkbox. On the *R_frm_Transect_Profile_Flag* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   f) When you are finished entering wadeable transect profile data, close the *R_frm_Transect_Profile* database entry form.

Data Entry Procedure: Channel/Riparian Transect (Boatable)
(*PHAB CHANNEL/RIPARIAN TRANSECT FORM - BOATABLE*)

1) Usually 11 forms per full event (one per transect), more if there are extra side channels.
2) For this form, it is helpful to enter the same section for all transects (A-K) before moving onto the next section. It means more moving between pages, however, a rhythm can be generated for each section, increasing efficiency.
3) The bank side refers to which side of the channel measurements were taken from and can be found in the top right corner.
4) On the master data entry form, click the *hasTransectCrossSection* checkbox. On the *Cross_Section_Master* database entry form:
   a) Click the hasBankSide checkbox. On the *R_frm_Transect_Cross_Section_Bank_Side* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   b) Click the *hasSubstrate* checkbox. On the *Substrate Boat* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   c) Click the *hasBankMeasure* checkbox. On the *Bank Measure* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   d) Click the *hasMetadata* checkbox. On the *Waypoints Boat* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   e) Click the *hasVegCover* checkbox. On the *Veg Cover* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   f) Click the *hasFishCover* checkbox. On the *Fish Cover* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   g) Click the *hasHumanInfluence* checkbox. On the *Human Influence* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   h) Click the *hasAlienPlant* checkbox. On the *Alien Plant* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

i) Click the hasCanopyCover checkbox. On the *R_frm_Transect_Cross_Section_*Canopy*_Cover_Boat* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

j) Click the *hasMethodFloat(Boatable)* checkbox. On the *Method Float* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

k) Click the *hasDepth(Boatable)* checkbox. On the *Depth Boat* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

l) Click the *hasLargeWood(Boatable)* checkbox. On the *Large Wood Boat* database entry form:

i) Enter each value in the corresponding space in the database entry form.

Note: Make sure to check whether or not the *CHECK IF UNMARKED ARE ZERO* box on the field form was checked.

ii) Close the form when you are finished.

m) Click the *hasFlags* checkbox. On the *Flags* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

n) If the *SLOPE/BEARING/DISTANCE (Optional)* portion of this field form was filled out:

i) Exit back out to the master data entry form.

ii) Click the *hasTransectSlopeBearing* checkbox.

iii) On the *Slope Bearing* database entry form, enter each value as required, and close the form when you are finished.

Note: Make sure to enter units for each measurement.

o) When you are finished entering all boatable transect cross section data, close the *Cross_Section_Master* database entry form.

Data Entry Procedure: Thalweg profile (Boatable) (*PHAB: THALWEG PROFILE FORM BOATABLE*)

1) Usually 10 forms per full event (one per space between transects).
2) On the master data entry form, click the *hasTransectProfile* checkbox. On the *R_frm_Transect_Profile* database entry form:
   a) Enter the appropriate values for *TotalReach*, *DistanceBtwn*, *IncrementBtwn*, and *Flag* into the corresponding fields in the database entry form.
   b) Click the *hasProfile* checkbox. On the *R_frm_Transect_Profile_Boat* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   c) Click the *Flag* checkbox. On the *Flags* database entry form:
      i) Enter each value in the corresponding space in the database entry form.
      ii) Close the form when you are finished.
   d) When you are finished entering all boatable Thalweg data, close the *R_frm_Transect_Profile* database entry form.

Data Entry Procedure: Slope and Bearing (Wadeable) (*SEI Form #7*)

1) One form per full event.
2) On the master data entry form, click the *hasTransectSlopeBearing* checkbox. On the *Slope Bearing* database entry form:
   a) Enter each value in the corresponding space in the database entry form.

      Note: Make sure to enter units for each measurement.
   b) Close the form when you are finished.

Data Entry Procedure: Torrent Evidence and Channel Constraint (*SEI Form #8*)

1) One form per full event.
2) On the master data entry form, click the *hasTorrent* checkbox. On the *Torrent* database entry form:
   a) Enter each value in the corresponding space in the database entry form.
   b) Close the form when you are finished.
3) On the master data entry form, click the *hasConstraint* checkbox. On the *Constraint* database entry form:
   a) Enter each value in the corresponding space in the database entry form.
      i) Double-check the units used for *ValleyWidthUnits* field.

ii) Check the *LimitedVisibility* checkbox if the crew could not see the valley borders.

4) If the back of *SEI Form #8.5* (the back-side of *SEI Form #8*) has dipper information (only occurs at samples taken at ROMO), click the *hasWildlife* checkbox on the master data entry form. On the *R_frm_Wildlife* database entry form:

   a) Enter each value in the corresponding space in the database entry form.

   b) Close the form when you are finished.

Data Entry Procedure: Periphyton and Benthos (*SEI Form #9*)

1) One form per full event.

2) On the master data entry form, click the *hasPeriphyton* checkbox. On the *Periphyton Master* database entry form:

   a) Enter the appropriate values for *CompositeVolume, NumTransectsSampled, PytSampleName, Comments, ID_SampleVol, Chloro_SampleVol, Chloro_FilterVol*, and *Biomass_FilterVol* into the corresponding fields in the database entry form.

   b) Click the *hasCorePeriphyton* checkbox. On the *R_frm_Transect_Periphyton_Core* database entry form:

      i) Enter each value in the corresponding space in the database entry form.

      ii) Close the form when you are finished.

   c) Click the *hasQAQCPeriphyton* checkbox. On the *R_frm_Transect_Periphyton_QAQC* database entry form:

      i) Enter each value in the corresponding space in the database entry form.

      ii) Close the form when you are finished.

   d) Click the *hasPlates* checkbox. On the *Benthos Rocks* database entry form:

      i) Enter each value in the corresponding space in the database entry form.

      ii) Close the form when you are finished.

   e) When you are finished entering all boatable periphyton data, close the *Periphyton Master* database entry form.

3) On the master data entry form, click the *hasBenthos* checkbox. On the *Benthos Master* database entry form:

   a) Enter the appropriate values for *NumTransectsSampled*, *NumJars*, *BenthosSampledName*, and *Comments* into the corresponding fields in the database entry form.

   b) Click the *hasCoreBenthos* checkbox. On the *R_frm_Transect_Benthos_Core* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

c) Click the *hasQAQCBenthos* checkbox. On the *R_frm_Transect_Benthos_QAQC* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

d) Click the *hasRocks* checkbox. On the *Benthos Rocks* database entry form:

i) Enter each value in the corresponding space in the database entry form.

ii) Close the form when you are finished.

e) When you are finished entering all benthos data, close the *Benthos Master* database entry form.

Data Entry Procedure: All Stream Types Stream Verification and Reach Layout (*SEI Form #1*)

This form was added last, because the corresponding database entry form is the last one listed/available in the ROMN SEI Database. Many field crews skip this form entirely; the form contains very little information that is actually housed in the database (it is primarily used by the field crews and ecologists to aid with future field visits).

1) Complete one form per full event.
2) Check the back of this form to see whether or not there is a sketch of the database.
   a) If there is a sketch, click the *hasSketch* checkbox on the master data entry form.
   b) If there is not a sketch, leave the checkbox unchecked.
3) All of the other information on the *SEI Form #1* is for field and office use only, and is not recorded in the ROMN SEI Database.

Data Entry Procedure: Quality Assurance of Field Sheet Data

1) Each field sheet is manually checked by **someone other than the person who originally entered the data**. This person will:
   a) Update fields as required for obvious data entry mistakes.
   b) For less obvious issues, work with field crews and ecologists to make sure that the correct information is entered into the database.
2) When all SEI datasheet information has been entered and QAQC'd for the entire field season, append the new information in the SEI Data Entry Database (*Z:\MONITORING\Streams\Data\DataGathering\DataEntry*) tables into the SEI Master Database tables (*Z:\MONITORING\Streams\Data\Certified*) with the same name.
   a) We create custom *Append* queries to do this for all tables that begin with: "*tbl_*" prefix.

b) Begin with the *tbl_Events* table.

c) For all other tables, we make sure that we append to parent tables before attempting to append to their child tables. See Appendix C for more details about the parent-to-child relationships for SEI database tables.

Note: At the time that this SOP was written, the SEI database system still had not been finalized enough to generate pre-made queries and macros to do this for you. These automated append tools will be developed in time for the 2016 field season.

3) Finalize the *Event Names* for the previous field season.

Note: During the sampling season, *Event Names* are in the format: *SiteName_YYYYMMYY_VisitType* (e.g., *GLAC_022_20150512_Partial*). Update these to the final *Event Name* syntax: *ParkLetterSiteNumber_VisitNumberAcrossYears* (e.g., *G022_31*).

a) Open the *tbl_Events* table, and select and copy all *EventName* that follows the syntax: *ParkLetterSiteNumber_VisitNumber* (for the example above it is: *G022_31*).

b) Open the *Xwalk_Event_Name_Changes* table, and append the copied records into the *EventName_2013* field.

c) Use the information found in the *tbl_Events* table to assign the next logical *Event Name* to the *EventCode* field in the *Xwalk_Event_Name_Changes* table.

d) Manually update the *EventName* field in the *tbl_Events* table with the correct *EventCode* field in the *Xwalk_Event_Name_Changes* table.

Note: Updating the *EventName* field in the *tbl_Events* table will automatically update the *EventName* in all child tables that share the *EventName* field.

Data Entry Procedure: Laboratory Data

ROMN uses external laboratories to analyze physical field samples taken for water sediment physiochemistry (SEI SOP 6: Water and Sediment Physiochemistry), periphyton (SEI SOP 9: Periphyton), and macroinvertibrates (SEI SOP 10: Macroinvertebrates).

The tabular results of samples sent to laboratories are sent back to ROMN in spreadsheet format. It can take anywhere from three to 12 months to receive data from the laboratories. For this reason, laboratory results are always appended into the SEI Master Database well after the field season is over and all field sheet data have been entered and QAQC'd (see section above*: Data Entry Procedure: Quality Assurance and Quality Control of Field Sheet Data*).

Additionally, spreadsheets with laboratory results tend to come from different laboratories and in various formats. To date, there has not been enough consistency to create macros or import queries to automate this process. To import laboratory results into the SEI Master Database:

1) Open the SEI Master Database located at: *Z:\MONITORING\Streams\Data\Certified*. The tables that hold laboratory data results are (for table, field, and schema details see: *Appendix C*):

   a) *IMPORT_benthos_Metrics* (laboratory metrics applied to each benthos field sample)

   b) *IMPORT_benthos_Flat* (counts of macroinvertebrates observed by taxon and life stage for each benthos field sample)

   c) *IMPORT_benthos_MMI_OE* (standard bioassessment metrics and indices [MMI – MtnIndex, HBI, etc.], and ratio of observed to predicted model [OE – standard O_P_5] applied to the macroinvertebrate taxa found in each benthos field sample)

   d) *IMPORT_benthos_OE* (numerous ratio of observed to predicted models [different OE models - O_P_5, E_P_5, etc.] for the macroinvertebrate taxa observed in each benthos sample)

   e) *IMPORT_periphyton_Metrics* (laboratory metrics applied to each periphyton field sample)

   f) *IMPORT_periphyton_Flat_Algae* (counts of algae observed by taxon for each periphyton field sample)

   g) *IMPORT_periphyton_Flat_Diatom* (counts of diatoms observed by taxon for each periphyton field sample)

   h) *IMPORT_periphyton_AFDM_Rhithron* (total carbon measured as ash free dry mass [AFDM] for each periphyton sample sent to Rhithron Associates laboratories)

   i) *IMPORT_periphyton_Chlorophyll_Rhithron* (chlorophyll measured for each periphyton sample sent to Rhithron Associates laboratories)

   j) *IMPORT_periphyton_ChlorophyllAFDM_FLBS* (chlorophyll a and total carbon measured as ash free dry mass [AFDM] and for each periphyton sample sent to the Flathead Lake Biological Station [FLBS] laboratories)

   k) *IMPORT_periphyton_ChlorophyllAFDM_NRSA* (chlorophyll a and total carbon measured as ash free dry mass [AFDM] and for each periphyton sample sent to the EPA National Rivers and Streams Assessment [NRSA] laboratories)

   l) *IMPORT_water_lab_NRSA* (physiochemical measures for each water quality sample sent to the EPA National Rivers and Streams Assessment [NRSA] laboratories)

   m) *IMPORT_water_lab_FLBS* (physiochemical measures for each water quality sample sent to the Flathead Lake Biological Station [FLBS] laboratories)

   n) *IMPORT_water_lab_EPA* (physiochemical measures for each water quality sample sent to the EPA laboratories)

   o) *IMPORT_water_lab_ETC* (physiochemical measures for each water quality sample sent to the Environmental Testing & Consulting [ETC] laboratories)

p) *IMPORT_water_lab_Kiowa* (physiochemical measures for each water quality sample sent to the Kiowa Environmental Chemistry Laboratory)

2) Make a new copy of each individual the laboratory spreadsheet located at: *Z:\MONITORING\Streams\Data\DataGathering\Lab*.

   a) Based on the information found in the spreadsheet, and the laboratory used, open the correct table in the SEI Master Database (listed above in the previous step).

   b) Arrange the information in each new spreadsheet such that the column headings match exactly (this may take some detective work).

   c) Make sure that the numeric and other parameters are in exactly the same format found with previous data uploaded to the database table.

      Note: While you can change the display format of the data, you must not change or otherwise correct the data received from the laboratory. Those actions occur later.

3) When the spreadsheet data are in the correct format, append the new data to the correct SEI Master Database table.

Data Entry Procedure: Quality Control and Data Certification

The QAQC procedures for information in the SEI Master Database (discreet field plot and water quality data) are still in final development.

The Current Final QAQC and Certification Process

1) A member of the ROMN data management team opens the ROMN SEI Master Database at: *Z:\MONITORING\Streams\Data\Certified*.

   a) The database will automatically open to the *PopulateTables* form. On the form, click the three buttons used to generate the summary tables used by the ROMN ecologist for final QAQC.

      i) *Make Benthos Summary Tbls* button.

      ii) *Make Periphyton Summary Tbls* button.

      iii) *Make Water/Sediment Summary Tbl* button.

   b) Export the tables listed below to *.csv* format and send the finalized tables to the lead ROMN SEI ecologist.

      i) Merge all of the fields (columns) found in these seven tables into a single table, such that the *EventName* field is unique, all other fields from the second table are listed to the right of those from the first table, all other fields from the third table are listed to the right of those from the second table, etc.

         (1) *SUMMARY_Benthos_Metrics_Events_1*.

         (2) *SUMMARY_Benthos_Metrics_Events_2_part1*.

         (3) *SUMMARY_Benthos_Metrics_Events_3*.

         (4) SUMMARY_Benthos_Metrics_Events_4_part1.

(5) *SUMMARY_Benthos_Metrics_Events_4_part2*.

(6) *SUMMARY_Benthos_Metrics_Events_5*.

(7) *SUMMARY_Benthos_Metrics_Events_6*.

ii) *SUMMARY_Benthos_MetricsStacked_Events*.

iii) *SUMMARY_BenthosMMIOE_Events*.

iv) *SUMMARY_BenthosOE_Events*.

v) *SUMMARY_BenthosPlot_Events*.

vi) *SUMMARY_Periphyton_AlgaePlot_Events*.

vii) *SUMMARY_Periphyton_ChlorophyllAFDM*.

viii) *SUMMARY_Periphyton_DiatomMetrics_Events*.

ix) *SUMMARY_Periphyton_DiatomPlot_Events*.

x) *SUMMARY_WaterChem_Sediment_Matrix_Events*.

xi) Merge all of the fields (columns) found in these two tables into a single table, such that the *EventName* and *SampleName* fields are unique, and all other fields from the second table are listed to the right of those from the first table.

(8) *SUMMARY_WaterChem_Water_Matrix_ConcatFlags_Events1*.

(9) *SUMMARY_WaterChem_Water_Matrix_ConcatFlags_Events2*.

xii) *SUMMARY_WaterChem_Water_Matrix_Events*.

xiii) *SUMMARY_WaterChem_Water_Stacked_ConcatFlags_Events*.

xiv) *SUMMARY_WaterChem_Water_Stacked_Events*.

xv) *SUMMARY_WaterChem_WaterSediment_Stacked_Events_Distinct*.

2) The lead ROMN SEI ecologist performs finer-level QAQC tasks (trimming and other corrections) using R-project and spreadsheet tools, and sends them back to the ROMN data management staff in MS Excel format.

3) The ROMN data management staff incorporates those changes and corrections into the SEI Master Database. At this point, the data are considered to be "Certified," and ready for public distribution.

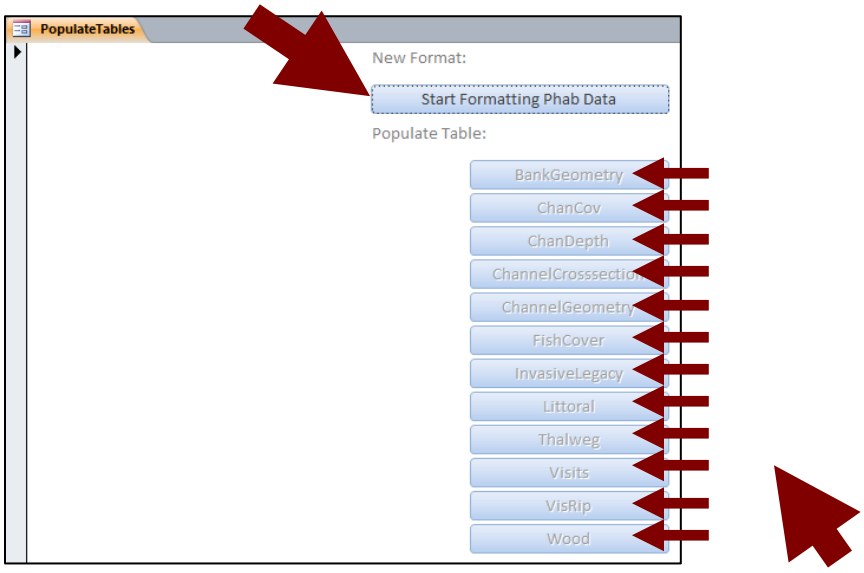
4) The ROMN data management staff removes all temporary working tables from the database, and posts/archives the final database to the NPS Data Store for public distribution.

NRSA PHAB QAQC Procedures (currently under final development)

These tasks are under final development, and will help the lead ROMN SEI ecologist to QAQC data more easily. We are customizing proven tools originally created by the U.S. Environmental Protection Agency's (EPA) National Rivers and Streams Assessment (NRSA) and streams Physical Habitat Characterization (PHAB) effort.

When the procedures are finalized, we will follow the basic steps below prior to generating the SUMMARY tables as outlined in the above section: *The Current Final QAQC and Certification Process*.

1) The ROMN data management staff opens the ROMN NRSA PHAB Database at: *Z:\MONITORING\Streams\Data\Certified\SEI_PHAB_NRSAformat_MASTER.accdb*.
   a) The ROMN NRSA PHAB Database contains a set of standard NRSA PHAB QAQC queries and macros that summarize and flag data that need further scrutiny.
   b) ROMN data management staff is currently customizing these queries to help analyze discreet plot/transect and related laboratory data found in the ROMN SEI Master Database.
2) The database automatically opens to the *PopulateTables* form. Click the *Start Formatting Phab Data* button.



   a) Working your way down the page, click all other buttons on the form.
3) The ROMN data management staff exports the tables generated by the tool to *.csv* format, and sends them to the lead ROMN SEI ecologist.
4) The lead ROMN SEI ecologist performs finer-level QAQC tasks (trimming and other corrections) using R-project and spreadsheet tools, and sends them back to the ROMN data management staff in MS Excel format.
5) The ROMN data management staff incorporates those changes and corrections into the SEI Master Database.
6) The ROMN data management staff exports the more detailed summary tables as outlined in section: *The Current Final QAQC and Certification Process*.

SEI SOP 14: Processing Data from Water Physiochemistry Sonde Loggers

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP presents the ROMN Data Management Team's processing of water physiochemistry loggers for download from the field computers to final summary tables. The SOP includes the current practices for acquiring, compiling, importing, adjusting, summarizing, and archiving data acquired from water physicochemistry loggers.

The equipment and software associated with water physiochemistry loggers change over time, and the methods that ROMN uses to process and archive this information is still under development. This SOP will be updated on a regular basis to the latest hardware, software, and procedures used.

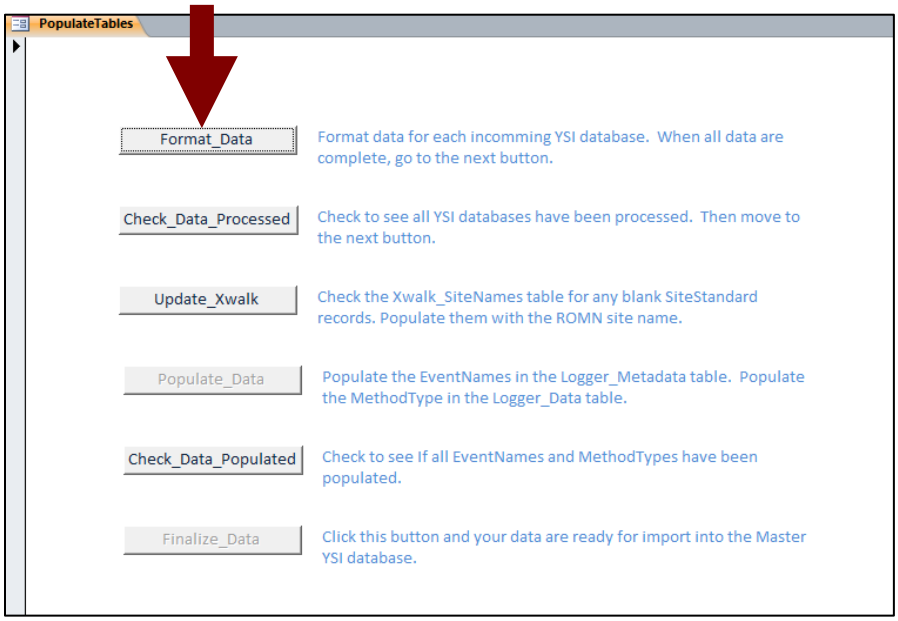
InSitu Water Physiochemistry Logger Processing Procedure: Office Processing YSI Sonde Data

1) During the field season, the downloaded YSI files will be saved as `YSIDataManager_YYYYMMDD` at: `Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\YSI\`
2) Make a copy of this database at: `Z:\MONITORING\Loggers\Data\Tools\YSI_ProcessingCode.accdb`.
   a) To the network drive folder: `Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\YSI\`.
   b) Using the file naming convention: `YSI_DataProcessing_YYYY_YYYYMMDD.accdb`.
3) Open the new InSituYSI database. The database automatically opens to the *`Populate Tables`* form (screenshot below).

4) Open the first YSIDataManager database and copy all the tables into the new *YSI_DataProcessing_YYYY_YYYYMMDD.accdb* database.

   Note: Go ahead and replace all existing tables that have the same name.

5) On the *Populate Tables* form, click the *Format_Data* button.



6) Move the YSIDataManager database that you just imported and formatted to: Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\YSI\Done\.

7) Repeat steps 4-6 for each YSIDataManager database.

   Note: Replace all existing tables that have the same name for each new YSIDataManager database imported.

8) When you are finished importing new database information, click the Check_Data_Processed button on the Populate Tables form.

9) Click on the Update_Xwalk button. On the next screen:

   a) Populate any null *Protocol* field records with the proper ROMN protocol name (field crews sometimes leave this blank).

   b) Populate any null *SiteStandard* field records with the accepted ROMN site name (field crews sometimes leave this blank, enter a non-standard name, etc.).

10) Open the Logger_Metadata table.

   a) Using information found in the separate SEI Master Database, Manually populate the *EventName* field for all *Logger_Metadata* table records.

   b) Make sure that all expected sites have been accounted for.

   c) Close the *Logger_Metadata* table.

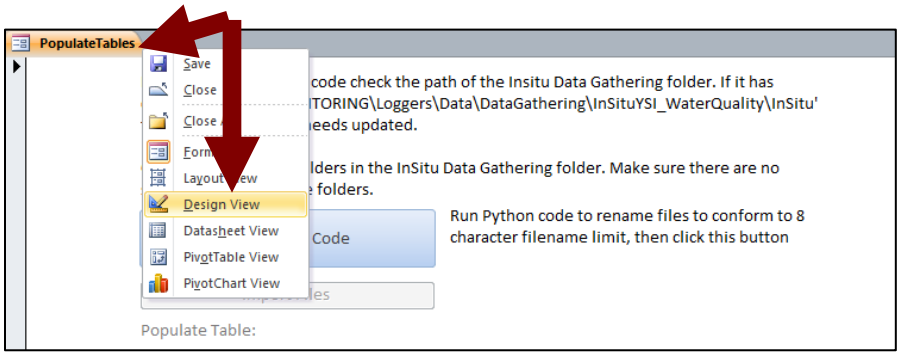
11) Open the *Logger_Data* table.
    a) Populate any null values in the *MethodType* field.
    b) Close the *Logger_Data* table.
12) On the *Populate Tables* form, click the *Populate_Data* button.
13) If any YSI data were written on field sheets:
    a) Enter them with a *Folder* value of *None* and a *Method_Type* value of *Manual*.
    b) Ensure a *Metadata* record is populated.
14) On the *Populate Tables* form, click the *Finalize Data* button.
15) Replace the *Xwalk_Sitenames* table in the database in the *tools* folder (*Z:\MONITORING\Loggers\Data\Tools*) with the table that has been updated this season.
16) After all raw YSI files have been imported into the YSI Database:
    a) Make a copy of YSI database, and name the new copy: *YSI_YearlyMaster_YYYY_YYYYMMDD.accdb*.
    b) Open the YSI Yearly Master Database, and delete all tables other than the *Logger_** tables.
    c) Append the data in theYSI Yearly Master Database *Logger_** tables into Master Water Quality Logger Database at: *Z:\MONITORING\Loggers\Data\Certified\WaterQuality_ROMN_AllYears_MASTER.accdb*.
    d) Move all YSI raw files and YSI Database files to: *Z:\MONITORING\Loggers\Data\Certified\FY##\RawData\InSituYSI_WaterQuality\YSI*.

InSitu Water Physiochemistry Logger Processing Procedure: Office Processing InSitu 9500 Sonde Data

1) During the field season, the *InSitu.dbf* files will be saved to a new folder for that day at: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\InSitu*.
    a) There are three types of files that the InSitu sonde produces:
        i) Header files, which contain the metadata and Unique Key for each file
        ii) Manual files
        iii) Timed files
2) Make a copy of this database at: *Z:\MONITORING\Loggers\Data\Tools\InSitu_ProcessingCode_FINAL.accdb*
    a) To the network drive folder: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\InSitu*.

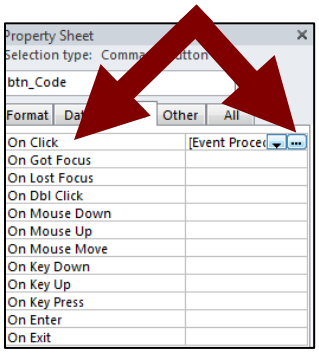
b) Using the file naming convention:
InSitu_DataProcessing_YYYY_YYYYMMDD.accdb.

3) Open the new InSitu Database that you just renamed. Right-click on the *PopulateTables* form (loads automatically) tab, and choose the *Design View* option.

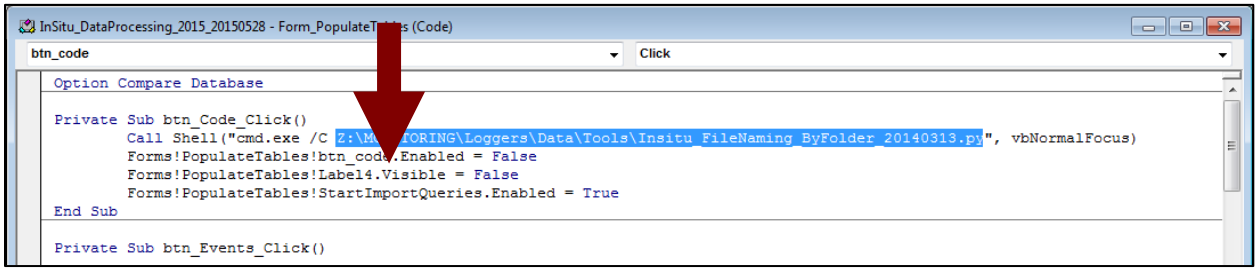


a) Right-click on the *Run Python Code* button and choose the *Properties* option.

b) On the *Property Sheet* menu, click the Event tab, and click the "…" icon on the *OnClick* row.



i) On the MS Access macro screen that pops up, check that the path and name of the python script listed on the second line matches the name of the actual python script at: *Z:\MONITORING\Loggers\Data\Tools\InSitu_FileNaming_ByFolder_YYYYMMDD.py* (or similar file name).



ii) Save the macro and close the MS Access macro application.

c) Open the python script in a script editor, located at: *Z:\MONITORING\Loggers\Data\Tools\InSitu_FileNaming_ByFolder_YYYYMMDD.py* (or similar file name).

i) In the paragraphs that begin with *StartDir* and *RenameDir*, make sure that the InSitu path folders match the current destination of InSitu files on network drive *Z:*.

```
StartDir = 'Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\InSitu\*'
containing files to rename (may be a root folder with subfolders) NOTE: Hard Coded Path name, Be
sure to change if folder structure changes

#IMPORTANT this String MUST end with \* to indicate we are searching for every thing in t
folder EX. 'Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\InSitu\*'.

RenameDir = 'Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_Wate  lity\InSitu\Done\\'
#Folder that files will be copied to when they are renamed. NOTE: Ha  oded Path name, Be sure
to change if folder structure changes

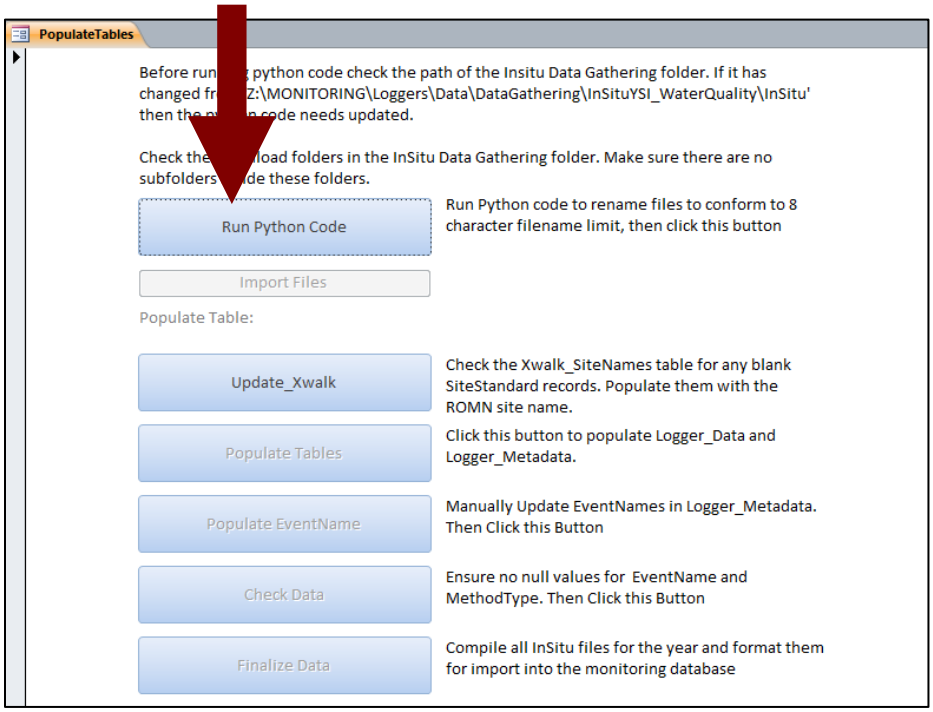
#IMPORTANT this string has NO special ending. Copy the path as it appears  n Windows Explorer EX.
'Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\InSitu\Do  '.
```

ii) Also make sure to end the file folder names as outlined in the code comment lines, denoted with a "*#*" symbol, located immediately below those sections.

4) In Windows Explorer, check that there are no *.dbf* files still in the *Done* folder before the script is run for the year.

5) Back on the InSitu database, right-click on the *PopulateTables* form tab, and choose the *Form View* option.

6) On the *PopulateTables* form, click the *Run Python Code* button.



a) This script renames the InSitu files, keeping their file type, to meet the character limit needed for later automated processing steps to work.

b) Only files in the following location and one level of subfolders will be renamed: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\InSitu*.

c) The other folders in this location (*Done*, *Old*, *ProcessNotes*, *Legacy*) are automatically skipped by the code.

d) Files are automatically moved from the individual download folders into the *Done* folder as they are renamed.

7) Click the *Import Files* button to begin importing the files into the database.

a) The code will navigate to the done folder and read-in all *.dbf* files contained there that meet the format of beginning with *Header*, *Manual*, or *Timed*.

b) The code will append the *.dbf* file to the appropriate table in the database if the file is not already present.

c) The function in this code to open files has an eight character limit on the file names it will accept. If you get a code error due to file names being too large, check and reduce the length of the problem filename(s).

8) Open the *Xwalk_SiteNames* table.

a) Field crews manually enter the *Site Names* into the logger files and they don't always match the standard format.

b) Populate any null values in the *SiteStandard* field.

c) Populate any null values in the *Protocol* field.

9) When there are no more null *SiteStandard* or *Protocol* records in the *Xwalk_SiteNames* table, click the *Update_Xwalk* button on the *PopulateTables* form.

10) Click the *Populate Tables* button.

11) Open the *Logger_Metadata* table.

a) Field crews manually enter the *Event Names* into the logger files, and they don't always match the standard format.

b) Using information the SEI Database, as well as the files in the logger folder:

i) Populate any null or incorrect values in the *EventName* field.

ii) If the record is an error check record (even if it occurs at a site) then enter the *EventName* as *Error Check*.

12) Open the *Logger_Data* table.

a) Field crews manually enter the *Method Types* into the logger files, and they don't always match the standard format.

b) Refer to the SEI database and the field sheets as required to check that all records in the *Method_Type* field are set to either *Timed* or *Manual*. If any InSitu data were written down on the field sheets:

i) Set the *Folder* value to *None*.

ii) Set the Method_Type to Manual.

iii) Make sure that all records that you just manually updated in the *Logger_Data* table, also have a corresponding record in the *Logger_Metadata* table.

13) When you are finished updating the *Logger_Data* and *Logger_Metadata* tables, click the *Populate EventName* button on the *PopulateTables* form.

14) Click the *Error Check Events* button on the *PopulateTables* form. This action populates the *tlu_ErrorCheckEvents* table with a record for each error check file.

15) Open the just updated *tlu_ErrorCheckEvents* table. For each record:

a) If it is obvious what event that error check would tie to in the *Logger_Data* or *Logger_Metadata* tables:

i) Change the *EventName* in *tlu_ErrorCheckEvents* to the correct event name.

ii) Leave the event name in *Logger_Metadata* as is.

b) If it is not obvious, or the error check could correspond to multiple events, then update the event name in *tlu_ErrorCheckEvents* to: *To be determined*.

16) Click the *Check Data* button.

a) If the *Logger_Metadata\EventName* or *Logger_Data\MethodType* fields were left null for any record, a message box will pop up and the *Finalize Data* button will not be enabled.

b) Populate any null *Logger_Metadata\EventName* or *Logger_Data\MethodType* fields, until the *Finalize Data* button is enabled on the *PopulateTables* form.

17) On the *PopulateTables* form, click the *Finalize Data* button.

18) Open the InSitu processing code located at: *Z:\MONITORING\Loggers\Data\Tools\InSitu_ProcessingCode_YYYYMMDD.aacb*.

a) Replace the *Xwalk_Sitenames* table in the processing database with the one that has been updated this season.

b) Close the processing database.

19) Once all raw InSitu files have been imported into the InSitu Database:

a) Make a copy of InSitu database, and name the new copy: *InSitu_YearlyMaster_YYYY_YYYYMMDD.accdb*

b) Open the InSitu Yearly Master Database and delete all tables other than the *Logger_** tables.

c) Append the data in the InSitu Yearly Master Database *Logger_** tables into the Master Water Quality Logger Database at: *Z:\MONITORING\Loggers\Data\Certified\WaterQuality_ROMN_AllYears_MASTER.accdb*.

20) Move all InSitu raw files and InSitu database files to: *Z:\MONITORING\Loggers\Data\Certified\FY##\RawData\InSituYSI_WaterQuality\inSitu*.

InSitu Water Physiochemistry Logger Processing Procedure: Office Processing Hanna Sonde

Hanna sondes are only used to take discreet measurements by field crew on the site, which is recorded on field sheets, and there are no logger files.

1) The data from the Hanna sonde is recorded on the field sheet packet by the field crew.
2) These data are entered and processed in the ROMN SEI Database (SEI SOP 13: Processing SEI Discreet Field and Laboratory Data).

InSitu Water Physiochemistry Logger Processing Procedure: Office Processing InSitu SmarTroll

SmarTroll logger data is downloaded to an iPhone or iPod using the iSitu application. Offloading files requires either wifi or a USB cable. Watch for files that are on the ipod but don't want to sync to iTunes.

Offloading via iTunes to a computer (no internet needed)

1) You must have an iTunes account with a purchased copy of the iSitu application. Up to 5 devices can be authorized with the same account information.
2) Connect iPod to computer using a USB cord. Open iTunes.
3) Select *SmarTroll iPod*.
4) Select the *Apps* tab at the top.
5) Scroll to the bottom and select the *i-Situ* application icon.
6) On the right hand side of the screen, *i-Situ Documents* should come up.
7) Drag files to any location on your computer, or select *Save to …* tool.
8) On ROMN network drive: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\SmarTroll*:
   a) Make a new folder that includes the date in the name and perhaps a description of the files to be offloaded.
   b) Copy the i-Situ files to the new folder (s).

c) These can be separate folders for each download. It is fine if there will be multiple copies of files with this download method. The duplicates will be taken care of by the database.

d) Make sure that the only files in this folder are from the current year (You can not just put it into a *done* folder because the database will check through all sub folders looking for files).

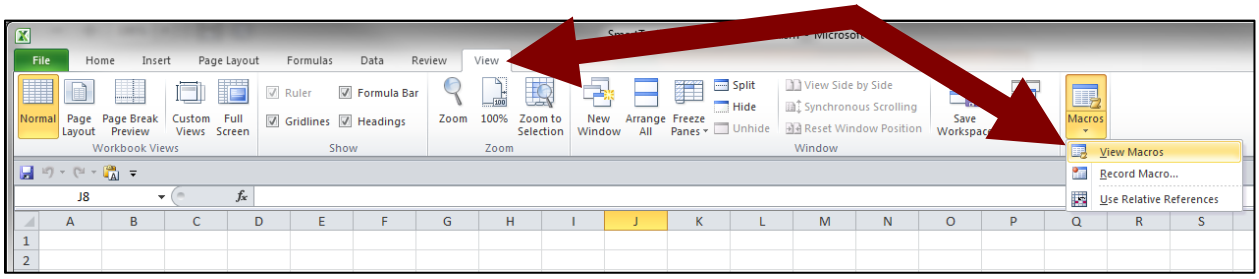
Offloading via email (WiFi needed)

1) The iPod or iPhone must first be set up with an email account.
2) Open i-Situ application.
3) Select lower left most icon to bring up the logs.
4) Select the log you want to view or email (a red dot indicates it is selected).
5) Once the logs you want to email are all selected, click on the email icon on the lower right of the screen. It will open a message with the logs automatically attached. Send email.

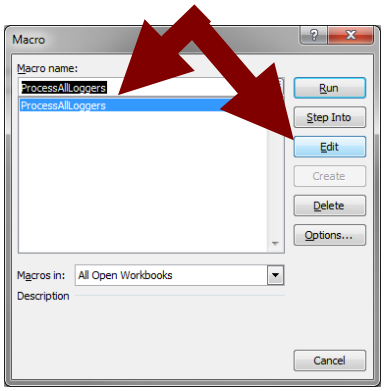
Next Steps

1) Make sure this folder is empty (processed files are typically placed into a done folder): *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\SmarTroll\ReadyToImport*.
2) Open the SmarTroll macro enabled workbook located at: *Z:\MONITORING\Loggers\Data\Tools\SmarTroll_LoggerMacro_YYYYMMDD.xlsm*.

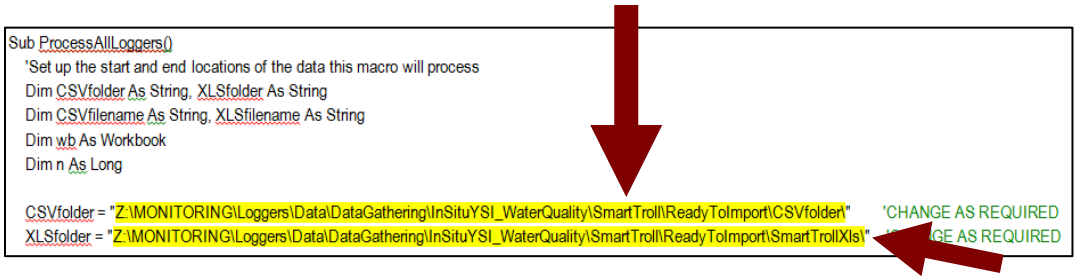
a) Select the *View/Macros/View Macros* menu option.



b) On the next pop-up screen, select the *ProcessAllLoggers* macro, and click the *Edit* button.

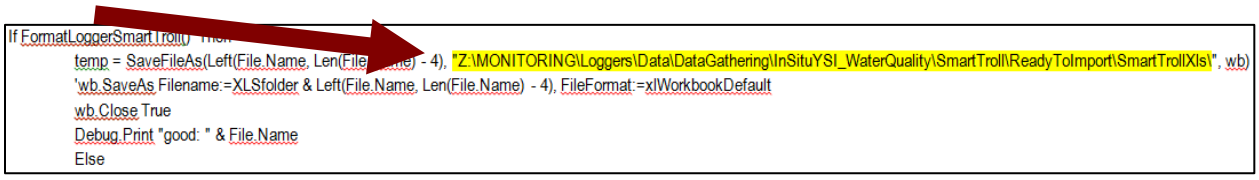


c) Near the top of the macro, make sure that the CSVfolder line is set to: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\SmarTroll\ReadyToImport\CSVfolder*.



d) Also make sure that the XLSfolder line is set to: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\SmarTroll\ReadyToImport\SmarTrollXls*.

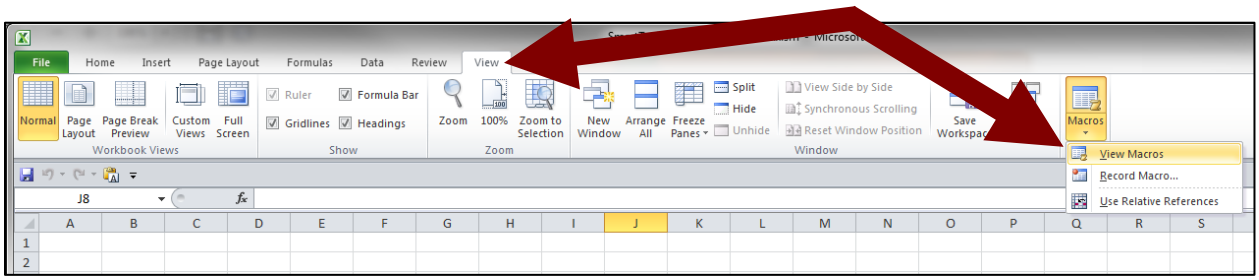
e) Scroll down to the temp = SaveFileAs line, and set the destination to: *Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\SmarTroll\ReadyToImport\SmarTrollXls*.



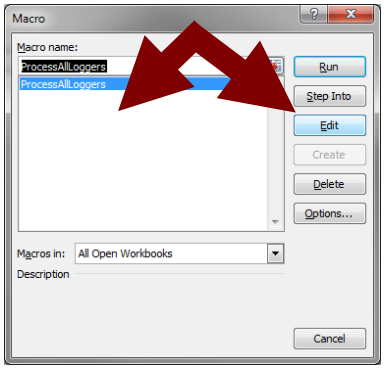
f) Save and close the macro script.

3) Back in the SmarTroll macro enabled workbook:

a) Select the *View/Macros/View Macros* menu option.



b) On the next pop-up screen, select the *ProcessAllLoggers* macro, and click the *Run* button.



Note: Running the macro will take anywhere from 30 minutes to one hour, depending on the number of files being processed.

c) If the macro takes too long or crashes, other SmarTroll users recommend that you (ROMN has not had to try this yet):

i) Add this line of code at the beginning of your macro script:
Application.ScreenUpdating = False

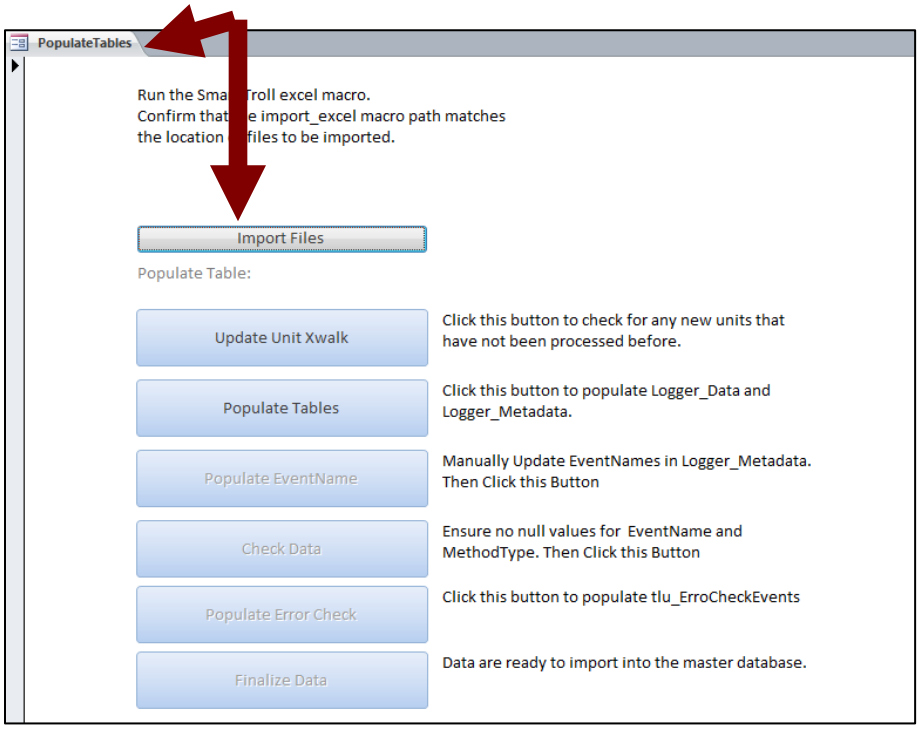
ii) Add this line to the end of your macro script:
Application.ScreenUpdating = True

d) Once the macro is finished, Make a copy of this database at:
Z:\MONITORING\Loggers\Data\Tools\SmarTroll_ProcessingTools_FINAL.accd.

e) To the network drive folder:
Z:\MONITORING\Loggers\Data\DataGathering\InSituYSI_WaterQuality\SmarTroll.

f) Using the file naming convention:
SmarTroll_DataProcessing_YYYMMDD.accd.

4) Open the new SmarTroll Database. On the *PopulateTables* form (opens automatically), click the *Import* button.



   a) The SmarTroll files incude the number of records the logger thinks it recorded, and this step includes a check to see if the number of records that are read in matches that count.

   b) Of a pop-up screen indicates missing file names, figure out and fix the issue with that missing file name.

