

III. Stream Condition Inventory Procedures

A. Pre-Field Procedures

Step 1. Determine What and Where to Inventory

Locating SCI reaches should consider the combination of management issues and anticipated management effects, stream sensitivity to those effects, and aquatic/riparian resource values of candidate watersheds and streams. Consideration of these factors may be a complex task. Two key steps need to be completed:

Determine Resource Values – Identify values most likely to be affected by management. This often requires an understanding of the resource values (i.e. fish stocks, amphibian populations) from large scales such as a river basin to small scales such as fish spawning sites, and edgewater pools for amphibian rearing.

Identify Sensitive Areas – Determine channel sensitivities relative to the resource values and anticipated management effects. For instance, a watershed might be stratified differently if the effect of concern is temperature (stratification by vegetation types), rather than sediment (where an erosion hazard based stratification might be used).

Resource values and sensitivity should be documented prior to fieldwork to help determine if SCI attributes or other stream attributes should be the focus of the effort. SCI is a set of protocols for measuring many attributes of channel and aquatic habitat conditions, but is not a complete list. SCI is a useful tool in many cases, but not all cases.

Step 2. Identify Watersheds to Inventory

Select watersheds for inventory that are of highest priority. Selection can be based on: (1) management activities of interest; (2) aquatic communities of interest; (3) watersheds of a particular type; (4) interest in establishing baseline or reference conditions; (5) a combination of these criteria.

Step 3. Characterize the Watershed

Collect existing watershed information including maps, aerial photos, past inventories (fish, watershed, soil, and vegetation surveys), and specialist knowledge on the watershed. This information is useful for describing basin history, stratifying or classifying streams and their basins, and describing existing information on stream and basin condition.

Step 4. Identify Stream Reaches to Inventory

Identify stream reaches that are most likely to display change based on analyses of channel morphology, biological communities and processes, and existing or proposed management activities. These are referred to as sensitive reaches and will be a high priority when determining stream condition inventory needs in a watershed. Also identify any stream reaches that may be considered reference reaches. These are streams or stream segments that are not noticeably disturbed by management activities, or may have recovered from historic management disturbances. This is an important stratification since the number of reference reaches is limited at both the forest and regional scale. Reference reaches are useful for comparison with non-reference reaches and in establishing a regional database of reference conditions for SCI attributes.

Reach Definitions:

- Reach – Any specified length of stream
- Sensitive reach – A reach that is likely to show change that relates to the inventory objective and is uniform in terms of channel and valley form characteristics.
- Survey segment – A section of a sensitive reach. Where sensitive reaches are shorter than 1,000 m, a subset of the SCI attributes is measured in this section. (Sample design

testing during protocol development showed that only some attributes need to be measured throughout long sensitive reaches).

- Reference reach – A reach that is undisturbed or is minimally disturbed by management activities, or may have recovered from historic management disturbances.
- Non-reference reach – A reach that shows evidence of current management disturbance or has not recovered from past management disturbances.

Step 5. Select Reaches

Select stream reaches that meet the inventory objectives. Selected reaches should meet two criteria: (1) likely to show change relative to question being asked and (2) uniform in terms of geomorphic characteristics (for example, gradient, flow, channel morphology and valley form). Selection should consider the availability of reference reaches with the same characteristics (watershed size, geology, etc.) that will strengthen data interpretation.

Most sensitive reaches selected are usually single thread channels. Reaches that are fully or partially braided should be selected with caution. However, where braiding occurs within a sensitive reach:

- Conduct measurements in the dominant channel (thalweg; most flow, etc.) for all attributes except LWD and cross-sections.
- Conduct LWD and cross-section measurements across all channels to the greatest bankfull width.

An example of sensitive reach selection is illustrated in Figure 9. In the example, vegetation management, road decommissioning, and fish habitat enhancement have all been implemented in the watershed. Managers are interested in both their effectiveness and their cumulative impact on channel condition. The stream increases in gradient as it ascends the watershed (moving from reach “A” to reach “H”). Downstream of reach “F,” lower gradient channel conditions are present. As lower gradient streams (and especially those with fine textured bank material) are most sensitive to changes in flow and sediment, these reaches are most likely to change as a result of management activity. Reach “E” is the closest lower gradient channel to the management activities, and therefore has the greatest potential for change in response to the activities. The upstream (lowest gradient) portion of reach “E,” a gravel bed channel type with a 1.5% gradient (e.g., C4 [Rosgen]; Response [Montgomery and Buffington]), is the likely candidate for sensitive reach designation.