5) On the *PopulateTables* form, click the *Update Unit Xwalk* button. This checks the import files.

   a) Any new units that we have not seen before for that field will be added to the *Xwalk_Units* table.

   b) Figure out and fix the necessary conversion from the unit that was reported and the accepted unit.

      i) If the conversion is a simple multiply or divide, then list the conversion operator and the conversion factor in the appropriate fields.

      ii) If there is a more complicated conversion needed then write a function and edit the queries to make that conversion.

      Note: There are some fields that are recorded by the Sonde but we do not report on yet. These may be added later by adding the new fields to the *update_LoggerSmarTroll* section.

6) On the *PopulateTables* form, click the *Populate Tables* button to populate the logger data and metadata tables.

   Note: This action will start by clearing these tables.

7) Open the *Logger_Data* table.
   a) Field crews manually enter the *Method Type* into the logger files, and they do not always match the standard format.
   b) Using information in the SEI Database, as well as the files in the logger folder, Populate any null or incorrect values in the *MethodType* field.
   c) Close the table.

8) Open the *Logger_Metadata* table.
   a) Field crews manually enter the *Event Names* and *Site Names* into the logger files, and they do not always match the standard format.
   b) Using information in the SEI Database, as well as the files in the logger folder:
      i) Populate any null or incorrect values in the *EventName* field.
      ii) Populate any null or incorrect values in the *SiteName* field.
      iii) Close the table.

9) On the *PopulateTables* form, click the *Check Data* button.

10) On the *PopulateTables* form, click the *Populate Error Check* button to populate the *tlu_Errorcheck* table.

11) Test that the *Error Check* button is working. This was done by hand in 2014 for all three WQ Databases.
   a) If the file is an error check then set the *EventName* value to *Error Check*.
   b) Where it is known which event the error check corresponds to, change the *EventName* in *tlu_Errorcheck* to the correct event.
   c) Where it is not known which event or the error check corresponds to multiple events change the event name in *tlu_Errorcheck* to *To Be Determined*.

12) Click the *Finalize Data* button.

13) Once all raw SmarTroll files have been imported into the SmarTroll Database:
   a) Make a copy of SmarTroll database, and name the new copy: *SmarTroll_YearlyMaster_YYYY_YYYYMMDD.accdb*.
   b) Open the SmarTroll Yearly Master Database, and delete all tables other than the *Logger_** tables.

c) Append the data in the SmarTroll Yearly Master Database *Logger_** tables into the master database: *Z:\MONITORING\Loggers\Data\Certified\WaterQuality_ROMN_AllYears_MASTER.accdb*.

14) Move all SmarTroll raw files and SmarTroll database files to: *Z:\MONITORING\Loggers\Data\Certified\FY##\RawData\SmarTrollYSI_WaterQuality\SmarTroll\.*

15) Append the data in the Logger_* tables into the Master Water Quality Logger Database at: *Z:\MONITORING\Loggers\Data\Certified\WaterQuality_ROMN_AllYears_MASTER.accdb*.

InSitu Water Physiochemistry Logger Processing Procedure: Final QAQC and Certification

These steps take place after the entire field season has finished, and the data from all water quality loggers have been appended to the Master Water Quality Logger Database.

1) Open the Master Water Quality Logger Database at: *Z:\MONITORING\Loggers\Data\Certified\WaterQuality_ROMN_AllYears_MASTER.accdb*.

2) Run the *QAQC_01_CheckNull* query. This query returns a list of logger files that have not been tied to an *EventName* in the *Logger_Metadata* table.

   a) Open the SEI Master Database SEI Master Database *Z:\MONITORING\Streams\Data\Certified*.

   b) Use the information in the SEI Master Database to add the appropriate *EventName* in the *Logger_Metadata* table.

   c) You are finished when the *QAQC_01_CheckNull* query returns no more rows.

3) Run these queries in the following order, to generate the summary tables that will be sent to the lead ecologist for final QAQC analysis.

   a) *Summary_Daily_01*.

   b) *Summary_Daily_02*.

   c) *Summary_Daily_03*.

4) Export the all new records added over the previous sampling season only, located in following tables, to *.csv* format.

   a) *Logger_Data*.

   b) *Logger_Metadata*.

   c) *SUMMARY_LoggerWaterQualityDaily*.

   d) *SUMMARY_LoggerWaterQualityDaily_r*.

5) The lead ecologist will perform corrections as needed, and send back the corrected (trimmed, annotated, etc.) records to the data management staff when they are finished.
6) The data management staff uses the information in the files sent back by the lead ecologist updates the information in the Water Quality Master Database.
7) Make an archive copy of the Water Quality Master Database using the format: *WaterQuality_ROMN_Master_YYYYMMDD.acdb*.
8) Save the archive copy of the database to: *Z:\MONITORING\Loggers\Data\Certified\old*.

SEI SOP 15: Processing HOBO Water Temperature Loggers

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

HOBO brand temperature loggers (HOBO loggers) are currently used for multiple ROMN monitoring protocols (SEI, AWEI, and ACVSS). All HOBO data, regardless of monitoring protocol or medium being sampled (water or soil), are currently managed using a single database system.

This SOP presents the ROMN Data Management Team's duties related to HOBO loggers: pre-season equipment set up, acquiring and processing field data, working with ecologists to analyze and certify the data, and archiving certified data.

The equipment and software associated with temperature loggers change over time, and the methods that ROMN uses to process and archive this information is still under development. This SOP will be updated on a regular basis to the latest hardware, software, and procedures used.

HOBO Water Temperature Logger Procedure: Pre-Season Set Up

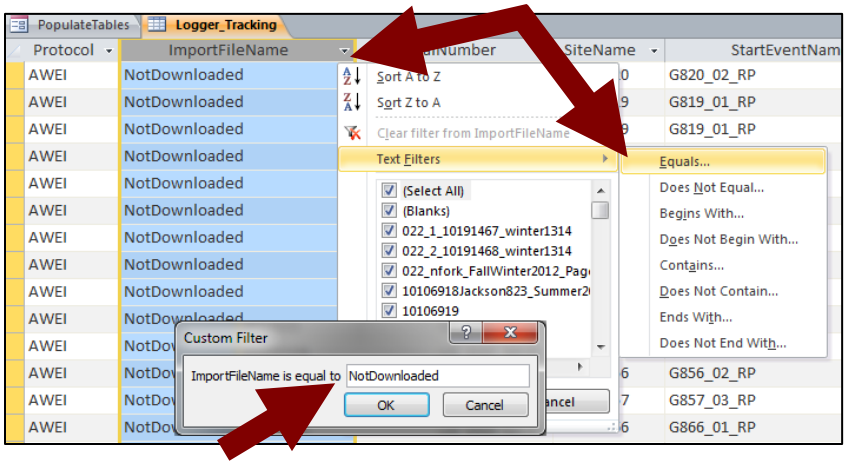
Obtaining a Pre-field Season Estimates for the Number of HOBO Loggers and Batteries

It is a good idea to work with ecologists to estimate the total number of HOBO Loggers and batteries that may be needed well in advance of the regular field season. To do this:

1) Well before the field season starts, open the HOBO Master Database located at: *Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb*.

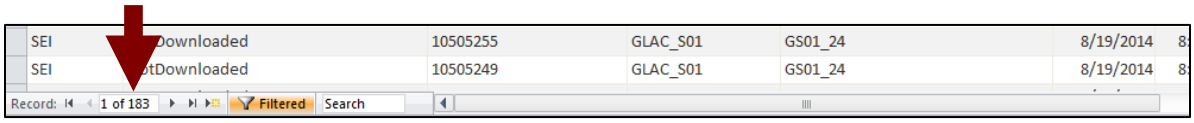
   a) Open the `Logger_Tracking` table.

   b) Click on the down arrow icon located on the right-hand border of the `ImportFileName` field, and choose the `Text Filters/Equals` option.



   c) On the *Custom Filter* pop-up box, paste *NotDownloaded* into the text box and click the *OK* button.

   d) The total number of HOBO loggers still in the field from last year, and that may need to be replaced over the coming sampling season, is displayed as the larger number in the *Record # of #* field, located in the bottom left-hand part of the table (example below = *183*).



2) Work with the lead ecologists for each protocol to find out about:

   a) The number of brand new sites where HOBO loggers may be added this year (very common).

   b) The number of existing sites where HOBO loggers will be removed entirely (very common).

   c) If they know of any HOBO logger units that are worn out that need to be replaced (uncommon).

3) It is also a good idea to have at least 16 additional HOBO loggers with fresh batteries, and 16 additional fresh batteries on hand before the field season begins (HOBO loggers are often added to new alpine vegetation monitoring sites in groups of 16 units).

4) Using the information above, calculate the estimated sum of HOBO loggers and batteries required for the coming field season.
5) Work with ROMN ecologists to purchase new HOBO loggers well before the field season begins.

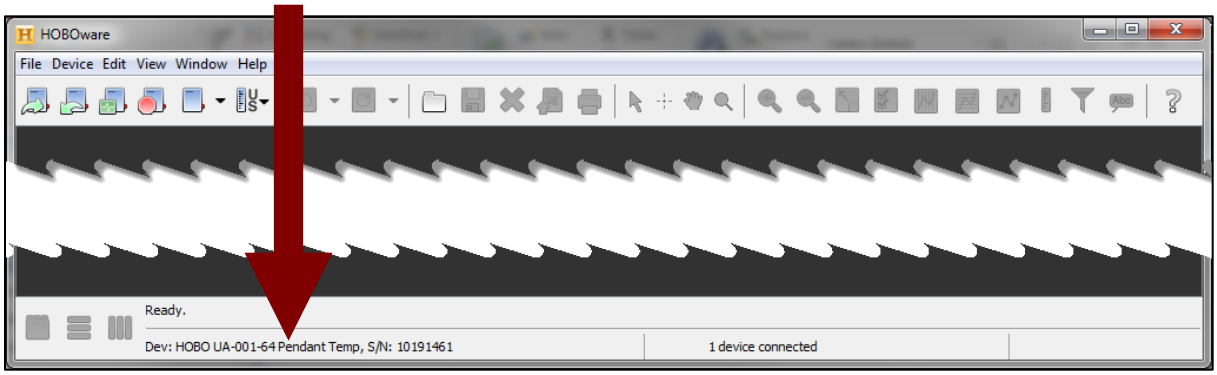
Checking the Battery Level of HOBO Loggers That May Go Into the Field

Batteries should only be checked by ROMN staff in the Fort Collins office. This helps us make sure that we don't run short on HOBO logger units or batteries over the current, or pending field season.

Tasks in this section require that you have a computer with OnSet HOBOware Version 3.7.3 program (HOBOware) installed, and a HOBO Optic USB Base Station (HOBO cradle) connected to it.

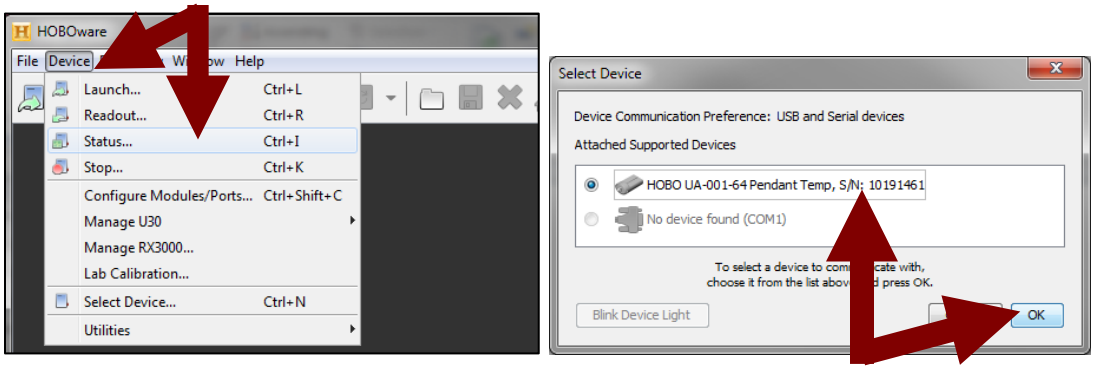
HOBO loggers being sent into the field should have 90% or higher battery power. To check and replace HOBO logger batteries:

1) On the computer, open the HOBOware program (Start/All Programs/Onset Applications/HOBOware).
2) Connect the HOBO cradle to the computer via the USB connector.
3) Insert a HOBO logger unit into the HOBO cradle.
   a) HOBOware should automatically detect the device within a few seconds. When the device is detected, the bottom left-hand corner of the HOBOware window will show something like: *DEV: HOBO UA-001-64 Pendant Temp, S/N XXXX*.



   b) If it is still not detected, take the HOBO logger unit out of the cradle and re-insert it (checks for bad HOBO logger unit connection to the HOBO cradle).
   c) If the device is not detected, you can try to manually connect via the *Device/Select Device* menu option (checks for a software issue).
   d) If it is still not detected, unplug the HOBO cradle from the computer and try connecting it to the same, and perhaps another, USB port (checks for a bad USB connection).
   e) If it is still not detected, replace the battery using the instructions below and try connecting it to the HOBO cradle again (checks for dead battery).

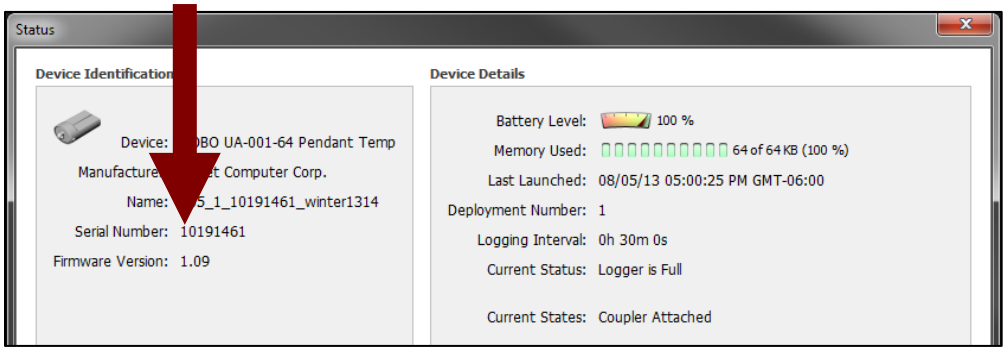
f) If it is still not detected, give the problem HOBO logger unit to the ROMN Data Manager to figure out (there is a mechanical problem with the unit). When HOBOware detects the HOBO logger unit, choose the *Device/Status* menu option.



4) On the next pop-up screen, select the HOBO device, and click the *OK* button.

5) On the next pop-up screen, click the *OK* button to continue.

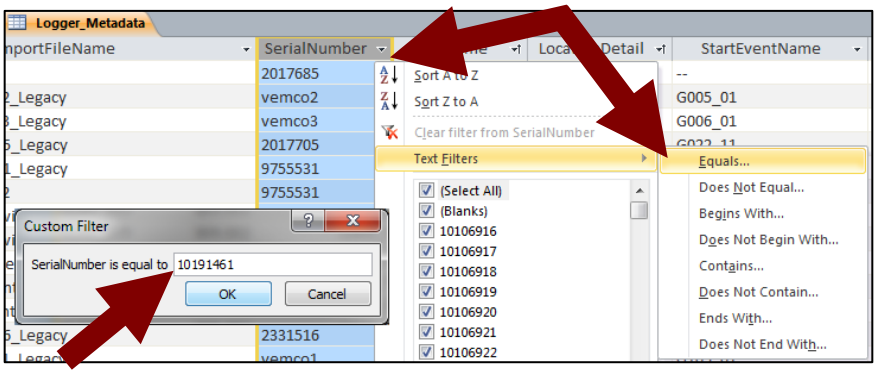
6) On the new *Status* window, note the *Serial Number* (upper left-hand screen).



7) Open the HOBO Master Database located at:
Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb.

a) Open the `Logger_Metadata` table.

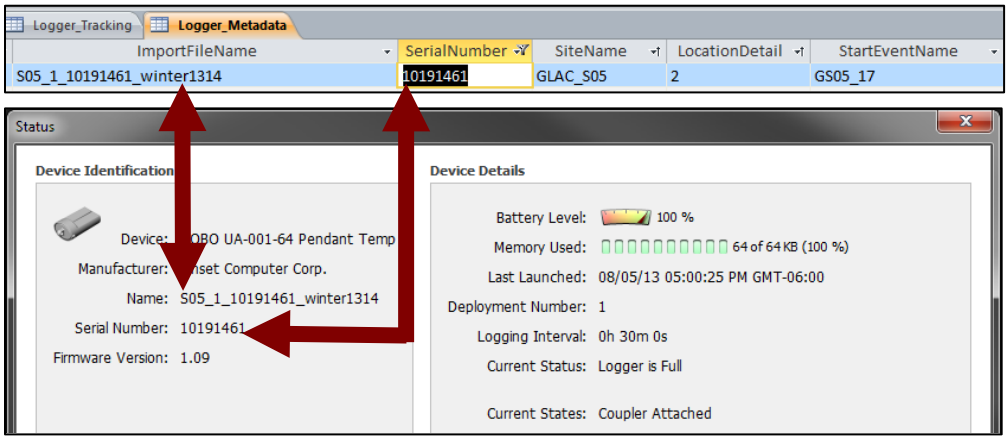
b) Click on the down arrow icon located the right-hand border of the `SerialNumber` field, and choose the `Text Filters/Equals` option.



8) On the next pop-up screen, enter the serial number of the HOBO logger you are checking, and click the *OK* button.

9) When the filtered records are returned, make sure that any old information in the HOBO logger from the previous field season has already been downloaded and processed before you go any further. To do this:

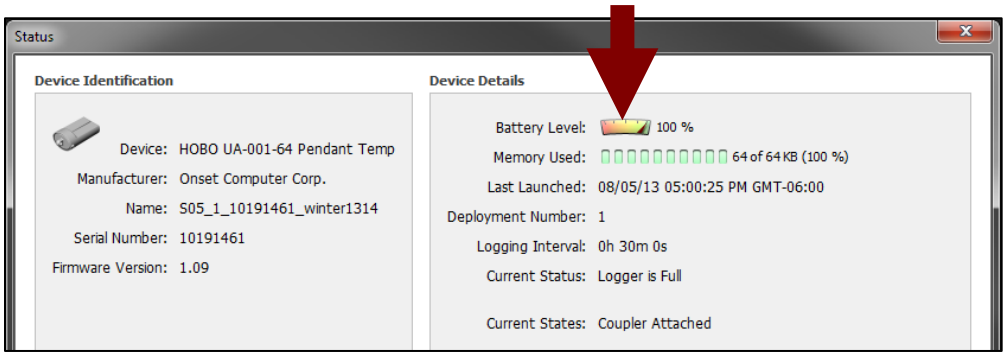
   a) In the *Logger_Metadata* table, make sure that you find matches between the *ImportFileName* and *SerialNumber* database fields and the corresponding information shown on the HOBOware *Status* window.



   b) If you see a match for both fields, continue on to Step 11 (the old records on the HOBO logger have already been downloaded and processed, and can be deleted later).

   c) If you do not see a match for both fields, immediately remove the HOBO logger from the HOBO cradle, and place it with the other *incoming* HOBO loggers (the old records on the HOBO logger have not been downloaded and processed, and you cannot delete them yet).

10) On the new *Status* window, check the *Battery Level* (upper right-hand screen).



   a) If the HOBO's battery level is equal to or greater than 90%, it does not require a new battery.

   b) If it is at less than 90%, the battery will need to be replaced. To replace the battery:

      i) Remove the HOBO from the cradle.Using a jeweler's screwdriver, unscrew and remove the two small screws that hold the cap in place.

ii) Remove the HOBO cap.

iii) Tilt the HOBO and remove its contents from the plastic shell.

Note: Pay close attention to how the contents are arranged inside the shell.

iv) Remove the battery from the HOBO using the HOBO Battery Remover (or a plastic knife), and replace it with a new battery (Sony CR2032, 3 Volts Lithium Cell J).

v) Return the HOBO apparatus into its plastic shell.

vi) Replace the cap, **making sure that the ammonium salt bag is inside the cap**.

vii) Replace the screws that hold the cap in place.

11) If you are pre-setting the logger for a specific launching date and time, proceed immediately to the next section: *Pre-launching HOBO Loggers at the ROMN Fort Collins Office*.

12) If you are just checking batteries, place all of the battery-checked loggers into a clearly-marked reusable zipper storage bag. Suggested information to mark on the bags includes:

a) Only batteries were checked so far (e.g., *HOBO loggers – Batteries Checked Only*).

b) Date of battery check (e.g., *Batteries Checked 6-10-2015*, *Batteries Checked 7-15-2015*, etc.).

c) A "Prepared by" statement (e.g., *Prepared by Kristin Long*, *Prepared by Fagan Johnson,* etc.).

d) Contact phone number (e.g., *Phone: 970-227-1093*).

HOBO Water Temperature Logger Procedure: Setting the Sampling Dates and Times (Launching) for HOBO Loggers

You can set up HOBO loggers to begin recording temperature on a specific date and time in the near or distant future (minutes, days, weeks, etc.). HOBOware software refers to this task as "*Launching*."

1) Setting the launching date and time for a HOBO logger can be done on any computer that has HOBOware software installed and a HOBO logger cradle connected to it (required).
2) When ecologists already know days to months in advance the approximate date and time when they are scheduled to set up HOBO loggers at a given site:
   a) Ecologists often usually ask ROMN data managers to set up HOBO loggers to begin recording temperatures days to weeks in advance (pre-launching).
   b) For more information, see the section below: Pre-launching HOBO Loggers at the ROMN Fort Collins Office.
3) For information about launching HOBO loggers outside the ROMN Fort Collins office, see the section below: *Launching HOBO Loggers Outside the ROMN Fort Collins Office*.

Pre-launching HOBO Loggers at the ROMN Fort Collins Office

This section is only for ROMN data managers and ecologists, and can only be performed inside the Fort Collins office.

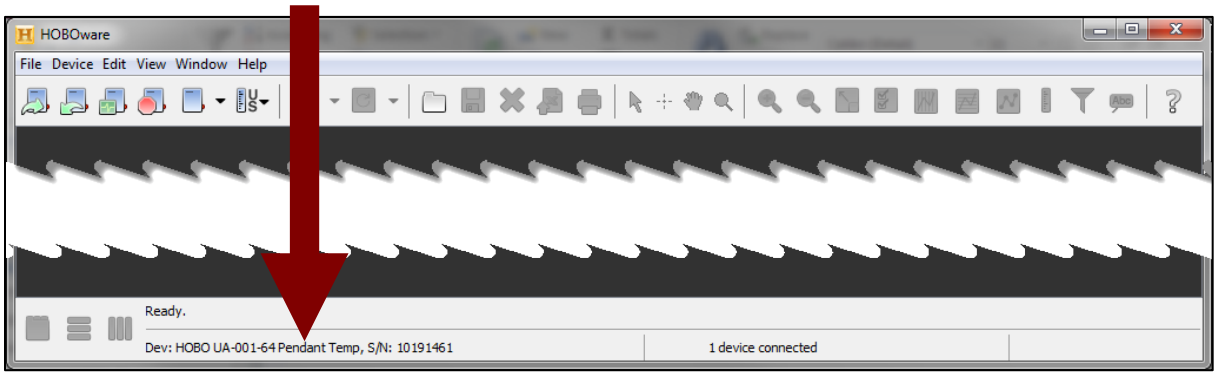
Some of the tasks outlined in this section require that you have access to shared databases that are located on the ROMN network drive `Z:\`, which is only available inside the Fort Collins office.

Tasks in this section require that you have a computer with OnSet HOBOware Version 3.7.3 program (HOBOware) installed, and a HOBO Optic USB Base Station (HOBO cradle) connected to it.

To set the launch date and time for an individual HOBO logger per a request from an ecologist:

1) Make sure that the battery power is at least 90% and any old records on the HOBO logger have already been downloaded and processed, per the instructions in the above section: *Checking the Battery Level of HOBO Loggers That May Go Into the Field*.
2) When you know that the battery power is at least 90%, and any previous HOBO logger records have already been downloaded and processed, open the HOBOware program on the computer (`Start/All Programs/Onset Applications/HOBOware`).
3) Connect the HOBO cradle to the computer via the USB connector.
4) Insert a HOBO logger unit into the HOBO cradle.

a) HOBOware should automatically detect the device within a few seconds. When the device is detected, the bottom left-hand corner of the HOBOware window will show something like: *DEV: HOBO UA-001-64 Pendant Temp, S/N XXXX*.



b) If it is still not detected, take the HOBO logger unit out of the cradle and re-insert it (checks for bad HOBO logger unit connection to the HOBO cradle).

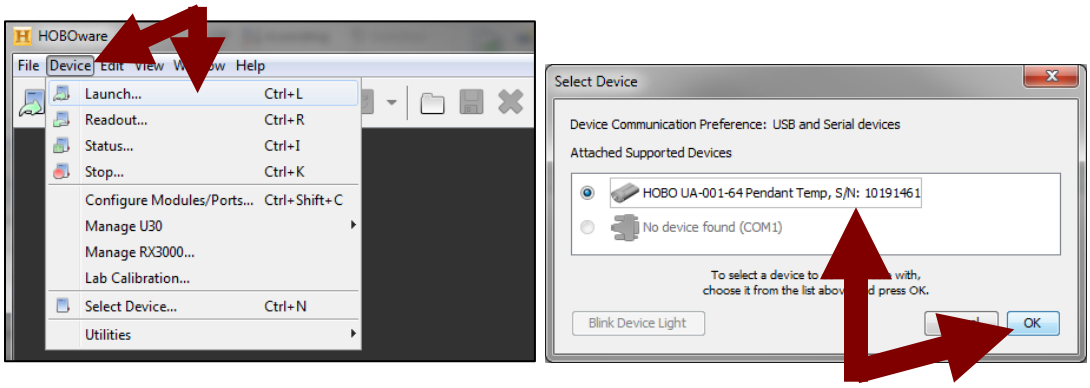
c) If the device is not detected, you can try to manually connect via the *Device/Select Device* menu option (checks for a software issue).

d) If it is still not detected, unplug the HOBO cradle from the computer and try connecting it to the same, and perhaps another, USB port (checks for a bad USB connection).

e) If it is still not detected, replace the battery using the instructions below and try connecting it to the HOBO cradle again (checks for dead battery).

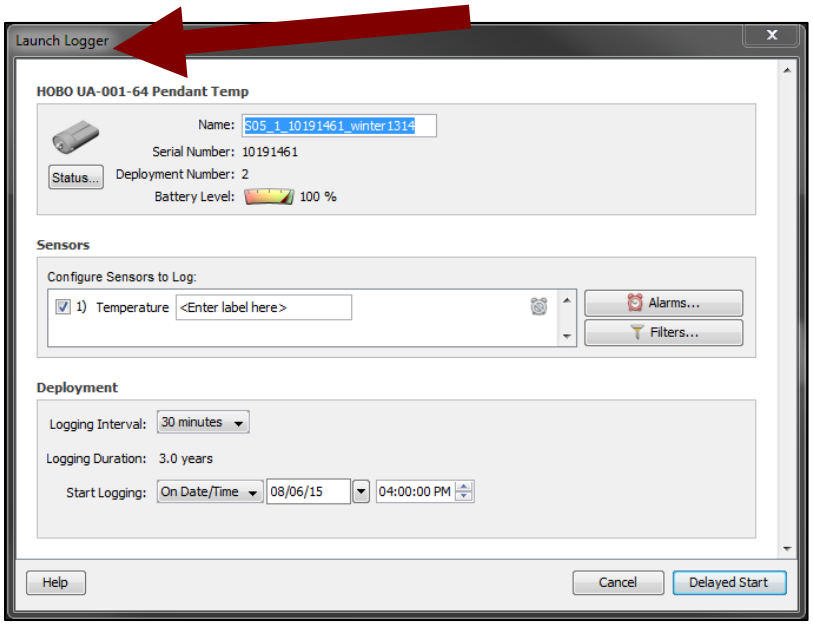
f) If it is still not detected, give the problem HOBO logger unit to the ROMN Data Manager to figure out (there is a mechanical problem with the unit).

5) In HOBOware software choose the *Device/Launch* Option.



a) On the next pop-up screen, select the HOBO device, and click the *OK* button.

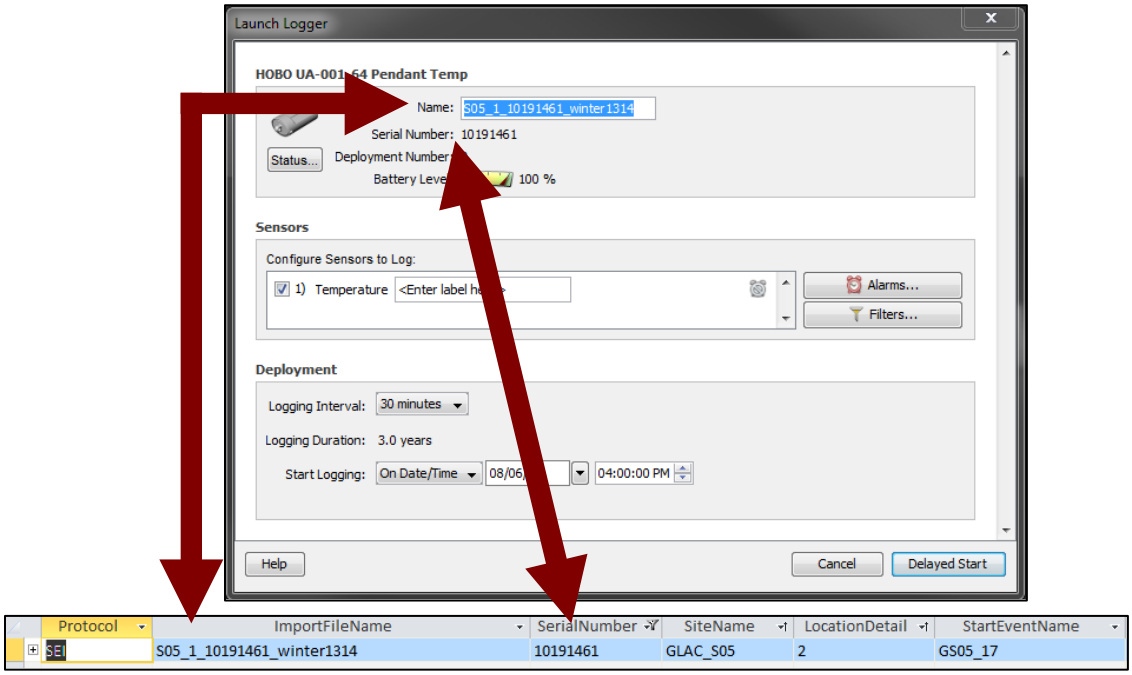
b) If another pop-up screen appears, just click the *OK* button to continue. This should open *Launch Logger* screen.



6) Open the HOBO Master Database located at: *Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb*.

7) Open the Logger_Tracking database table, and make sure that there is a record where the:

a) *ImportFileName* table field matches the HOBOware *Name* field.



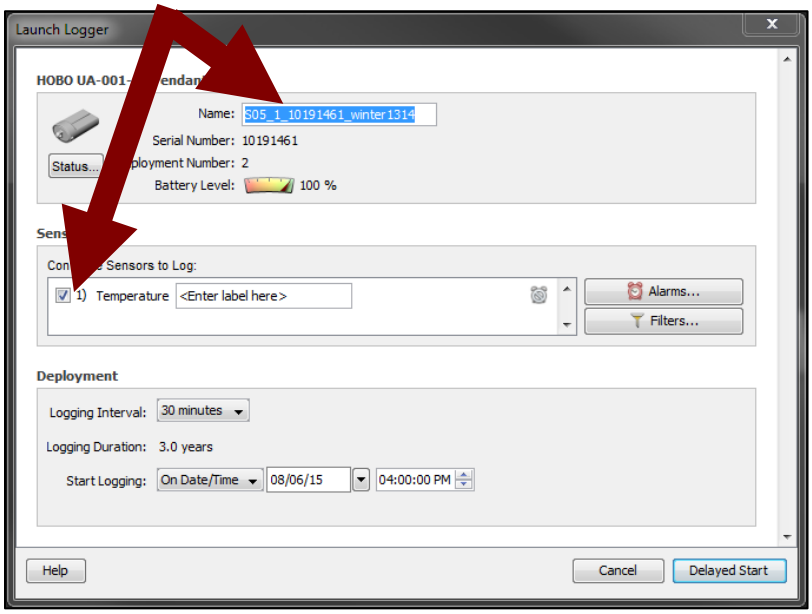
b) The *SerialNumber* table field matches the HOBOware *Serial Number* field.

c) If both match, continue to Step 8 (older HOBO data has already been downloaded).

d) If there is not a record in the database where both match, immediately remove the HOBO logger from the HOBO cradle, and place it with the incoming HOBO loggers (older HOBO data still needs to be downloaded).

8) If any old data on the HOBO logger was already downloaded, on the *Launch Logger* window:

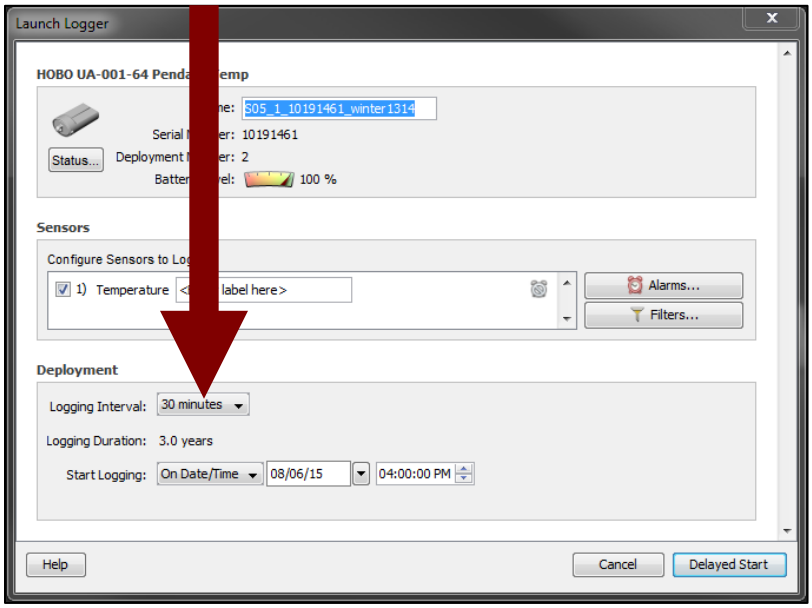
a) Make sure that the *Temperature* box is checked, and create a *Name* for the HOBO logger unit.



i) The standard format is: *Site_(1 or 2)_Serial#_Timeframe* (e.g ., *S05_1_10191461_winter1314*)

ii) The exact format of the name is not important as long as it is not intentionally confusing (i.e. just calling the logger something like: *GLAC_SO5_1* with no other qualifiers).

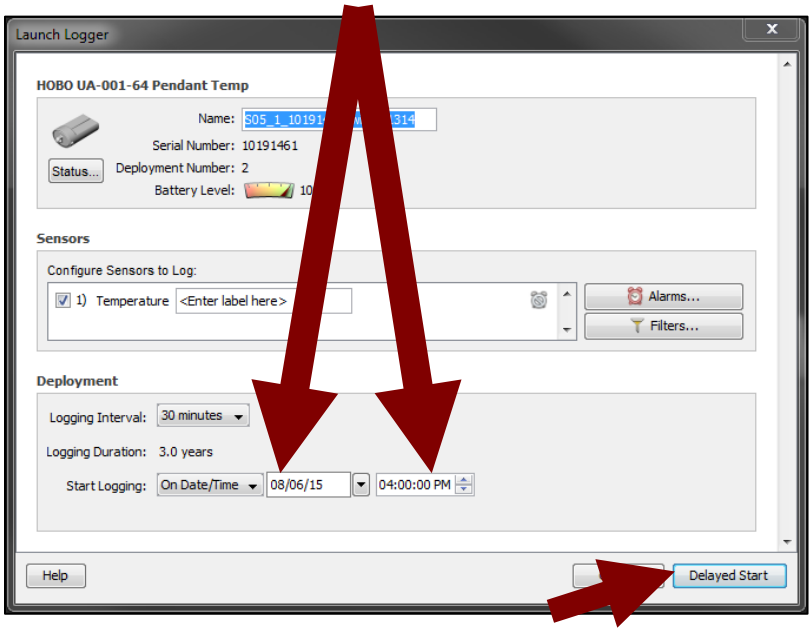
b) Set the *Logging Interval* to the correct unit for that protocol.



i) For SEI, *Logging Interval = 30 Minutes*.

ii) For AVCSS and AWEI, *Logging Interval = 1 hour*.

c) Use the *Start Logging* tools to set the exact date and time you want the HOBO logger to begin recording temperature. **Make sure that all times are set to start exactly on the hour or half-hour** (e.g., 8:00 AM, 8:30 AM, etc.).

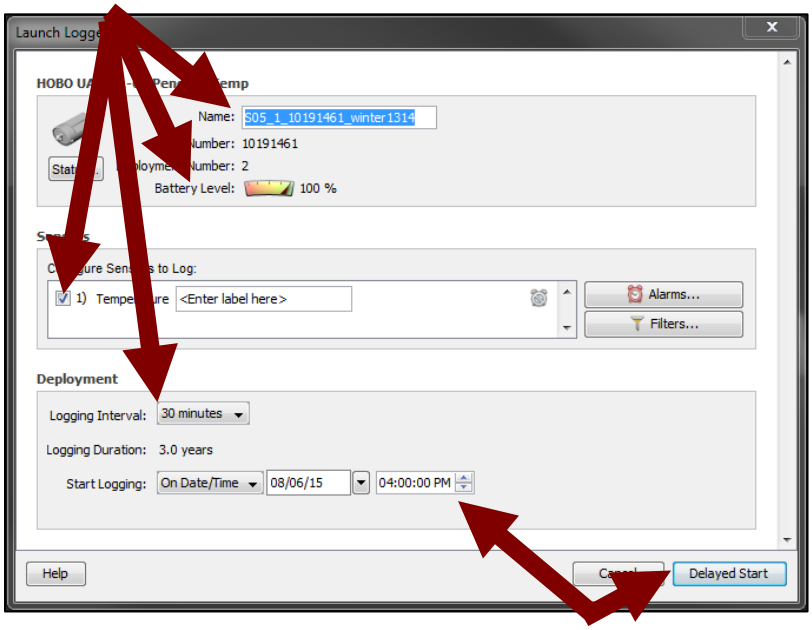


a) To finish setting the launching date and time, click the *Delayed Start* button.

9) Double-check that the HOBO logger was set up correctly and is ready for deployment.

a) In the HOBOware software choose the *Device>Launch* Option (again).

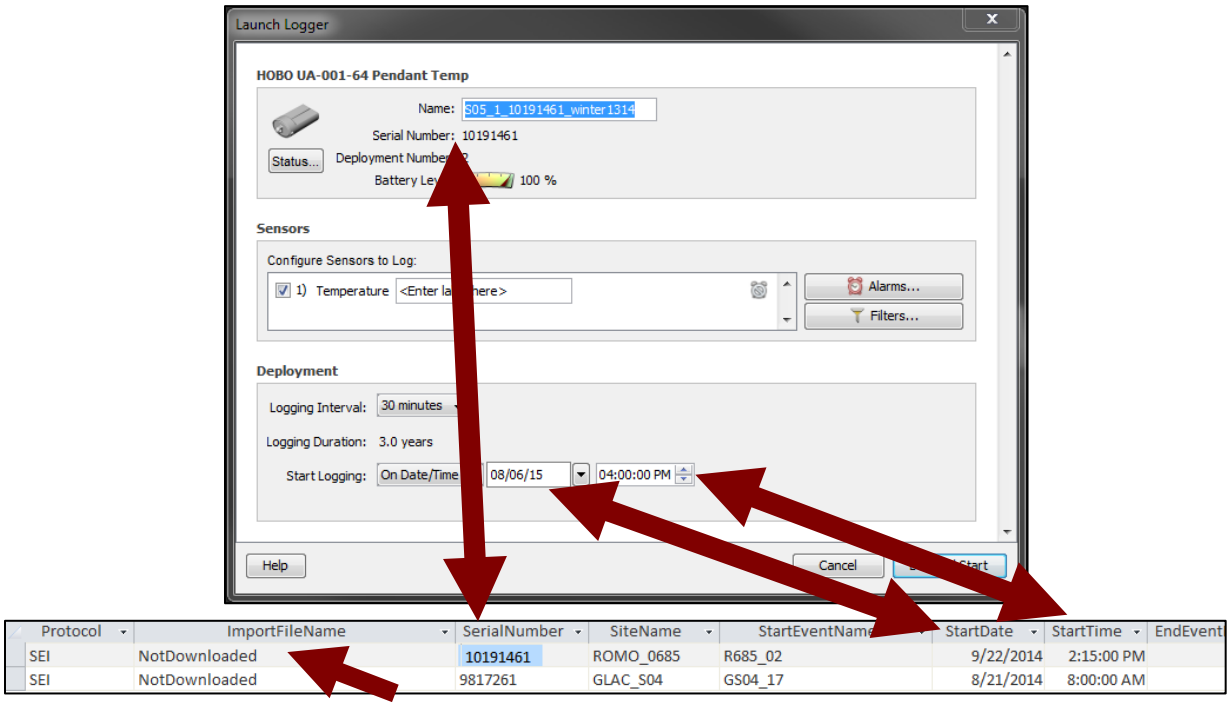
b) On the *Launch Logger* screen, make sure that the *Battery Level* is at 90% or greater, and that the other launch settings are correct.



c) If everything is okay, proceed to Step 11 below.

d) If everything is not okay, re-try setting the launch date and time using Steps 8 and 9 above.

10) In the *Logger_Tracking* database table, create a new record and use the information on the HOBOware Launch Logger screen to fill in the *SerialNumber*, *StartDate*, and *StartTime* fields.



11) Set *ImportFileName* = *NotDownloaded* (the default file name prior to final download).

12) Use any other information from the ROMN ecologist to fill out as many of the following fields as possible: *Protocol*, *SiteName*, *StartEventName*, *LocationDetail*, and *Notes* (scroll right to see the *LocationDetail* and *Notes* fields).

Protocol	ImportFileName	SerialNumber	SiteName	StartEventName	StartDate	StartTime	EndEvent
SEI	NotDownloaded	10191461	ROMO_0685	R685_02	9/22/2014	2:15:00 PM	
SEI	NotDownloaded	9817261	GLAC_S04	GS04_17	8/21/2014	8:00:00 AM	

Note: Depending on how much information is provided by the ecologist, you may not be able to fill in all of those fields. Just fill in as many fields as you can.

13) Place the HOBO logger(s) in a clearly-marked reusable zipper storage bag for field crews to use. Suggested information to mark on the bags includes (depends on info provided by ecologists):

a) Logger type and general park and protocol statement: (e.g., *HOBO Loggers for 2015 ROMO SEI*, *HOBO Loggers for 2015 GRKO WEI*, etc.).

b) Site name (e.g., *GLAC_S01*, *ROMO_0685*, etc.)

c) Date batteries were checked (e.g., *Batteries checked: 4-15-2015*).

d) Pre-set launch date and time (e.g., *Set to launch on 8-10-15 at 8:30 AM*).

e) Pre-set launch record interval (e.g., *Interval: ½ hr*, *Interval: 1 hr*, etc.).

f) A "Prepared by" statement (e.g., *Prepared by Kristin Long*, *Prepared by Fagan Johnson,* etc.).

g) Contact phone number (e.g., *Phone: 970-227-1093*).

Launching HOBO Loggers Outside the ROMN Fort Collins Office

This section is for anyone setting the launching date and time for HOBO loggers outside the ROMN Fort Collins office (by ROMN field crews, park staff, etc.).

Setting the launching date and time for a HOBO logger can be done on any computer that has HOBOware software installed and a HOBO logger cradle connected to it (required). Field laptops have the advantage of allowing you to launch HOBO loggers on-site, or to re-set the launch dates or times for pre-set HOBO loggers as needed.

Tasks in this section require that you have a computer with OnSet HOBOware Version 3.7.3 program (HOBOware) installed, and a HOBO Optic USB Base Station (HOBO cradle) connected to it.

To set the launch date and time for an individual HOBO logger:

1) Only use HOBO loggers that were sent out by the ROMN data management or ecologist staff at the Fort Collins office. This ensures that:

a) The HOBO logger batteries have already been checked (≥ 90% power).

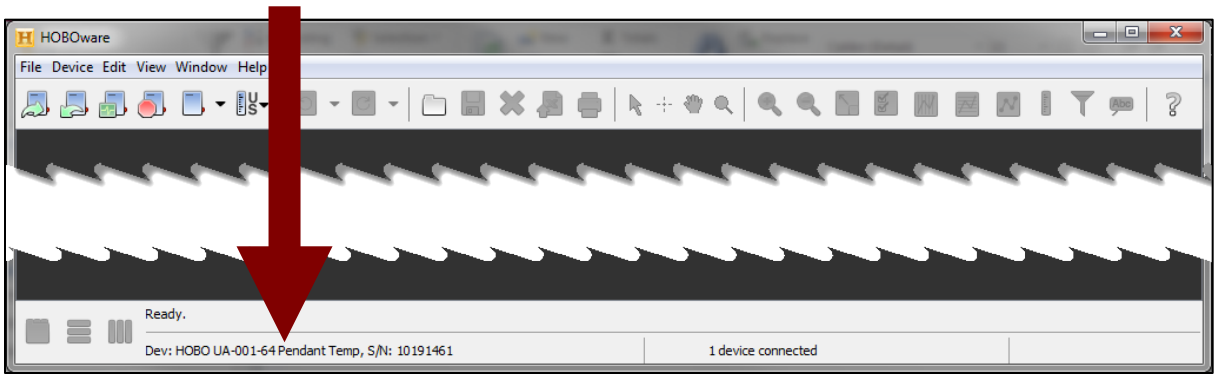
b) Any old information on the HOBO loggers has already been downloaded into the central HOBO logger database system (launching also deletes all old data on the HOBO logger).

2) To set a HOBO logger to launch to a future date and time (can be minutes, days, weeks, etc):

   a) Turn on the Onset HOBOware software (Start/All Programs/Onset Applications/HOBOware).

   b) Connect the HOBO cradle (HOBO Optic USB Base Station) to a computer that already has the Onset HOBOware software installed.

      i) The HOBOware software should automatically detect the device within a few seconds. When the device is detected, the bottom left-hand corner of the HOBOware window will show: *DEV: HOBO UA-001-64 Pendant Temp, S/N XXXX*.

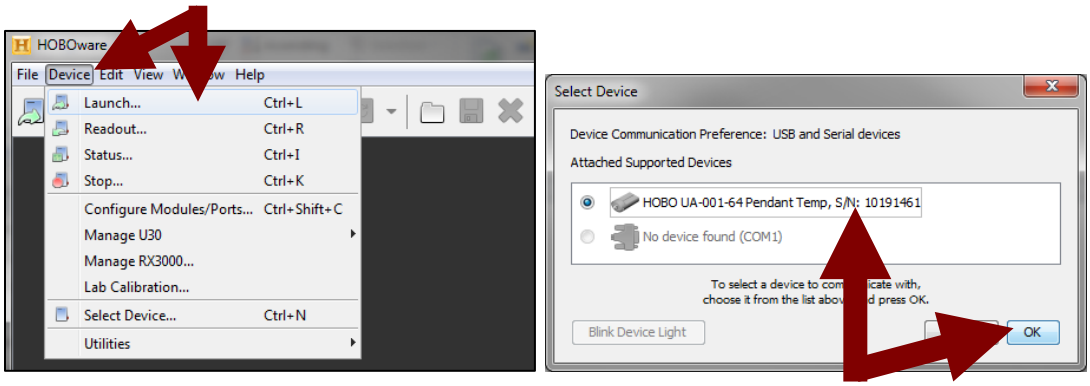


      ii) If the device is not detected, you can try to manually connect via the *Device/Select Device* menu option.

      iii) If there is still no connection, check that the logger is correctly placed in the cradle. It is often worth taking the logger out of the cradle and reconnecting it.

      iv) If there is still no connection, this could mean that the logger battery is dead (see below).

3) Insert a HOBO logger unit into the cradle, and in HOBOware software choose the *Device/Launch* Option.

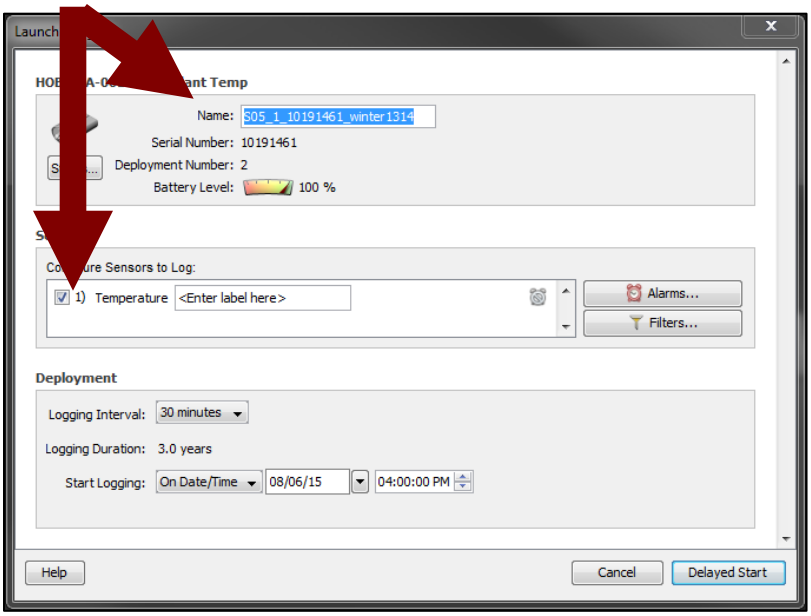


   c) On the next pop-up screen, select the HOBO device, and click the *OK* button.

   d) If another pop-up screen appears, just click the *OK* button to continue.

   e) On the *Launch Logger* window:

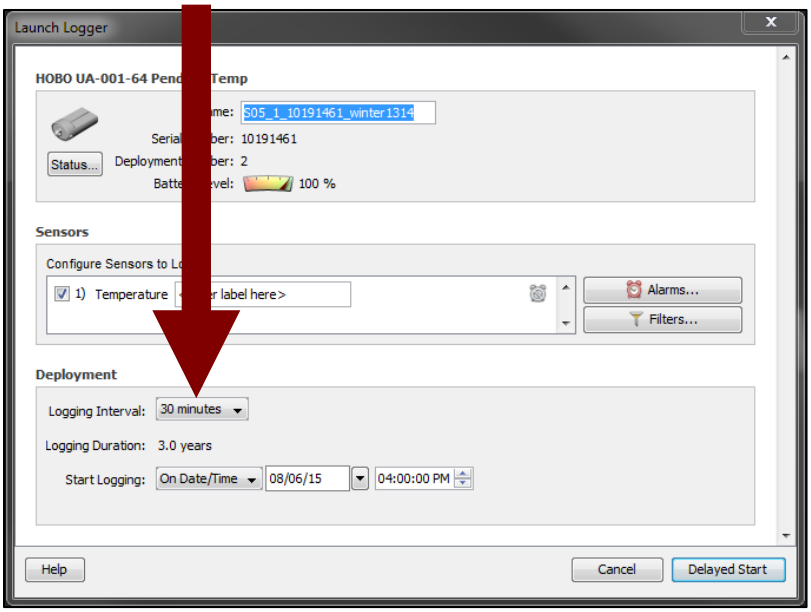
i) Make sure that the *Temperature* box is checked, and create a *Name* for the HOBO logger unit.



(10) The standard format is: *Site_(1 or 2)_Serial#_Timeframe* (e.g ., *S05_1_10191461_winter1314*)

(11) The exact format of the name is not important as long as it is not intentionally confusing (i.e. just calling the logger something like: *GLAC_SO5_1* with no other qualifiers).

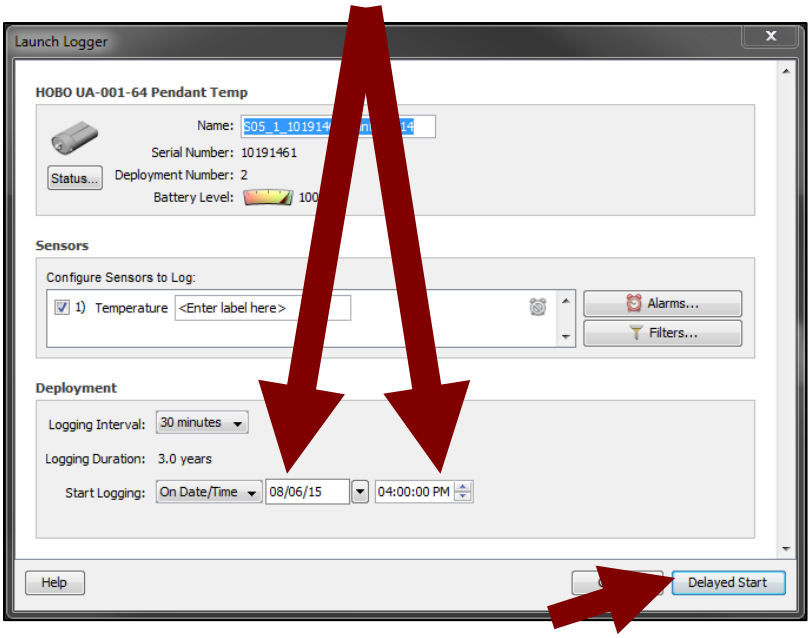
ii) Set the *Logging Interval* to the correct unit for that protocol.



(1) For SEI, *Logging Interval = 30 Minutes*.

(2) For AVCSS and AWEI, *Logging Interval = 1 hour*.

iii) Use the *Start Logging* tools to set the exact date and time you want the HOBO logger to begin recording temperature. **Make sure** that all times are set to start exactly on the hour or half-hour (e.g., *8:00 AM*, *8:30 AM*, *9:00 AM*, etc.).

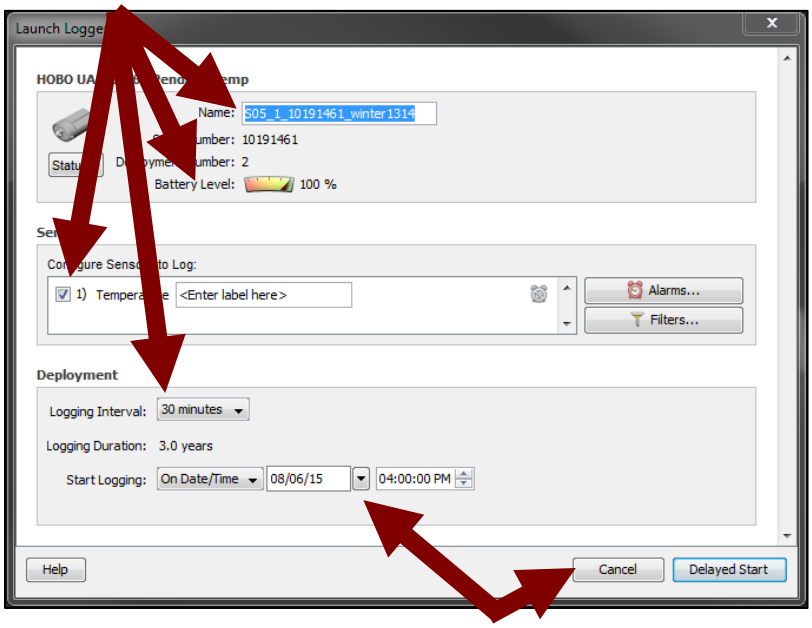


iv) To finish setting the launching date and time, click the *Delayed Start* button.

4) Double-check that the HOBO logger was set up correctly and is ready for deployment.

a) In the HOBOware software choose the *Device>Launch* Option (again).

b) On the *Launch Logger* screen, make sure that the *Battery Level* is at 90% or greater, and that the other launch settings are correct.



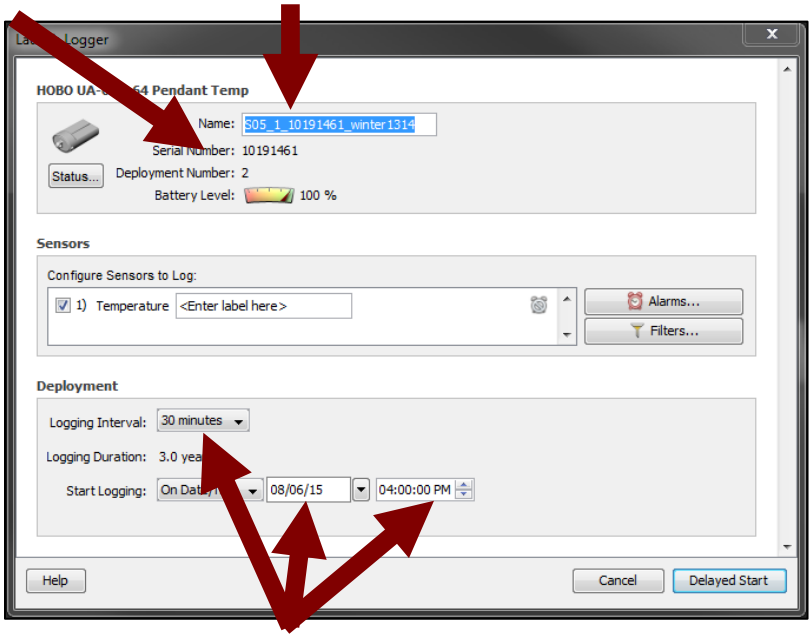
c) If everything is okay, continue to Step 5 below.

d) If everything is not okay, re-try setting the launch date and time using Steps 3 and 4 above.

5) Using the information on the *Launch Logger* screen, and any information from field visits:

a) Thoroughly fill out the HOBO Temp Logger section of the SEI Form #3a for the event that the HOBO will be launched at.

b) Or note as many of the following as possible in a MS Excel spreadsheet: ROMN protocol (*SEI*, *WEI*, etc.), HOBO logger *Name*, *Serial Number*, *Site Name* (should be part of the file name), *Start Event Name*, the *Start Logging Date* and *Time*, and any important comments (*Notes*).



c) Click the *Cancel* button when you are finished.

d) When you have placed all of the HOBO loggers into the field for the season, send this spreadsheet back to the ROMN data mangers via email (helps us generally keep track of the hundreds of individual HOBO logger units).

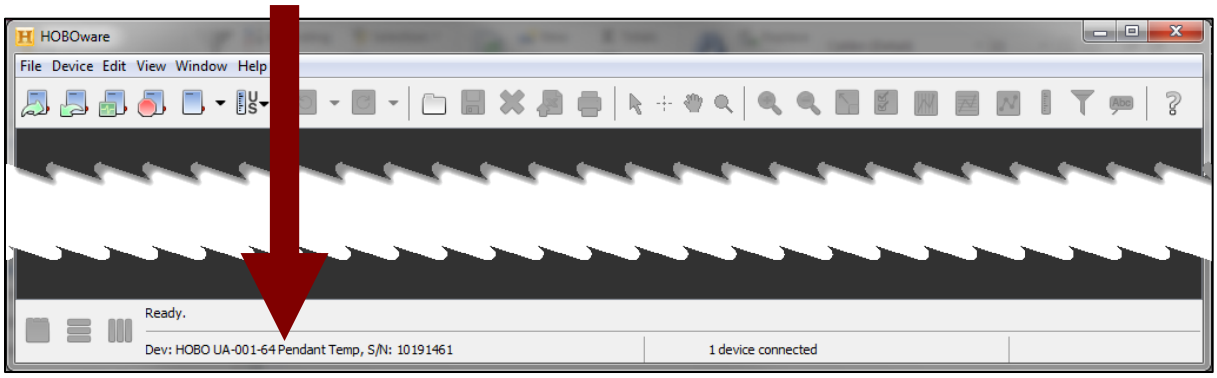
HOBO Water Temperature Logger Procedure: Logger Download

This section outlines how to download the information from individual HOBO loggers to individual files located on the ROMN *Z:* drive for future processing. These steps should only be done by ROMN data management staff.

Tasks in this section require that you have a computer with OnSet HOBOware Version 3.7.3 program (HOBOware) installed, and a HOBO Optic USB Base Station (HOBO cradle) connected to it.

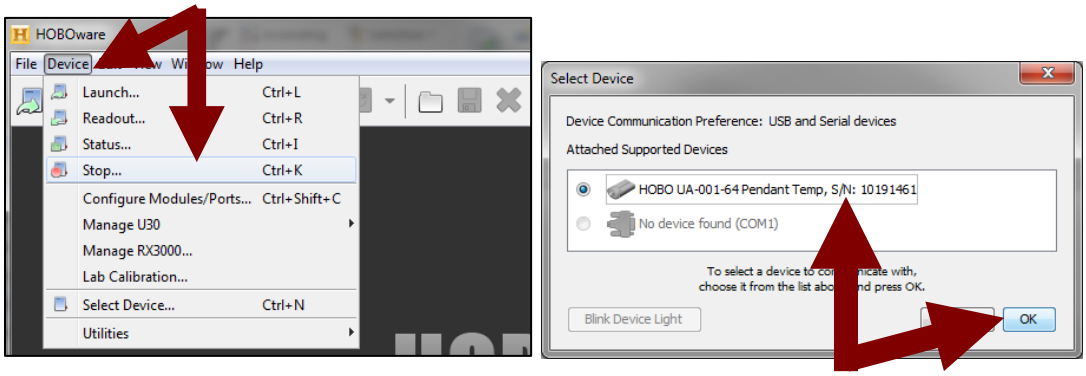
Whenever a HOBO logger is brought into the office and placed into the incoming bin, it should be downloaded as soon as possible. To do this:

1) On the computer, open the HOBOware program (*Start/All Programs/Onset Applications/HOBOware*).
2) Connect the HOBO cradle to the computer via the USB connector.
3) Insert a HOBO logger unit into the HOBO cradle.
   a) HOBOware should automatically detect the device within a few seconds. When the device is detected, the bottom left-hand corner of the HOBOware window will show something like: *DEV: HOBO UA-001-64 Pendant Temp, S/N XXXX*.



   b) If it is still not detected, take the HOBO logger unit out of the cradle and re-insert it (checks for bad HOBO logger unit connection to the HOBO cradle).
   c) If the device is not detected, you can try to manually connect via the *Device/Select Device* menu option (checks for a software issue).
   d) If it is still not detected, unplug the HOBO cradle from the computer and try connecting it to the same, and perhaps another, USB port (checks for a bad USB connection).
   e) If it is still not detected, replace the battery using the instructions below and try connecting it to the HOBO cradle again (checks for dead battery).
   f) If it is still not detected, give the problem HOBO logger unit to the ROMN Data Manager to figure out (there is a mechanical problem with the unit).

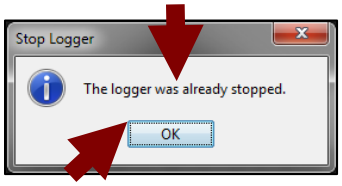
4) Before HOBO loggers can be downloaded, they must be stopped (stop recording). To stop a HOBO logger, insert the HOBO logger unit into the cradle, and in HOBOware software choose the *Device/Stop* Option.



a) On the next pop-up screen, select the HOBO device, and click the *OK* button.

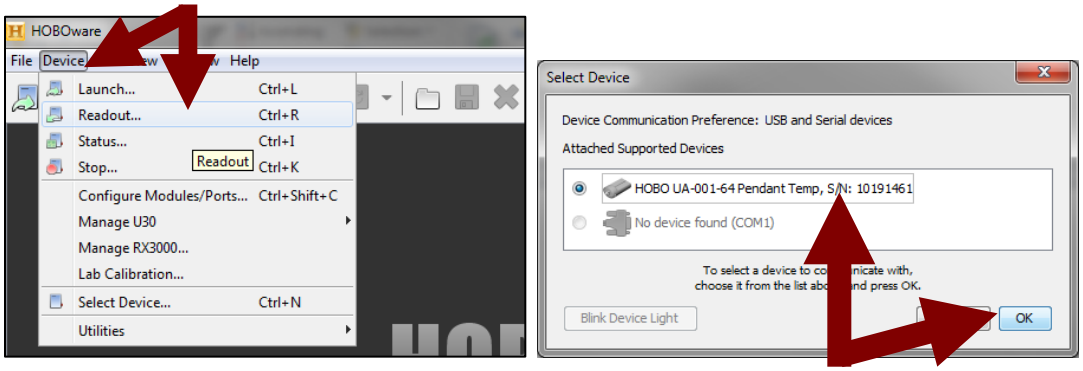
b) If another pop-up screen appears, just click the *OK* button to continue.

5) You that you are successful when a pop-up screen similar to the one below appears, saying something like: *The logger was stopped* (there are several slightly different messages).



6) Click the *OK* button to stop the HOBO logger.

7) When the logger has been stopped, click the *Device/Readout* menu option.

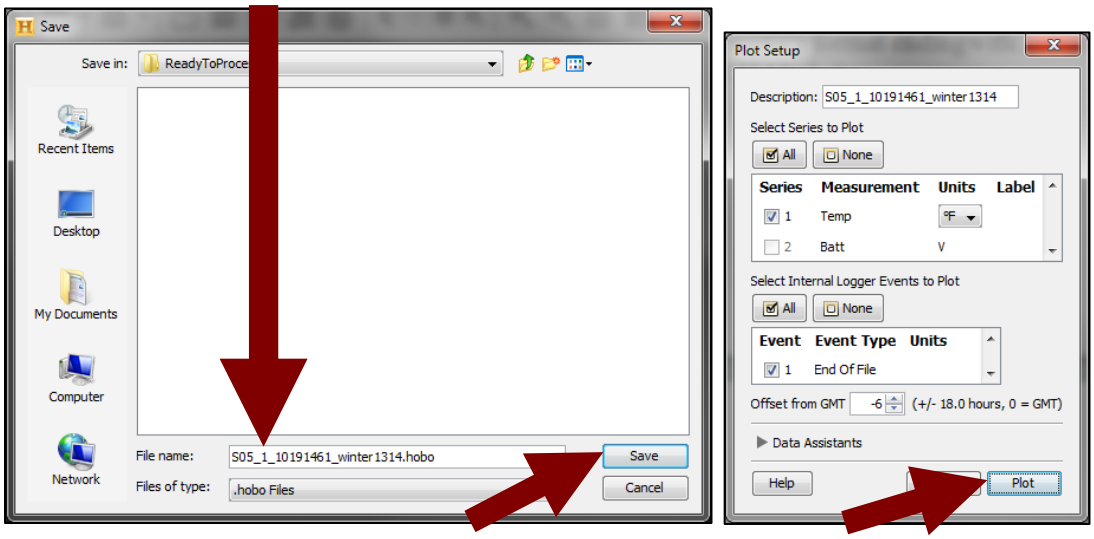


8) On the next pop-up screen, select the HOBO device, and click the *OK* button.

9) Click the *OK* button on the next pop-up box. The next *Readout Logger* window will pop up next, displaying the progress (this may take a couple of minutes).

10) When the *Save* window pops up, save the file to the network folder: *Z:\MONITORING\Loggers\Data\DataGathering\HOBO\ReadyToProcess*.

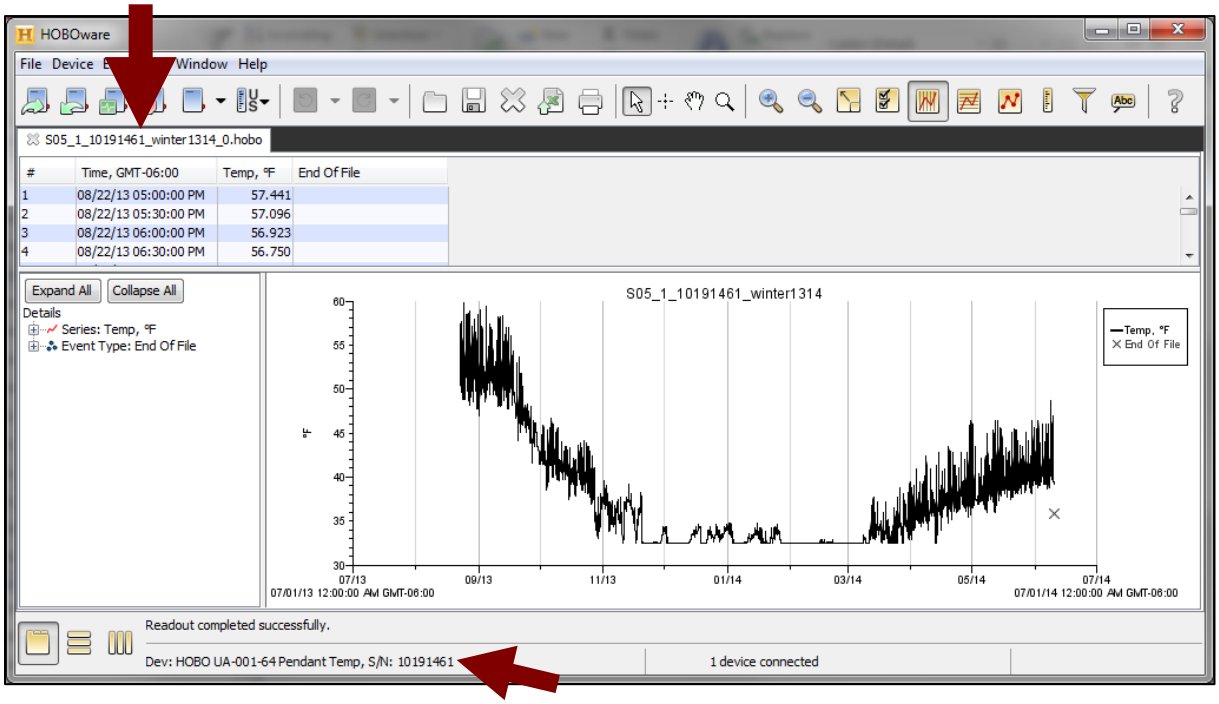
a) The file name will automatically use the name given to the HOBO logger when it was launched, ending *.hobo*. **MAKE SURE** that the file name also has the HOBO logger unit serial number embedded into it (e.g., *S05_1_10191461_winter1314.hobo*).



b) Click the *Save* button. When the *Plot Setup* window pops-up, click the *Plot* button.

11) When the file is successfully downloaded, the HOBOware application will automatically generate screens that will look something like the screenshot below. Important elements:

a) The name of the new file generated is displayed just above the table located near the top left-hand part of the HOBOware window (e.g., *S05_1_10191461_winter1314.hobo*).



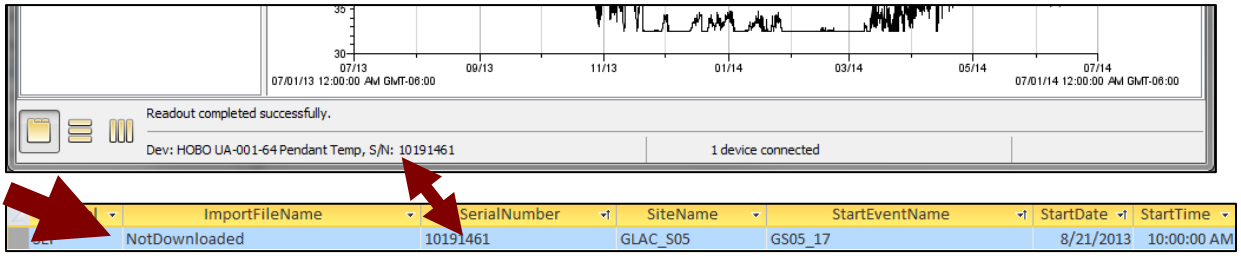
b) The eight-digit HOBO logger serial number (*S/N:*) is displayed at the very end of the HOBO cradle attachment statement, which located near the bottom left-hand part of the HOBOware window (e.g., *10191461*).

Note: Don't worry about any strange-looking temperature readings at the beginning or the end of the HOBOware graph for that logger. We will trim all non-sampling temperature readings later. Why does this occur?

- If field crews are running late, loggers set to launch on a certain date and time will begin logging temperatures hours to days before the HOBO logger is installed.
- Field crews don't turn off the loggers after removing them from the sampling site, usually resulting in days to months of additional temperature readings.

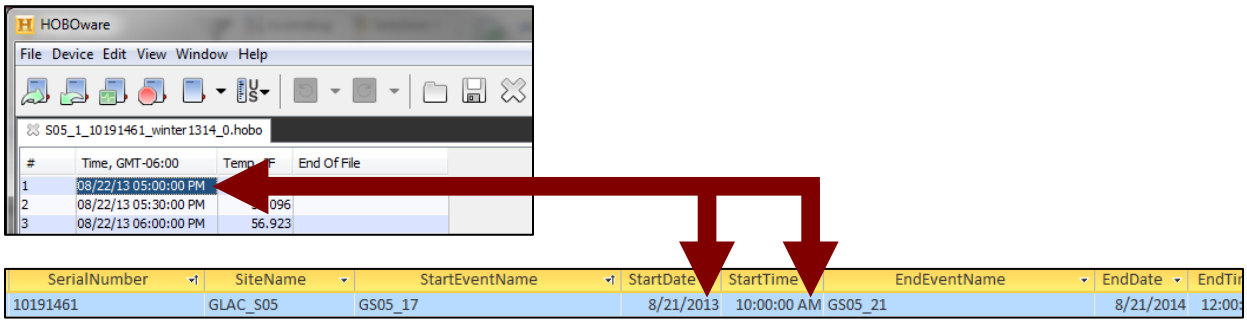
12) Open the HOBO Master Database located at: *Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb*.

13) Open the *Logger_Tracking* database table, and use the information in the HOBOware window to locate the record with the correct *SerialNumber*, and where: *ImportFileName = NotDownloaded*.

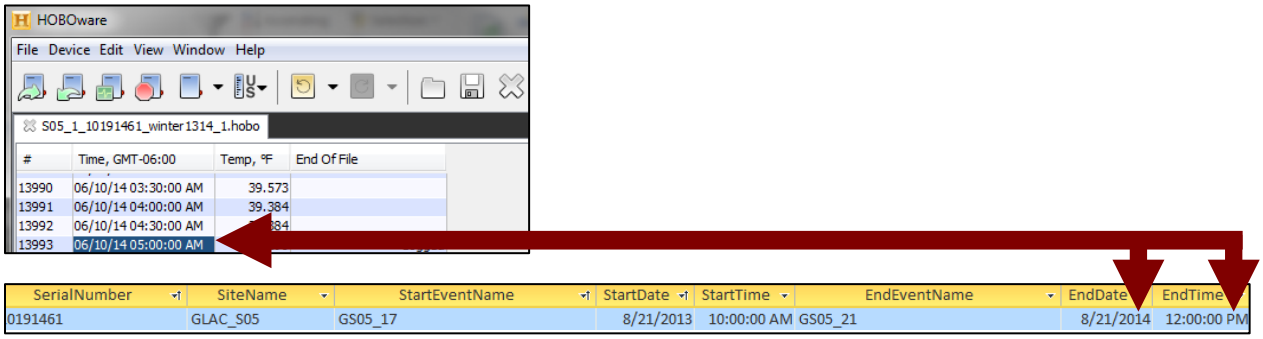


14) Use the information on the HOBOware program to update the sampling date and time fields found in the *Logger_Tracking* database table.

a) For the same *Logger_Tracking* table record, use the *Time, GMT…* field for the ***FIRST*** record in the HOBOware plot table to update the *StartDate* and *StartTime* database table fields.

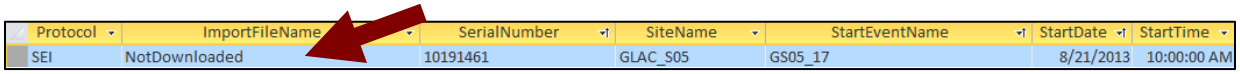


b) For the same *Logger_Tracking* table record, use the *Time, GMT…* field for the ***LAST*** record in the HOBOware plot table to update the *EndDate* and *EndTime* database table fields.



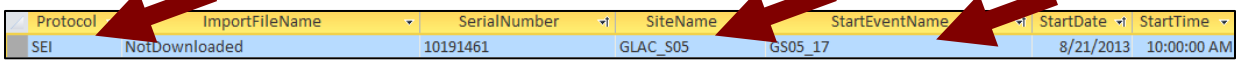
15) In the *Logger_Tracking* table, also make sure that:

a) The *ImportFileName* field remains as *NotDownloaded* (do not manually update).

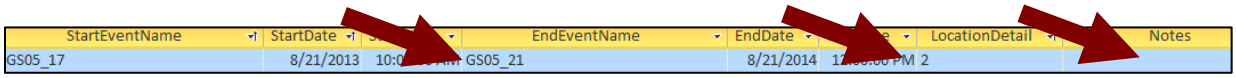


b) Using information in the SEI Data Entry Database and field forms, figure out and make sure that the following fields are filled in correctly for that same record:

i) *Protocol*, *SiteName*, and *StartEventName*.



ii) *EndEventName*, *LocationDetail*, and *Notes*.



Note: For a vast majority of HOBO loggers, the *Logger_Tracking* database table fields will already be filled in correctly. We are just double-checking here for those rare instances where the HOBO loggers were launched by ROMN ecologists without sending the information to the ROMN data management staff, when pre-launched HOBO loggers were placed at different/wrong sites by field crews, etc.

HOBO Water Temperature Logger Processing Procedure: Office Processing and QAQC

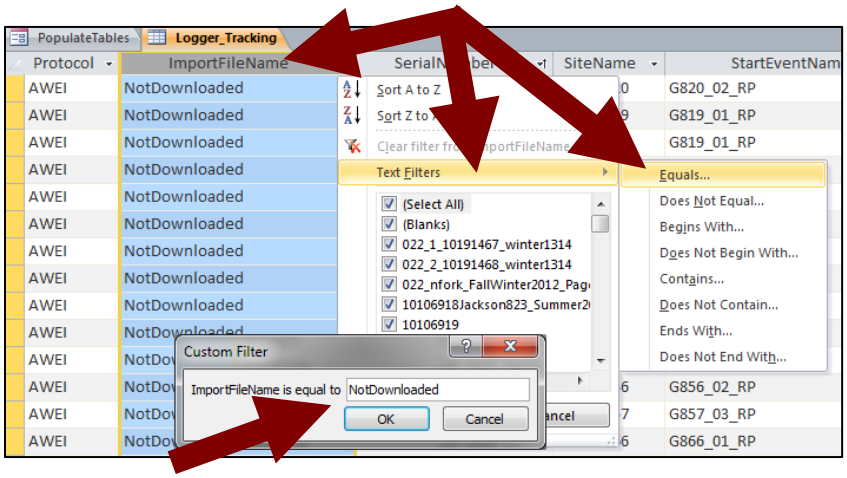
This section outlines how to import the previously downloaded HOBO logger files (see section: *HOBO Water Temperature Logger Procedure: Logger Download*) into the HOBO Logger Database system. These steps should only be done by ROMN data management staff.

Importing HOBO logger information into the database system is usually done in one big batch at the very end of the sampling season, but can also be done in multiple batches throughout the sampling season. The process to upload all batches, regardless of the number of individual HOBO logger files involved, is the same.

Tasks in this section require that you have a computer with OnSet HOBOware Version 3.7.3 program (HOBOware) installed, and a HOBO Optic USB Base Station (HOBO cradle) connected to it.

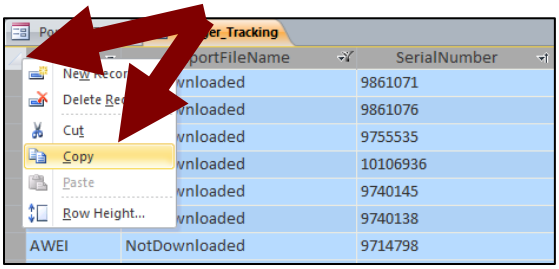
1) Make a copy of the database located at:
   Z:\MONITORING\Loggers\Data\Tools\HOBO_ProcessingCode_FINAL.accdb.
   a) To the network drive folder:
      Z:\MONITORING\Loggers\Data\DataGathering\HOBO.
   b) Using the file naming convention:
      HOBO_DataCompiling_YYYY_YYYYMMDD.accdb.

      Note: The new HOBO Data Compiling Database includes tools for trimming data that are not run in the HOBO Master Database.
2) Open the HOBO Master Database located at:
   Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb.
   a) Open the `Logger_Tracking` table.
   b) Click on the down arrow icon located the right-hand border of the `ImportFileName` field, and choose the `Text Filters/Equals` option.



c) On the *Custom Filter* pop-up box, paste *NotDownloaded* into the text box and click the *OK* button.

d) Right-click on the icon located in the upper left-hand corner of the table, and choose the *Copy* option.



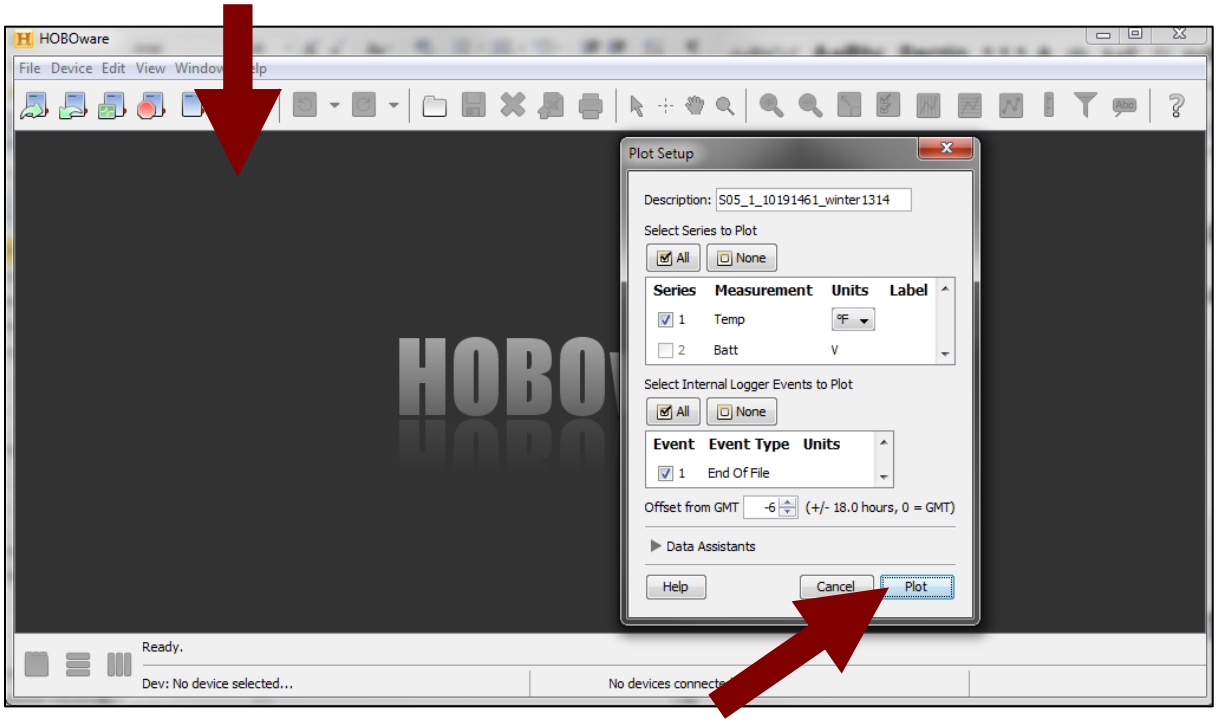
3) Open the HOBO Data Compiling Database located at: *Z:\MONITORING\Loggers\Data\DataGathering\HOBO\HOBO_DataCompiling_YYYY_YYYYMMDD.accdb*.

i) Open the *Logger_Expecting* table (this table should be blank at this point).

ii) Paste the *Logger_Tracking* table records copied from the HOBO Master Database.

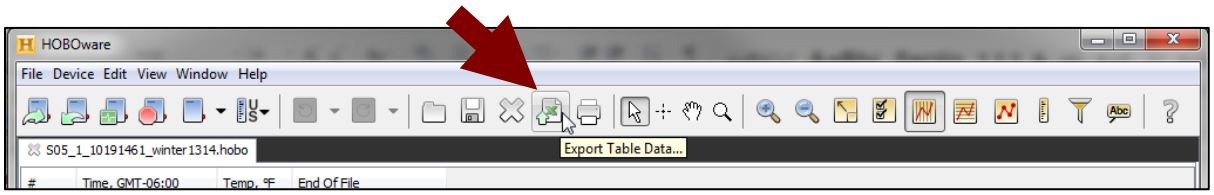
4) Make sure that all of the *.hobo* files that you want to process were successfully downloaded to the network drive folder: *Z:\MONITORING\Loggers\Data\DataGathering\HOBO\ReadyToProcess*.

5) In Windows Explorer, double-click on an individual *.hobo* file that you want to process in this batch. This will open each individual file in the HOBOware program.

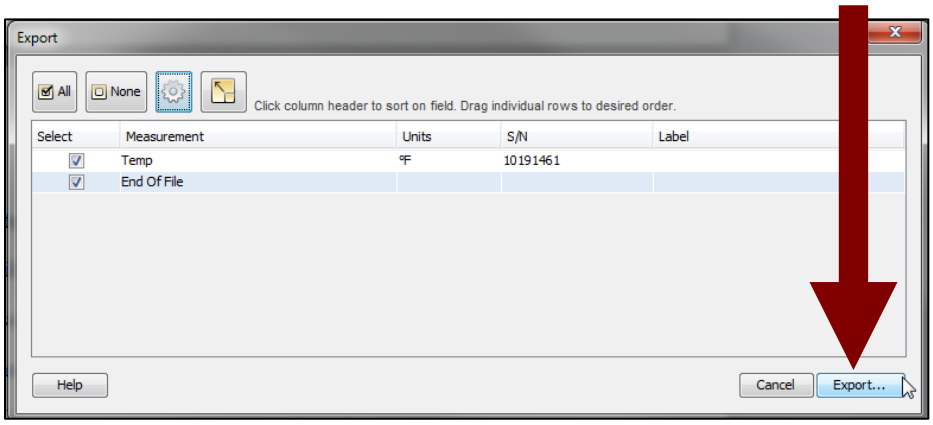


a) When the *Plot Setup* pop-up window appears, click the *Plot* button to continue.

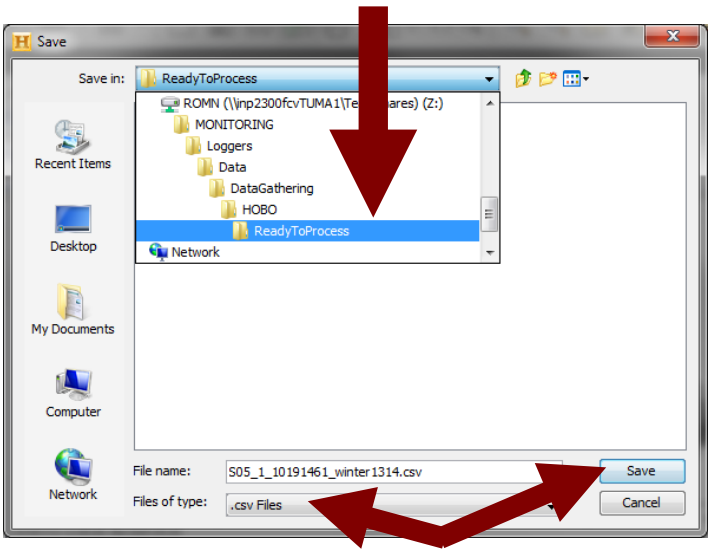
b) Click the *Export Table Data* icon located near the top-center of the HOBOware window (or use the *File/Export Table Data* menu option).



c) On the next screen, click the *Export* button.



d) On the Save screen, use the navigation tools built into the Save in: field to: Z:\MONITORING\Loggers\Data\DataGathering\HOBO\ReadyToProcess\

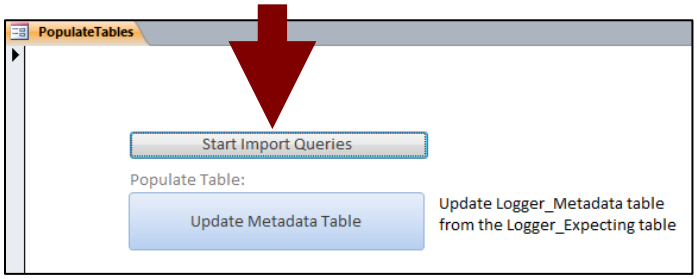


e) Make sure that the *Files of type:* field is set to *.csv Files*, and click the *Save* button.

f) Repeat Steps a-e above for each individual *.hobo* file that you want to process in this batch.

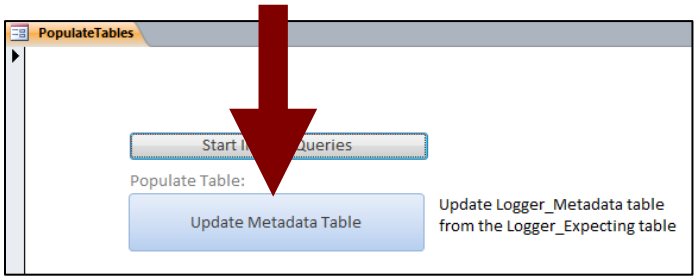
6) When you are ready to import a batch of HOBO logger *.csv* files into the HOBO Data Compiling Database:

a) On the *Populate Tables* database form (auto-loads whenever the database is opened) click the *Start Import Queries* button.



Note: This step imports the data found in the *.csv* files into the *Logger_Data* table, and will add the HOBO file name to the *Logger_Metadata* table.

b) On the Populate Tables form, click the Update Metadata Table button.



Note: This step updates additional fields in the *Logger_Metadata* table with site and event information found in the *Logger_Expecting* table.

i) An error message box will pop-up for each instance where the information in the *Logger_Metadata* does not match that found in the *Logger_Expecting* table.

ii) Each time that you push the *Update Metadata Table* button, records that do not match are added to the *Working_Metadata_Vs_Expecting* table.

iii) Figure out and update records in the *Logger_Expecting* table until no more error pop-up boxes appear when you click the *Update Metadata Table* (and there are no more records in the *Working_Metadata_Vs_Expecting* table).

(3) Errors are almost always due to simple data entry typos.

(4) In rare cases, we discover HOBO loggers that were downloaded but never added to the HOBO database system. In such cases, you will need to use the procedures outlined in *Step 17* in section; *HOBO Water Temperature Logger Procedure: Logger Download* to add the relevant information to both the:

(a) Add the *Logger_Tracking* table in the HOBO Master Database.

(b) *Logger_Expecting* table in the HOBO Data Compiling Database.

7) The remaining steps can only take place after:

   c) The field season has ended.

   d) All SEI discreet sampling data for that field season has been entered into the SEI Master Database (*Z:\MONITORING\Streams\Data\Certified*).

   e) All SEI *Events* from the just finished field season have been given final *Event Names* (see: *SEI SOP 13: Processing SEI Discreet Field and Laboratory Data*) and in the *Xwalk_Event_Name_Changes* table;

      i) The original *Event Name* used during the sampling season for each event is recorded in the *EventName_2013* field.

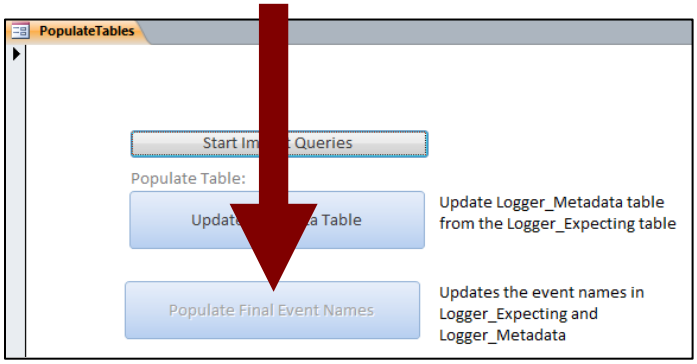
      ii) The final *Event Name* given to each event is recorded in the *EventName_Code* field.

8) Use the information in the SEI Master Database *Xwalk_Event_Name_Changes* table fields to append the HOBO Data Compiling Database *Xwalk_Event_SEI* table fields for that field season, where:

   b) *Xwalk_Event_Name_Changes.EventName_2013* = *Xwalk_Event_SEI.OriginalEventName*

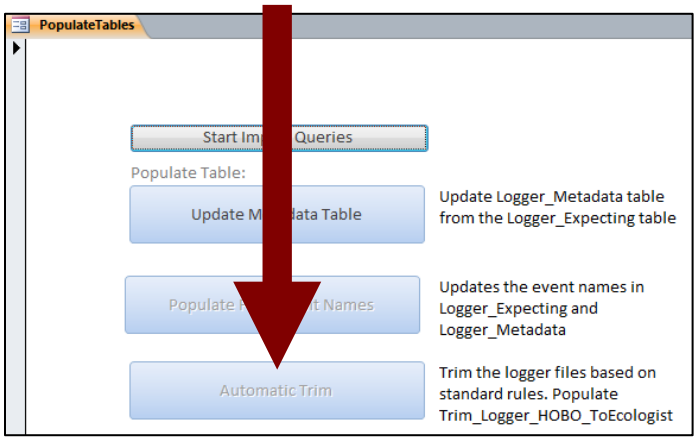
   c) *Xwalk_Event_Name_Changes.EventName_Code* = *Xwalk_Event_SEI.CurrentEventName*

9) On the *Populate Tables* form, click the *Populate Final Event Names* button.



Note: This step updates the *Event Names* in both the *Logger_Metadata* and *Logger_Expecting* tables.

a) On the *Populate Tables* form, click the *Automatic Trim* button.



Note: This step trims the logger files based on standard rules and populates the new *Trim_Logger_HOBO_toEcologist* table for the lead ecologist to look at.

b) Export the *Trim_Logger_HOBO_toEcologist* table to *.csv* format and send it to the ROMN ecologist.

10) The ROMN ecologist:

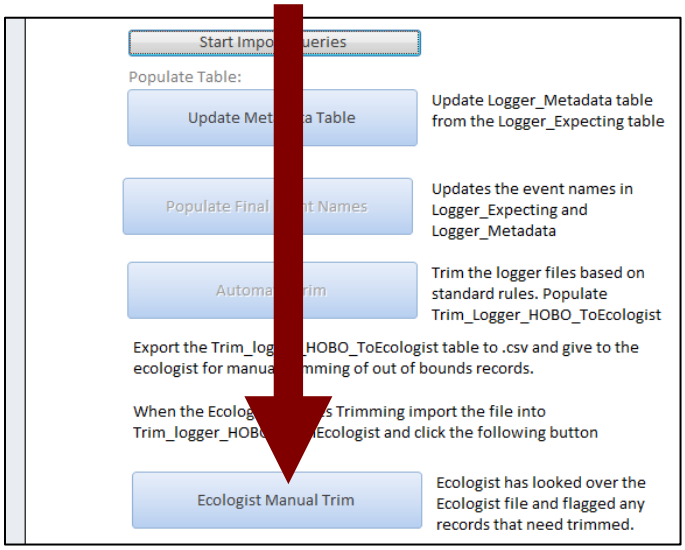
a) Manually trims additional temperatures from the *Trim_Logger_HOBO_toEcologist.csv* file until they are satisfied that all outlier temperatures have been trimmed from the file.

b) Sends the results back to the ROMN data management staff as a *.csv* file.

11) ROMN data management staff then:

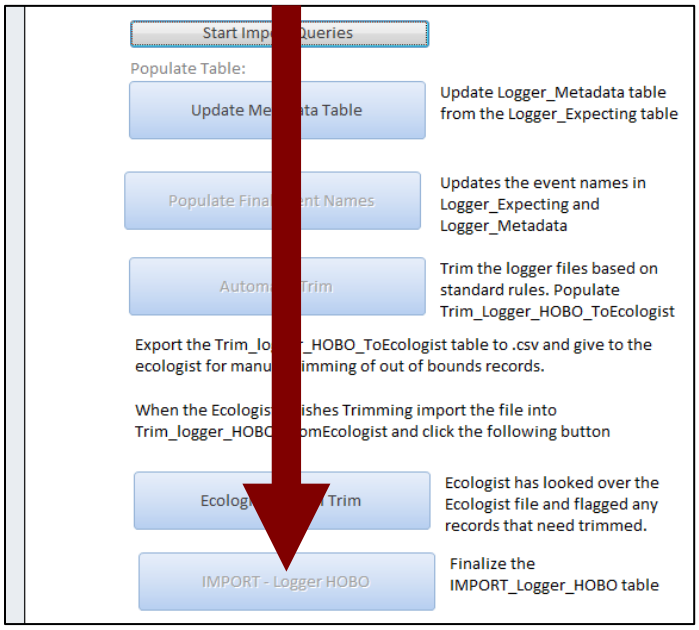
a) Creates a new table called *Trim_logger_HOB_FromEcologist* and populates the records in this new table with contents of the *.csv* file obtained from the ecologist.

b) On the *Populate Tables* form, click the *Ecologist Manual Trim* button.



Note: This step updates the values in the *Logger_Data* table with the trimmed values obtained from the ecologist.

d) Back on the *Populate Tables* form, click the *Import – Logger HOBO* button.



Note: This step appends the information in the *Logger_Data* and *Logger_Metadata* tables in the HOBO Data Compiling Database, into the corresponding tables found in the HOBO Master Database at: *Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb*.

HOBO Water Temperature Logger Processing Procedure: Certification

1) Open the HOBO Data Compiling Database located at: *Z:\MONITORING\Loggers\Data\DataGathering\HOBO\HOBO_DataCompiling_YYYY_YYYYMMDD.accdb*.
2) Open the HOBO Master Database at: *Z:\MONITORING\Loggers\Data\Certified\HOBO_ROMN_AllYears_MASTER.accdb*.
3) Append all new records found in the HOBO Compiling Database *Logger_data* table into the HOBO Master Database *Import_Logger_HOBO_Data* table.
4) Append all new records found in the HOBO Compiling *Database Logger_Metadata* table into the HOBO Master *Database Import_Logger_HOBO_Metadata* table.
5) In the HOBO Master Database, run the Summary macro, which will generate these summary tables for the ecologists to use:
    c) *Summary_LoggerHOBO_Raw*
    d) *Summary_LoggerHOBO_Daily*
    e) *Summary_LoggerHOBO_Weekly*
6) Copy the final certified annual database to the appropriate folder for the current year: *Z:\MONITORING\Loggers\Data\Certified\FY##*.
7) Move the raw *.hobo* and *.csv* files from the *Z:\MONITORING\Loggers\Data\DataGathering\HOBO* folder to: *Z:\MONITORING\Loggers\Data\Certified\FY##\RawData*.
8) When the certified folder is complete, delete the files from the Data Gathering folder to clean it out for the next year.
9) Make an archive copy of the Water Quality Master Database using the format: *HOBO_ROMN_ALLYEARS_MASTER_YYYYMMDD.acdb*.
10) Save the archive copy of the database to: *Z:\MONITORING\Loggers\Data\Certified\old*.

SEI SOP 16: SEI Photo Management

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP follows the current process of managing photos for the SEI protocol from downloading pictures from field cameras to end of year certification. Changes to hardware and software are very common with photo management, and this SOP will be updated as needed to show the most current methods and procedures used by ROMN staff.

Photo Management Procedure: Downloading Digital Photos

1) Navigate to the ReadyToRename folder inside the Photos folder for Streams: *Z:\MONITORING\Streams\Data\DataGathering\Photos\ReadyToRename*.
2) Plug your camera into the computer using an USB cable.
3) When the computer recognizes the camera as a hard drive, use Windows Explorer to copy the images in the camera to the *ReadyToRename* folder.
4) Once you have insured that all of the photos were successfully copied to the *ReadyToRename* folder, it is safe to remove the images from the camera.

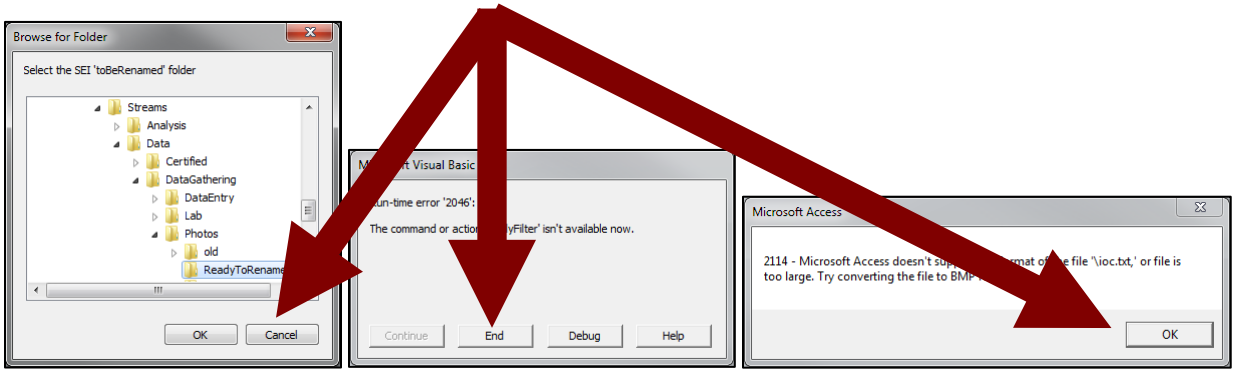
Photo Management Procedure: Preparing the SEI Photo Database

The procedures below import all SEI sampling site information into the SEI Photo Database. The SEI Photo Database requires this information in order to rename the photos correctly later.

These procedures should only be performed by ROMN data management staff, and only after all SEI field sheet data has been appended into the SEI Master Database per: SEI SOP 13: Processing SEI Discreet Field and Laboratory Data.

To import all current SEI site information:

1) Open the SEI Photo Data Entry Database at:
   Z:\MONITORING\Streams\Data\DataGathering\Photos.
2) On the next 3-4 pop-up screens, click the *Cancel*, *End*, and *OK* buttons (the number of pop-up screens is dependent on your exact computer software configuration) .



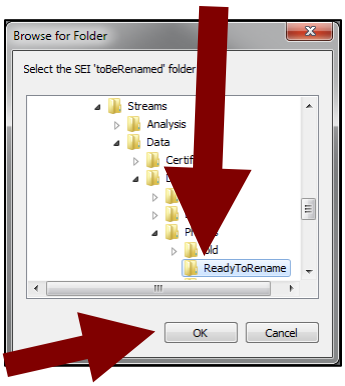
3) Open the SEI Data Entry Database at: *Z:\MONITORING\Streams\Data\DataEntry*.
4) Append any missing site records in the in the SEI Photo Database *tlu_Sites* table, with the site records listed in the SEI Data Entry Database *tlu_Sites* table.

Photo Management Procedure: Renaming Photos

The procedures below rename field photos to associate them with the protocol, and for core sampling photos, the site at which they were taken.

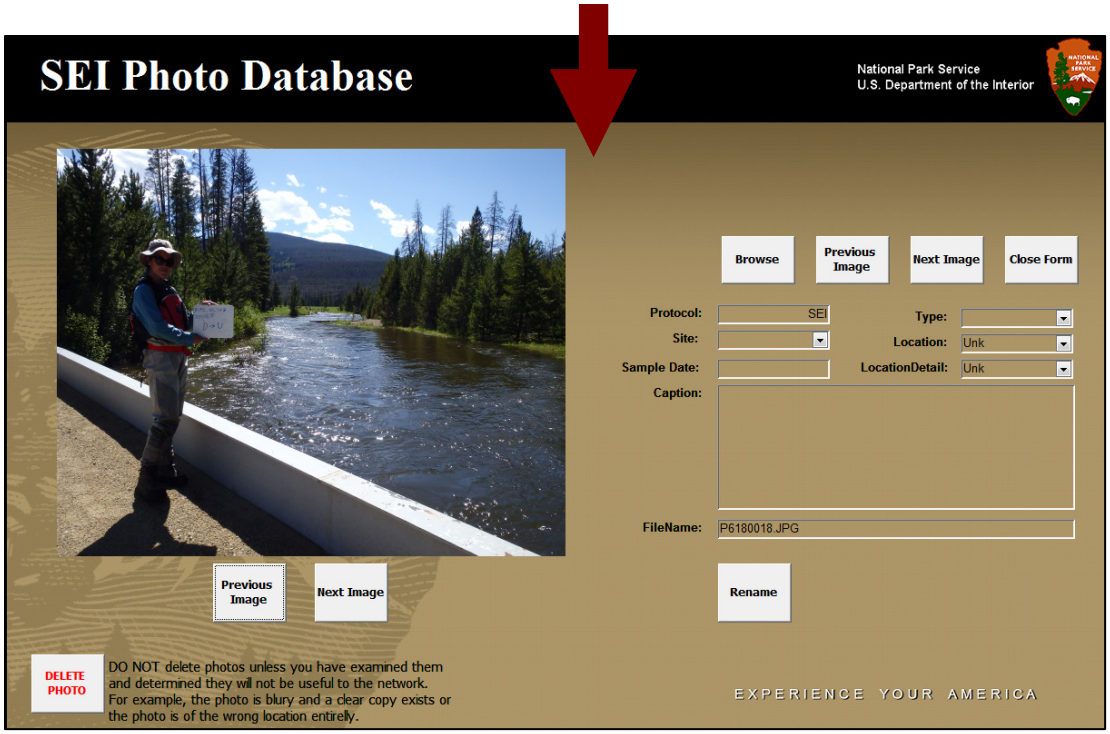
These procedures can be performed by anyone after the field season is over, and the ROMN data management staff has already prepared the SEI Photo Database for use per: *Photo Management Procedure: Preparing the SEI Photo Database*. To rename photos:

1) Open the SEI Photo Data Entry Database at:
   Z:\MONITORING\Streams\Data\DataGathering\Photos.
2) Use the navigation tools in the Browse for Folder pop-up screen to select the SEI ReadyToRename folder at:
   Z:\MONITORING\Streams\Data\DataGathering\Photos\ReadyToRename.



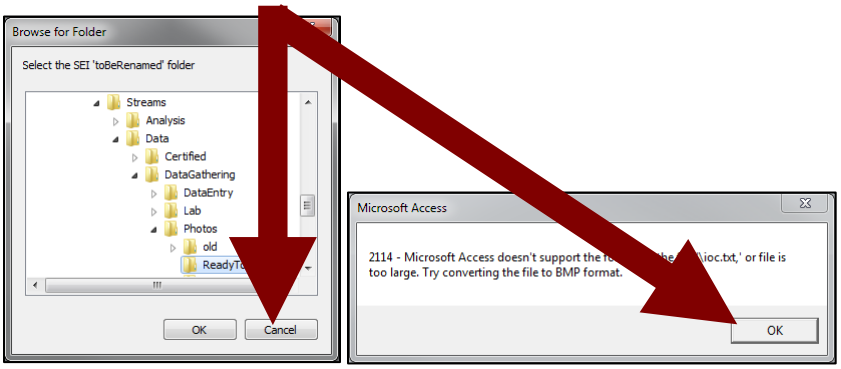
3) Click the *OK* button (this action may lock-up the database for a minute or so).

a) If you are on an older computer with a 32-bit operating system, the database should open to the default SEI Photo Database form shown below.

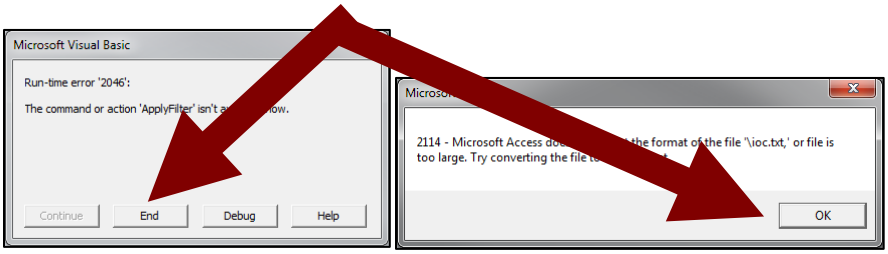


b) If you are on a computer with a 64-bit operating system, you may get a series of pop-up error messages. If you do:

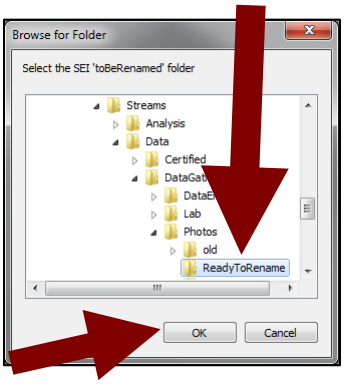
i) On the next two pop-up screens, click the `Cancel`, and `OK` buttons.



ii) On the next two pop-up screens, click the `End`, and `OK` buttons.



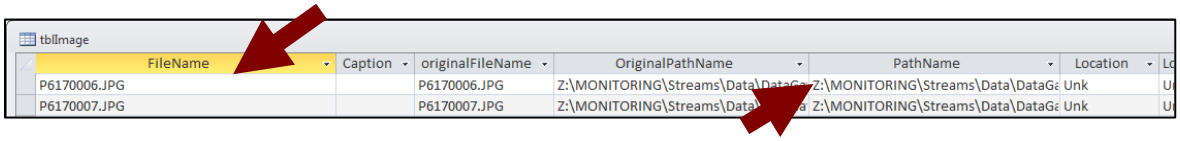
iii) Click the Browse button and use the navigation tools in the *Browse for Folder* pop-up screen to select the SEI *ReadyToRename* folder at: *Z:\MONITORING\Streams\Data\DataGathering\Photos\ReadyToRename*.



iv) Click the *OK* button.

4) The database automatically checks the file names and drive path for files in that folder against the records found in the *tblImage* table.

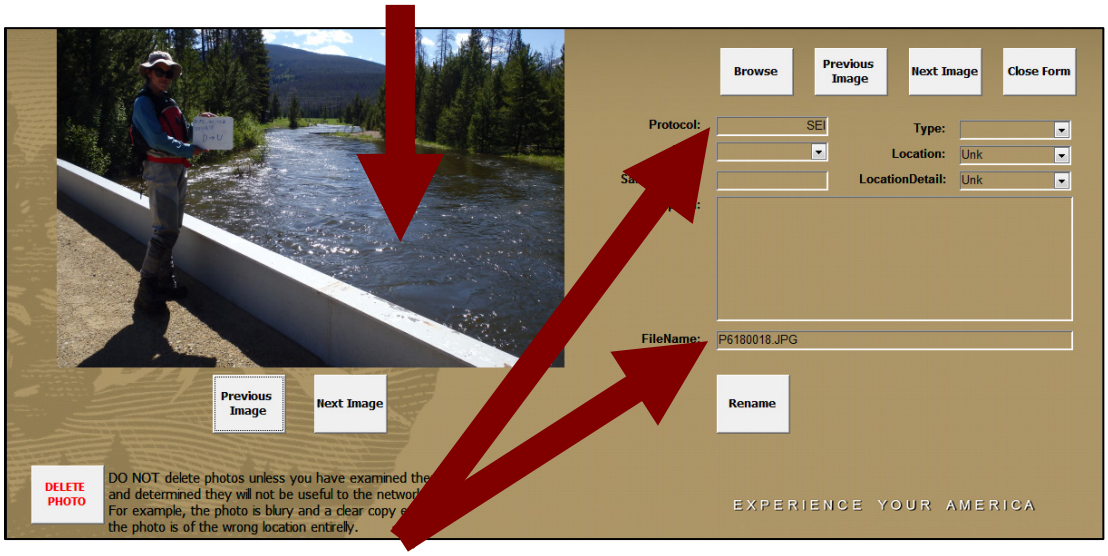
a) If the file is not already listed, it will append the new *FileName* into the table.



b) If the file path (*PathName*) is different, the database will automatically update the path for you as well.

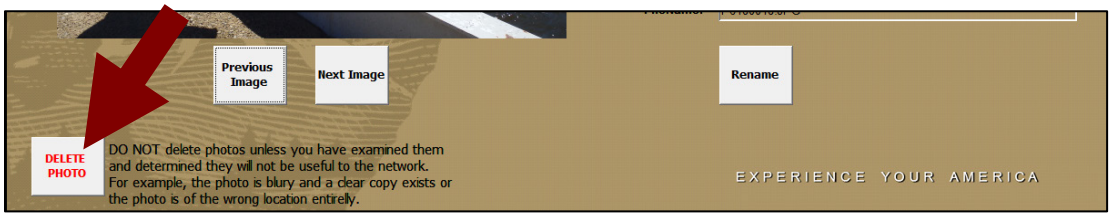
Note: The *OriginalPathName* will not be edited.

5) The database should automatically open to the *frmImage* form, which displays one photo at-a-time in the left-hand part of the form, and the file name (*FileName*) is located beside the lower right-hand corner of the photo.



Note: The file name (*FileName*) is located beside the lower right-hand corner of the photo, and the *Protocol* field will default to *SEI*.

6) What you do next depends on the photo.
   a) If there is a field crew member holding a placard displaying the sampling event information (a vast majority of photos), continue to the *Renaming Core Field Photos* section.
   b) If there is not a field crew member holding a placard (common), continue to the *Renaming Miscellaneous Field Photos* section.
   c) Only permanently delete photos that are definitely unusable (too blurry, wrong location shown, etc.) and when there is also a clearer photo from the same location (rare).
      i) To permanently delete a photo, click the *Delete Photo* button.



Renaming Core Field Photos

If the photo shows a field crew member holding a placard displaying the sampling event information (site, location, date, etc.), it is considered a *Core* photo. To rename a *Core* photo:

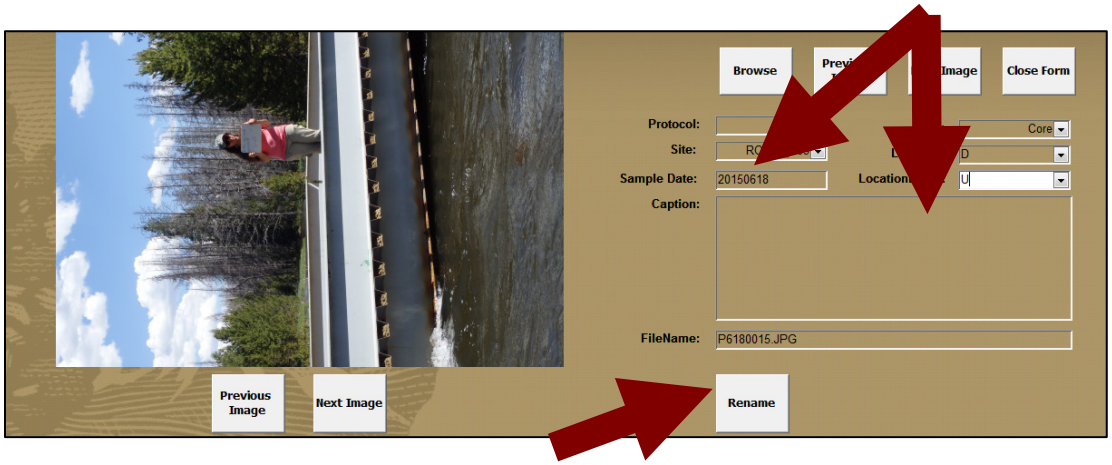
1) If you cannot read the information on the placard:
   a) Try opening the photo in a web browser or photo editor that allows you to zoom into photo.
   b) If you still can not read the placard in another program, you will need to contact the field crew members or lead ecologist to determine the required information for that photo.
2) When you know the site and location information, set the *Type* field to the *Core* option.



3) Use the information on the placard to select the correct transect *Location* (e.g., *A*, *B*, etc.) and direction *LocationDetail* (e.g., *U*, *L*, etc.) parameters.

Note: Before you set the *Location* and *LocationDetails* parameters to *Unk* (unknown), do your best to figure out the correct information from adjacent photos, the SEI database, or talking to field crews or ecologists (if immediately available).

4) Add the *Sample Date* using the format: *YYYMMDD* (e.g., *20150618*), and *Caption* message as desired (optional).

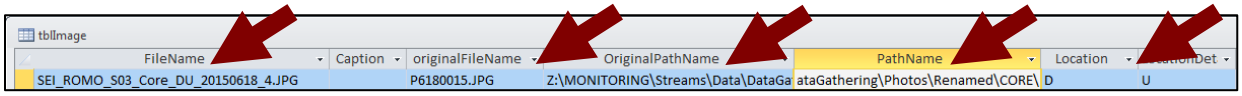


5) Press the *Rename* button to finish. When you click the *Rename* button, the database:

   a) Moves the digital photo file to the network drive: *Z:\MONITORING\Streams\Data\DataGathering\Photos\Renamed\CORE*.

   b) Renames the file in the new location using the following naming convention: *SEI_SiteName_Core_[Location][LocationDetail]_YYYMMDD_Number.jpg* (e.g., *SEI_GLAC_S01_CORE_DU_20150618_4.jpg*).

   c) Archives the original file name and path and all of the information that you added above to the *tblImage* table.

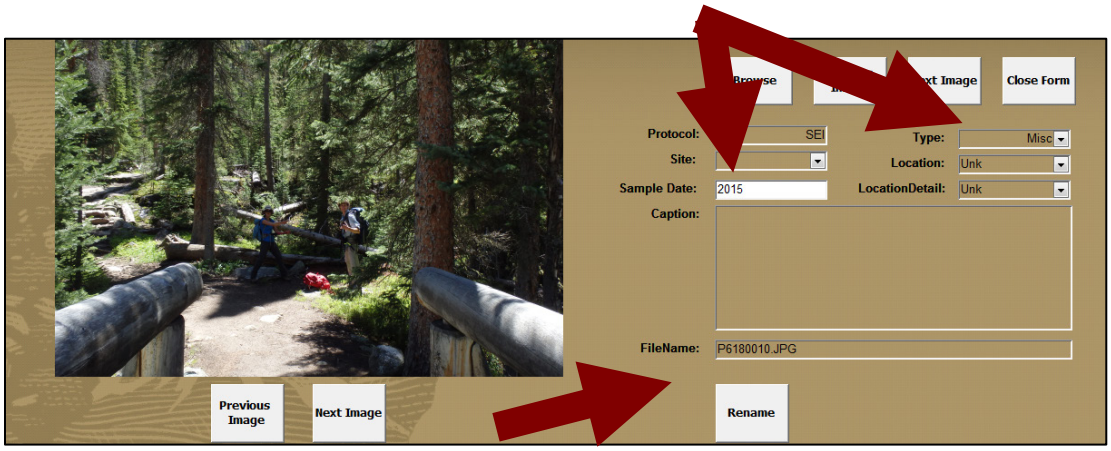


   d) The next photo that needs to be renamed will appear on the default SEI Photo Database form. This signals that you are finished with the previous photo.

Renaming Miscellaneous Field Photos

If the photo does not have a field crew member holding a placard, displaying the sampling event information (site, location, date, etc.), it is considered a *Miscellaneous* photo. To rename it:

1) Set the `Type` field to `Misc` and type in the current numeric year value into the `Sample Date` field.

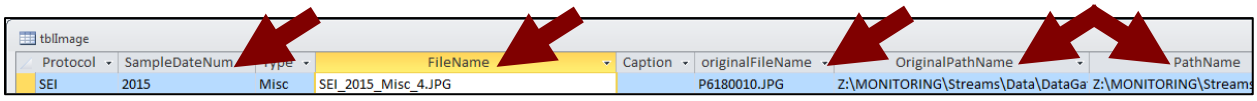


2) Press the `Rename` button to copy and rename the image. When you click the `Rename` button, the database:

   a) Moves the digital photo file to the network drive: `Z:\MONITORING\Streams\Data\DataGathering\Photos\Renamed\MISC\`.

   b) Renames the file in the new location using the following naming convention: `SEI_2015_MISC_Number.jpg` (e.g., `SEI_2015_MISC_4.jpg`).

   c) Archives the original file name and path and all of the information that you added above to the `tblImage` table.



   d) The next photo that needs to be renamed will appear on the default SEI Photo Database form. This signals that you are finished with the previous photo.

Photo Management Procedure: Certifying

When all of the photos have been renamed completely and correctly, copy the photos over to the certified data folder, and copy all of the photo information from the SIE Data Entry Database to the SEI Master Photo Database.

1) In Windows Explorer, move the entire CORE folder from: `Z:\MONITORING\Streams\Data\DataGathering\Photos\Core\` to `Z:\MONITORING\Streams\Data\Certified\FY##\Photos\`.

2) Similarly, move the entire MISC folder from:
Z:\MONITORING\Streams\Data\DataGathering\Photos\MISC to
Z:\MONITORING\Streams\Data\Certified\FY##\Photos.

3) Move the SEI Photo Data Entry Database from:
Z:\MONITORING\Streams\Data\DataGathering\Photos to
Z:\MONITORING\Streams\Data\Certified\FY##\Photos.

4) Open the SEI Photo Data Entry Database at:
Z:\MONITORING\Streams\Data\DataGathering\Photos.

5) Open the SEI Master Photo Database at: *Z:\MONITORING\Streams\Images\Photos*.

6) Append all photo records from the *tbleImage* table in the SEI Photo Data Entry Database into the *tblImage* in the SEI Master Photo Database.

SEI SOP 17: Data Analysis

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

As of publication, this SOP was under development. Future revisions will include updated background and methods.

SEI SOP 18: Revising the Protocol

Version 1.0, January 2016

Change History

Previous Version	Date	Author	Change Description	Reason

Introduction

This SOP explains how to make and track changes to the SEI Protocol, including SOPs. While this protocol has been developed using current standardized methodology, all long-term monitoring programs need to be flexible to adapt to changes. As new technologies, methods, and equipment become available, this protocol will be updated as appropriate. Current best practices will be weighed against the continuity of protocol information in determining revisions. Project staff should refer to this SOP whenever edits are necessary and should be familiar with the protocol versioning system in order to identify and use the most current versions of the protocol documents. All changes will be made in a timely manner with the appropriate level of review.

All edits require review for clarity and technical soundness. Small changes to existing documents (e.g., formatting, simple clarification of existing content, small changes in the task schedule or project budget, or general updates to information management handling SOPs) may be reviewed in-house by ROMN staff; however, major changes to data collection or analysis techniques, sampling design, or response design will trigger an outside review.

Update Procedure

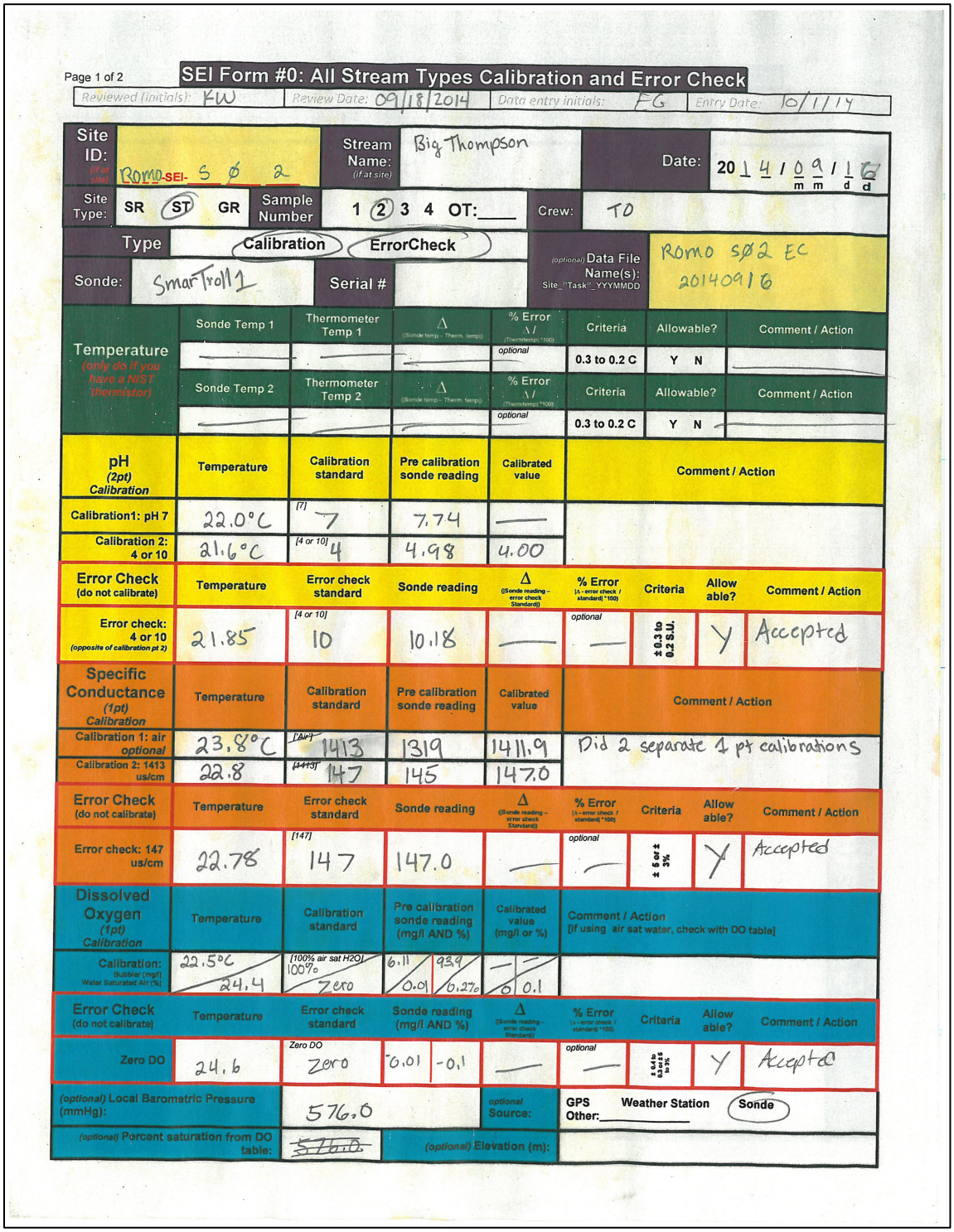
1) Discuss proposed changes with other project staff prior to making modifications. It is imperative to consult with the Data Manager prior to making changes because certain types of changes may jeopardize dataset integrity unless they are planned and executed to avoid this. Also, because certain changes may require altering the database structure or functionality, advance notice of changes is necessary to help minimize disruptions to project operations. Consensus should be reached regarding who will be making the changes and in what timeframe.
2) Make the agreed upon changes in the appropriate protocol document. A change in one document may necessitate other changes elsewhere in the protocol. For example, a change in the narrative

may require changes to several SOPs. Similarly, renumbering an SOP may mean changing document references in several other documents. Also, the project task list and other appendices may need to be updated to reflect changes in timing or responsibilities for the various project tasks.

3) Document all edits in the Revision History Log embedded in the protocol narrative and each SOP. Log changes only in the document being edited (e.g., if there is a change to an SOP, log those changes only in that document). Record the date of the changes (i.e., the date when all changes were finalized), author of the revision, the change and the paragraph(s) and page(s) where changes are made, the (brief) reason for making the changes, and the new version number. Version numbers increase incrementally by hundredths (e.g., version 1.01, 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0). Record the previous version number, date of revision, and author of revision; identify paragraphs and pages where changes are made, rationale for revisions, and the new version number.
4) Circulate the changed document for internal review among project staff and cooperators. Minor changes and clarifications will be reviewed in-house. When significant changes in methodology are suggested, revisions will first undergo internal review by the project staff. Additional external review including, but not limited to, National Park Service staff with appropriate water quality, aquatic communities, and statistical expertise will be required.
5) Upon ratifying and finalizing changes:
    a) Ensure that the version date (last saved date field code in the document header) and file name (field code in the document footer) are updated properly throughout the document.
    b) Make a copy of each changed file to the protocol archive folder (i.e., a subfolder under the Protocol folder in the project workspace).
    c) The copied files should be renamed by appending the revision date in YYYYMMDD format. In this manner, the revision date becomes the version number and this copy becomes the "versioned" copy to be archived and distributed.
    d) The current, primary version of the document (i.e., not the versioned document just copied and renamed) does not have a date stamp associated with it.
    e) To avoid unplanned edits to the document, reset the document to read-only by right-clicking on the document in Windows Explorer and checking the appropriate box in the Properties popup.
    f) Inform the Data Manager so the new version number(s) can be incorporated into the project metadata.
6) As appropriate, create PDF files of the versioned documents to post to the Internet and share with others. These PDF files should have the same name and be made from the versioned copy of the file.

7) Send a digital copy of the revised monitoring plan to the Network Contact and Network Data Manager. The revised monitoring plan will be forwarded to project and park staff who had been using a previous version of the affected document. Ensure that field staff have a hardcopy of the new version.
8) The Network Data Manager will place a copy of the revised protocol in the proper folder on the ROMN shared drive. In addition, the Network Data Manager will archive the previous version in the ROMN archive drive.
9) The Network Data Manager will post the revised version and update the associated records in the proper I&M databases, including but not limited to NatureBib, NPS Data Store, ROMN Intranet and Internet web sites, and the Protocol database.

Appendix A: 2014 SEI Field Sheets



Page 1 of 2

SEI Form #0: All Stream Types Calibration and Error Check

Reviewed (initials): KW | Review Date: 09/18/2014 | Data entry initials: FG | Entry Date: 10/1/14

Site ID: (if at site)	ROMO-SEI-S Ø 2	Stream Name: (if at site)	Big Thompson	Date:	20 14 / 09 / 16 (m m / d d)
Site Type:	SR (ST) GR	Sample Number	1 (2) 3 4 OT:___	Crew:	TO
Type	Calibration (ErrorCheck)			(optional) Data File Name(s): Site_"Task"_YYYMMDD	Romo SØ2 EC 20140916
Sonde:	SmarTroll	Serial #			

Temperature (only do if you have a NIST thermistor)	Sonde Temp 1	Thermometer Temp 1	Δ (Sonde temp – Therm. temp)	% Error |Δ / (Thermtemp) *100|	Criteria	Allowable?	Comment / Action
				optional	0.3 to 0.2 C	Y N	
	Sonde Temp 2	Thermometer Temp 2	Δ (Sonde temp – Therm. temp)	% Error |Δ / (Thermtemp) *100|	Criteria	Allowable?	Comment / Action
				optional	0.3 to 0.2 C	Y N	

pH (2pt) Calibration	Temperature	Calibration standard	Pre calibration sonde reading	Calibrated value	Comment / Action
Calibration1: pH 7	22.0°C	[7] 7	7.74	—	
Calibration 2: 4 or 10	21.6°C	[4 or 10] 4	4.98	4.00	

Error Check (do not calibrate)	Temperature	Error check standard	Sonde reading	Δ (Sonde reading – error check Standard)	% Error |Δ - error check / standard| *100	Criteria	Allow able?	Comment / Action
Error check: 4 or 10 (opposite of calibration pt 2)	21.85	[4 or 10] 10	10.18	—	optional —	±0.3 to 0.2 S.U.	Y	Accepted

Specific Conductance (1pt) Calibration	Temperature	Calibration standard	Pre calibration sonde reading	Calibrated value	Comment / Action
Calibration 1: air optional	23.8°C	[Air] 1413	1319	1411.9	Did 2 separate 1 pt calibrations
Calibration 2: 1413 us/cm	22.8	[1413] 147	145	147.0	

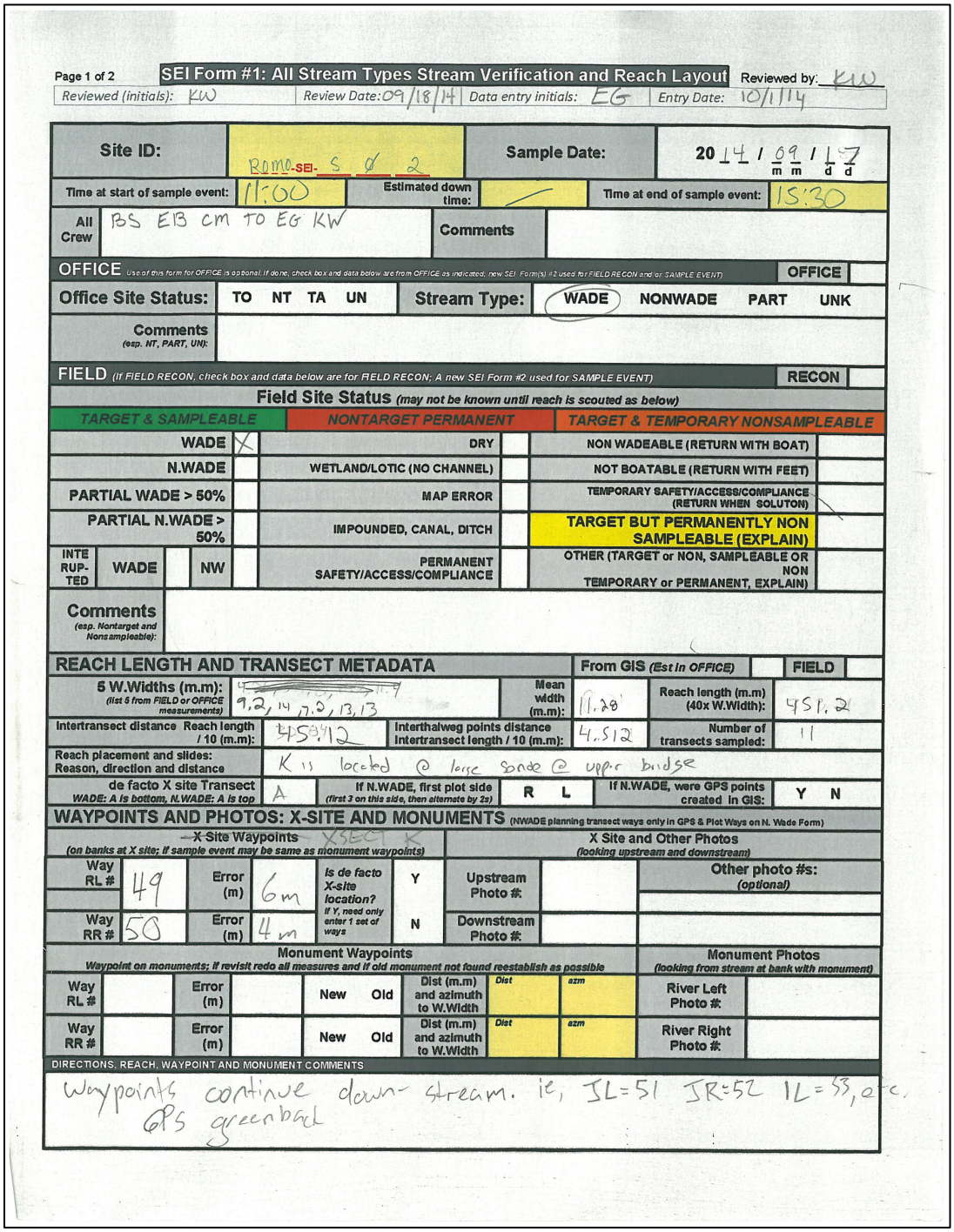
Error Check (do not calibrate)	Temperature	Error check standard	Sonde reading	Δ (Sonde reading – error check Standard)	% Error |Δ - error check / standard| *100	Criteria	Allow able?	Comment / Action
Error check: 147 us/cm	22.78	[147] 147	147.0	—	optional —	± 5 or ± 3%	Y	Accepted

Dissolved Oxygen (1pt) Calibration	Temperature	Calibration standard	Pre calibration sonde reading (mg/l AND %)		Calibrated value (mg/l or %)		Comment / Action [if using air sat water, check with DO table]
Calibration: Bubbler (mg/l) / Water Saturated Air (%)	22.5°C / 24.4	[100% air sat H2O] 100% / Zero	6.11 / 0.01	93.9 / 0.2%	— / 0	— / 0.1	

Error Check (do not calibrate)	Temperature	Error check standard	Sonde reading (mg/l AND %)		Δ (Sonde reading – error check Standard)	% Error |Δ - error check / standard| *100	Criteria	Allow able?	Comment / Action
Zero DO	24.6	Zero DO Zero	-0.01	-0.1	—	optional —	±0.4 to 0.2 mg/l or 2%	Y	Accepted

(optional) Local Barometric Pressure (mmHg):	576.0	optional Source:	GPS Other:___	Weather Station (Sonde)
(optional) Percent saturation from DO table:	~~576.0~~	(optional) Elevation (m):		

Figure A-1. SEI Form #0: Calibration and Error Check



Page 1 of 2 — SEI Form #1: All Stream Types Stream Verification and Reach Layout — Reviewed by: KW

Reviewed (initials): KW | Review Date: 09/18/14 | Data entry initials: EG | Entry Date: 10/1/14

Site ID:	Rome-SEI- S 8 2	Sample Date:	2014 / 09 / 17 (m m / d d)
Time at start of sample event:	11:00	Estimated down time:	Time at end of sample event: 15:30
All Crew	BS EB CM TO EG KW	Comments	

OFFICE — Use of this form for OFFICE is optional. If done, check box and data below are from OFFICE as indicated; new SEI Form(s) #2 used for FIELD RECON and/or SAMPLE EVENT) — OFFICE

Office Site Status: TO NT TA UN — Stream Type: (WADE) NONWADE PART UNK

Comments (esp. NT, PART, UN):

FIELD (If FIELD RECON, check box and data below are for FIELD RECON; A new SEI Form #2 used for SAMPLE EVENT) — RECON

Field Site Status (may not be known until reach is scouted as below)

TARGET & SAMPLEABLE		NONTARGET PERMANENT		TARGET & TEMPORARY NONSAMPLEABLE	
WADE	X	DRY		NON WADEABLE (RETURN WITH BOAT)	
N.WADE		WETLAND/LOTIC (NO CHANNEL)		NOT BOATABLE (RETURN WITH FEET)	
PARTIAL WADE > 50%		MAP ERROR		TEMPORARY SAFETY/ACCESS/COMPLIANCE (RETURN WHEN SOLUTON)	
PARTIAL N.WADE > 50%		IMPOUNDED, CANAL, DITCH		TARGET BUT PERMANENTLY NON SAMPLEABLE (EXPLAIN)	
INTERRUPTED WADE		NW		PERMANENT SAFETY/ACCESS/COMPLIANCE		OTHER (TARGET or NON, SAMPLEABLE OR NON TEMPORARY or PERMANENT, EXPLAIN)	

Comments (esp. Nontarget and Nonsampleable):

REACH LENGTH AND TRANSECT METADATA — From GIS (Est in OFFICE) — FIELD

5 W.Widths (m.m): (list 5 from FIELD or OFFICE measurements)	9.2, 14, 7.0, 13, 13	Mean width (m.m):	11.24	Reach length (m.m) (40x W.Width):	451.2
Intertransect distance Reach length / 10 (m.m):	45.12	Interthalweg points distance Intertransect length / 10 (m.m):	4.512	Number of transects sampled:	11
Reach placement and slides: Reason, direction and distance	K is located @ large sande @ upper bridge				
de facto X site Transect WADE: A is bottom, N.WADE: A is top	A	If N.WADE, first plot side (first 3 on this side, then alternate by 2s)	R L	If N.WADE, were GPS points created in GIS:	Y N

WAYPOINTS AND PHOTOS: X-SITE AND MONUMENTS (NWADE planning transect ways only in GPS & Plot Ways on N. Wade Form)

X Site Waypoints (on banks at X site; if sample event may be same as monument waypoints) — ~~X Site Waypoints~~ XSECT K

X Site and Other Photos (looking upstream and downstream)

Way RL #	49	Error (m)	6m	Is de facto X-site location? If Y, need only enter 1 set of ways	Y	Upstream Photo #:	Other photo #s: (optional)
Way RR #	50	Error (m)	4m		N	Downstream Photo #:	

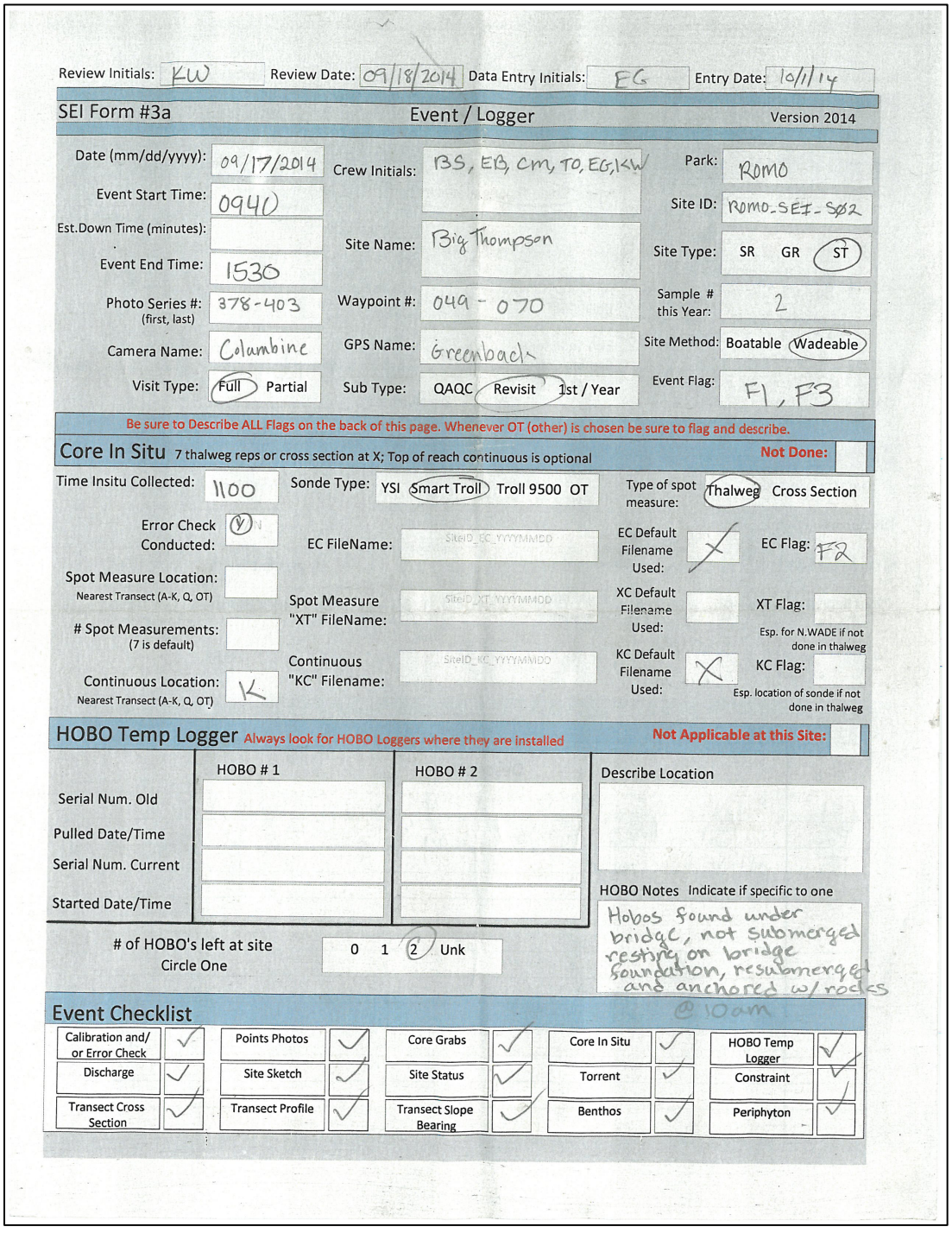
Monument Waypoints (Waypoint on monuments; if revisit redo all measures and if old monument not found reestablish as possible) — Monument Photos (looking from stream at bank with monument)

Way RL #		Error (m)		New Old	Dist (m.m) and azimuth to W.Width	Dist	azm	River Left Photo #:	
Way RR #		Error (m)		New Old	Dist (m.m) and azimuth to W.Width	Dist	azm	River Right Photo #:	

DIRECTIONS, REACH, WAYPOINT AND MONUMENT COMMENTS

Waypoints continue down-stream. ie, JL=51 JR=52 JL=53, etc. GPS greenback

Figure A-2. SEI Form #1: Site Verification and Layout



Review Initials: KW Review Date: 09/18/2014 Data Entry Initials: EG Entry Date: 10/1/14

SEI Form #3a — Event / Logger — Version 2014

Date (mm/dd/yyyy): 09/17/2014	Crew Initials: BS, EB, CM, TO, EG, KW	Park: ROMO	
Event Start Time: 0940		Site ID: ROMO_SEI_S02	
Est.Down Time (minutes):	Site Name: Big Thompson	Site Type: SR GR (ST)	
Event End Time: 1530			
Photo Series #: (first, last) 378-403	Waypoint #: 049 - 070	Sample # this Year: 2	
Camera Name: Columbine	GPS Name: Greenback	Site Method: Boatable (Wadeable)	
Visit Type: (Full) Partial	Sub Type: QAQC (Revisit) 1st / Year	Event Flag: F1, F3	

Be sure to Describe ALL Flags on the back of this page. Whenever OT (other) is chosen be sure to flag and describe.

Core In Situ 7 thalweg reps or cross section at X; Top of reach continuous is optional — Not Done:

Time Insitu Collected: 1100	Sonde Type: YSI (Smart Troll) Troll 9500 OT	Type of spot measure: (Thalweg) Cross Section	
Error Check Conducted: (Y) N	EC FileName: SiteID_EC_YYYYMMDD	EC Default Filename Used: X	EC Flag: F2
Spot Measure Location: Nearest Transect (A-K, Q, OT)			
# Spot Measurements: (7 is default)	Spot Measure "XT" FileName: SiteID_XT_YYYYMMDD	XC Default Filename Used:	XT Flag: Esp. for N.WADE if not done in thalweg
Continuous Location: Nearest Transect (A-K, Q, OT) K	Continuous "KC" Filename: SiteID_KC_YYYYMMDD	KC Default Filename Used: X	KC Flag: Esp. location of sonde if not done in thalweg

HOBO Temp Logger Always look for HOBO Loggers where they are installed — Not Applicable at this Site:

	HOBO # 1	HOBO # 2
Serial Num. Old		
Pulled Date/Time		
Serial Num. Current		
Started Date/Time		

Describe Location:

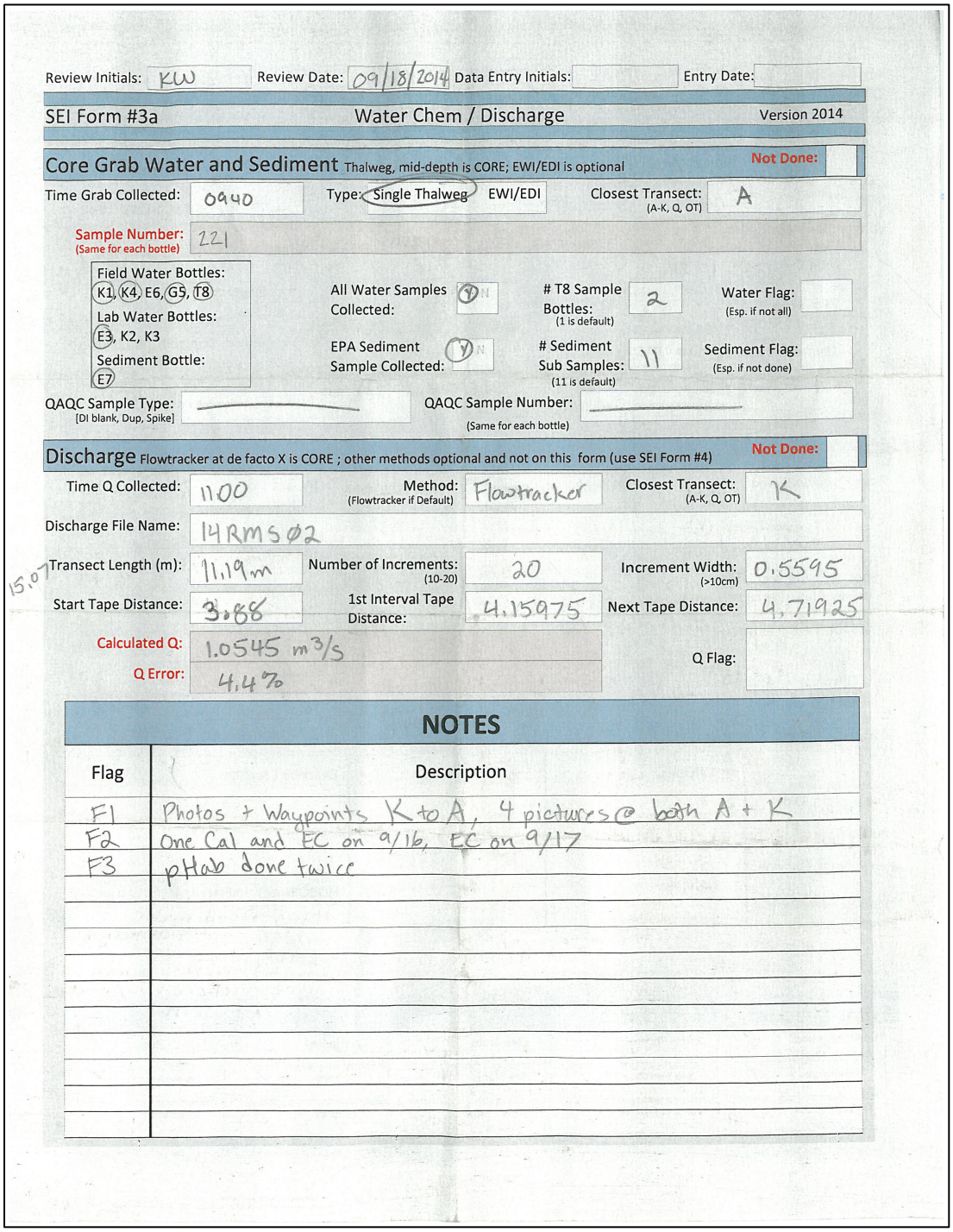
HOBO Notes Indicate if specific to one: Hobos found under bridge, not submerged resting on bridge foundation, resubmerged and anchored w/ rocks @ 10am

of HOBO's left at site Circle One: 0 1 (2) Unk

Event Checklist

Calibration and/ or Error Check	✓	Points Photos	✓	Core Grabs	✓	Core In Situ	✓	HOBO Temp Logger	✓
Discharge	✓	Site Sketch	✓	Site Status	✓	Torrent	✓	Constraint	✓
Transect Cross Section	✓	Transect Profile	✓	Transect Slope Bearing	✓	Benthos	✓	Periphyton	✓

Figure A-3. SEI Form #3a: Sentinel Event



Review Initials: KW Review Date: 09/18/2014 Data Entry Initials: Entry Date:

SEI Form #3a — Water Chem / Discharge — Version 2014

Core Grab Water and Sediment Thalweg, mid-depth is CORE; EWI/EDI is optional — Not Done:

Time Grab Collected: 0940 Type: (Single Thalweg) EWI/EDI Closest Transect: (A-K, Q, OT) A

Sample Number: (Same for each bottle) 221

Field Water Bottles: (K1) (K4) E6, (G5), (T8)
Lab Water Bottles: (E3), K2, K3
Sediment Bottle: (E7)

All Water Samples Collected: (Y) N # T8 Sample Bottles: (1 is default) 2 Water Flag: (Esp. if not all)

EPA Sediment Sample Collected: (Y) N # Sediment Sub Samples: (11 is default) 11 Sediment Flag: (Esp. if not done)

QAQC Sample Type: [DI blank, Dup, Spike] QAQC Sample Number: (Same for each bottle)

Discharge Flowtracker at de facto X is CORE ; other methods optional and not on this form (use SEI Form #4) — Not Done:

Time Q Collected: 1100 Method: (Flowtracker if Default) Flowtracker Closest Transect: (A-K, Q, OT) K

Discharge File Name: 14RMS02

15.07 Transect Length (m): 11.19m Number of Increments: (10-20) 20 Increment Width: (>10cm) 0.5595

Start Tape Distance: 3.88 1st Interval Tape Distance: 4.15975 Next Tape Distance: 4.71925

Calculated Q: 1.0545 m^3/s Q Flag:

Q Error: 4.4%

NOTES

Flag	Description
F1	Photos + Waypoints K to A, 4 pictures @ both A + K
F2	One Cal and EC on 9/16, EC on 9/17
F3	pHab done twice

Figure A-4. SEI Form #4: Discharge

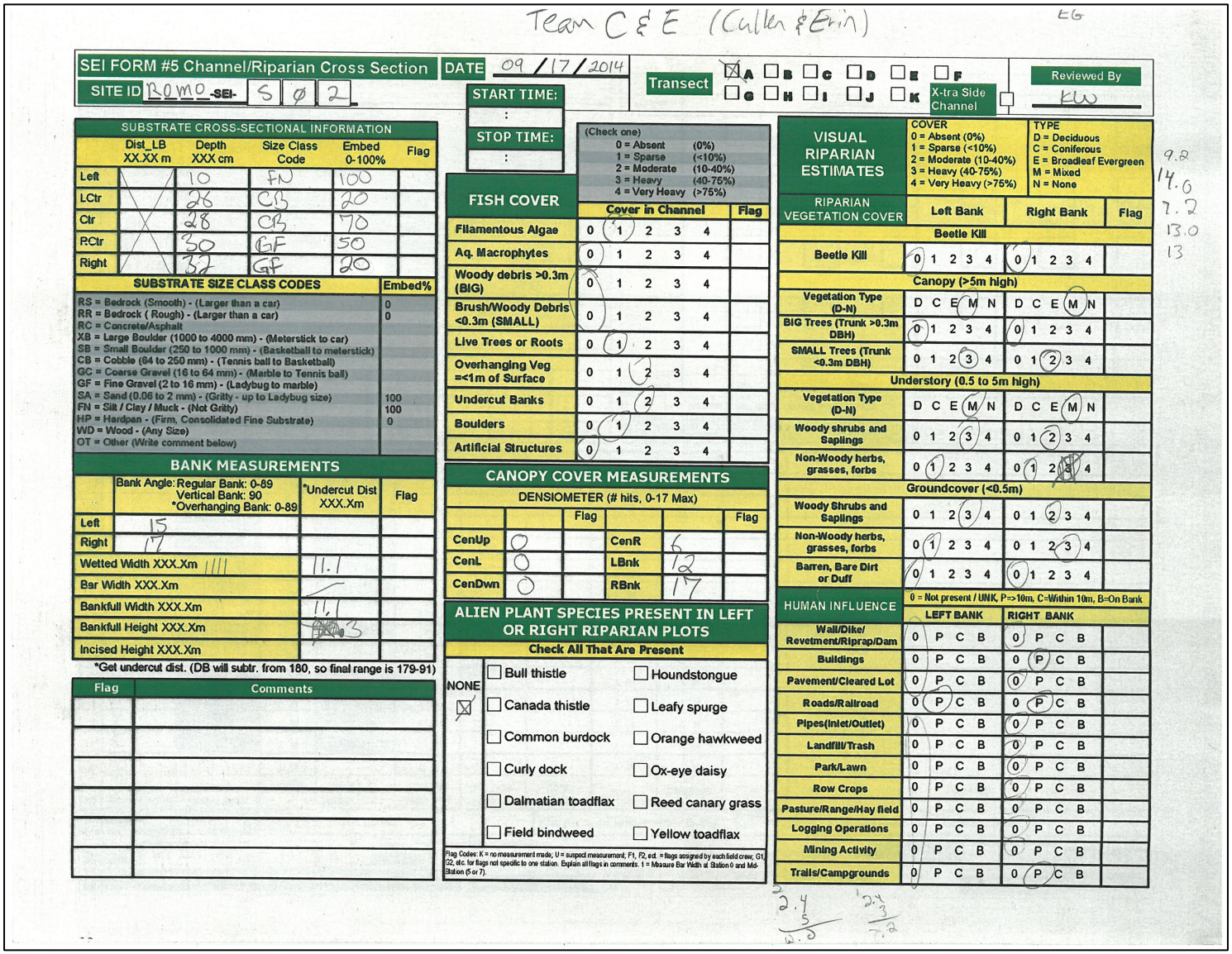
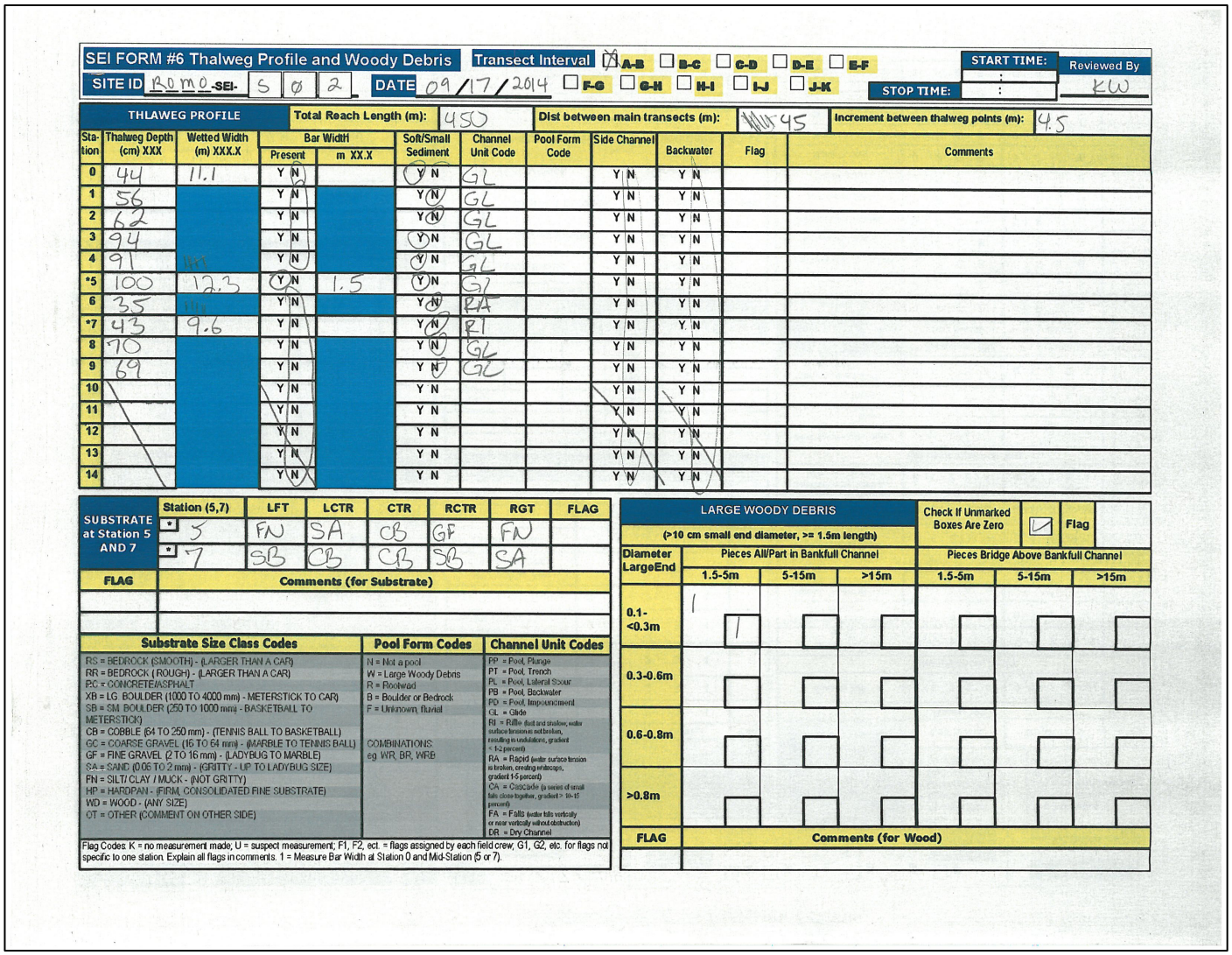


Figure A-5. SEI Form #5: Channel/Riparian Cross Section



SEI FORM #6 Thalweg Profile and Woody Debris — Transect Interval: ☒ A-B ☐ B-C ☐ C-D ☐ D-E ☐ E-F ☐ F-G ☐ G-H ☐ H-I ☐ I-J ☐ J-K

SITE ID: ROMO-SEI-502 — DATE: 09/17/2014 — START TIME: — STOP TIME: — Reviewed By: KW

THALWEG PROFILE — Total Reach Length (m): 450 — Dist between main transects (m): 45 — Increment between thalweg points (m): 4.5

Station	Thalweg Depth (cm) XXX	Wetted Width (m) XXX.X	Bar Width Present	Bar Width m XX.X	Soft/Small Sediment	Channel Unit Code	Pool Form Code	Side Channel	Backwater	Flag	Comments
0	44	11.1	Y N		Y N	GL		Y N	Y N		
1	56		Y N		Y N	GL		Y N	Y N		
2	62		Y N		Y N	GL		Y N	Y N		
3	94		Y N		Y N	GL		Y N	Y N		
4	91		Y N		Y N	GL		Y N	Y N		
*5	100	12.3	Y N	1.5	Y N	GL		Y N	Y N		
6	35		Y N		Y N	RA		Y N	Y N		
*7	43	9.6	Y N		Y N	RI		Y N	Y N		
8	70		Y N		Y N	GL		Y N	Y N		
9	69		Y N		Y N	GL		Y N	Y N		
10			Y N		Y N			Y N	Y N		
11			Y N		Y N			Y N	Y N		
12			Y N		Y N			Y N	Y N		
13			Y N		Y N			Y N	Y N		
14			Y N		Y N			Y N	Y N		

SUBSTRATE at Station 5 AND 7

Station (5,7)	LFT	LCTR	CTR	RCTR	RGT	FLAG
* 5	FN	SA	CB	GF	FN	
* 7	SB	CB	CB	SB	SA	

FLAG	Comments (for Substrate)

Substrate Size Class Codes

RS = BEDROCK (SMOOTH) - (LARGER THAN A CAR)
RR = BEDROCK (ROUGH) - (LARGER THAN A CAR)
RC = CONCRETE/ASPHALT
XB = LG. BOULDER (1000 TO 4000 mm) - METERSTICK TO CAR)
SB = SM. BOULDER (250 TO 1000 mm) - BASKETBALL TO METERSTICK)
CB = COBBLE (64 TO 250 mm) - (TENNIS BALL TO BASKETBALL)
GC = COARSE GRAVEL (16 TO 64 mm) - (MARBLE TO TENNIS BALL)
GF = FINE GRAVEL (2 TO 16 mm) - (LADYBUG TO MARBLE)
SA = SAND (0.06 TO 2 mm) - (GRITTY - UP TO LADYBUG SIZE)
FN = SILT/ CLAY / MUCK - (NOT GRITTY)
HP = HARDPAN - (FIRM, CONSOLIDATED FINE SUBSTRATE)
WD = WOOD - (ANY SIZE)
OT = OTHER (COMMENT ON OTHER SIDE)

Pool Form Codes

N = Not a pool
W = Large Woody Debris
R = Rootwad
B = Boulder or Bedrock
F = Unknown, fluvial

COMBINATIONS:
eg WR, BR, WRB

Channel Unit Codes

PP = Pool, Plunge
PT = Pool, Trench
PL = Pool, Lateral Scour
PB = Pool, Backwater
PD = Pool, Impoundment
GL = Glide
RI = Riffle (fast and shallow, water surface tension is not broken, resulting in undulations, gradient < 1-2 percent)
RA = Rapid (water surface tension is broken, creating rantaspic, gradient 1-5 percent)
CA = Cascade (a series of small falls close together, gradient > 5-15 percent)
FA = Falls (water falls vertically or near vertically without obstruction)
DR = Dry Channel

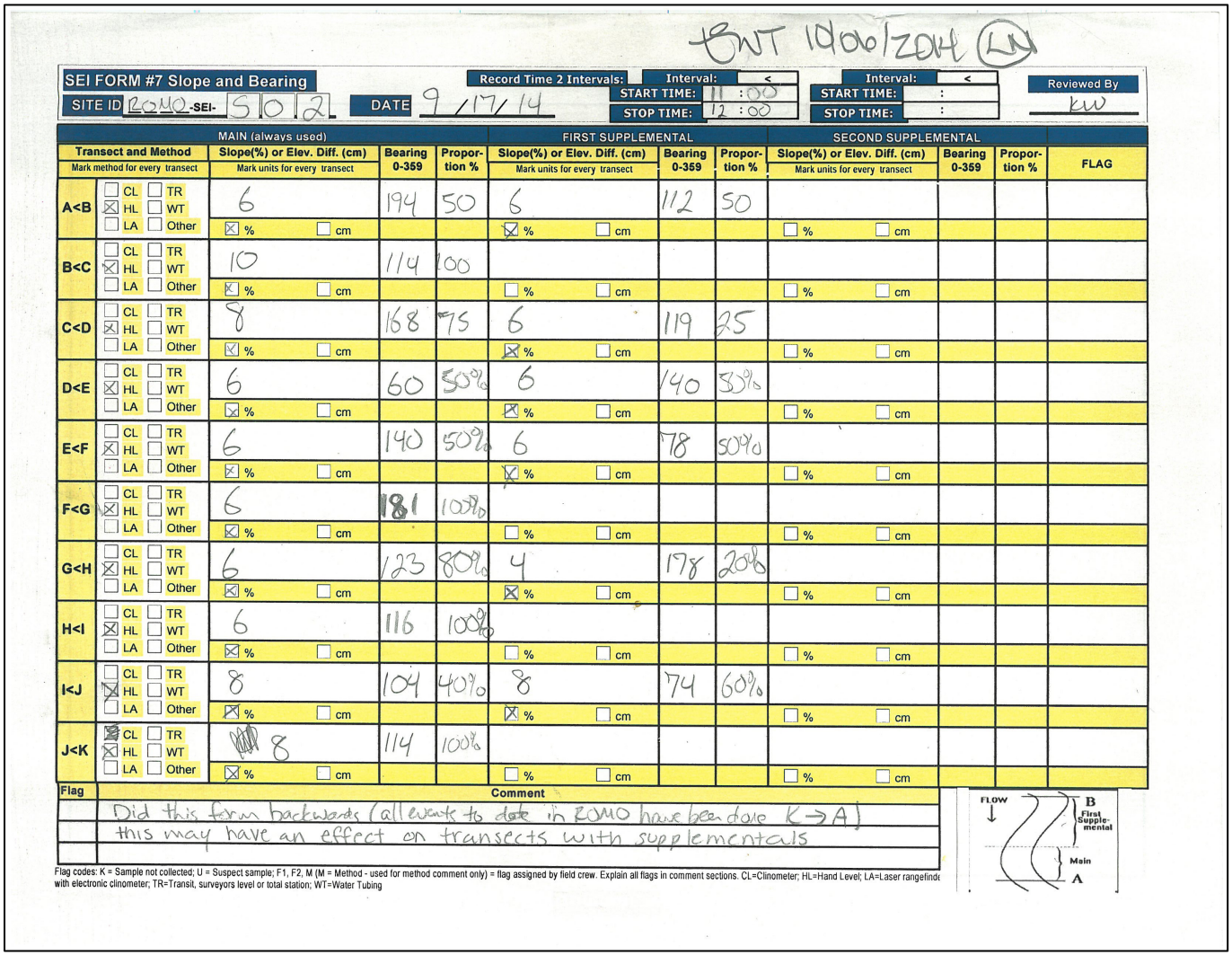
Flag Codes: K = no measurement made; U = suspect measurement; F1, F2, ect. = flags assigned by each field crew; G1, G2, etc. for flags not specific to one station. Explain all flags in comments. 1 = Measure Bar Width at Station 0 and Mid-Station (5 or 7).

LARGE WOODY DEBRIS (>10 cm small end diameter, >= 1.5m length) — Check If Unmarked Boxes Are Zero: ☑ — Flag:

Diameter LargeEnd	Pieces All/Part in Bankfull Channel 1.5-5m	5-15m	>15m	Pieces Bridge Above Bankfull Channel 1.5-5m	5-15m	>15m
0.1-<0.3m	1					
0.3-0.6m						
0.6-0.8m						
>0.8m						

FLAG	Comments (for Wood)

Figure A-6. SEI Form #6: Thalweg Profile and Large Woody Debris



BNT 10/06/2014 (LN)

SEI FORM #7 Slope and Bearing

SITE ID: ROMO-SEI-5012 DATE: 9/17/14

Record Time 2 Intervals: Interval: < START TIME: 11:00 STOP TIME: 12:00

Interval: < START TIME: : STOP TIME: :

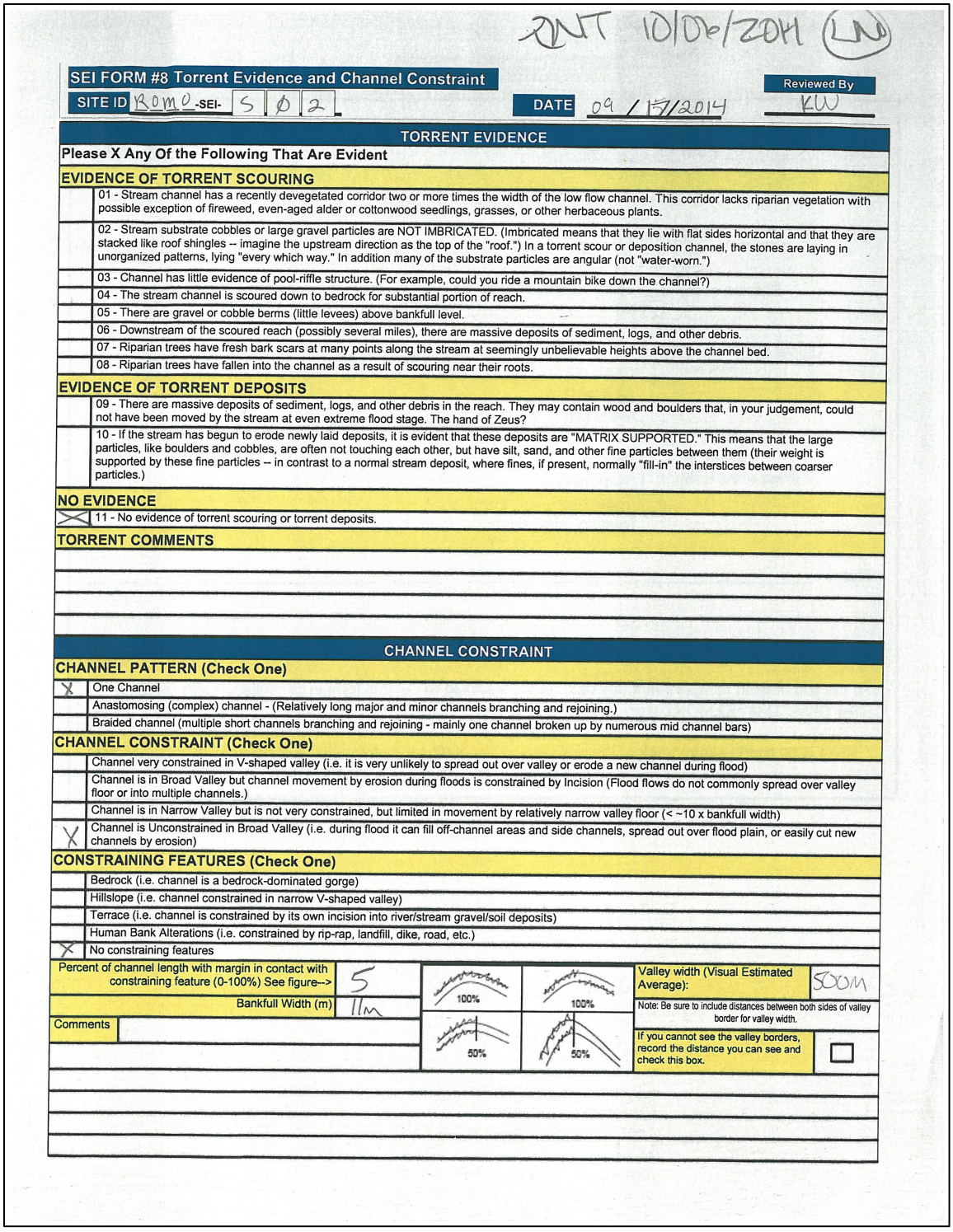
Reviewed By: KW

	MAIN (always used)				FIRST SUPPLEMENTAL			SECOND SUPPLEMENTAL			
Transect and Method (Mark method for every transect)	Slope(%) or Elev. Diff. (cm) (Mark units for every transect)	Bearing 0-359	Proportion %	Slope(%) or Elev. Diff. (cm) (Mark units for every transect)	Bearing 0-359	Proportion %	Slope(%) or Elev. Diff. (cm) (Mark units for every transect)	Bearing 0-359	Proportion %	FLAG
A<B: [x] HL	6 [x] % [ ] cm	194	50	6 [x] % [ ] cm	112	50	[ ] % [ ] cm			
B<C: [x] HL	10 [x] % [ ] cm	114	100	[ ] % [ ] cm			[ ] % [ ] cm			
C<D: [x] HL	8 [x] % [ ] cm	168	75	6 [x] % [ ] cm	119	25	[ ] % [ ] cm			
D<E: [x] HL	6 [x] % [ ] cm	60	50%	6 [x] % [ ] cm	140	50%	[ ] % [ ] cm			
E<F: [x] HL	6 [x] % [ ] cm	140	50%	6 [x] % [ ] cm	78	50%	[ ] % [ ] cm			
F<G: [x] HL	6 [x] % [ ] cm	181	100%	[ ] % [ ] cm			[ ] % [ ] cm			
G<H: [x] HL	6 [x] % [ ] cm	123	80%	4 [x] % [ ] cm	178	20%	[ ] % [ ] cm			
H<I: [x] HL	6 [x] % [ ] cm	116	100%	[ ] % [ ] cm			[ ] % [ ] cm			
I<J: [x] HL	8 [x] % [ ] cm	104	40%	8 [x] % [ ] cm	74	60%	[ ] % [ ] cm			
J<K: [x] CL [x] HL	8 [x] % [ ] cm	114	100%	[ ] % [ ] cm			[ ] % [ ] cm			

Flag	Comment
	Did this form backwards (all events to date in ROMO have been done K→A)
	this may have an effect on transects with supplementals

Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, M (M = Method - used for method comment only) = flag assigned by field crew. Explain all flags in comment sections. CL=Clinometer; HL=Hand Level; LA=Laser rangefinde with electronic clinometer; TR=Transit, surveyors level or total station; WT=Water Tubing

Figure A-7. SEI Form #7: Slope/Sinuosity



SEI FORM #8 Torrent Evidence and Channel Constraint

SITE ID ROMO-SEI-502 DATE 09/15/2014 Reviewed By KW

TORRENT 10/06/2014 (LN)

TORRENT EVIDENCE

Please X Any Of the Following That Are Evident

EVIDENCE OF TORRENT SCOURING

	01 - Stream channel has a recently devegetated corridor two or more times the width of the low flow channel. This corridor lacks riparian vegetation with possible exception of fireweed, even-aged alder or cottonwood seedlings, grasses, or other herbaceous plants.
	02 - Stream substrate cobbles or large gravel particles are NOT IMBRICATED. (Imbricated means that they lie with flat sides horizontal and that they are stacked like roof shingles -- imagine the upstream direction as the top of the "roof.") In a torrent scour or deposition channel, the stones are laying in unorganized patterns, lying "every which way." In addition many of the substrate particles are angular (not "water-worn.")
	03 - Channel has little evidence of pool-riffle structure. (For example, could you ride a mountain bike down the channel?)
	04 - The stream channel is scoured down to bedrock for substantial portion of reach.
	05 - There are gravel or cobble berms (little levees) above bankfull level.
	06 - Downstream of the scoured reach (possibly several miles), there are massive deposits of sediment, logs, and other debris.
	07 - Riparian trees have fresh bark scars at many points along the stream at seemingly unbelievable heights above the channel bed.
	08 - Riparian trees have fallen into the channel as a result of scouring near their roots.

EVIDENCE OF TORRENT DEPOSITS

	09 - There are massive deposits of sediment, logs, and other debris in the reach. They may contain wood and boulders that, in your judgement, could not have been moved by the stream at even extreme flood stage. The hand of Zeus?
	10 - If the stream has begun to erode newly laid deposits, it is evident that these deposits are "MATRIX SUPPORTED." This means that the large particles, like boulders and cobbles, are often not touching each other, but have silt, sand, and other fine particles between them (their weight is supported by these fine particles -- in contrast to a normal stream deposit, where fines, if present, normally "fill-in" the interstices between coarser particles.)

NO EVIDENCE

X	11 - No evidence of torrent scouring or torrent deposits.

TORRENT COMMENTS

CHANNEL CONSTRAINT

CHANNEL PATTERN (Check One)

X	One Channel
	Anastomosing (complex) channel - (Relatively long major and minor channels branching and rejoining.)
	Braided channel (multiple short channels branching and rejoining - mainly one channel broken up by numerous mid channel bars)

CHANNEL CONSTRAINT (Check One)

	Channel very constrained in V-shaped valley (i.e. it is very unlikely to spread out over valley or erode a new channel during flood)
	Channel is in Broad Valley but channel movement by erosion during floods is constrained by Incision (Flood flows do not commonly spread over valley floor or into multiple channels.)
	Channel is in Narrow Valley but is not very constrained, but limited in movement by relatively narrow valley floor (< ~10 x bankfull width)
X	Channel is Unconstrained in Broad Valley (i.e. during flood it can fill off-channel areas and side channels, spread out over flood plain, or easily cut new channels by erosion)

CONSTRAINING FEATURES (Check One)

	Bedrock (i.e. channel is a bedrock-dominated gorge)
	Hillslope (i.e. channel constrained in narrow V-shaped valley)
	Terrace (i.e. channel is constrained by its own incision into river/stream gravel/soil deposits)
	Human Bank Alterations (i.e. constrained by rip-rap, landfill, dike, road, etc.)
X	No constraining features

Percent of channel length with margin in contact with constraining feature (0-100%) See figure--> 5

Bankfull Width (m) 11m

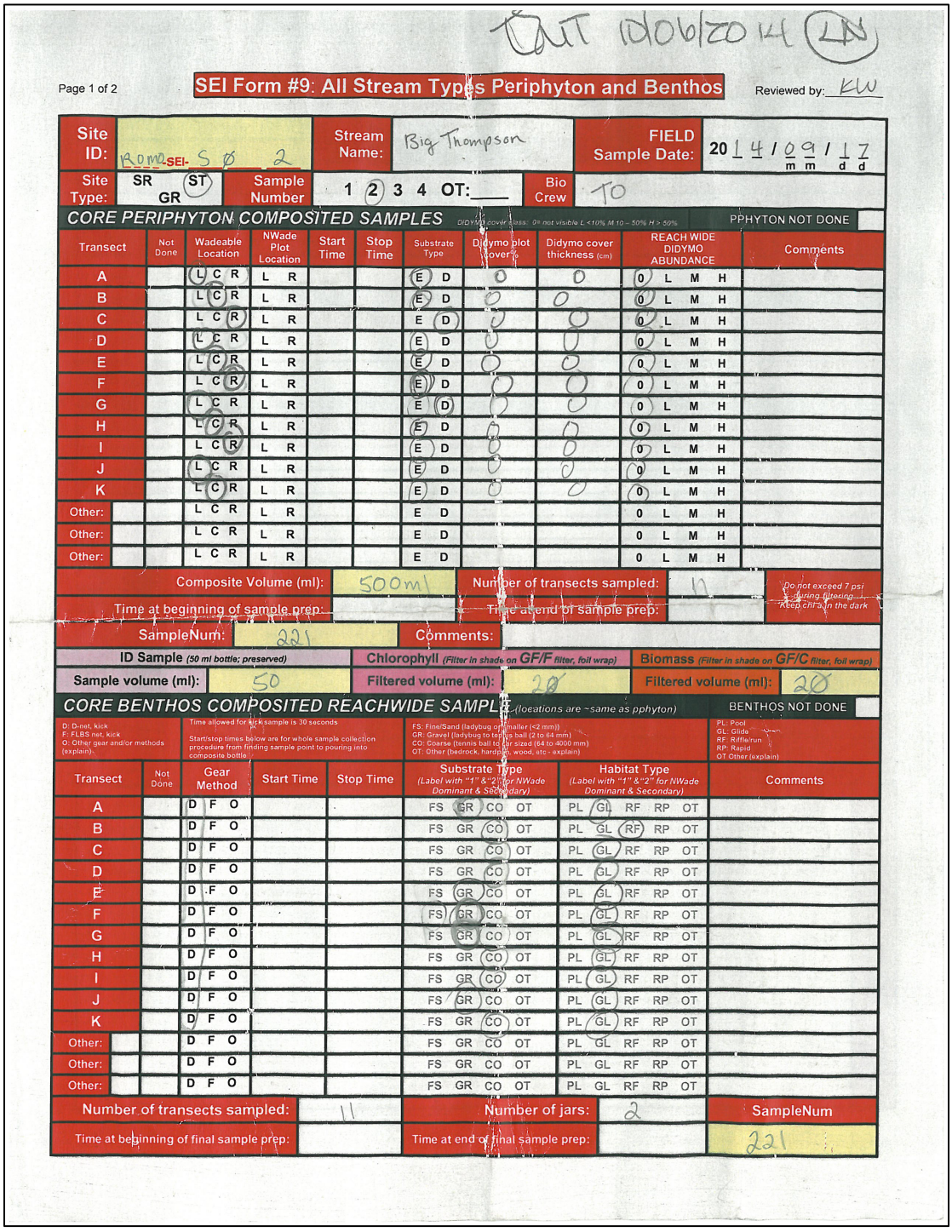
Valley width (Visual Estimated Average): 500m

Note: Be sure to include distances between both sides of valley border for valley width.

If you cannot see the valley borders, record the distance you can see and check this box. ☐

Comments

Figure A-8. SEI Form #8: Torrent and Channel Constraint



Page 1 of 2

SEI Form #9: All Stream Types Periphyton and Benthos

Reviewed by: KW

Site ID:	BOMD-SEI-S Ø 2	Stream Name:	Big Thompson	FIELD Sample Date:	2014/09/17 (m m / d d)		
Site Type:	SR (ST) GR	Sample Number	1 (2) 3 4 OT:___	Bio Crew	TO		

CORE PERIPHYTON COMPOSITED SAMPLES — DIDYMO cover class: 0= not visible L <10% M 10 – 50% H > 50% — PPHYTON NOT DONE

Transect	Not Done	Wadeable Location	NWade Plot Location	Start Time	Stop Time	Substrate Type	Didymo plot cover %	Didymo cover thickness (cm)	REACH WIDE DIDYMO ABUNDANCE	Comments
A		(L) C R	L R			(E) D	0	0	(0) L M H	
B		L (C) R	L R			(E) D	0	0	(0) L M H	
C		L C (R)	L R			E (D)	0	0	(0) L M H	
D		(L) C R	L R			E (D)	0	0	(0) L M H	
E		(L) C R	L R			(E) D	0	0	(0) L M H	
F		(L) C R	L R			(E) D	0	0	(0) L M H	
G		L (C) R	L R			E (D)	0	0	(0) L M H	
H		L (C) R	L R			(E) D	0	0	(0) L M H	
I		L C (R)	L R			E (D)	0	0	(0) L M H	
J		(L) C R	L R			(E) D	0	0	(0) L M H	
K		L (C) R	L R			(E) D	0	0	(0) L M H	
Other:		L C R	L R			E D			0 L M H	
Other:		L C R	L R			E D			0 L M H	
Other:		L C R	L R			E D			0 L M H	

Composite Volume (ml):	500ml	Number of transects sampled:	11
Time at beginning of sample prep:		Time at end of sample prep:	

Do not exceed 7 psi during filtering. Keep chrs in the dark

SampleNum: 221 Comments:

ID Sample (50 ml bottle; preserved)		Chlorophyll (Filter in shade on GF/F filter, foil wrap)		Biomass (Filter in shade on GF/C filter, foil wrap)	
Sample volume (ml):	50	Filtered volume (ml):	20	Filtered volume (ml):	20

CORE BENTHOS COMPOSITED REACHWIDE SAMPLE (locations are ~same as pphyton) — BENTHOS NOT DONE

D: D-net, kick
F: FLBS net, Kick
O: Other gear and/or methods (explain)

Time allowed for kick sample is 30 seconds

Start/stop times below are for whole sample collection procedure from finding sample point to pouring into composite bottle

FS: Fine/Sand (ladybug or smaller (<2 mm))
GR: Gravel (ladybug to tennis ball (2 to 64 mm))
CO: Coarse (tennis ball to car sized (64 to 4000 mm)
OT: Other (bedrock, hardpan, wood, etc - explain)

PL: Pool
GL: Glide
RF: Riffle/run
RP: Rapid
OT Other (explain)

Transect	Not Done	Gear Method	Start Time	Stop Time	Substrate Type (Label with "1" &"2" for NWade Dominant & Secondary)	Habitat Type (Label with "1" &"2" for NWade Dominant & Secondary)	Comments
A		(D) F O			FS (GR) CO OT	PL (GL) RF RP OT	
B		(D) F O			FS GR (CO) OT	PL GL (RF) RP OT	
C		(D) F O			FS GR (CO) OT	PL (GL) RF RP OT	
D		(D) F O			FS GR (CO) OT	PL (GL) RF RP OT	
E		(D) F O			FS (GR) CO OT	PL (GL) RF RP OT	
F		(D) F O			FS (GR) CO OT	PL (GL) RF RP OT	
G		(D) F O			FS (GR) CO OT	PL (GL) RF RP OT	
H		(D) F O			FS GR (CO) OT	PL (GL) RF RP OT	
I		(D) F O			FS GR (CO) OT	PL (GL) RF RP OT	
J		(D) F O			FS GR (CO) OT	PL (GL) RF RP OT	
K		(D) F O			FS (GR) CO OT	PL (GL) RF RP OT	
Other:		D F O			FS GR CO OT	PL GL RF RP OT	
Other:		D F O			FS GR CO OT	PL GL RF RP OT	
Other:		D F O			FS GR CO OT	PL GL RF RP OT	

Number of transects sampled:	11	Number of jars:	2	SampleNum
Time at beginning of final sample prep:		Time at end of final sample prep:		221

Figure A-9. SEI Form #9: Periphyton and Benthos

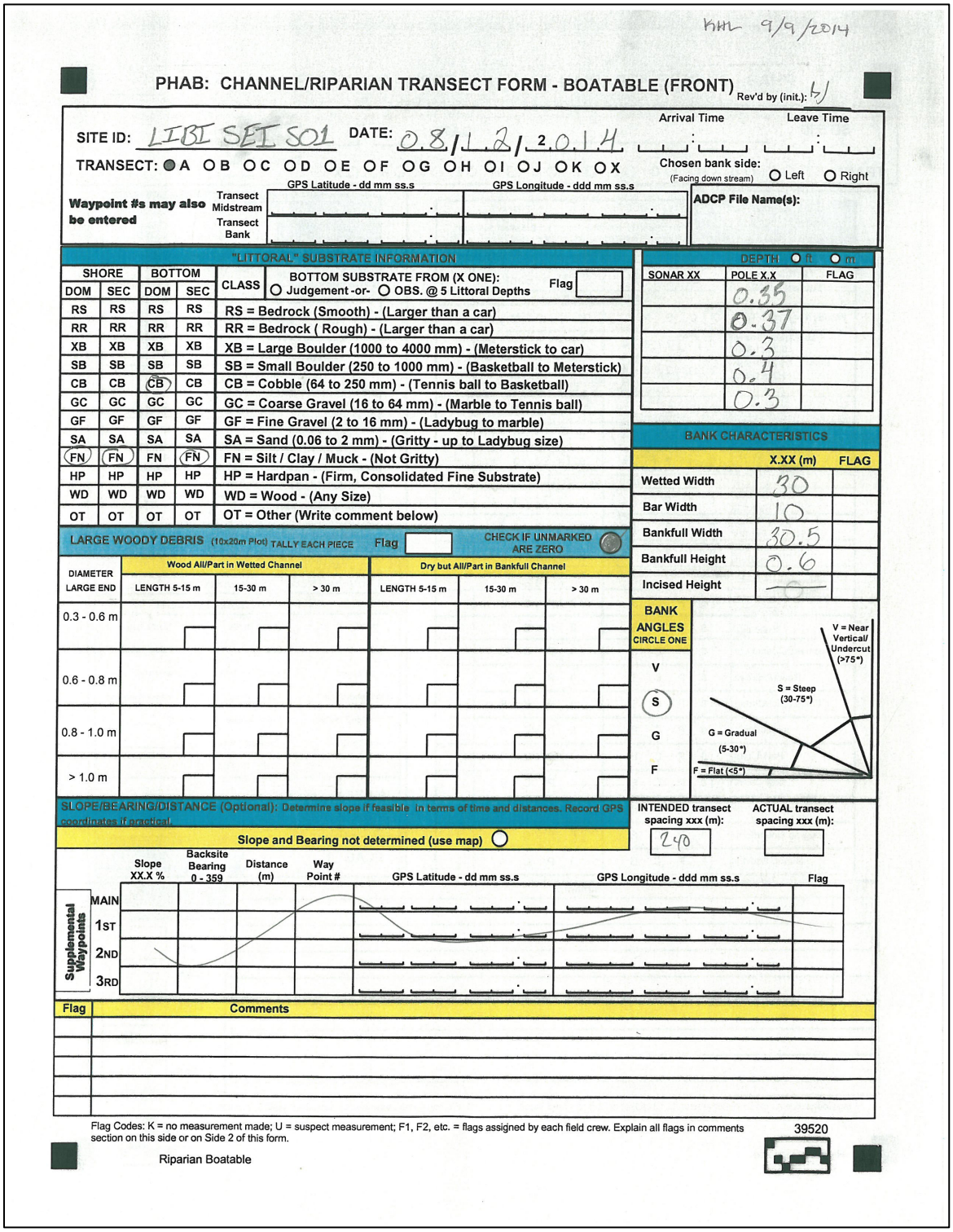
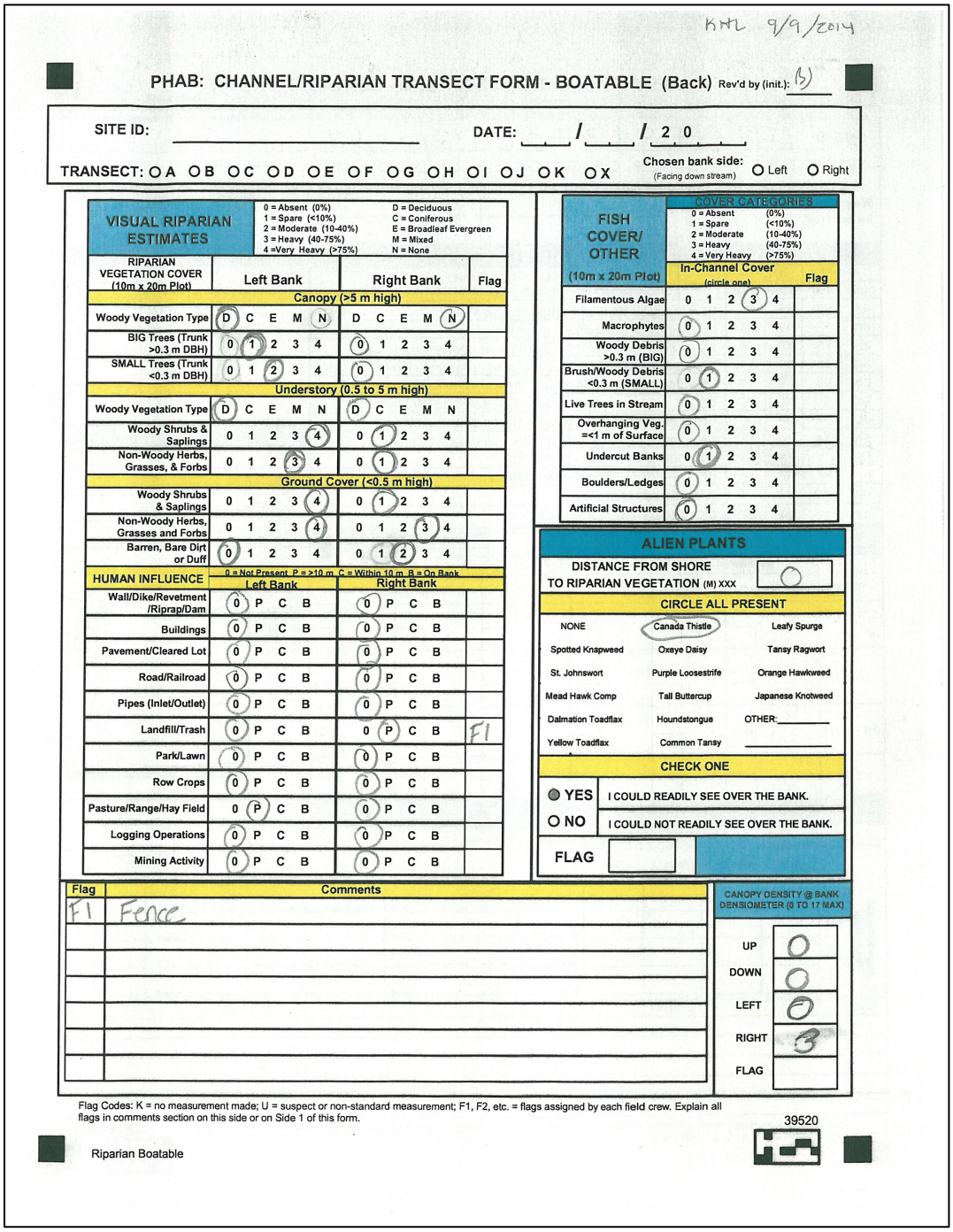


Figure A-10. SEI Form: Boatable Channel/Riparian front



KML 9/9/2014

PHAB: CHANNEL/RIPARIAN TRANSECT FORM - BOATABLE (Back) Rev'd by (init.): BJ

SITE ID: _____ DATE: __/__/20__

TRANSECT: OA OB OC OD OE OF OG OH OI OJ OK OX Chosen bank side: (Facing down stream) O Left O Right

VISUAL RIPARIAN ESTIMATES

0 = Absent (0%) 1 = Spare (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
D = Deciduous C = Coniferous E = Broadleaf Evergreen M = Mixed N = None

RIPARIAN VEGETATION COVER (10m x 20m Plot)	Left Bank	Right Bank	Flag
Canopy (>5 m high)			
Woody Vegetation Type	D C E M N	D C E M N	
BIG Trees (Trunk >0.3 m DBH)	0 1 2 3 4	0 1 2 3 4	
SMALL Trees (Trunk <0.3 m DBH)	0 1 2 3 4	0 1 2 3 4	
Understory (0.5 to 5 m high)			
Woody Vegetation Type	D C E M N	D C E M N	
Woody Shrubs & Saplings	0 1 2 3 4	0 1 2 3 4	
Non-Woody Herbs, Grasses, & Forbs	0 1 2 3 4	0 1 2 3 4	
Ground Cover (<0.5 m high)			
Woody Shrubs & Saplings	0 1 2 3 4	0 1 2 3 4	
Non-Woody Herbs, Grasses and Forbs	0 1 2 3 4	0 1 2 3 4	
Barren, Bare Dirt or Duff	0 1 2 3 4	0 1 2 3 4	
HUMAN INFLUENCE (0 = Not Present P = >10 m C = Within 10 m B = On Bank)	Left Bank	Right Bank	
Wall/Dike/Revetment /Riprap/Dam	0 P C B	0 P C B	
Buildings	0 P C B	0 P C B	
Pavement/Cleared Lot	0 P C B	0 P C B	
Road/Railroad	0 P C B	0 P C B	
Pipes (Inlet/Outlet)	0 P C B	0 P C B	
Landfill/Trash	0 P C B	0 P C B	F1
Park/Lawn	0 P C B	0 P C B	
Row Crops	0 P C B	0 P C B	
Pasture/Range/Hay Field	0 P C B	0 P C B	
Logging Operations	0 P C B	0 P C B	
Mining Activity	0 P C B	0 P C B	

FISH COVER/ OTHER (10m x 20m Plot)

COVER CATEGORIES: 0 = Absent (0%) 1 = Spare (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

In-Channel Cover (circle one)		Flag
Filamentous Algae	0 1 2 3 4	
Macrophytes	0 1 2 3 4	
Woody Debris >0.3 m (BIG)	0 1 2 3 4	
Brush/Woody Debris <0.3 m (SMALL)	0 1 2 3 4	
Live Trees in Stream	0 1 2 3 4	
Overhanging Veg. =<1 m of Surface	0 1 2 3 4	
Undercut Banks	0 1 2 3 4	
Boulders/Ledges	0 1 2 3 4	
Artificial Structures	0 1 2 3 4	

ALIEN PLANTS

DISTANCE FROM SHORE TO RIPARIAN VEGETATION (M) XXX: 0

CIRCLE ALL PRESENT

NONE	Canada Thistle	Leafy Spurge
Spotted Knapweed	Oxeye Daisy	Tansy Ragwort
St. Johnswort	Purple Loosestrife	Orange Hawkweed
Mead Hawk Comp	Tall Buttercup	Japanese Knotweed
Dalmation Toadflax	Houndstongue	OTHER:_____
Yellow Toadflax	Common Tansy	_____

CHECK ONE

- YES: I COULD READILY SEE OVER THE BANK.
- NO: I COULD NOT READILY SEE OVER THE BANK.

FLAG

Flag	Comments
F1	Fence

CANOPY DENSITY @ BANK DENSIOMETER (0 TO 17 MAX)

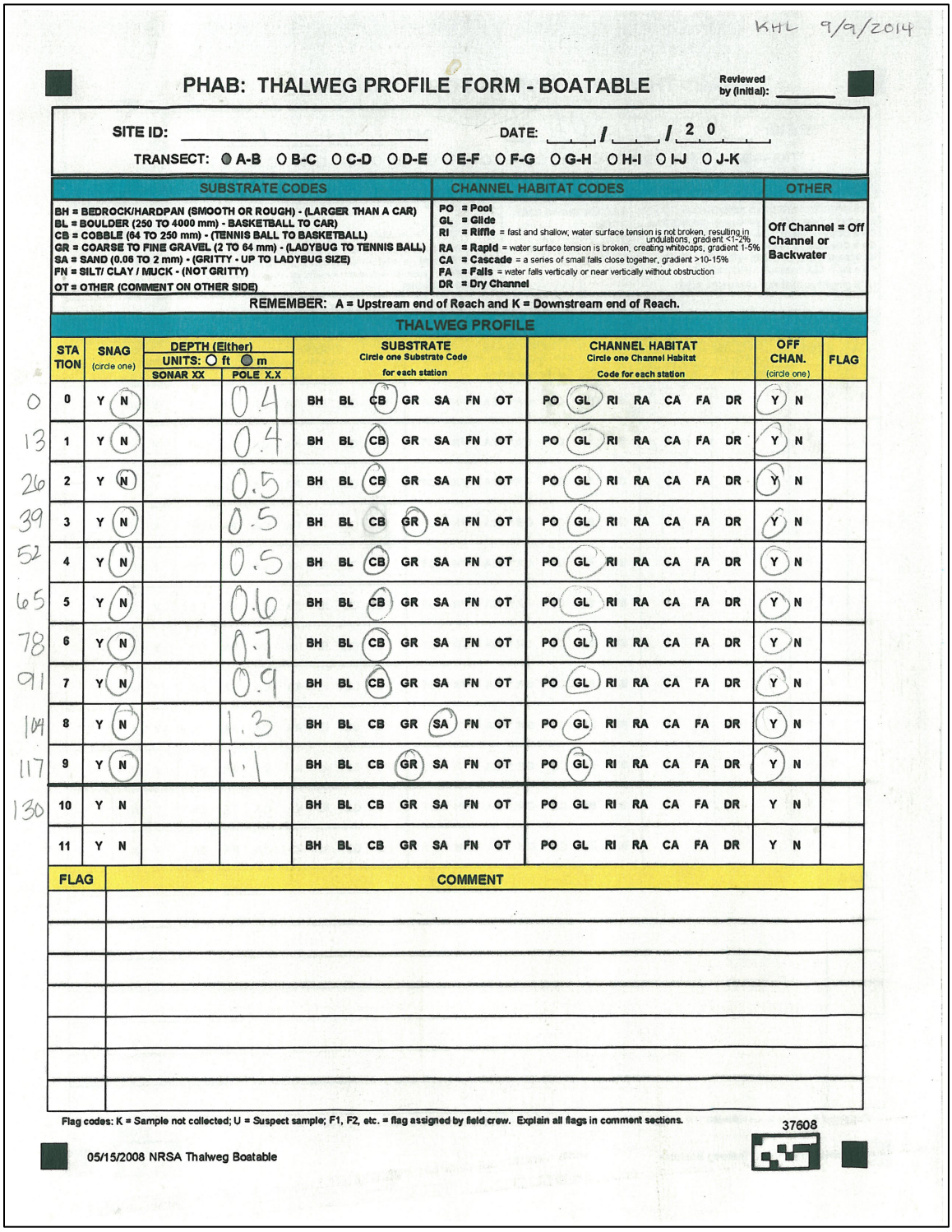
UP	0
DOWN	0
LEFT	0
RIGHT	3
FLAG	

Flag Codes: K = no measurement made; U = suspect or non-standard measurement; F1, F2, etc. = flags assigned by each field crew. Explain all flags in comments section on this side or on Side 1 of this form.

39520

Riparian Boatable

Figure A-11. SEI Form: Boatable Channel/Riparian back



KHL 9/9/2014

PHAB: THALWEG PROFILE FORM - BOATABLE

Reviewed by (initial): _____

SITE ID: _____ DATE: ____/____/20____

TRANSECT: ● A-B ○ B-C ○ C-D ○ D-E ○ E-F ○ F-G ○ G-H ○ H-I ○ I-J ○ J-K

SUBSTRATE CODES	CHANNEL HABITAT CODES	OTHER
BH = BEDROCK/HARDPAN (SMOOTH OR ROUGH) - (LARGER THAN A CAR) BL = BOULDER (250 TO 4000 mm) - BASKETBALL TO CAR) CB = COBBLE (64 TO 250 mm) - (TENNIS BALL TO BASKETBALL) GR = COARSE TO FINE GRAVEL (2 TO 64 mm) - (LADYBUG TO TENNIS BALL) SA = SAND (0.06 TO 2 mm) - (GRITTY - UP TO LADYBUG SIZE) FN = SILT/ CLAY / MUCK - (NOT GRITTY) OT = OTHER (COMMENT ON OTHER SIDE)	PO = Pool GL = Glide RI = Riffle = fast and shallow; water surface tension is not broken, resulting in undulations, gradient <1-2% RA = Rapid = water surface tension is broken, creating whitecaps, gradient 1-5% CA = Cascade = a series of small falls close together, gradient >10-15% FA = Falls = water falls vertically or near vertically without obstruction DR = Dry Channel	Off Channel = Off Channel or Backwater

REMEMBER: A = Upstream end of Reach and K = Downstream end of Reach.

THALWEG PROFILE

	STATION	SNAG (circle one)	DEPTH (Either) UNITS: ○ ft ● m SONAR XX	DEPTH (Either) UNITS: ○ ft ● m POLE X.X	SUBSTRATE Circle one Substrate Code for each station	CHANNEL HABITAT Circle one Channel Habitat Code for each station	OFF CHAN. (circle one)	FLAG
0	0	Y (N)		0.4	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
13	1	Y (N)		0.4	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
26	2	Y (N)		0.5	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
39	3	Y (N)		0.5	BH BL CB (GR) SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
52	4	Y (N)		0.5	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
65	5	Y (N)		0.6	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
78	6	Y (N)		0.7	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
91	7	Y (N)		0.9	BH BL (CB) GR SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
104	8	Y (N)		1.3	BH BL CB GR (SA) FN OT	PO (GL) RI RA CA FA DR	(Y) N	
117	9	Y (N)		1.1	BH BL CB (GR) SA FN OT	PO (GL) RI RA CA FA DR	(Y) N	
130	10	Y N			BH BL CB GR SA FN OT	PO GL RI RA CA FA DR	Y N	
	11	Y N			BH BL CB GR SA FN OT	PO GL RI RA CA FA DR	Y N	

FLAG	COMMENT

Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, etc. = flag assigned by field crew. Explain all flags in comment sections.

37608

05/15/2008 NRSA Thalweg Boatable

Figure A-12. SEI Form: Boatable Thalweg

Appendix B: Stream Ecological Integrity JHA

The following JHA is for stream-specific safety hazards that may be encountered in the field. More complete safety SOPs are available from ROMN within the ROMN SOP: Safety Preparation and Training and in park specific Job Hazard Analyses (JHAs).

ROMN Job Hazard Analyses

Stream Ecological Integrity Field Monitoring

JOB HAZARD ANALYSIS	JOB TITLE (and number if applicable): **Stream Ecological Integrity Field Monitoring**	DATE: **07/09/2015**	NEW
	Title of Person Who Does the Job: All ROMN field-going employees	Analysis By: ROMN staff	
	Supervisor: Mike Britten	Reviewed By: Erin Borgman	
Park: Rocky Mountain Network Parks	Division: Inventory and Monitoring	Approved By: Mike Britten	

REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE):

1. Water or other liquid for hydration (one gallon per person per day). Consider the need for water purification.
2. Food (snacks) sufficient to sustain energy for twenty-four hours.
3. Sun protection (hat, sunglasses, and sunscreen).
4. First-aid kit and any personal medication needs.
5. Communication device, such as satellite phone or park radio. For work in wilderness settings, a back-up communication device is required (e.g. park radio and GPS communication device such as a SPOT).
6. Adequate clothing and footwear to provide protection from current and predicted weather and environmental hazards (sharp plants, rocks, and sun), especially for cold and windy conditions in alpine and subalpine.
7. Navigation equipment: map, compass, and GPS.
8. Headlamp or flashlight with spare batteries.
9. Insect repellent or jacket.
10. Bear spray.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE
Sampling in stream *While wading, a river if you catch your foot in debris (submerged, partially submerged or on the surface) and fall it can be very difficult to get back on your feet. The force of the current can trip even a very strong person in a "debris jam." Examine all sampling or measurements sites carefully.	• Slippery surfaces, steep banks, deep water, cold water, drowning or being swept away by current, submerged debris, floating debris, soft stream bottom, slippery rock bottom due to algae, high velocity or depth	• Wear PFD and studded boot soles. • Use wading rod for support. • Be aware of submerged hazards. • Use appropriate type of waders (hip/chest/insulated). For chest waders, always wear a belt. Suspenders on the waders should not be so tight that waders could not be quickly removed in the event of an emergency. • Know your limits. Don't attempt the measurement if there is any doubt that you will be able to safely cross the stream. • Know the stream velocity and depth that is safe to wade (refer to field folder). • Don't wade in a swift flowing stream immediately above a debris jam. • Wear your PFD at all times you are in the water if appropriate given stream depth and/or velocity. • Know what hazards exist downstream. • Determine how you will get out of the river if you are swept away. • If it is too dangerous, find a safer area or use a cableway or bridge. If a safe alternative is not available, discontinue measurement. • Use extreme care walking on riprap. Rocks can shift unexpectedly and serious falls are possible. • Do not attempt to collect samples from vertical or near vertical banks.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE
Sampling stream from a boat	• Falling off boat, drowning or being swept away by current, boat traffic, boat capsizing	• Proper field clothing should be worn to prevent hypothermia, heat exhaustion, sunstroke, drowning, or other dangers. • Field personnel must be able to swim, and personal flotation devices must be used. A PFD and suitable footwear must be worn at all times while on a boat. • Should someone fall out of the boat, first reach for them with a hand, then life jacket, belt, oar, or thalweg pole. If that fails to reach the person, then use a throw rope or another floating object. Lastly, row toward the person. • Maintain complete control of the boat at all times. • Avoid overloading the boat. An overloaded boat is generally off balance and has a higher risk of capsizing. Weight should be evenly distributed in the boat with special care taken to avoid placing heavy loads near the bow. • If other traffic is on water body, use flags or other measure to indicate tagline. Have cutters ready. Have a second person on shore to warn boating traffic. Consider using alternate ways to measure distance such as a handheld laser range finder. Wear highly visible clothing. • Beware of getting out of, or falling out of, the boat on the downstream side. Swift water can pin a person under the boat and an object in the stream such as a rock or log.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE
Chemical Hygeine	• Collection of WQ samples: Contamination of samples; contamination of the sampler.	• Personnel will use caution not to contaminate the samples and to avoid contact with chemicals. PPE will include appropriate gloves and glasses.
	• Preservation of precipitation samples: Chemical use, chemical transportation, and hazardous waste, use of ethanol	• Material Data Safety Sheets (MSDS's) are available for all potentially hazardous substances. • Wear gloves and safety goggles (or sunglasses) when handling chemicals. • Ethanol should be kept away from sparks and open flames due to its flammable nature. • Use formalin and ethanol in well-ventilated areas to prevent headaches and nausea.

Appendix C: SEI Database Design

This appendix outlines the basic schema and tables used for the four database systems used to manage SEI data. They are:

1) SEI Database
2) Water Quality Logger Database
3) HOBO Logger Database
4) ROMN SEI Photo Database

SEI Database Schema and Tables

The ROMN SEI Database is based on the standard NRDS design, created by the NPS Inventory & Monitoring Program, and contains all monitoring data spanning back to 2007.

Multiple versions of the working SEI MS Access database are maintained by ROMN.

1) The master working SEI MS Access database, containing information for all sampling years, is stored at: *Z:\MONITORING\Streams\Data\Certified*.
2) Separate working copies are maintained for data entry and QAQC. The ROMN SEI Database used for the current field season can always be found at stored at: *Z:\MONITORING\Streams\Data\DataGathering\DataEntry*.
3) All versions of the SEI MS Access database share the same basic schema based on the NRDT model, as outlined in figures and tables below.

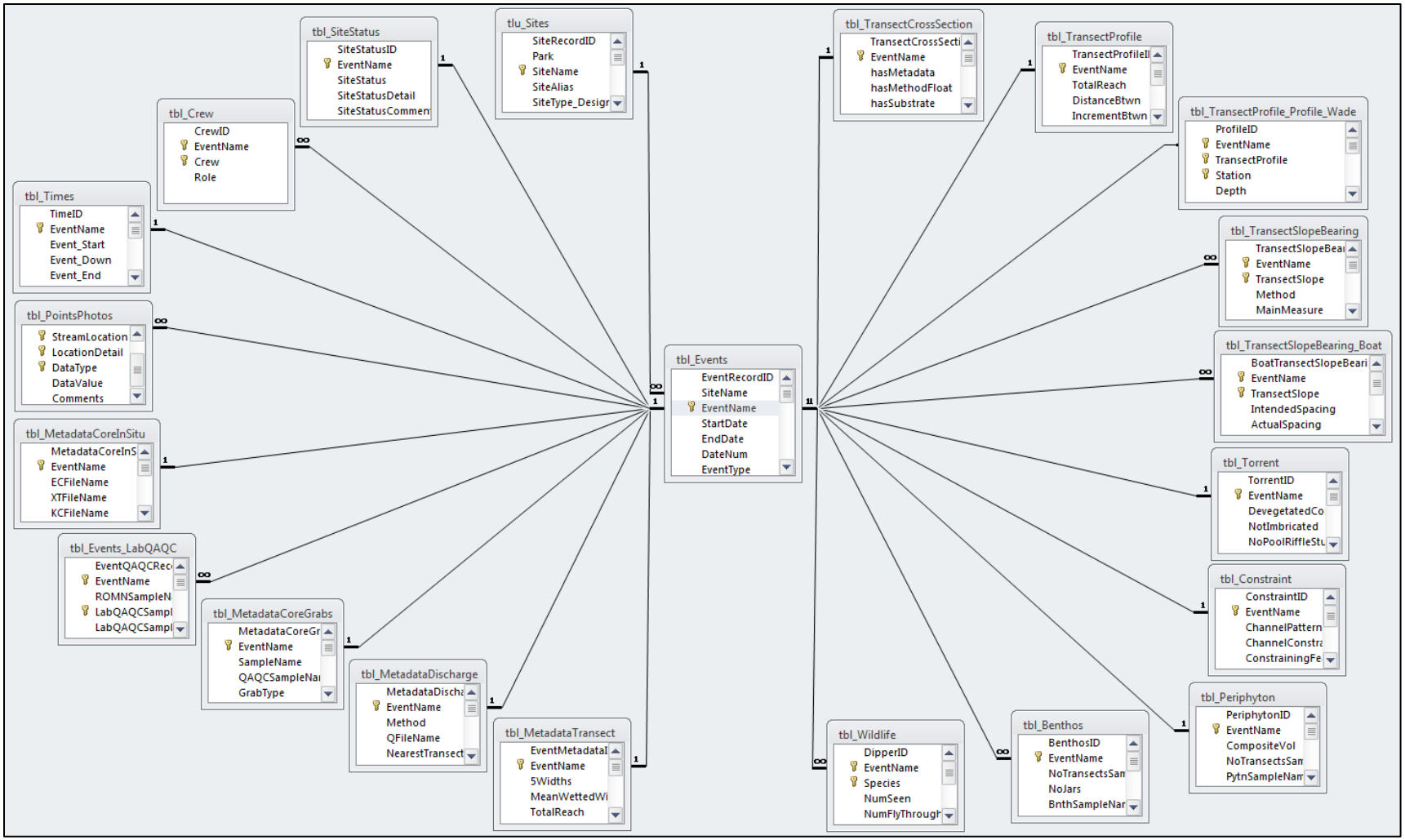


Figure C-1. Diagram showing the relationships between the core ROMN SEI database tables (does not show temporary working tables or pilot project tables that contain non-related legacy data; *tlu_Sites* is the only lookup table shown, because it is the only lookup table with child-tables).

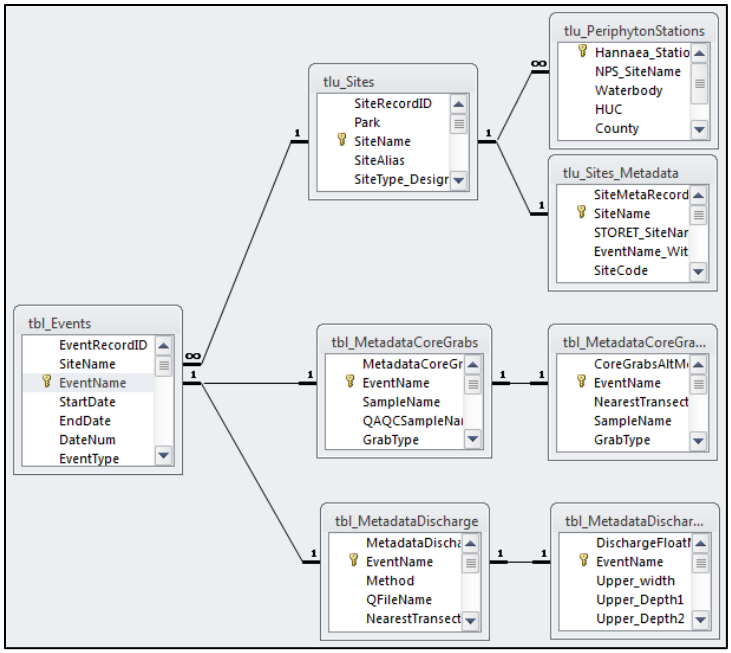


Figure C-2. Diagram showing the ROMN SEI Database relationships between the central *tbl_Events* table and the *tlu_Sites* table and its child tables, *tbl_MetaDataCoreGrabs* and its child table, and the *tbl_MetadataDischarge* and its child table (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-1. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Events* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventRecordID	Auto Number	Sampling event ID code	4
SiteName	Text	Foreign Key to tlu_Sites	50
EventName	Text	Event long name (Key field)	255
StartDate	Date/Time	Date (mm/dd/yy) when sampling began	8
EndDate	Date/Time	Date (mm/dd/yy) when sampling ended	8
DateNum	Text	Calculated date num	255
EventType	Text	Office, recon, field, lab	10
FieldVisitType	Text	Full, revisit-full, partial, qaqc, other	255
AccessType	Text	Wadeable, boatable	10
EventComment	Memo	Directions to site and monument comments	64,000
hasCrew	Yes/No		1
hasTimes	Yes/No		1
hasCalibrationError	Yes/No	Form#0 - related table currently in Excel	1
hasSiteStatus	Yes/No	Should be required for all events	1

Field Name	Field Type	Description	Size (# chars)
hasPointsPhotos	Yes/No		1
hasSiteSketch	Yes/No	Sketch of the Site	1
hasMetadataCoreInSitu	Yes/No	Use file name as relation to logger file	1
hasMetadataCoreGrabs	Yes/No	Use sample names as relation to labs ...core grab water and sediment samples	1
hasMetadataDischarge	Yes/No	Use file name as relation to logger	1
hasMetadataTransect	Yes/No	Reach length and transect metadata	1
hasTransectCrossSection	Yes/No		1
hasTransectProfile	Yes/No		1
hasTransectSlopeBearing	Yes/No		1
hasTorrent	Yes/No		1
hasConstraint	Yes/No		1
hasPeriphyton	Yes/No		1
hasBenthos	Yes/No		1
hasWildlife	Yes/No	This was added to the protocol in 2014	1
hasLabQAQC	Yes/No		1

Table C-2. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Sites* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Park	Text		255
SiteName	Text	Site name (key field)	255
SiteAlias	Text		255
SiteType_Design	Text	Original design type	255
SiteType_Event	Text	How we are treating the site. Sent.satellite are samples yearly as partial events (loggers usually). Sent.survey are are treated as sent sites. Rel have no wells.	255
Zone_UTM	Number		8
Lat_UTM_Map	Number		8
Lon_UTM_Map	Number		8
Lat_UTM_GPS	Number		8
Lon_UTM_GPS	Number		8
Lat_Dddd_Map	Number		8

Field Name	Field Type	Description	Size (# chars)
Lon_Dddd_Map	Number		8
Lat_Dddd_GPS	Number		8
Lon_Dddd_GPS	Number		8
Lat_DMS1_GPS	Text		255
Lon_DMS1_GPS	Text		255
Lat_DMS2_GPS	Text		255
Lon_DMS2_GPS	Text		255
xmarinus	Number		8
ymarinus	Number		8
Datum	Text		255
Elevation	Number		8
Aspect	Number		8
Slope	Number		8
EstHError	Number		8
AccuracyNotes	Text		255
SiteNotes	Text		255

Table C-3. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_PeriphytonStations* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Hannaea_Station_No	Auto Number		4
NPS_SiteName	Text	(Key Field)	255
Waterbody	Text		255
HUC	Auto Number		4
County	Text		255
Lat	Number		8
Long	Number		8

Table C-4. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Sites_Metadata* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
SiteMetaRecordID	Auto Number		4
SiteName	Text		255
STORET_SiteName	Text		255
EventName_WithSiteData	Text		255
SiteCode	Text		255
GROUP	Text		255
State	Text		255
ParkCode	Text		255
WatershedName	Text		255
StreamName	Text		255
strahler	Number		8
strahler_char	Text		255
mdcaty	Text		255
Description	Text		255
stratum	Text		255
EastWest	Text		255
HUC2	Number		8
HUC4	Number		8
HUC6	Number		8
HUC8	Number		8
HUC2_NAME	Text		255
HUC4_NAME	Text		255
HUC6_NAME	Text		255
HUC8_NAME	Text		255
DistToroad	Number		8
Panel	Text		255
PanelRank	Text		255
pilotbse	Text		255
pilotovr	Text		255
Cost_Time	Number		8
Cost_Class	Text		255
wgt	Number		8
adjwt070809_wholepark_nc_Tnt	Number	New weights for a non clipped frame and T and NT sites	8
adjwt070809_wholepark_nc_T	Number	New weights for a non clipped frame and just T sites	8

Field Name	Field Type	Description	Size (# chars)
adjwt070809_wholepark_ clp_Tnt	Number	New weights for a clipped frame and T and NT sites	8
adjwt070809_wholepark_ clp_T	Number	New weights for a clipped frame and just T sites	8
adjwt070809_oldwholepark	Number		8
adjwt070809_oldnfork	Number		8
sampyear	Text		255
status070809	Text		255
status_targetpop_070809	Text	Target or nontarget based on what was sampled	255
status_truestream_070809	Text	Target or nontarget based on what was really stream (so it includes some crazy way back there sites that we classified as stream but that are impossible to get to safely so they are not part of the target pop)	255
status0708	Text		255
status07	Text		255
status070809_char	Text		255
status_targetpop_070809_char	Text		255
status_truestream_070809_char	Text		255
status0708_char	Text		255
status07_char	Text		255
allyear_wholepark	Text		255
allyear_nfork	Text		255
allpark	Text		255
nfork	Text		255

Table C-5. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_MetadataCoreGrabs* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
MetadataCoreGrabsID	Auto Number		4
EventName	Text	(Key Field)	255
SampleName	Text		255
QAQCSampleName	Text		100
GrabType	Text	Single thalweg, ewi/edi	50
NearestTransect	Text	A-k, discharge, other	100
AllSamplesCollected	Yes/No		1
NumT8	Auto Number	Number of T8 bottles	4
SampleComments	Text	Water samples	255
EPASedimentCollected	Yes/No		1

Field Name	Field Type	Description	Size (# chars)
NumberSubSamples	Auto Number		4
SubSampleComments	Text	Sediment samples	255
QAQCType	Text		255
hasAlternativeMethod	Yes/No	This refers to a method that was never used but might come up again in the future	1
hasWaterEPA	Yes/No		1
hasWaterFLBS	Yes/No		1
hasWaterKiowa	Yes/No		1
hasWaterNRSA	Yes/No		1
hasWaterETC	Yes/No	"Environmental Testing & Consulting" in collaboration with GRYN	1

Table C-6. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_MetadataCoreGrabs_AlternativeMethod* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
CoreGrabsAltMethodID	Auto Number		4
EventName	Text	(Key field)	255
NearestTransect	Text	A-k, discharge, other	50
SampleName	Text		255
GrabType	Text	Single Thalweg, EWI/EDI, crosssectiontransect	50
FS	Yes/No	(500 ml Teflon, Chill)	1
FS_Comment	Text		200
SD	Yes/No	(1000 ml Nalgene, Chill)	1
SD_Comment	Text		200
N1	Yes/No	(250 ml Nalgene, Freeze)	1
N1_Comment	Text		200
N2	Yes/No	(250 ml Nalgene filter, Freeze)	1
N2_Comment	Text		200
AN	Yes/No	(250 ml Nalgene, Chill)	1
AN_Comment	Text		200
AL	Yes/No	Base: 125 ml Nalgene, prsrv chill	1
AL_Comment	Text		200
OC	Yes/No	Base: 250 ml glass, prsrv chill	1
OC_Comment	Text		200

Field Name	Field Type	Description	Size (# chars)
CM	Yes/No	Base: 125 ml Nalgene, chill	1
CM_Comment	Text		200
AK	Yes/No	Base: 125 ml Nalgene, chill	1
AK_Comment	Text		200
QAQCType	Text		255
QAQCSampleName	Text		100
QAQCComments	Text		255

Table C-7. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_MetadataDischarge* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text	(Key field)	255
Method	Text	Flowtracker; float; visual; gage; meter; weir; flume; volumetric	25
QFileName	Text		255
NearestTransect	Text		20
TransectLength_m	Number		8
NumberIncrements	Auto Number	10-20	4
IncrementWidth_cm	Number	>10cm	8
StartingTapeDist	Number		8
FirstIntervalTapeDist	Number	50% of increment width	8
NextTapeDist	Number		8
QCalculated	Number	M3/s	8
QError	Number	%	8
QComments	Text		255
QualitativeFlow	Text	Before 2011, only done for "visual q"...dry; no flow; low; normal; above normal; flood	255
QuantivativeFlowEst	Number	In field visual estimate	8
QuantivativeFlowEstUnits	Text	M3/s; cfs	10
hasLoggerFlowTracker	Yes/No		1
hasAlternateMethod	Yes/No	Anything other than "flowtracker"	1

Table C-8. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_MetadataDischarge_AlternativeMethod* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
DischargeFloatMethodID	Auto Number		4
EventName	Text	(Key field)	255
Upper_width	Number	Width of the upper section of the float reach in meters	8
Upper_Depth1	Number	Depth1 of the upper section of the float reach in centimeters (cm)	8
Upper_Depth2	Number	Depth2 of the upper section of the float reach in centimeters (cm)	8
Upper_Depth3	Number	Depth3 of the upper section of the float reach in centimeters (cm)	8
Upper_Depth4	Number	Depth4 of the upper section of the float reach in centimeters (cm)	8
Upper_Depth5	Number	Depth5 of the upper section of the float reach in centimeters (cm)	8
Middle_width	Number	Width of the Middle section of the float reach in meters	8
Middle_Depth1	Number	Depth1 of the Middle section of the float reach in centimeters (cm)	8
Middle_Depth2	Number	Depth2 of the Middle section of the float reach in centimeters (cm)	8
Middle_Depth3	Number	Depth3 of the Middle section of the float reach in centimeters (cm)	8
Middle_Depth4	Number	Depth4 of the Middle section of the float reach in centimeters (cm)	8
Middle_Depth5	Number	Depth5 of the Middle section of the float reach in centimeters (cm)	8
Lower_width	Number	Width of the lower section of the float reach in meters	8
Lower_Depth1	Number	Depth1 of the lower section of the float reach in centimeters (cm)	8
lower_Depth2	Number	Depth2 of the lower section of the float reach in centimeters (cm)	8
lower_Depth3	Number	Depth3 of the lower section of the float reach in centimeters (cm)	8
lower_Depth4	Number	Depth4 of the lower section of the float reach in centimeters (cm)	8
lower_Depth5	Number	Depth5 of thelower section of the float reach in centimeters (cm)	8
FloatDist_1	Number	Float distance - Float1	8
FloatDist_2	Number	Float distance - Float2	8
FloatDist_3	Number	Float distance - Float3	8

Field Name	Field Type	Description	Size (# chars)
FloatTime_1	Date/Time	Maybe move to time table??? Float time - float1	8
FloatTime_2	Date/Time	Maybe move to time table??? Float time - float2	8
FloatTime_3	Date/Time	Maybe move to time table??? Float time - float3	8
DaySinceRain	Number		4
VisualQ	Text		25
QualFlowSeverity	Text	Dry, no flow, low, normal, above normal, flood	50
Limb	Text	Base, rising, peak, falling	50
Comments	Text		255

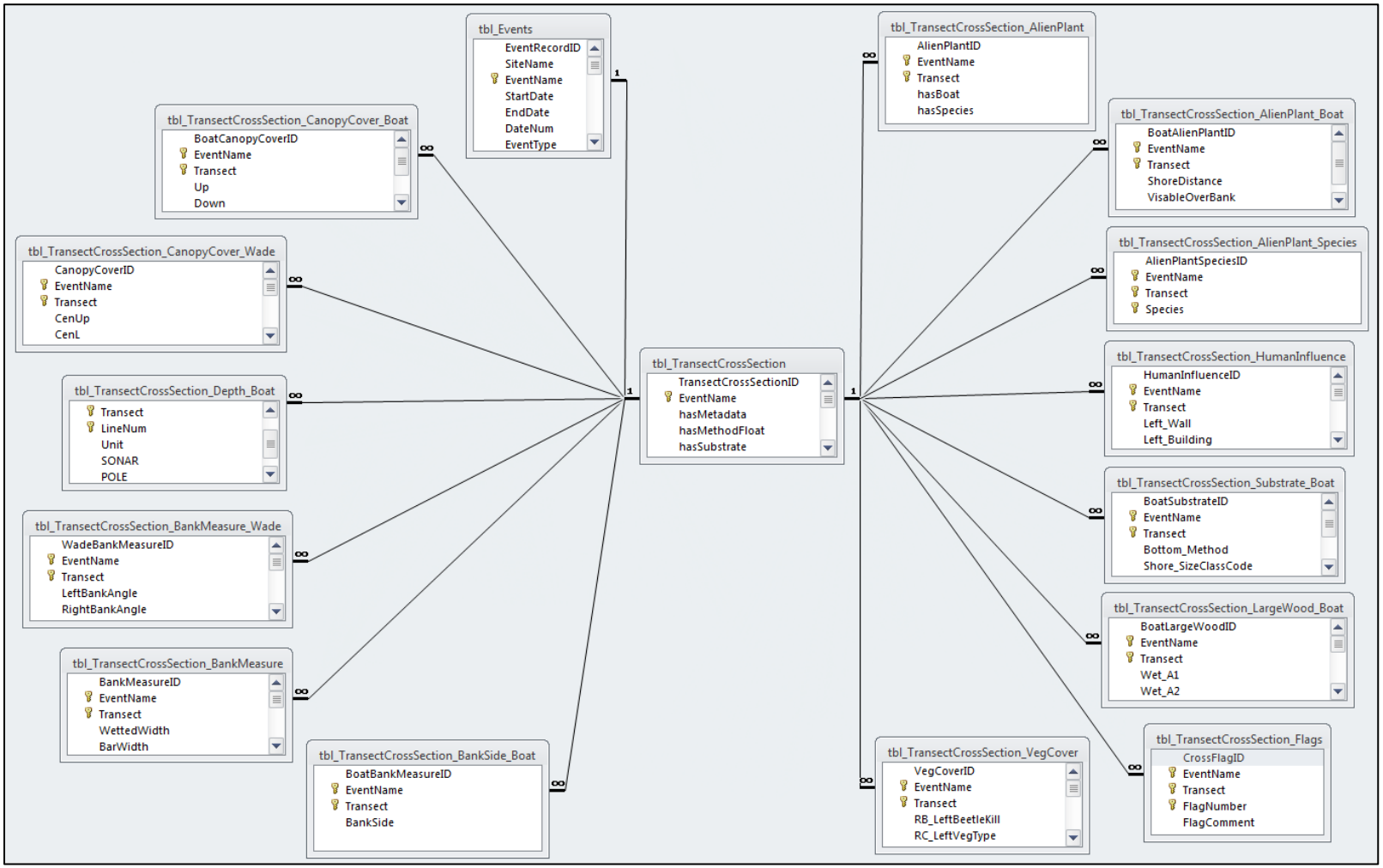


Figure C-3. Diagram showing the ROMN SEI Database relationships between the central *tbl_Events* table and the *tbl_TransectCrossSection* table and its child tables (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-9. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
TransectCrossSectionID	Auto Number		4
EventName	Text	(Key Field)	255
hasMetadata	Yes/No		1
hasMethodFloat	Yes/No	This is an alternative method that has never been used but may be used in the future	1
hasSubstrate	Yes/No		1
hasDepth	Yes/No		1
hasBankMeasure	Yes/No		1
hasVegCover	Yes/No		1
hasFishCover	Yes/No		1
hasAlienPlant	Yes/No		1
hasHumanInfluence	Yes/No		1
hasCanopyCover	Yes/No		1
hasLargeWood	Yes/No		1
hasFlags	Yes/No		1
hasBankSide	Yes/No		1
hasWildlife	Yes/No	This was added to the protocol in 2014	1
Comments	Text		255

Table C-10. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_AlienPlant* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Alienplantid	Auto Number		4
Eventname	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	5
Hasboat	Yes/No		1
Hasspecies	Yes/No		1

Table C-11. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_AlienPlant_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BoatAlienPlantID	Auto Number		4
EventName	Text	(Key field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
ShoreDistance	Number	Dist from shore to riparian veg (m)	8
VisableOverBank	Yes/No	Boat only - can see over the bank	1
Flag	Text		255

Table C-12. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_AlienPlant_Species* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
AlienPlantSpeciesID	Auto Number		4
EventName	Text	(Key field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	5
Species	Text	(Key Field)	100

Table C-13. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_HumanInfluence* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
HumanInfluenceID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
Left_Wall	Text		5
Left_Building	Text		5
Left_Pavement	Text		5
Left_Road	Text		5
Left_Pipes	Text		5
Left_Landfill	Text		5
Left_Park	Text		5
Left_Crops	Text		5

Field Name	Field Type	Description	Size (# chars)
Left_Pasture	Text		5
Left_Logging	Text		5
Left_Mining	Text		5
Left_TrailsCamp	Text	As of 2014 ONLY in Wade	5
Right_Wall	Text		5
Right_Building	Text		5
Right_Pavement	Text		5
Right_Road	Text		5
Right_Pipes	Text		5
Right_Landfill	Text		5
Right_Park	Text		5
Right_Crops	Text		5
Right_Pasture	Text		5
Right_Logging	Text		5
Right_Mining	Text		5
Right_TrailsCamp	Text		5
FlagWall	Text		255
FlagBuilding	Text		255
FlagPavement	Text		255
FlagRoad	Text		255
FlagPipes	Text		255
FlagLandfill	Text		255
FlagPark	Text		255
FlagCrops	Text		255
FlagPasture	Text		255
FlagLogging	Text		255
FlagMining	Text		255
FlagTrailsCamp	Text		255
FlagLegacy	Text	070809 only had one flag option	255

Table C-14. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_Substrate_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BoatSubstrateID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2

Field Name	Field Type	Description	Size (# chars)
Bottom_Method	Text	Judgement, Observation at 5 littoral depths	50
Shore_SizeClassCode	Text	RS - OT - See Look Up Table	50
Bottom_SizeClassCode	Text	RS - OT - See Look Up Table	50
ShoreSub_SizeClassCode	Text	Legacy: RS - OT - See Look Up Table	50
BottomSub_SizeClassCode	Text	Legacy: RS - OT - See Look Up Table	255
Flag	Text		255

Table C-15. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_LargeWood_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BoatLargeWoodID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	5
Wet_A1	Number	Large End Diameter 0.3 - 0.6 and Length 5 - 15 m	8
Wet_A2	Number	Large End Diameter 0.3 - 0.6 and Length 15 - 30 m	8
Wet_A3	Number	Large End Diameter 0.3 - 0.6 and Length > 30 m	8
Wet_B1	Number	Large End Diameter 0.6 - 0.8 and Length 5 - 15 m	8
Wet_B2	Number	Large End Diameter 0.6 - 0.8 and Length 15 - 30 m	8
Wet_B3	Number	Large End Diameter 0.6 - 0.8 and Length > 30 m	8
Wet_C1	Number	Large End Diameter 0.8 - 1.0 and Length 5 - 15 m	8
Wet_C2	Number	Large End Diameter 0.8 - 1.0 and Length 15 - 30 m	8
Wet_C3	Number	Large End Diameter 0.8 - 1.0 and Length > 30 m	8
Wet_D1	Number	Large End Diameter > 1.0 and Length 5 - 15 m	8
Wet_D2	Number	Large End Diameter > 1.0 and Length 15 - 30 m	8
Wet_D3	Number	Large End Diameter > 1.0 and Length > 30 m	8
Dry_A1	Number	Large End Diameter 0.3 - 0.6 and Length 5 - 15 m	8
Dry_A2	Number	Large End Diameter 0.3 - 0.6 and Length 15 - 30 m	8
Dry_A3	Number	Large End Diameter 0.3 - 0.6 and Length > 30 m	8
Dry_B1	Number	Large End Diameter 0.6 - 0.8 and Length 5 - 15 m	8

Field Name	Field Type	Description	Size (# chars)
Dry_B2	Number	Large End Diameter 0.6 - 0.8 and Length 15 - 30 m	8
Dry_B3	Number	Large End Diameter 0.6 - 0.8 and Length > 30 m	8
Dry_C1	Number	Large End Diameter 0.8 - 1.0 and Length 5 - 15 m	8
Dry_C2	Number	Large End Diameter 0.8 - 1.0 and Length 15 - 30 m	8
Dry_C3	Number	Large End Diameter 0.8 - 1.0 and Length > 30 m	8
Dry_D1	Number	Large End Diameter > 1.0 and Length 5 - 15 m	8
Dry_D2	Number	Large End Diameter > 1.0 and Length 15 - 30 m	8
Dry_D3	Number	Large End Diameter > 1.0 and Length > 30 m	8
FlagWet_A1	Text		50
FlagWet_A2	Text		50
FlagWet_A3	Text		50
FlagWet_B1	Text		50
FlagWet_B2	Text		50
FlagWet_B3	Text		50
FlagWet_C1	Text		50
FlagWet_C2	Text		50
FlagWet_C3	Text		50
FlagWet_D1	Text		50
FlagWet_D2	Text		50
FlagWet_D3	Text		50
FlagDry_A1	Text		50
FlagDry_A2	Text		50
FlagDry_A3	Text		50
FlagDry_B1	Text		50
FlagDry_B2	Text		50
FlagDry_B3	Text		50
FlagDry_C1	Text		50
FlagDry_C2	Text		50
FlagDry_C3	Text		50
FlagDry_D1	Text		50
FlagDry_D2	Text		50
FlagDry_D3	Text		50
FlagLegacy	Text	Prior to 2010 there was only one flag field for all of LWD	255

Table C-16. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_Flags* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
CrossFlagID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	(Key Field)	2
FlagNumber	Text	(Key Field)	255
FlagComment	Text		255

Table C-17. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_VegCover* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Vegcoverid	Auto Number		4
Eventname	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
RB_leftbeetlekill	Number	Beetlekill	1
RC_leftvegtype	Text	Canopy	2
RC_leftbigtrees	Number	Canopy	1
RC_leftsmalltrees	Number	Canopy	1
RC_rightvegtype	Text	Canopy	2
RC_rightbigtrees	Number	Canopy	1
RC_rightsmalltrees	Number	Canopy	1
RU_leftvegtype	Text	Understory	2
RU_leftwoodyshrubs	Number	Understory	1
RU_leftherbsgrasses	Number	Understory	1
RB_rightbeetlekill	Number	Beetlekill	1
RU_rightvegtype	Text	Understory	2
RU_rightwoodyshrubs	Number	Understory	1
RU_rightherbsgrasses	Number	Understory	1
RG_leftwoodyshrubs	Number	Groundcover	1
RG_leftherbsgrasses	Number	Groundcover	1
RG_leftdirt	Number	Groundcover	1
RG_rightwoodyshrubs	Number	Groundcover	1
RG_rightherbsgrasses	Number	Groundcover	1
RG_rightdirt	Number	Groundcover	1
Flagrb_Beetle	Text	Beetlekill	255
Flagrc_vegtype	Text	Canopy	255

Field Name	Field Type	Description	Size (# chars)
Flagrc_bigtrees	Text	Canopy	255
Flagrc_smalltrees	Text	Canopy	255
Flagru_vegtype	Text	Understory	255
Flagru_woodyshrubs	Text	Understory	255
Flagru_herbsgrasses	Text	Understory	255
Flagrg_woodyshrubs	Text	Groundcover	255
Flagrg_herbsgrasses	Text	Groundcover	255
Flagrg_Dirt	Text	Groundcover	255

Table C-18. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_BankSide_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BoatBankMeasureID	Auto Number		4
EventName	Text	(Key field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (key field)	2
BankSide	Text	Left, right	25

Table C-19. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_BankMeasure* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BankMeasureID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
WettedWidth	Number	Meters....comparable to alternative method (float) both boat and wade	8
BarWidth	Number	Meters BOTH BOAT AND WADE	8
BankFullWidth	Number	Meters BOTH BOAT AND WADE	8
BankFullHeight	Number	Meters BOTH BOAT AND WADE	8
IncisedHeight	Number	Meters BOTH BOAT AND WADE	8
FlagWettedWidth	Text	Both boat and wade	255
FlagBarWidth	Text	Both boat and wade	255
FlagBankfullWidth	Text	Both boat and wade	255
FlagBankFullHeight	Text	Both boat and wade	255
FlagIncisedHeight	Text	Both boat and wade	255

Field Name	Field Type	Description	Size (# chars)
FlagLegacy	Text	07 08 09 there was one field for flags.	255
hasBoat	Yes/No		1
hasWade	Yes/No		1

Table C-20. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_BankMeasure_Wade* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
WadeBankMeasureID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
LeftBankAngle	Number	0-180 - prior to 2014 value range was 0-360 : NEED convert legacy data into 0-180 angle	2
RightBankAngle	Number	0-180 - prior to 2014 value range was 0-360 : NEED convert legacy data into 0-180 angle	2
LeftUndercutDist	Number	Meters	8
RightUndercutDist	Number	Meters	8
LeftPlumbDist	Number	Meters - top to undercut down to water	2
RightPlumbDist	Number	Meters- top to undercut down to water	2
FlagLeftBankAngle	Text		50
FlagRightBankAngle	Text		50
FlagLeftUndercutDist	Text		50
FlagRightUndercutDist	Text		50
FlagLeftPlumbDist	Text		50
FlagRightPlumbDist	Text		50

Table C-21. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_BankMeasure_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Boatbankmeasureid	Auto Number		4
Eventname	Text	Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
Bankside	Text	Left, Right	25

Table C-22. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_Depth_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Boatdepthid	Auto Number		4
Eventname	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet.	2
Linenum	Number	The increment number of the sample. (Key Field)	8
Unit	Text	Feet, Meters	10
Sonar	Number		8
Pole	Number		8
Flag	Text		255

Table C-23. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_CanopyCover_Wade* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Canopycoverid	Auto Number		4
Eventname	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
Cenup	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Cenl	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Cendwn	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Cenr	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Lbnk	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Rbnk	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Flagcenup	Text	Canopy Cover Measurements 0 - 17 densiometer	255
Flagcenl	Text	Canopy Cover Measurements 0 - 17 densiometer	255
Flagcendwn	Text	Canopy Cover Measurements 0 - 17 densiometer	255
Flagcenr	Text	Canopy Cover Measurements 0 - 17 densiometer	255
Flaglbnk	Text	Canopy Cover Measurements 0 - 17 densiometer	255
Flagrbnk	Text	Canopy Cover Measurements 0 - 17 densiometer	255
Flaglegacy	Text	Flag from 070809 data (only one flag option during those years)	255

Table C-24. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectCrossSection_CanopyCover_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Boatcanopycoverid	Auto Number		4
Eventname	Text	(Key Field)	255
Transect	Text	We will have a record in this table for every transect visited. If no record, then there was no field sheet. (Key Field)	2
Up	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Down	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Left	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Right	Auto Number	Canopy Cover Measurements 0 - 17 densiometer	4
Flag	Text	Canopy Cover Measurements 0 - 17 densiometer	255

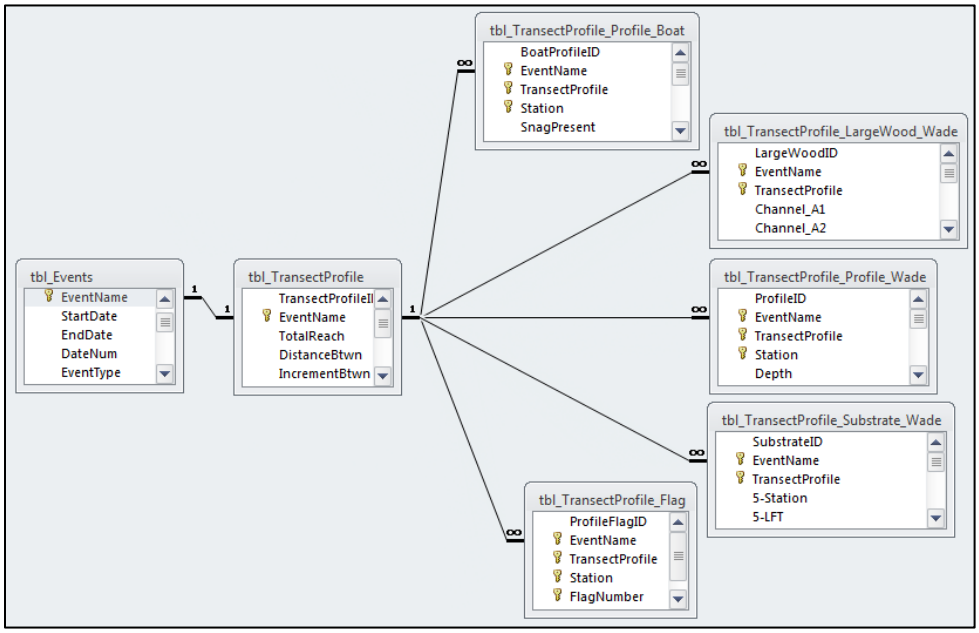


Figure C-4. Diagram showing the ROMN SEI Database relationships between the central *tbl_Events* table and the *tbl_TransectProfile* table and its child tables (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-25. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectProfile* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Transectprofileid	Auto Number	The term Profile is often interchanged with Thalweg	4
Eventname	Text	(Key Field)	255

Field Name	Field Type	Description	Size (# chars)
Totalreach	Number	Actual meters = actual distance * [number of thalweg sections sampled (which will hopefully be 10)	8
Distancebtwn	Number	Actual meters =(the average wetted width * 40) / 10 BUT WITH POSSIBLE SLIGHT ADJUSTMENT FOR ROUNDING	8
Incrementbtwn	Number	Field collected meters	8
Hasprofile	Yes/No		1
Hassubstrate	Yes/No		1
Haslargewood	Yes/No		1
Hasflag	Yes/No		1
Comments	Text		255

Table C-26. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectProfile_Profile_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Boatprofileid	Auto Number		4
Eventname	Text	(Key Field)	255
Transectprofile	Text	(Key Field)	5
Station	Auto Number	(Key Field)	4
Snagpresent	Yes/No	Y, N,	1
Depthunits	Text	Feet, Meters	15
Depthsonar	Number	Thalweg depth in cm	4
Depthpole	Number	Thalweg depth in cm	4
Substrate	Text	Wade - This is only done at station 5 and 7	50
Channelhabitat	Text	Wade - This is called "channelunitcode"	5
Offchannel	Yes/No	Y,N,	1
Flag	Text		5
Comment	Memo		64,000

Table C-27. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectProfile_LargeWood_Wade* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Largewoodid	Auto Number		4
Eventname	Text	(Key Field)	255
Transectprofile	Text	(Key Field)	5
Channel_A1	Number	Small End Diameter 0.1 - 0.3 and Length 1.5 - 5 m	8

Field Name	Field Type	Description	Size (# chars)
Channel_A2	Number	Small End Diameter 0.1 - 0.3 and Length 5 - 15 m	8
Channel_A3	Number	Small End Diameter 0.1 - 0.3 and Length > 15 m	8
Channel_B1	Number	Med End Diameter 0.3 - 0.6 and Length 1.5 - 5 m	8
Channel_B2	Number	Med End Diameter 0.3 - 0.6 and Length 5 - 15 m	8
Channel_B3	Number	Med End Diameter 0.3 - 0.6 and Length > 15 m	8
Channel_C1	Number	Large End Diameter 0.6 - 0.8 and Length 1.5 - 5 m	8
Channel_C2	Number	Large End Diameter 0.6 - 0.8 and Length 5 - 15 m	8
Channel_C3	Number	Large End Diameter 0.6 - 0.8 and Length > 15 m	8
Channel_D1	Number	X Large End Diameter > 0.8 and Length 1.5 - 5 m	8
Channel_D2	Number	X Large End Diameter > 0.8 and Length 5 - 15 m	8
Channel_D3	Number	X Large End Diameter > 0.8 and Length > 15 m	8
Bridging_A1	Number	Small End Diameter 0.1 - 0.3 and Length 1.5 - 5 m	8
Bridging_A2	Number	Small End Diameter 0.1 - 0.3 and Length 5 - 15 m	8
Bridging_A3	Number	Small End Diameter 0.1 - 0.3 and Length > 15 m	8
Bridging_B1	Number	Med End Diameter 0.3 - 0.6 and Length 1.5 - 5 m	8
Bridging_B2	Number	Med End Diameter 0.3 - 0.6 and Length 5 - 15 m	8
Bridging_B3	Number	Med End Diameter 0.3 - 0.6 and Length > 15 m	8
Bridging_C1	Number	Large End Diameter 0.6 - 0.8 and Length 1.5 - 5 m	8
Bridging_C2	Number	Large End Diameter 0.6 - 0.8 and Length 5 - 15 m	8
Bridging_C3	Number	Large End Diameter 0.6 - 0.8 and Length > 15 m	8
Bridging_D1	Number	X Large End Diameter > 0.8 and Length 1.5 - 5 m	8
Bridging_D2	Number	X Diameter > 0.8 and Length 5 - 15 m	8
Bridging_D3	Number	X Diameter > 0.8 and Length > 15 m	8
Flagchannel_A1	Text	Diameter 0.1 - 0.3 and Length 1.5 - 5 m	50
Flagchannel_A2	Text	Diameter 0.1 - 0.3 and Length 5 - 15 m	50
Flagchannel_A3	Text	Diameter 0.1 - 0.3 and Length > 15 m	50
Flagchannel_B1	Text	Diameter 0.3 - 0.6 and Length 1.5 - 5 m	50
Flagchannel_B2	Text	Diameter 0.3 - 0.6 and Length 5 - 15 m	50
Flagchannel_B3	Text	Diameter 0.3 - 0.6 and Length > 15 m	50
Flagchannel_C1	Text	Diameter 0.6 - 0.8 and Length 1.5 - 5 m	50
Flagchannel_C2	Text	Diameter 0.6 - 0.8 and Length 5 - 15 m	50
Flagchannel_C3	Text	Diameter 0.6 - 0.8 and Length > 15 m	50
Flagchannel_D1	Text	Diameter > 0.8 and Length 1.5 - 5 m	50
Flagchannel_D2	Text	Diameter > 0.8 and Length 5 - 15 m	50

Field Name	Field Type	Description	Size (# chars)
Flagchannel_D3	Text	Diameter > 0.8 and Length > 15 m	50
Flagbridging_A1	Text	Diameter 0.1 - 0.3 and Length 1.5 - 5 m	50
Flagbridging_A2	Text	Diameter 0.1 - 0.3 and Length 5 - 15 m	50
Flagbridging_A3	Text	Diameter 0.1 - 0.3 and Length > 15 m	50
Flagbridging_B1	Text	Diameter 0.3 - 0.6 and Length 1.5 - 5 m	50
Flagbridging_B2	Text	Diameter 0.3 - 0.6 and Length 5 - 15 m	50
Flagbridging_B3	Text	Diameter 0.3 - 0.6 and Length > 15 m	50
Flagbridging_C1	Text	Diameter 0.6 - 0.8 and Length 1.5 - 5 m	50
Flagbridging_C2	Text	Diameter 0.6 - 0.8 and Length 5 - 15 m	50
Flagbridging_C3	Text	Diameter 0.6 - 0.8 and Length > 15 m	50
Flagbridging_D1	Text	Diameter > 0.8 and Length 1.5 - 5 m	50
Flagbridging_D2	Text	Diameter > 0.8 and Length 5 - 15 m	50
Flagbridging_D3	Text	Diameter > 0.8 and Length > 15 m	50

Table C-28. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectProfile_Profile_Wade* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Profileid	Auto Number		4
Eventname	Text	(Key Field)	255
Transectprofile	Text	(Key Field)	5
Station	Auto Number		4
Depth	Number	Thalweg depth in cm	4
Wettedwidth	Number	Meters	4
Barwidthpresent	Yes/No	Y, N,	1
Barwidthsize	Number	Station 0 and 5 or 7 only	4
Softsediment	Yes/No	Y,N,	1
Channelunitcode	Text		5
Poolformcode	Text	Can be many combinations of root lookup	5
Sidechannel	Yes/No	Y,N, called "off channel in Boatable"	1
Backwater	Yes/No	Y,N,	1
Flag	Text		5
Comment	Memo		64,000

Table C-29. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectProfile_Substrate_Wade* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
SubstrateID	Auto Number		4
EventName	Text	(Key Field)	255
TransectProfile	Text	(Key Field)	5
5-Station	Auto Number		4
5-LFT	Text		50
5-LCTR	Text		50
5-CTR	Text		50
5-RCTR	Text		50
5-RGT	Text		50
Flag5-SUB	Text		50
7-Station	Auto Number		4
7-LFT	Text		50
7-LCTR	Text		50
7-CTR	Text		50
7-RCTR	Text		50
7-RGT	Text		50
Flag7-SUB	Text		50

Table C-30. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectProfile_Flag* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Profileflagid	Auto Number		4
Eventname	Text	(Key Field)	255
Transectprofile	Text	(Key Field)	5
Station	Text	Only needed for Profile data...data not taken at the station level gets a "none" value (Key Field)	5
Flagnumber	Text	(Key Field)	50
Flagcomment	Text		255

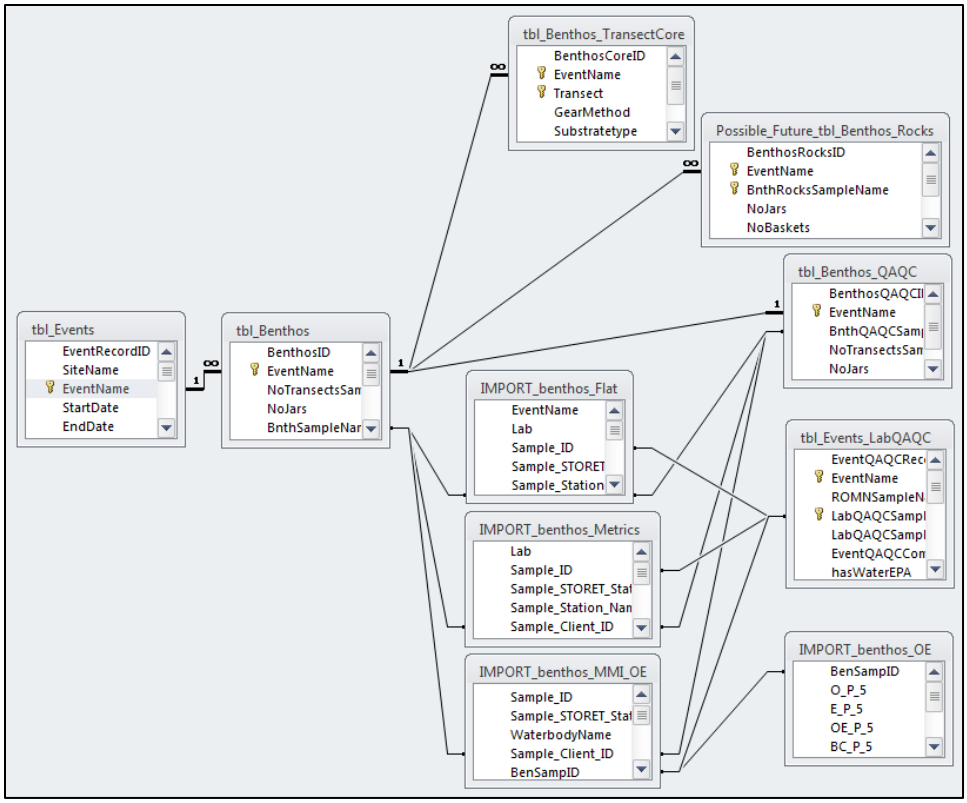


Figure C-5. Diagram showing the ROMN SEI database relationships between the central *tbl_Events* table and the *tbl_Benthos* table and its child tables (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-31. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Benthos* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BenthosID	Auto Number		4
EventName	Text	(Key Field)	255
NoTransectsSampled	Auto Number		4
NoJars	Auto Number		4
BnthSampleName	Text		255
Comments	Text		250
hasTransectCore	Yes/No		1
hasQAQC	Yes/No		1
hasRocks	Yes/No		1
hasIMPORT_Metric	Yes/No		1
hasIMPORT_MMI_OE	Yes/No		1
hasIMPORT_Flat	Yes/No	DELETE: after getting new data from lab for all years (Legacy)	1

Table C-32. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Benthos_TransectCore* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BenthosCoreID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	(Key Field)	2
GearMethod	Text	D;F;O	50
Substratetype	Text	FS;GR;CO;OT	50
HabitatType	Text	PL;GL;RF;RP;OT	50
Comments	Text		250

Table C-33. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *Possible_Future_tbl_Benthos_Rocks* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BenthosRocksID	Auto Number		4
EventName	Text	(Key Field)	255
BnthRocksSampleName	Text	(Key Field)	255
NoJars	Auto Number		4
NoBaskets	Auto Number		4
BasketID	Auto Number		4
Description	Text		250
Comments	Text		255

Table C-34. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Benthos_QAQC* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BenthosQAQCID	Auto Number		4
EventName	Text	(Key Field)	255
BnthQAQCSampleName	Text		255
NoTransectsSampled	Auto Number		4
NoJars	Auto Number		4
Comments	Text		250

Table C-35. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_benthos_Metrics* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Lab	Text		255
Sample_ID	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Station_Name	Text		255
Sample_Client_ID	Text		255
Group	Text		255
Metric	Text		255
Value	Number		8
Richness	Number		8
Proportion	Number		8
Rating	Text		255
SummaryParameter	Text		255

Table C-36. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_benthos_Flat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
Lab	Text		255
Sample_ID	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Station_Name	Text		255
Sample_Client_ID	Text		255
Sample_Date_Collected	Date/Time		8
Sample_Collection_Procedure ID	Text		255
Order	Text		255
Family	Text		255
Taxon	Text		255
TSN	Number		8
Count	Number		8
Large_Rare	Text		255
Life_Stage	Text		255
Unique	Yes/No		1
Qualifier	Text		255
BI	Number		8

Field Name	Field Type	Description	Size (# chars)
FFG	Text		255
ProportionOfSampleUsed	Number		8

Table C-37. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_benthos_MMI_OE* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Lab	Text		255
Sample_ID	Text		255
Sample_STORET_Station_ID	Text		255
WaterbodyName	Text		255
Sample_Client_ID	Text		255
BenSampID	Number		8
SiteClass	Text		255
CollDate	Date/Time		8
CollMeth	Text		255
Lat_Dec	Number		8
Long_Dec	Number		8
TotalInd	Number		8
EphemTax	Number		8
EphemTaxScM	Number		8
PlecTax	Number		8
PlecTaxScM	Number		8
EPTPct	Number		8
EPTPctScM	Number		8
MtnIndex	Number		8
NonInsPct	Number		8
NonInsPctScM	Number		8
PredPctM	Number		8
PredPctScM	Number		8
BrrwrTaxPct	Number		8
BrrwrTaxPctScM	Number		8
HBI	Number		8
HBIScM	Number		8
EPTTax	Number		8
EPTTaxScP	Number		8
PlainsIndex	Number		8
TanypodPct	Text		255

Field Name	Field Type	Description	Size (# chars)
TanypodPctScP	Number		8
Orth2MidgPct	Text		255
Orth2MidgPctScP	Number		8
PredatorTax	Number		8
PredatorTaxScP	Number		8
FiltCollPct	Number		8
FiltCollPctScP	Number		8
EPTnoHBPct	Number		8
EPTnoHBPctScLV	Number		8
MidgePct	Number		8
MidgePctScLV	Number		8
LowValIndex	Number		8
CrusMolPct	Number		8
CrusMolPctScLV	Number		8
ShredderTax	Number		8
ShredderTaxScLV	Number		8
PredPctLV	Number		8
PredPctScLV	Number		8
ModelTest	Text		255
OE_P_5	Number		8
TotalBugs	Number		8
BC	Number		8

Table C-38. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_benthos_OE* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BenSampID	Number		8
O_P_5	Number		8
E_P_5	Number		8
OE_P_5	Number		8
BC_P_5	Number		8
O_P_0	Number		8
E_P_0	Number		8
OE_P_0	Number		8
BC_P_0	Number		8

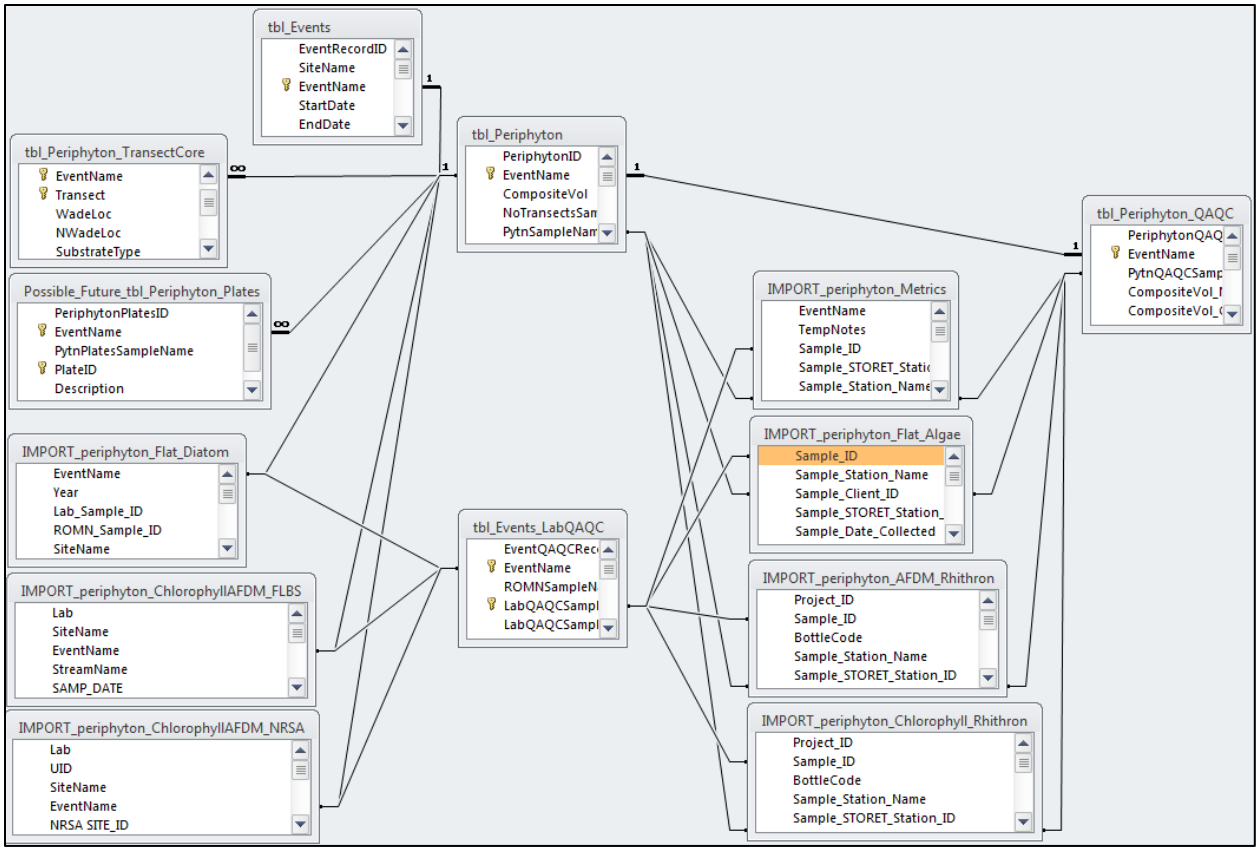


Figure C-6. Diagram showing the ROMN SEI database relationships between the central *tbl_Events* table and the *tbl_Periphyton* table and its child tables (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-39. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Periphyton* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Periphytonid	Auto Number		4
Eventname	Text	(Key Field)	255
Compositevol	Number	ml	8
Notransectssampled	Auto Number		4
Pytnsamplename	Text		255
Comments	Text		250
Samplevol_Name	Auto Number	ID sample ml	4
Filtervol_Chloro	Auto Number	Filtered volume - Chlorophyll ml	4
Filtervol_Biomass	Auto Number	Filtered volume - Biomass ml	4
Hastransectcore	Yes/No		1
Hasqaqc	Yes/No		1
Hasplates	Yes/No		1

Field Name	Field Type	Description	Size (# chars)
Hasimport_Metric	Yes/No		1
Hasimport_DF	Yes/No		1
Hasimport_chlorafdm	Yes/No		1
Hasimport_chlorafdmqaqc	Yes/No		1
Hasimport_Flat_Legacy	Yes/No	DELETE after new data delivered (Legacy)	1
Hasimport_metricloren_Legacy	Yes/No	DELETE after new data delivered (Legacy)	1

Table C-40. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Periphyton_TransectCore* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
PeriphytonCoreID	Auto Number		4
EventName	Text	(Key Field)	255
Transect	Text	(Key Field)	2
WadeLoc	Text	L,C,R	2
NWadeLoc	Text	L,R	2
SubstrateType	Text	E,D Like Substrate Class Code but lumped because that makes sense in the field.	2
DidymoCoverPct	Auto Number	Didymo plot cover %	4
DidymoCoverThick	Number	Didymo cover thickness cm (<1 is recorded as .9)	8
DidymoAbundance	Text	0,L,M,H	2
Comments	Text		255

Table C-41. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *Possible_Future_tbl_Periphyton_Plates* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
PeriphytonPlatesID	Auto Number		4
EventName	Text	(Key Field)	255
PytnPlatesSampleName	Text		255
PlateID	Auto Number	(Key Field)	4
Description	Text		250
Comments	Text		255

Table C-42. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Periphyton_QAQC* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
PeriphytonQAQCID	Auto Number		4
EventName	Text	(Key Field)	255
PytnQAQCSampleName	Text		255
CompositeVol_Name	Number	ml	8
CompositeVol_Chlor	Number	ml	8
CompositeVol_Biomass	Number	ml	8
Volume_Name	Number	ml - volume of the main sample ID	8
Volume_Chlor	Number	ml - volume of the chlor sample ID	8
Volume_Biomass	Number	ml - volume of the AFDM sample ID	8
Comments_Name	Text		250
Comments_Chlor	Text		250
Comments_Biomass	Text		250

Table C-43. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Events_LabQAQC* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventQAQCRecordID	Auto Number	Lab Sample event ID code	4
EventName	Text	event long name	255
ROMNSampleName	Text		255
LabQAQCSampleName	Text		255
LabQAQCSampleType	Text		255
EventQAQCComment	Memo	directions to site and monument comments	64,000
hasWaterEPA	Yes/No		1
hasWaterFLBS	Yes/No		1
hasWaterKiowa	Yes/No		1
hasWaterNRSA	Yes/No		1
hasWaterETC	Yes/No	"Environmental Testing & Consulting" in collaboration with GRYN	1
hasPeriphyton_Metric	Yes/No		1
hasPeriphyton_DF	Yes/No		1
hasPeriphyton_ChlorAFDM	Yes/No		1
hasPeriphyton_ChlorAFDMQAQC	Yes/No		1
hasPeriphyton_MetricLoren_Legacy	Yes/No	DELETE after new data delivered (Legacy)	1
hasBenthos_Metric	Yes/No		1

Field Name	Field Type	Description	Size (# chars)
hasBenthos_MMI_OE	Yes/No		1

Table C-44. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_periphyton_Metrics* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
TempNotes	Text		255
Sample_ID	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Station_Name	Text		255
Sample_Client_ID	Text		255
Metric	Text		255
Category	Text		255
Value	Text		255
PRA	Number		8
MTMRating	Text		255
MTPRating	Text		255
Probability	Number		8
DFScore	Number		8

Table C-45. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_periphyton_Flat_Algae* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Sample_ID	Text		255
Sample_Station_Name	Text		255
Sample_Client_ID	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Date_Collected	Text		255
OriginalVolume	Number		8
TransectLength	Number		8
Dilution_Concentration_factor	Number		8
VolumeCountedmL	Number		8
Division	Text		255
Taxon	Text		255
Count	Number		8
Analyst_Laboratory	Text		255

Field Name	Field Type	Description	Size (# chars)
PM_CellDepth_mm	Text		255
TransectWidth_at_400x_mm	Text	in the field	255
Sample_Notes	Text		255
LiveDiatoms_Prcnt	Text	percent live diatoms	255
Sample_ID	Text		255
Sample_Station_Name	Text		255
Sample_Client_ID	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Date_Collected	Text		255
OriginalVolume	Number		8
TransectLength	Number		8
Dilution_Concentration_factor	Number		8
VolumeCountedmL	Number		8
Division	Text		255
Taxon	Text		255
Count	Number		8
Analyst_Laboratory	Text		255
PM_CellDepth_mm	Text		255
TransectWidth_at_400x_mm	Text	in the field	255
Sample_Notes	Text		255
LiveDiatoms_Prcnt	Text	percent live diatoms	255

Table C-46. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_periphyton_Flat_Diatom* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
Year	Text		255
Lab_Sample_ID	Text		255
ROMN_Sample_ID	Text		255
SiteName	Text		255
StreamName	Text		255
Sample_Date_Collected	Text		255
Lab	Text		255
Taxon	Text		255
TSN	Number		8
Count	Number		8
DidymoWholeSlipCount	Text		255

Field Name	Field Type	Description	Size (# chars)
Abnormal	Number		8
Rare	Text		255

Table C-47. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_periphyton_AFDM_Rhithron* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Project_ID	Text		255
Sample_ID	Text		255
BottleCode	Text		255
Sample_Station_Name	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Client_ID	Text		255
Sample_Date_Collected	Number		8
Samp_Lat	Number		8
Samp_Lon	Number		8
PreAshedWt_g	Number		8
AshedWt_g	Number		8
AFDM_mass_g	Number		8
PPHYTON_FiltVol_AFDM_mL	Number		8
PPHYTON_TotalCompVol_mL	Number		8
PPHYTON_TotalAreaSampled_cm2	Number		8
AFDMv_g_mL	Number	mass per unit volume g/mL	8
AFDMma_g_cm2	Number	mass per unit area g/cm2	8
AFDM_mg_m2	Number	FINAL calculation for SUMMARY	8

Table C-48. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_periphyton_Chlorophyll_Rhithron* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Project_ID	Text		255
Sample_ID	Text		255
BottleCode	Text		255
Sample_Station_Name	Text		255
Sample_STORET_Station_ID	Text		255
Sample_Client_ID	Text		255
Sample_Date_Collected	Number		8

Field Name	Field Type	Description	Size (# chars)
Samp_Lat	Text		255
Samp_Lon	Text		255
PPHYTON_TotalAreaSampled_cm2	Number		8
PPHYTON_TotalAreaSampled_m2	Number		8
FiltVol_Chlra_mL	Number		8
PPHYTON_TotalCompVol_mL	Number		8
ChlaFactor	Number		8
ChlaFactor_a_ml_cm2	Number		8
TotalSlurry_Prcnt	Number	percent of total slurry	8
664	Number		8
750_Before	Number		8
665	Number		8
750_After	Number		8
664b_750b	Number		8
665a_750a	Number		8
DF	Number		8
VolumeSolvent_acetone_L	Number		8
TotalSampleVolume_L	Number		8
LengthCuvette_cm	Number		8
ChlaCuvette_Ce_mg_L	Number	mg/L	8
PheophytonCuvette_Pe_mg_L	Number		8
Chla_mg_m2	Number	mg/m2	8
TotalChlaSlurry_mg_m2	Number	FINAL calculation for SUMMARY mg/m2	8
Lab_Comments	Text		255

Table C-49. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_periphyton_ChlorophyllAFDM_FLBS* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Lab	Text		255
SiteName	Text		255
EventName	Text		255
StreamName	Text		255
SAMP_DATE	Number		8
ROMN_SampleNumber_Periphyton	Text		255
FLBS_SampleNumber	Text		255
ExtVol_ml_Chla	Number		8

Field Name	Field Type	Description	Size (# chars)
FilteredVol_ml_Chla	Number		8
TotalVol_ml_Chla	Number		8
AreaSampled_cm2_Chla	Number		8
665_BeforeAcid	Number		8
750_BeforeAcid	Number		8
665_AfterAcid	Number		8
750_AfterAcid	Number		8
665b_750b	Number		8
665a_750a	Number		8
D665	Number		8
Chla_ug_cm2	Number	ug/cm2	8
Chla _mg_m2	Number	FINAL calculation for SUMMARY mg/m2	8
PreAshedWt_g	Number		8
AshedWt_g	Number		8
FilteredVol_ml_AFDM	Number		8
TotalVol_ml_AFDM	Number		8
AreaSampled_cm2_AFDM	Number		8
AFDM_mg_cm2	Number	mg/cm2	8
AFDM_mg_m2	Number	FINAL calculation for SUMMARY mg/m2	8
Notes	Text		255

Table C-50. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Sites* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Lab	Text		255
UID	Number		8
SiteName	Text		255
EventName	Text		255
NRSA SITE_ID	Text		255
DATE_COL	Number		8
VISIT_NO	Number		8
XLAT_DD	Number		8
XLON_DD	Number		8
STATE	Text		255
Medium_CHLA	Text		255
SAMPLE_TYPEx_CHLA	Text		255
SAMPLE_CAT_CHLA	Text		255

Field Name	Field Type	Description	Size (# chars)
SAMPLE_ID_CHLA	Number		8
CHLA	Number		8
Medium_CHLfinal	Text		255
SAMPLE_TYPEx_CHLfinal	Text		255
SAMPLE_CAT_CHLfinal	Text		255
SAMPLE_ID_CHLfinal	Number		8
COMP_VOL	Number		8
TRAN_NO	Number		8
VOLUME	Number		8
AREA_CM2	Number		8
Chl-a (mg/m2)	Number	FINAL calculation for SUMMARY	8
Medium_AFDM	Text		255
AFDM	Number		8
AFDM_UNITS	Text		255
AFDM_TOT	Number		8
AFDM_TOT_UNITS	Text		255
AFDM_mgPERm2	Number	FINAL calculation for SUMMARY mg/m2	8

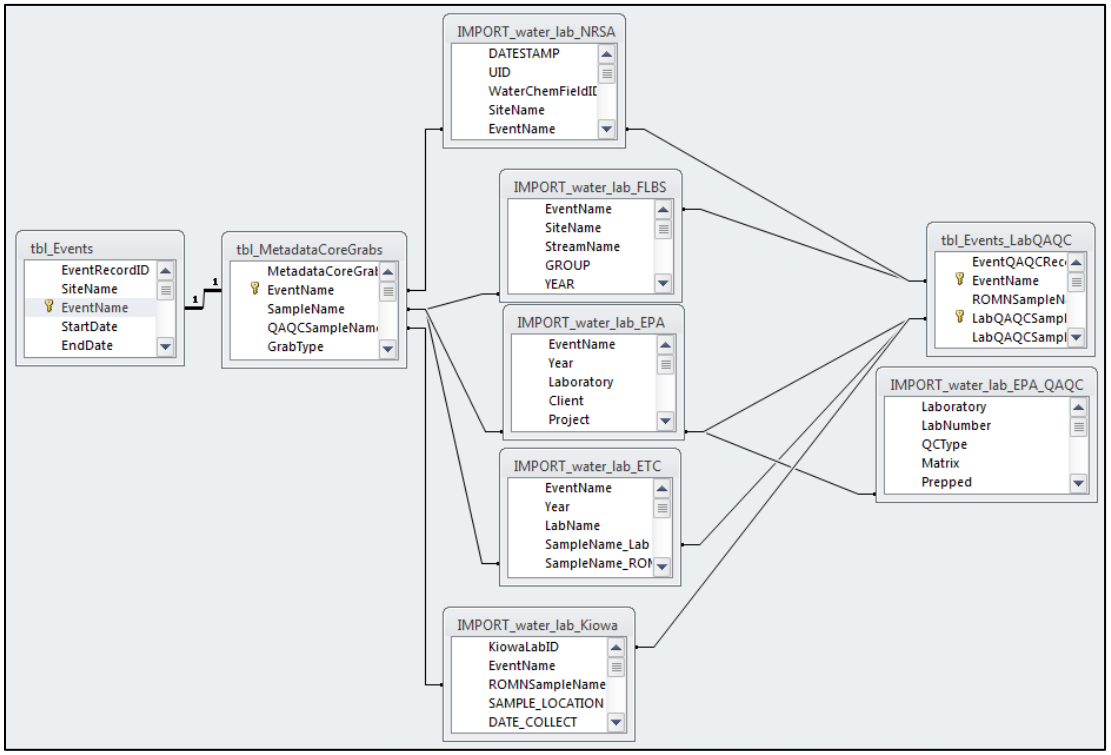


Figure C-7. Diagram showing the ROMN SEI database relationships between the central *tbl_Events* table and the *tbl_MetadataCoreGrabs* table and its child tables that contain water quality laboratory data (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-51. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_water_lab_NRSA* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
DATESTAMP	Date/Time		8
UID	Text		255
WaterChemFieldID	Text		255
SiteName	Text		255
EventName	Text		255
DATE_COL	Date/Time		8
VISIT_NO	Number		8
SITE_CLASS	Text		255
VALXSITE	Text		255
USE_NRSA	Text		255
STRAHLERORDER	Text		255
SAM_CODE	Text		255
SAMPLE_CAT	Text		255
AL	Number		8
AL_DATE_ANALYZED	Text		255
AL_HOLDING_TIME	Text		255
AL_UNITS	Text		255
ANC	Number		8
ANC_DATE_ANALYZED	Text		255
ANC_HOLDING_TIME	Text		255
ANC_UNITS	Text		255
CA	Number		8
CA_DATE_ANALYZED	Text		255
CA_HOLDING_TIME	Text		255
CA_UNITS	Text		255
CL	Number		8
CL_DATE_ANALYZED	Text		255
CL_HOLDING_TIME	Text		255
CL_UNITS	Text		255
COLOR	Number		8
COLOR_DATE_ANALYZED	Text		255
COLOR_HOLDING_TIME	Text		255
COLOR_UNITS	Text		255
COND	Number		8
COND_DATE_ANALYZED	Text		255
COND_HOLDING_TIME	Text		255

Field Name	Field Type	Description	Size (# chars)
COND_UNITS	Text		255
DOC	Number		8
DOC_DATE_ANALYZED	Text		255
DOC_HOLDING_TIME	Text		255
DOC_UNITS	Text		255
K	Number		8
K_DATE_ANALYZED	Text		255
K_HOLDING_TIME	Text		255
K_UNITS	Text		255
MG	Number		8
MG_DATE_ANALYZED	Text		255
MG_HOLDING_TIME	Text		255
MG_UNITS	Text		255
SODIUM	Number		8
SODIUM_DATE_ANALYZED	Text		255
SODIUM_HOLDING_TIME	Text		255
SODIUM_UNITS	Text		255
NH4	Number		8
NH4_DATE_ANALYZED	Text		255
NH4_HOLDING_TIME	Text		255
NH4_UNITS	Text		255
NO2	Number		8
NO2_DATE_ANALYZED	Text		255
NO2_HOLDING_TIME	Text		255
NO2_UNITS	Text		255
NO3	Number		8
NO3_DATE_ANALYZED	Text		255
NO3_HOLDING_TIME	Text		255
NO3_UNITS	Text		255
NO3NO2	Text		255
NO3NO2_DATE_ANALYZED	Text		255
NO3NO2_HOLDING_TIME	Text		255
NO3NO2_UNITS	Text		255
NTL	Number		8
NTL_DATE_ANALYZED	Text		255
NTL_HOLDING_TIME	Text		255
NTL_UNITS	Text		255
PHLAB	Number		8
PHLAB_DATE_ANALYZED	Text		255

Field Name	Field Type	Description	Size (# chars)
PHLAB_HOLDING_TIME	Text		255
PHLAB_UNITS	Text		255
PTL	Number		8
PTL_DATE_ANALYZED	Text		255
PTL_HOLDING_TIME	Text		255
PTL_UNITS	Text		255
SIO2	Number		8
SIO2_DATE_ANALYZED	Text		255
SIO2_HOLDING_TIME	Text		255
SIO2_UNITS	Text		255
SO4	Number		8
SO4_DATE_ANALYZED	Text		255
SO4_HOLDING_TIME	Text		255
SO4_UNITS	Text		255
TSS	Number		8
TSS_DATE_ANALYZED	Text		255
TSS_HOLDING_TIME	Text		255
TSS_UNITS	Text		255
TURB	Number		8
TURB_DATE_ANALYZED	Text		255
TURB_HOLDING_TIME	Text		255
TURB_UNITS	Text		255
COMMENT	Text		255

Table C-52. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_water_lab_FLBS* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
SiteName	Text		255
StreamName	Text		255
GROUP	Text		255
YEAR	Number		8
SAMPTYPE	Text		255
QAQC	Text		255
REVISIT	Text		255
VisitNo_WithinYear	Number		8
VisitNo_AcrossYear	Number		8

Field Name	Field Type	Description	Size (# chars)
Xwalk_SAMP_DATE	Number		8
FLBSSAMPLE_ID	Text		255
ROMN_SampleNumber_Chem	Text		255
ROMNSampleNumber_Chem_FLBSAbbrev	Text		255
SITEDESC	Text		255
SAMPLE	Text		255
SAMPLE ID	Text		255
VARIABLE	Text		255
L	Text		255
VALUE	Number		8
VALUE2	Text		255
QC	Text		255
STATUS	Text		255
NOTES	Text		255
Reps	Text		255
Spikes	Text		255
Knowns	Text		255
DupAVal	Text		255
DupBVal	Text		255
SITENUM	Text		255
COLLECTION_DATE	Date/Time		8
FLBS_DATABASE_SAMP_DATE	Number		8
COLLECTION_TIME	Date/Time		8
LOGIN_DATE	Date/Time		8
LOGIN_TIME	Date/Time		8
LAB_RECEIVED_DATE	Date/Time		8
LAB_RECEIVED_TIME	Date/Time		8
START_DEPTH	Text		255
END_DEPTH	Text		255
BILL_DATE	Text		255
QCNOTE	Text		255
FIELD_NOTE	Text		255
UNIT	Text		255

Table C-53. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_water_lab_EPA* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
Year	Number		8
Laboratory	Text		255
Client	Text		255
Project	Text		255
ProjectNumber	Text		255
SampleName	Text		255
SampleID	Text	ROMN Sample Name	255
LabNumber	Text	Lab Sample Name	255
LabNumber_ChangedFrom	Text	original Lab ID	255
ClientMatrix	Text		255
Sampled	Date/Time		8
Prepped	Date/Time		8
Analyzed	Date/Time		8
Batch	Text		255
Analysis	Text		255
Method	Text		255
PrepMethod	Text		255
Analyte	Text		255
CASNumber	Text		255
Surrogate	Text		255
Result	Text		255
LabQual	Text		255
AnalyteQual	Text		255
ReportLimit	Text		255
Units	Text		255
Dilution	Text		255
SpkAmt	Text		255
Recovery	Text		255
LowerLimit	Text		255
UpperLimit	Text		255
Analyst	Text		255
AnalysisClass	Text		255

Table C-54. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_water_lab_ETC* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
Year	Text		255
LabName	Text		255
SampleName_Lab	Text		255
SampleName_ROMN	Text		255
Test	Text		255
Flag	Text		255
Result	Number		8
H	Text		255
Units	Text		255
MQL	Number		8
DF	Number		8
DateTime_Analyzed	Date/Time		8
By	Text		255
Analytical_Method	Text		255
SampleFraction	Text		255

Table C-55. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *IMPORT_water_lab_Kiowa* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
KiowaLabID	Text		255
EventName	Text		255
ROMNSampleName	Text		255
SAMPLE_LOCATION	Text		255
DATE_COLLECT	Text		255
TIME_COLLECT	Number		8
pH	Text		255
COND_µmhos_cm	Text		255
ANC_mg_CaCO3_L	Text		255
NH4Plus_mg_N_L	Text		255
CaPlusPlus_mg_L	Text		255
MgPlusPlus_mg_L	Text		255
NaPlus_mg_L	Text		255
KPlus_mg_L	Text		255
ClMinus_mg_L	Text		255

Field Name	Field Type	Description	Size (# chars)
NO3Minus_mg_N_L	Text		255
SO4Equal_mg_S_L	Text		255
SO4Equal_mg_SO4_L	Text		255
PO4_3Minus_mg_P_L	Text		255
Si_mg_Si_L	Text		255
Si_mg_SiO2_L	Text		255
Mn_mg_L	Text		255
Mn_ug_L	Text	If Kiowa delivers Mn_mg_L, do not bring it in.	255
NO2Minus_mg_N_L	Text		255
NO2_3Minus_mg_N_L	Text	Same as NO3- + NO2 mg N/L	255
TN_mg_N_L	Text		255
TDN_mg_N_L	Text		255
PN_mg_N_L	Text		255
DON_mg_N_L	Text		255
IN_mg_N_L	Text		255
TP_mg_P_L	Text		255
TDP_mg_P_L	Text		255
PP_mg_P_L	Text		255
DOP_mg_P_L	Text		255
IP_mg_P_L	Text		255
DOC_mg_C_L	Text		255
TSS_mg_L	Text		255
SUMPlus	Text	SUM +	255
SUMMinus	Text	SUM-	255
SUMPlus_Minus_SUMMinus__ SUMPlus_Plus_SUMMinus	Text	SUM+ - SUM -_SUM+ + SUM -	255

Table C-56. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectSlopeBearing* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
TransectSlopeBearingID	Auto Number		4
EventName	Text	(Key Field)	255
TransectSlope	Text	Boatable data are typically imported from GIS instead of collected in the field. (Key Field)	5
Method	Text	Wade only - Clinometer, HL, Abney level, Transome, WT, Other	50
MainMeasure	Number	Slope or Elevation	8
MainMeasureUnit	Text	%, cm	10
MainBearing	Auto Number	0 -359	4

Field Name	Field Type	Description	Size (# chars)
MainBearingProportion	Number	%	8
MainSlopeProportion	Number	%	8
FirstMeasure	Number	Slope or Elevation	8
FirstMeasureUnit	Text	%, cm	10
FirstBearing	Auto Number	0 -359	4
FirstBearingProportion	Number	%	8
FirstSlopeProportion	Number	%	8
SecondMeasure	Number	Slope or Elevation	8
SecondMeasureUnit	Text	%, cm	10
SecondBearing	Auto Number	0 -359	4
SecondBearingProportion	Number	%	8
SecondSlopeProportion	Number	%	8
ThirdMeasure	Number	BOATABLE -Slope % - May collect in Wadable but not on field sheet	8
ThirdMeasureUnit	Text	BOATABLE - Slope % - May collect in Wadable but not on field sheet	10
ThirdBearing	Auto Number	BOATABLE -0 -359 - May collect in Wadable but not on field sheet	4
ThirdBearingProportion	Auto Number	BOATABLE -% - May collect in Wadable but not on field sheet	4
ThirdSlopeProportion	Auto Number	BOATABLE -% - May collect in Wadable but not on field sheet	4
Comments	Text		255
hasBoat	Yes/No		1

Table C-57. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_TransectSlopeBearing_Boat* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
BoatTransectSlopeBearingID	Auto Number		4
EventName	Text	These data are typically imported from GIS instead of collected in the field. (Key Field)	255
TransectSlope	Text	(Key Field)	5
IntendedSpacing	Number	BOATABLE - intended transect spacing (m)	8
ActualSpacing	Number	BOATABLE - actual transect spacing (m)	8
MainDist	Number	BOATABLE - meters	8
FirstDist	Number	BOATABLE - meters	8
SecondDist	Number	BOATABLE - meters	8
ThirdDist	Number	BOATABLE - meters	8
Comments	Text		255

Table C-58. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Torrent* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
TorrentID	Auto Number		4
EventName	Text	Event long name. (Key Field)	255
DevegetatedCorridor	Yes/No	Evidence of Torrent Scouring	1
NotImbricated	Yes/No	Evidence of Torrent Scouring	1
NoPoolRiffleSturcture	Yes/No	Evidence of Torrent Scouring	1
ScouredToBedrock	Yes/No	Evidence of Torrent Scouring	1
CobbleBerms	Yes/No	Evidence of Torrent Scouring	1
DownStreamSediment	Yes/No	Evidence of Torrent Scouring	1
TreesScarred	Yes/No	Evidence of Torrent Scouring	1
TreesInChannel	Yes/No	Evidence of Torrent Scouring	1
DepositsInReach	Yes/No	Evidence of Torrent Deposits	1
MatixSupported	Yes/No	Evidence of Torrent Deposits	1
NoScouringOrDeposits	Yes/No	No Evidence of Torrent Scouring or Deposits	1
Comments	Memo		64,000

Table C-59. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Constraint* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
ConstraintID	Auto Number		4
EventName	Text	Event long name. (Key Field)	255
ChannelPattern	Text	One, Anastomosing (Complex), Braided	50
ChannelConstraint	Text	Very, Broad Valley but constrained, Narrow Valley, Unconstrained	50
ConstrainingFeatures	Text	Bedrock, Hillslope, Terrace, Human, None - USED IN 2007	50
PercentInContact	Auto Number	Percent of Channel length with margin in contact with constraining feature.	4
BankfullWidth	Number	Bank Full Width (m)	8
ValleyWidth	Number	Valley width (Visual Estimated Average) (Note: be sure to include distances between both sides of Valley border for valley width:	8
ValleyWidthUnits	Text	Valley Width units of measure	100
LimitedVisability	Yes/No	Cannot see valley borders	1
Comments	Memo		64,000

Table C-60. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Wildlife* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
DipperID	Auto Number		4
EventName	Text	(Key Field)	255
Species	Text	(Key Field)	100
NumSeen	Auto Number		4
NumFlyThrough	Auto Number		4
Perched	Yes/No		1
Swimming	Yes/No		1
Vocalizing	Yes/No		1
Nesting	Yes/No		1
Comments	Text		255

Table C-61. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Events_LabQAQC* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventQAQCRecordID	Auto Number	Lab Sample event ID code	4
EventName	Text	Event long name. (Key Field)	255
ROMNSampleName	Text		255
LabQAQCSampleName	Text	(Key Field)	255
LabQAQCSampleType	Text		255
EventQAQCComment	Memo	Directions to site and monument comments	64,000
hasWaterEPA	Yes/No		1
hasWaterFLBS	Yes/No		1
hasWaterKiowa	Yes/No		1
hasWaterNRSA	Yes/No		1
hasWaterETC	Yes/No	"Environmental Testing & Consulting" in collaboration with GRYN	1
hasPeriphyton_Metric	Yes/No		1
hasPeriphyton_DF	Yes/No		1
hasPeriphyton_ChlorAFDM	Yes/No		1
hasPeriphyton_ChlorAFDMQAQC	Yes/No		1
hasPeriphyton_MetricLoren_Legacy	Yes/No	DELETE after new data delivered (Legacy)	1
hasBenthos_Metric	Yes/No		1
hasBenthos_MMI_OE	Yes/No		1

Table C-62. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_MetadataCoreInSitu* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
MetadataCoreInSituID	Auto Number		4
EventName	Text	Event long name. (Key Field)	255
ECFileName	Text		255
XTFileName	Text		255
KCFileName	Text		255
SpotType	Text	Thalweg, CrossSectionTransect	25
ErrorCheck	Yes/No		1
SpotMeasures	Text	nearest transect (A-K, Q, OT) of sport measures	255
NumberMeasures	Auto Number	number of spot measures	4
Continuous	Text	nearest transect (A-K, Q, OT) of continuous reading	225
ECComments	Memo		64,000
XTComments	Memo		64,000
KCComments	Memo		64,000
HOBO_SerialOld1	Text		50
HOBO_SerialCurrent1	Text		50
HOBO_Location1	Text		255
HOBO_Notes1	Text		255
HOBO_SerialOld2	Text		50
HOBO_SerialCurrent2	Text		50
HOBO_Location2	Text		255
HOBO_Notes2	Text		255
HOBO_CountCurrent	Auto Number	Number of HOBOs left at the Site after the Event	4
hasHOBODownload	Yes/No		1
NumFiles	Auto Number	Expected number of HOBO files resulting from this Event	4
hasLoggerYSI	Yes/No		1
hasLoggerInsitu	Yes/No	Troll 9500 on the label of the sonde	1
hasLoggerSmartTroll	Yes/No		1
hasLoggerOther	Yes/No		1
LoggerOtherDescription	Text	Describe the logger used: make/model/file type	50

Table C-63. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_PointsPhotos* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
PointPhotoID	Auto Number	UNique ID	4
EventName	Text	Event long name. (Key Field)	255
StreamLocation	Text	During which portion of the Event were these data collected. (Key Field)	255
LocationDetail	Text	More detail about the location of the data. (Key Field)	255
DataType	Text	What is the source of the data value. (Key Field)	255
DataValue	Text	What is the value recorded in the field	255
Comments	Text		255

Table C-64. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Times* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
TimeID	Auto Number		4
EventName	Text	Event long name. (Key Field)	255
Event_Start	Date/Time		8
Event_Down	Auto Number		4
Event_End	Date/Time		8
CoreInSitu_Collected	Date/Time	YSI, InSitu, Other	8
CoreInSitu_HOBODownloaded1	Date/Time	First HOBO - start of file	8
CoreInSitu_HOBODeployed1	Date/Time	First HOBO - end of file	8
CoreInSitu_HOBODownloaded2	Date/Time	Second HOBO - start of file	8
CoreInSitu_HOBODeployed2	Date/Time	Second HOBO - end of file	8
CoreGrabs_Collected	Date/Time		8
CoreDischarge_Collected	Date/Time		8
CrossSectionA_Start	Date/Time		8
CrossSectionA_End	Date/Time		8
CrossSectionB_Start	Date/Time		8
CrossSectionB_End	Date/Time		8
CrossSectionC_Start	Date/Time		8
CrossSectionC_End	Date/Time		8
CrossSectionD_Start	Date/Time		8
CrossSectionD_End	Date/Time		8
CrossSectionE_Start	Date/Time		8
CrossSectionE_End	Date/Time		8
CrossSectionF_Start	Date/Time		8

Field Name	Field Type	Description	Size (# chars)
CrossSectionF_End	Date/Time		8
CrossSectionG_Start	Date/Time		8
CrossSectionG_End	Date/Time		8
CrossSectionH_Start	Date/Time		8
CrossSectionH_End	Date/Time		8
CrossSectionI_Start	Date/Time		8
CrossSectionI_End	Date/Time		8
CrossSectionJ_Start	Date/Time		8
CrossSectionJ_End	Date/Time		8
CrossSectionK_Start	Date/Time		8
CrossSectionK_End	Date/Time		8
ProfileAB_Start	Date/Time		8
ProfileAB_End	Date/Time		8
ProfileBC_Start	Date/Time		8
ProfileBC_End	Date/Time		8
ProfileCD_Start	Date/Time		8
ProfileCD_End	Date/Time		8
ProfileDE_Start	Date/Time		8
ProfileDE_End	Date/Time		8
ProfileEF_Start	Date/Time		8
ProfileEF_End	Date/Time		8
ProfileFG_Start	Date/Time		8
ProfileFG_End	Date/Time		8
ProfileGH_Start	Date/Time		8
ProfileGH_End	Date/Time		8
ProfileHI_Start	Date/Time		8
ProfileHI_End	Date/Time		8
ProfileIJ_Start	Date/Time		8
ProfileIJ_End	Date/Time		8
ProfileJK_Start	Date/Time		8
ProfileJK_End	Date/Time		8
SlopeBearing1_Start	Date/Time		8
SlopeBearing1_End	Date/Time		8
SlopeBearing2_Start	Date/Time		8
SlopeBearing2_End	Date/Time		8
PeriphytonPrep_Start	Date/Time		8
PeriphytonPrep_End	Date/Time	2010 DATA: often when the end time was null, it was recorded with a default of 1 min before the next start time	8
PeriphytonA_Start	Date/Time		8

Field Name	Field Type	Description	Size (# chars)
PeriphytonA_End	Date/Time		8
PeriphytonB_Start	Date/Time		8
PeriphytonB_End	Date/Time		8
PeriphytonC_Start	Date/Time		8
PeriphytonC_End	Date/Time		8
PeriphytonD_Start	Date/Time		8
PeriphytonD_End	Date/Time		8
PeriphytonE_Start	Date/Time		8
PeriphytonE_End	Date/Time		8
PeriphytonF_Start	Date/Time		8
PeriphytonF_End	Date/Time		8
PeriphytonG_Start	Date/Time		8
PeriphytonG_End	Date/Time		8
PeriphytonH_Start	Date/Time		8
PeriphytonH_End	Date/Time		8
PeriphytonI_Start	Date/Time		8
PeriphytonI_End	Date/Time		8
PeriphytonJ_Start	Date/Time		8
PeriphytonJ_End	Date/Time		8
PeriphytonK_Start	Date/Time		8
PeriphytonK_End	Date/Time		8
BenthosPrep_Start	Date/Time		8
BenthosPrep_End	Date/Time	2010 DATA: often when the end time was null, it was recorded with a default of 1 min before the next start time	8
BenthosA_Start	Date/Time		8
BenthosA_End	Date/Time		8
BenthosB_Start	Date/Time		8
BenthosB_End	Date/Time		8
BenthosC_Start	Date/Time		8
BenthosC_End	Date/Time		8
BenthosD_Start	Date/Time		8
BenthosD_End	Date/Time		8
BenthosE_Start	Date/Time		8
BenthosE_End	Date/Time		8
BenthosF_Start	Date/Time		8
BenthosF_End	Date/Time		8
BenthosG_Start	Date/Time		8
BenthosG_End	Date/Time		8
BenthosH_Start	Date/Time		8

Field Name	Field Type	Description	Size (# chars)
BenthosH_End	Date/Time		8
BenthosI_Start	Date/Time		8
BenthosI_End	Date/Time		8
BenthosJ_Start	Date/Time		8
BenthosJ_End	Date/Time		8
BenthosK_Start	Date/Time		8
BenthosK_End	Date/Time		8
Wildlife_Start	Date/Time		8
Wildlife_End	Date/Time		8
BoatTransectA_Start	Date/Time		8
BoatTransectA_End	Date/Time		8
BoatTransectB_Start	Date/Time		8
BoatTransectB_End	Date/Time		8
BoatTransectC_Start	Date/Time		8
BoatTransectC_End	Date/Time		8
BoatTransectD_Start	Date/Time		8
BoatTransectD_End	Date/Time		8
BoatTransectE_Start	Date/Time		8
BoatTransectE_End	Date/Time		8
BoatTransectF_Start	Date/Time		8
BoatTransectF_End	Date/Time		8
BoatTransectG_Start	Date/Time		8
BoatTransectG_End	Date/Time		8
BoatTransectH_Start	Date/Time		8
BoatTransectH_End	Date/Time		8
BoatTransectI_Start	Date/Time		8
BoatTransectI_End	Date/Time		8
BoatTransectJ_Start	Date/Time		8
BoatTransectJ_End	Date/Time		8
BoatTransectK_Start	Date/Time		8
BoatTransectK_End	Date/Time		8
BoatProfileAB_Start	Date/Time		8
BoatProfileAB_End	Date/Time		8
BoatProfileBC_Start	Date/Time		8
BoatProfileBC_End	Date/Time		8
BoatProfileCD_Start	Date/Time		8
BoatProfileCD_End	Date/Time		8
BoatProfileDE_Start	Date/Time		8
BoatProfileDE_End	Date/Time		8

Field Name	Field Type	Description	Size (# chars)
BoatProfileEF_Start	Date/Time		8
BoatProfileEF_End	Date/Time		8
BoatProfileFG_Start	Date/Time		8
BoatProfileFG_End	Date/Time		8
BoatProfileGH_Start	Date/Time		8
BoatProfileGH_End	Date/Time		8
BoatProfileHI_Start	Date/Time		8
BoatProfileHI_End	Date/Time		8
BoatProfileIJ_Start	Date/Time		8
BoatProfileIJ_End	Date/Time		8
BoatProfileJK_Start	Date/Time		8
BoatProfileJK_End	Date/Time		8

Table C-65. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tbl_Crew* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
CrewID	Auto Number		4
EventName	Text	(Key Field)	255
Crew	Text	(Key Field)	255
Role	Text		255

Table C-66. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_AlienSpecies* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
CommonName	Text		50
ScientificName	Text		50

Table C-67. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_BankAngle* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		255
Angle	Text		255
Discription	Text		255

Table C-68. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Benthos_GearMethod* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
GearMethod_Code	Text		255
GearMethod_Name	Text		255
GearMethod_NetSize	Number	meters	8

Table C-69. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Benthos_HabitatType* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
HabitatType_Code	Text		255
HabitatType_Name	Text		255

Table C-70. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_ChannelUnitCodes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		2
Description	Text		50

Table C-71. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Constraint_ChannelConstraint* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		50
Description	Text		255

Table C-72. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Constraint_ChannelPattern* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		50
Description	Text		100

Table C-73. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Constraint_ConstrainingFeature* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		50
Description	Text		255

Table C-74. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_CoverInChannel* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Number		1
Description	Text		50
Quantification	Text		20
ValueEstimate	Number		8

Table C-75. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Crew* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Initials	Text	(Key Field)	5
FirstName	Text		255
LastName	Text		255
Active	Yes/No		1
Role	Text		255

Table C-76. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Event_NameCodes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		255
Description	Text		255
Placement	Text		255

Table C-77. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_HumanUseMeasures* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		1
HumanInf_Meas	Text		255
LegacyQuatification	Text		5

Table C-78. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_InSituSampleTypes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
MethodCode	Text	Sample type code	15
MethodDescription	Text		255

Table C-79. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_LabFlags_WaterQuality* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventName	Text		255
Lab	Text		255
SampleName_ROMN	Text		255
SampleName_Lab	Text		255
LocalParameter	Text		255
Parameter	Text		255
CharacteristicName	Text		255
SampleFraction	Text		255
Medium	Text		255
FlagLab	Text		255
FlagAnalyte	Text		255
FlagResult	Text		255
FlagExceptionsDescription	Text		255
FlagResultDescription	Text		255
FlagStoretCode	Text		255
FlagDVCode	Text		255
Flag	Auto Number	This field indicates if the flag should show up in the final summary	4
FlagNotes	Text		255

Table C-80. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Metadata_Discharge* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		255
Field	Text		255

Table C-81. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Misc* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		255
Description	Text		255
Table	Text		255
Field	Text		255

Table C-82. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Parks* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
PARKCODE	Text		255
PARKNAME	Text		255
PARKTYPE	Text		255

Table C-83. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Periphyton_DidymoAbundance* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		50
Description	Text		255

Table C-84. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_PeriphytonStations* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Hannaea_Station_No	Auto Number		4
NPS_SiteName	Text		255
Waterbody	Text		255
HUC	Auto Number		4
County	Text		255
Lat	Number		8
Long	Number		8

Table C-85. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_PointsPhotos_DataType* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
DataType	Text		255

Table C-86. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_PointsPhotos_Location* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
StreamLocation	Text		255

Table C-87. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_PointsPhotos_LocationDetail* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
LocationDetail	Text		255

Table C-88. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_PoolFormCodes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		3
Description	Text		50

Table C-89. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Sites_Design_GLAC* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
siteid	Text		255
xcoord	Number		8
ycoord	Number		8
mdcaty	Text		255
wgt	Number		8
stratum	Text		255
panel	Text		255
comid	Number		8
gnis_id	Text		255
reachcode	Text		255
gnis_name	Text		255
ftype	Number		8
fcode	Number		8
length_m	Number		8
strahler	Number		8
shreve	Number		8
nhd_level	Number		8
type	Text		255
hydro_desc	Text		255
ap_type	Text		255
dangle	Text		255
in_out	Text		255
gnis_inter	Text		255
three_mi	Text		255
hydrostage	Text		255
glacwtnm	Text		255
glacwtid	Number		8
glacwtac	Number		8
huc	Number		8
huc_name	Text		255
useco_l4	Number		8
level4	Text		255
level4_nam	Text		255
cost_min	Number		8
cost_max	Number		8
cost_sum	Number		8

Field Name	Field Type	Description	Size (# chars)
cost_sd	Number		8
cost_mean	Number		8
cost_class	Text		255
rchcnt_m	Number		8
site_elev	Number		8
long_dec	Number		8
lat_dec	Number		8
evalstatus	Text		255
evalreason	Text		255
pnl_rank	Number		8
pilotbse	Number		8
sitecost_h	Number		8
sitenum	Number		8
pilotovr	Number		8
zone	Number		8
baseover	Text		255
east_11	Number		8
north_11	Number		8
east_12	Number		8
north_12	Number		8
strmslpmn	Number		8
officestat	Text		255
reconstat	Text		255
reconhydro	Text		255
reconslide	Text		255
notes	Text		255
offcehydro	Text		255

Table C-90. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Sites_Design_ROMO* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
siteID	Text		255
xcoord	Number		8
ycoord	Number		8
mdcaty	Text		255
wgt	Number		8
stratum	Text		255

Field Name	Field Type	Description	Size (# chars)
panel	Text		255
EvalStatus	Text		255
EvalReason	Text		255
join_count	Number		8
target_fid	Number		8
comid	Number		8
gnis_id	Text		255
gnis_name	Text		255
reachcode	Text		255
ftype	Number		8
strahler	Number		8
rowid_	Number		8
fid_1	Number		8
max	Number		8
mean	Number		8
sum	Number		8
fcode_1	Number		8
descriptio	Text		255
hydrograph	Text		255
target_pop	Text		255
gnis_id_1	Text		255
gnis_name_	Text		255
length	Number		8
lengthkm	Number		8
lengthspli	Number		8
order_cost	Text		255
max_1	Number		8
mean_1	Number		8
sum_1	Number		8
cost_class	Text		255
cost_cls2	Text		255
ordr_cost2	Text		255
stratacost	Text		255
Lat	Number		8
Lon	Number		8

Table C-91. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Sites_TransectAzimuths* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
SiteName	Text		255
Transect	Text		255
Length	Number		8
Azimuth	Number		8
PerReach	Number		8
Sup1Az	Text		255
PerReachS1	Text		255
Sup2Az	Text		255
PerReachS2	Text		255
SlopeDeg	Number		8
SlopePer	Number		8
Average_Azimuth	Number		8

Table C-92. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Sites_WatershedAttributes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
ParkCode	Text		255
SiteName	Text		255
StreamName	Text		255
Elevation_M	Number	Elevation at the site (meters)	8
Elevation_FT	Number	Elevation at the site (feet)	8
ElevationMAX_FT	Number		8
ElevationMIN_FT	Number		8
Aspect	Number		8
Slope	Number		8
ALAKEPCT	Number		8
BSLOPGM	Number		8
WatershedName	Text		255
GROUP	Text		255
SiteClass	Text	Site class as identified in Jessup et al. (2006)	255
Canada	Number	Catchment extends into Canada (1 = yes, 0 = no)	4
CRB	Number	Within the Columbia River Basin (1 = yes, 0 = no)	4
Perimeter_m	Number	catchment perimeter m	8

Field Name	Field Type	Description	Size (# chars)
Area_m2	Number	catchment area m2	8
Area_mi2	Number	catchment area mi2	8
Area_km2	Number	catchment area km2	8
strahler	Number		8
strahler_char	Text		255
mdcaty	Text		255
stratum	Text		255
L3_1_ECO	Text	Dominant Level 3 ecoregion within catchment (ecoregion number)	255
HUC2	Number		8
HUC4	Number		8
HUC6	Number		8
HUC8	Number		8
HUC4_NAME	Text		255
HUC6_NAME	Text		255
HUC8_NAME	Text		255
MIN_CatchStreamTempModel08	Number		8
MAX_CatchStreamTempModel08	Number		8
RANGE_CatchStreamTempModel08	Number		8
MEAN_CatchStreamTempModel08	Number		8
STD_CatchStreamTempModel08	Number		8
SUM_CatchStreamTempModel08	Number		8
SModeledMaxStreamTemp	Number		8
ppt_MEAN07	Number		8
ppt_STD07	Number		8
ppt_SUM07	Number		8
ppt_MEAN08	Number		8
ppt_STD08	Number		8
ppt_SUM08	Number		8
ppt_MEAN09	Number		8
ppt_STD09	Number		8
ppt_SUM09	Number		8
ppt_MIN_mm	Number		8
ppt_MAX_mm	Number		8
ppt_AVG_mm	Number		8

Field Name	Field Type	Description	Size (# chars)
ppt_Median	Number		8
ppt_STD_mm	Number		8
ppt_SUM_mm	Number		8
ppt_mm	Number	30 yr normal mean annual total precip in mm at site	8
ppt_mm_c	Number	30 yr normal mean annual total precip in mm at catchment centroid	8
ppt_inches_c	Number		8
ppt_m_c	Number	30 yr normal mean annual total precip in meters at catchment centroid	8
ppt_mm_c_predicted	Number	30 yr normal mean annual total precip in meters at catchment centroid with regression based correction for catchments that have Canada portion	8
ppt_PT	Number	Total annual precipitation at the site over 1971 - 2000 from 800m normal PRISM data	8
Tmax_MIN_C	Number		8
Tmax_MAX_C	Number		8
Tmax_AVG_C	Number		8
Tmax_Media	Number		8
Tmax_STD_C	Number		8
tmax_c_c	Number	30 yr normal max annual temperature in C at catchment centroid	8
tmax_c	Number	30 yr normal max annual temperature in C at site	8
TMAX_PT	Number	Annual mean of daily maximum temperatures at the site over 1971 - 2000 from 800m normal PRISM data	8
tmin_c	Number	30 yr normal min annual temperature in C at site	8
tmin_c_c	Number	30 yr normal min annual temperature in C at catchment centroid	8
Runoff_millimyr_grid_Mean	Number	50 year mean runoff in millimeters/yr at site from catchment summary	8
Runoff_myr_grid_Mean	Number	50 year mean runoff in meters/yr at site from catchment summary	8
Runoff_myr_grid_Mean_predcited	Number	50 year mean runoff in meters/yr at site from catchment summary with regression based correction for catchments that have Canada portion	8
Runoff_mmyr_grid_Sum	Number	50 year sum runoff in mm/yr at site from catchment summary	8
Q_MEAN_cms	Text		255
Q_N	Number		8
Q_SD	Number		8
Temp_Mean_fromQ	Number		8
Burn_05toCurrent	Number		8

Field Name	Field Type	Description	Size (# chars)
Burn_pre05	Number		8
Burn_1984toCurrent	Number		8
GlacierPer	Number		8
DistLake_Mainstem	Number		8
LakeName_Mainstem	Text		255
LakeSize_Mainstem	Number		8
LakeWeight_Mainstem	Number		8
DistLake_Trib	Number		8
LakeName_Trib	Text		255
LakeSize_Trib	Number		8
LakeWeight_Trib	Number		8
DistLake_Closest	Number		8
LakeName_Closest	Text		255
LakeSize_Closest	Number		8
LakeWeight_Closest	Number		8
AbandonedMines	Number		8
AbandonedMineDensity	Number		8
NumDams	Number		8
MineDensity	Number		8
NumMines	Number		8
NumTRI	Number		8
TRIDensity	Number		8
NumPCS	Number		8
PCSDensity	Number		8

Table C-93. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_SiteStatusDetail* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
SiteStatus	Text		40
SiteStatusDetail	Text		255

Table C-94. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_SlopeBearingMethod* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
MethodCode	Text		10
Description	Text		50

Table C-95. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_SubstrateSizeCodes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		2
Description	Text		100
SortCode	Number		2

Table C-96. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_SubstrateType* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		255
Description	Text		255
Table	Text		255

Table C-97. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_Transect* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Transect	Text		2

Table C-98. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_TransectProfile* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Transect	Text		5

Table C-99. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_VegCoverCategories* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Number		1
Description	Text		50

Table C-100. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_VegTypeCategories* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Code	Text		1
Type	Text		30

Table C-101. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *tlu_WaterYear* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
Date_ddmmyyyy	Text	Current date dd/mm/yyyy	255
Date_mmddyyyy	Text	Current date mm/dd/yyyy	255
DateNum_yyyymmdd	Number	Current date yyyymmdd	8
Year	Text	Current date yyyy	255
Month	Text	Current date mm	255
Day	Text	Current date dd	255
JulianDate	Text	Julian year date ###	10
JulianDate_inWaterYear	Text	Water year date ###	10
CurrentYear	Number	Current date yy	8
CurrentYear_PlusOne	Number	Current date yy +1	8
WaterYear_First	Text	First year in water year yy	255
WaterYear_Second	Text	Second year in water year yy	255
WaterYear_Code	Text	First and second water years yyyy	255
Season	Text	Water year date - Season	255

Table C-102. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *Species_Benthos_TaxaAttributes* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
sort	Number		8
Original_OTU	Text		255
Original_Rank	Text		255
ORIG_CODE	Text		255
OriginalNotUnique	Number		8
Original_ID_Modified	Number		8
Original_TSN	Number		8
Original_NPS_TSN	Number		8
Original_NPS_AcceptedTSN	Number		8
Original_NPS_Accepted_Name	Text		255
Original_OTU_Phylum	Text		255
Original_OTU_Class	Text		255
Original_OTU_Family	Text		255
Original_OTU_Order	Text		255
Original_OTU_Warm	Number		8
Original_OTU_STI	Number		8
Original_OTU_MT	Text		255
Original_OTU_MI	Number		8
Original_OTU_EPA_ FFG	Text		255
Original_OTU_EPA_NW_HBI	Number		8
Original_OTU_MT_FFG	Text		255
Original_OTU_FFG	Text		255
Original_OTU_BI	Number		8
Original_OTU_NAT_TOL	Number		8
Original_OTU_MW_TOL	Number		8
Original_OTU_NW_TOL	Number		8
ROMN_Rank	Text		255
ROMN_OTU	Text		255
ROMN_CODE	Text		255
ROMNNotUnique	Number		8
ROMN_OTU_TSN	Number		8
ROMN_NPS_TSN	Number		8
ROMN_NPS_AcceptedTSN	Number		8
ROMN_NPS_Accepted_Name	Text		255
ROMN_OTU_Phylum	Text		255
ROMN_OTU_Class	Text		255

Field Name	Field Type	Description	Size (# chars)
ROMN_OTU_Family	Text		255
ROMN_OTU_Order	Text		255
ROMN_OTU_Warm	Number		8
ROMN_OTU_STI	Number		8
ROMN_OTU_MT	Text		255
ROMN_OTU_MI	Number		8
ROMN_OTU_EPA_ FFG	Text		255
ROMN_OTU_EPA_NW_HBI	Number		8
ROMN_OTU_MT_FFG	Text		255
ROMN_OTU__BI	Number		8
ROMN_OTU_NAT_TOL	Number		8
ROMN_OTU_MW_TOL	Number		8
ROMN_OTU_NW_TOL	Number		8
MMI_OTU	Text		255
RIVPACS_OTU	Text		255

Table C-103. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *Species_Benthos_TaxaList* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
sort	Number		8
OTU	Text		255
Unknown	Text		255
Rank	Text		255
TSN	Number		8
HighestClassification	Text	(family,order, class,phylum, ect)	255
Phylum	Text		255
Class	Text		255
Family	Text		255
Order	Text		255
NPSTSN	Number		8
NPS_AcceptedTSN	Number		8
NPS_Accepted_Name	Text		255

Table C-104. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *Species_Periphyton_Algae* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
sort	Number		8
AddedIn	Number		8
NPSBAHLS_CODE	Text		255
BahlsCounter	Number		8
TSN	Number		8
Note	Text		255
Level	Text		255
NewToScience	Text		255
Unknown	Text		255
Taxon	Text		255
GenusSpecies	Text		255
Genus	Text		255
Species	Text		255
Form	Text		255
SpeciesVarietyForm	Text		255
Synonym	Text		255
Author	Text		255
Reference	Text		255
NPS_AcceptedTSN	Number		8
NPS_AcceptedName	Text		255

Table C-105. Field names, types, descriptions, and size properties for all fields in the ROMN SEI Database *Species_Periphyton_Diatoms* lookup table. Lookup tables provide static lists of repeated values used to populate targeted fields in the core NRDT Event-based tables. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
sort	Number		8
AddedIn	Number		8
NPSBAHLS_CODE	Text		255
BahlsCounter	Number		8
TSN	Number		8
Level	Text		255
NewToScience	Text		255
Unknown	Text		255
Taxon	Text		255

Field Name	Field Type	Description	Size (# chars)
GenusSpecies	Text		255
Genus	Text		255
Species	Text		255
Form	Text		255
SpeciesVarietyForm	Text		255
Synonym	Text		255
Author	Text		255
Reference	Text		255
NPS_AcceptedTSN	Number		8
NPS_AcceptedName	Text		255
TSNold	Number		8
Pollution Tolerance Class	Number		8
Habitat	Text		255
pH	Number		8
Salinity	Number		8
Nitrogen Uptake Metabolism	Number		8
Oxygen Requirements	Number		8
Saprobity	Number		8
Trophic State	Number		8
Moisture	Number		8
Motility	Text		255
Distribution	Text		255
GLACIncreaser	Text		255
MountainGeneralIncreaser	Text		255
MountainMetalsIncreaser	Text		255
MountainNutrientIncreaser	Text		255
MountainSedimentIncreaser	Text		255

Water Quality Logger Database Schema and Tables

The ROMN Water Quality Logger Database is used to manage data obtained from *in situ* water physiochemistry loggers. The process for processing data in water quality loggers into the ROMN Master Water Quality Logger Database is outlined in: *SEI SOP 14: Processing In Situ Water Physiochemistry Loggers*.

The basic schema and tables for the Master Water Quality Logger Database are outlined below.

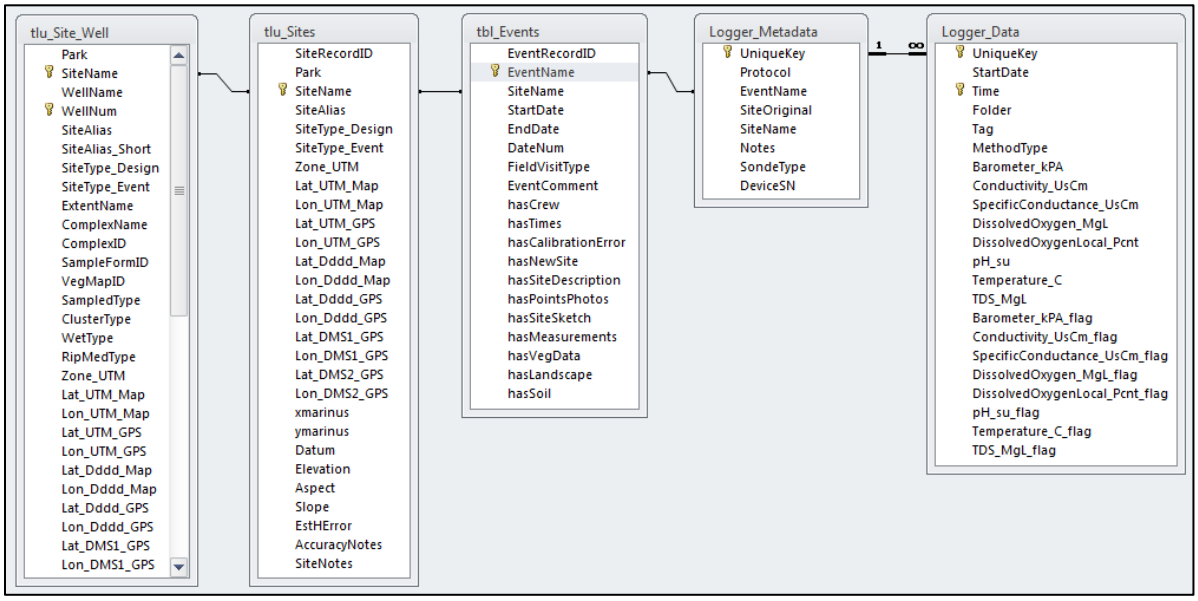


Figure C-8. Diagram showing the ROMN Master Water Quality Logger Database (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-106. Field names, types, descriptions, and size properties for all fields in the ROMN Master Water Quality Logger Database *tbl_Events* table. Not all fields have descriptions, especially those with self-explanatory field names.

Field Name	Field Type	Description	Size (# chars)
EventRecordID	Auto Number	Sampling event ID code	4
EventName	Text	event long name...Site_DateNum_VisitType (Key Field)	50
SiteName	Text	also the main wellID	50
StartDate	Date/Time	Date (mm/dd/yy) when sampling began	8
EndDate	Date/Time	Date (mm/dd/yy) when sampling ended	8
DateNum	Text	calculated date num	20
FieldVisitType	Text	Full, Revisit-Full, Revisit-Partial, Partial, QAQC, 1st Year	100
EventComment	Memo	description of what was done, form and PDA notes	0
hasCrew	Yes/No	the field crew at the event	1

Field Name	Field Type	Description	Size (# chars)
hasTimes	Yes/No	the start and end times of each part of the event	1
hasCalibrationError	Yes/No	Form#0 - related table currently in Excel	1
hasNewSite	Yes/No	types,status,plot shift, evaluation, GPS, Done at new sites only	1
hasSiteDescription	Yes/No	weather, ambient barometric air pressure, monuments	1
hasPointsPhotos	Yes/No	photos collected at during the event	1
hasSiteSketch	Yes/No	Sketch of the Site	1
hasMeasurements	Yes/No	well measurements	1
hasVegData	Yes/No	econab vegetation data, herbivory	1
hasLandscape	Yes/No	form 8- site and complex level disturbance and landscape	1
hasSoil	Yes/No	soil horizon and samples	1

Table C-107. Field names, types, descriptions, and size properties for all fields in the ROMN Master Water Quality Logger Database *Logger_Metadata* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
UniqueKey	Text	(Key Field)	255
Protocol	Text		255
EventName	Text		255
SiteOriginal	Text		255
SiteName	Text		255
Notes	Text		255
SondeType	Text		255
DeviceSN	Number		8

Table C-108. Field names, types, descriptions, and size properties for all fields in the ROMN Master Water Quality Logger Database *Logger_Data* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
UniqueKey	Text	(Key Field)	255
StartDate	Date/Time		8
Time	Date/Time	(Key Field)	8
Folder	Text		255
Tag	Text		255
MethodType	Text		255
Barometer_kPA	Text		255
Conductivity_UsCm	Text		255

Field Name	Field Type	Description	Size (# chars)
SpecificConductance_UsCm	Text		255
DissolvedOxygen_MgL	Text		255
DissolvedOxygenLocal_Pcnt	Text		255
pH_su	Text		255
Temperature_C	Text		255
TDS_MgL	Text		255
Barometer_kPA_flag	Text		255
Conductivity_UsCm_flag	Text		255
SpecificConductance_UsCm_flag	Text		255
DissolvedOxygen_MgL_flag	Text		255
DissolvedOxygenLocal_Pcnt_flag	Text		255
pH_su_flag	Text		255
Temperature_C_flag	Text		255
TDS_MgL_flag	Text		255

Table C-109. Field names, types, descriptions, and size properties for all fields in the ROMN Master Water Quality Logger Database *tlu_Sites* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
SiteRecordID	Auto Number		4
Park	Text		255
SiteName	Text	(Key Field)	255
SiteAlias	Text		255
SiteType_Design	Text	original design type	255
SiteType_Event	Text	how we are treating the site. Sent.Satellite are samples yearly as partial events (loggers usually). Sent.Survey are are treated as Sent sites. Rel have no wells.	255
Zone_UTM	Number		8
Lat_UTM_Map	Number		8
Lon_UTM_Map	Number		8
Lat_UTM_GPS	Number		8
Lon_UTM_GPS	Number		8
Lat_Dddd_Map	Number		8
Lon_Dddd_Map	Number		8
Lat_Dddd_GPS	Number		8
Lon_Dddd_GPS	Number		8
Lat_DMS1_GPS	Text		255

Field Name	Field Type	Description	Size (# chars)
Lon_DMS1_GPS	Text		255
Lat_DMS2_GPS	Text		255
Lon_DMS2_GPS	Text		255
xmarinus	Number		8
ymarinus	Number		8
Datum	Text		255
Elevation	Number		8
Aspect	Number		8
Slope	Number		8
EstHError	Number		8
AccuracyNotes	Text		255
SiteNotes	Text		255

Table C-110: Field names, types, descriptions, and size properties for all fields in the ROMN Master Water Quality Logger Database *tlu_Site_Well* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
Park	Text		255
SiteName	Text	(Key Field)	255
WellName	Text		255
WellNum	Number	(Key Field)	8
SiteAlias	Text		255
SiteAlias_Short	Text		255
SiteType_Design	Text	original design type	255
SiteType_Event	Text	how we are treating the site. Sent.Satellite are samples yearly as partial events (loggers usually). Sent.Survey are are treated as Sent sites. Rel have no wells.	255
ExtentName	Text		255
ComplexName	Text		255
ComplexID	Text		255
SampleFormID	Text		255
VegMapID	Text		255
SampledType	Text		255
ClusterType	Text		255
WetType	Text	ROMN's wet type	255
RipMedType	Text		255
Zone_UTM	Text		255
Lat_UTM_Map	Number	Lat for the site. Use this for mapping.	8
Lon_UTM_Map	Number	Lon for the site. Use this for mapping.	8

Field Name	Field Type	Description	Size (# chars)
Lat_UTM_GPS	Number	Lat for the well. Use this for reporting.	8
Lon_UTM_GPS	Number	Lat for the well. Use this for reporting.	8
Lat_Dddd_Map	Number		8
Lon_Dddd_Map	Number		8
Lat_Dddd_GPS	Number		8
Lon_Dddd_GPS	Number		8
Lat_DMS1_GPS	Text		255
Lon_DMS1_GPS	Text		255
Lat_DMS2_GPS	Text		255
Lon_DMS2_GPS	Text		255
Elevation_GIS	Number		8
Aspect_GIS	Number		8
Slope_GIS	Number		8
Aspect_Field	Number		8
Slope_Field	Number		8
Watershed_ID	Text		255
Catchment_ID	Text		255
CatchmentArea	Number		8
MDCATY	Text		255
WET_TYPE	Text	originated in GIS	255
HydroRegime	Text		255
StreamClass	Text		255
PRETYPE	Text		255
POSTTYPE	Text		255
STRATUM	Text		255
PANEL	Text		255
EVALSTATUS	Text		255
EVALREASON	Text		255
EvalUnit	Text		255
ImpactReference	Text	Notes on impacted vs reference (source xls also had random attributes in this field)	255
Inactive	Number	Year the site was retired from WEI	2
Active	Auto Number	Year the site activated	4
Primary	Yes/No		1
SiteNotes	Text		255
ComplexID_Notes	Text		255

HOBO Logger Database Schema and Tables

The ROMN HOBO Logger Database is used to manage data obtained from HOBO temperature loggers. The process for processing data in water quality loggers into the ROMN Master HOBO Logger Database is outlined in: *SEI SOP 15: Processing HOBO Water Temperature Loggers*.

The basic schema and tables for the Master HOBO Logger Database are outlined below.

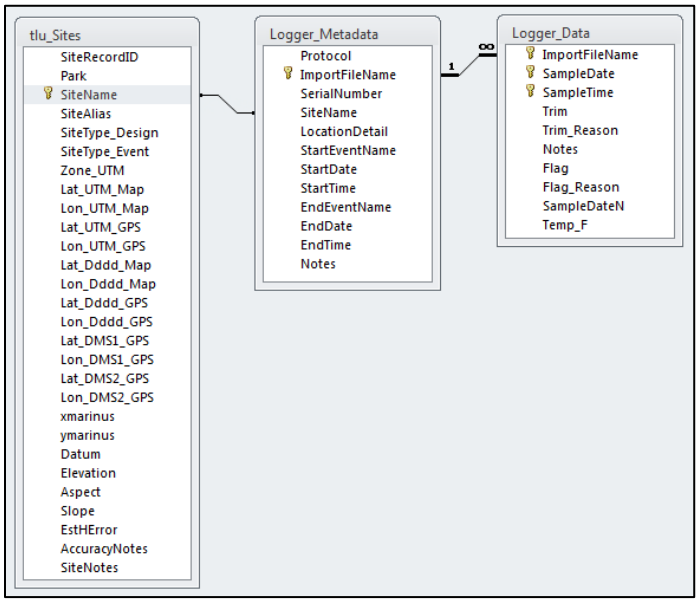


Figure C-9. Diagram showing the ROMN HOBO Logger Database (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-111: Field names, types, descriptions, and size properties for all fields in the ROMN HOBO Logger Database `tlu_Sites` table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
SiteRecordID	Auto Number		4
Park	Text		255
SiteName	Text	(Key Field)	255
SiteAlias	Text		255
SiteType_Design	Text	original design type	255
SiteType_Event	Text	how we are treating the site. Sent.Satellite are samples yearly as partial events (loggers usually). Sent.Survey are are treated as Sent sites. Rel have no wells.	255
Zone_UTM	Number		8
Lat_UTM_Map	Number		8
Lon_UTM_Map	Number		8
Lat_UTM_GPS	Number		8
Lon_UTM_GPS	Number		8

Field Name	Field Type	Description	Size (# chars)
Lat_Dddd_Map	Number		8
Lon_Dddd_Map	Number		8
Lat_Dddd_GPS	Number		8
Lon_Dddd_GPS	Number		8
Lat_DMS1_GPS	Text		255
Lon_DMS1_GPS	Text		255
Lat_DMS2_GPS	Text		255
Lon_DMS2_GPS	Text		255
xmarinus	Number		8
ymarinus	Number		8
Datum	Text		255
Elevation	Number		8
Aspect	Number		8
Slope	Number		8
EstHError	Number		8
AccuracyNotes	Text		255
SiteNotes	Text		255

Table C-112: Field names, types, descriptions, and size properties for all fields in the ROMN HOBO Logger Database *Logger_Metadata* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
Protocol	Text		255
ImportFileName	Text	This is the ONLY key field. None of the other information is known at the time of import. (Key Field)	255
SerialNumber	Text	This will be populated from Expecting tbl after data are uploaded into Data tbl. This happens during yearly data gathering process.	255
SiteName	Text		255
LocationDetail	Text		255
StartEventName	Text		255
StartDate	Date/Time		8
StartTime	Date/Time		8
EndEventName	Text		255
EndDate	Date/Time		8
EndTime	Date/Time		8
Notes	Text		255
Protocol	Text		255
ImportFileName	Text		255

Field Name	Field Type	Description	Size (# chars)
SerialNumber	Text		255
SiteName	Text		255
StartEventName	Text		255
StartDate	Date/Time		8
StartTime	Date/Time		8
EndEventName	Text		255
EndDate	Date/Time		8
EndTime	Date/Time		8
LocationDetail	Text		255
Notes	Text		255

Table C-113: Field names, types, descriptions, and size properties for all fields in the ROMN HOBO Logger Database *Logger_Data* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
ImportFileName	Text	(Key Field)	255
SampleDate	Date/Time	(Key Field)	8
SampleTime	Date/Time	(Key Field)	8
Trim	Yes/No		1
Trim_Reason	Text		255
Notes	Text		255
Flag	Yes/No		1
Flag_Reason	Text		255
SampleDateN	Auto Number		4
Temp_F	Number		8

SEI Photo Database Schema and Tables

The ROMN SEI Photo Database Schema is used to manage data obtained from HOBO temperature loggers. The process for processing data in water quality loggers into the ROMN SEI Photo Database is outlined in: *SEI SOP 16: SEI Photo Management*.

Multiple versions of the working SEI Photo Database are maintained by ROMN.

1) The master working SEI Photo Database, containing information for all sampling years, is stored at: *Z:\MONITORING\Streams\Images\Photos*.
2) An annual certified version of the SEI Photo Database is stored at: *Z:\MONITORING\Streams\Data\Certified\FY##*.
3) Seprarate working copies are maintained for annual data entry and QAQC at: *Z:\MONITORING\Streams\Data\DataGathering\Photos*.
4) All versions of the SEI Photo Database share the same basic schema as outlined in figures and tables below.

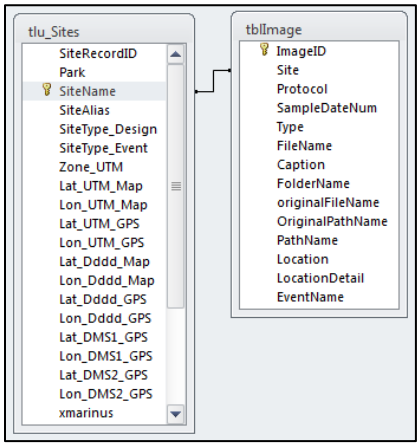


Figure C-10. Diagram showing the ROMN SEI Photo Database (does not show lookup tables, temporary working tables, or pilot project tables that contain non-related legacy data).

Table C-114: Field names, types, descriptions, and size properties for all fields in the ROMN HOBO Logger Database *tlu_Sites* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
SiteRecordID	Auto Number		4
Park	Text		255
SiteName	Text	(Key Field)	255
SiteAlias	Text		255
SiteType_Design	Text	original design type	255

Field Name	Field Type	Description	Size (# chars)
SiteType_Event	Text	how we are treating the site. Sent.Satellite are samples yearly as partial events (loggers usually). Sent.Survey are are treated as Sent sites. Rel have no wells.	255
Zone_UTM	Number		8
Lat_UTM_Map	Number		8
Lon_UTM_Map	Number		8
Lat_UTM_GPS	Number		8
Lon_UTM_GPS	Number		8
Lat_Dddd_Map	Number		8
Lon_Dddd_Map	Number		8
Lat_Dddd_GPS	Number		8
Lon_Dddd_GPS	Number		8
Lat_DMS1_GPS	Text		255
Lon_DMS1_GPS	Text		255
Lat_DMS2_GPS	Text		255
Lon_DMS2_GPS	Text		255
xmarinus	Number		8
ymarinus	Number		8
Datum	Text		255
Elevation	Number		8
Aspect	Number		8
Slope	Number		8
EstHError	Number		8
AccuracyNotes	Text		255
SiteNotes	Text		255

Table C-115: Field names, types, descriptions, and size properties for all fields in the ROMN HOBO Logger Database *tbl_Image* table. Not all fields have descriptions, especially those with self-explanatory field names

Field Name	Field Type	Description	Size (# chars)
ImageID	Auto Number	(Key Field)	4
Site	Text		50
Protocol	Text		50
SampleDateNum	Text		255
Type	Text		255
FileName	Text		50
Caption	Text		0
FolderName	Text		255
originalFileName	Text		255

Field Name	Field Type	Description	Size (# chars)
OriginalPathName	Text		255
PathName	Text		255
Location	Text	"A";"B";"C";"D";"E";"F";"G";"H";"I";"J";"K";"XA";"XB";"XC";"XD";"XE";"XF";"XI";"XJ";"XK";"Unk"	255
LocationDetail	Text	U;D;L;R;Unk	255
EventName	Text		255

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 960/131484, February 2016

National Park Service
U.S. Department of the Interior

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