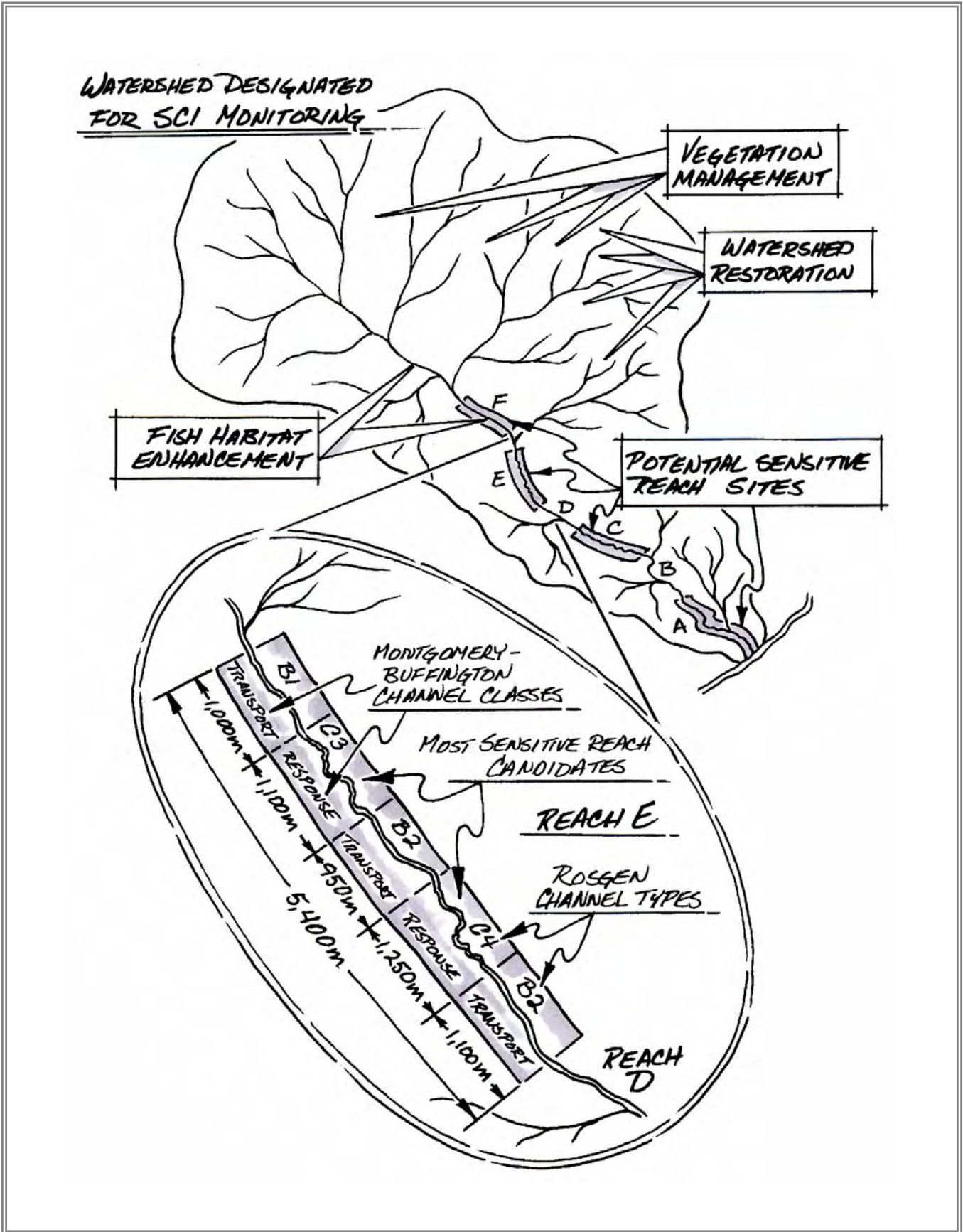


Figure 9 – Sensitive Reach Designation

Step 6. Determine the Length of the Sensitive Reach

Use GIS or other methods to estimate the length of the sensitive reach.

Maximum Length – While there is no maximum length, sensitive reaches greater than 2,500 m should be double-checked for uniformity of channel conditions. If uniformity is correct, sensitive reaches cannot be arbitrarily shortened.

Minimum Length – The recommended minimum length is 500 m if pools are key condition attributes of the sensitive reach. Reaches as short as 100 m are acceptable, provided LWD and pools are not key attributes.

Step 7. Survey Safety

Surveying streams can be hazardous at any flow. Survey locations are frequently in remote locations and caution should be taken to minimize the possibility of injuries. It is critical that surveyors have appropriate field gear and first aid equipment. A Job Hazard Analysis must be prepared prior to fieldwork and reviewed periodically during the survey.

B. Field Procedures

Collecting SCI Attribute data in the field is conducted by using a multiple pass sequence up and down the reach. This is often most efficiently done using the four-pass sequence recommended in Step 3 of this section. While the four-pass sequence is not mandatory, surveyors should first gain experience with it before using alternative methods of collecting the data. The overall objective is to conduct the most efficient and accurate inventory that the four-pass sequence or another alternative may provide. Alternatives to the recommended sequence may be employed depending on crew size, unique reach features, accessibility, etc.

General Notes regarding field procedures:

Protocols – SCI protocols should be carried in the field to help quality assurance.

Units of measure - All measurements are metric.

- **Left and right bank** - Streambanks are referenced looking downstream.
- **Estimated data** – Circle all estimated data (e.g., if pool depth cannot be accurately measured, estimate the depth as closely as possible and circle it on the data form).
- **Photographs** – Surveyors should be familiar with cameras and photo techniques (Hall 2001) since photos provide valuable supplemental information and context to SCI data.
- **Cleaning equipment** – Survey equipment should be cleaned between site visits. See Appendix C for a recommended cleaning protocol.
- **To establish a new SCI reach** follow steps 1-6 below. If the reach is being remeasured, proceed to step 3.

Step 1. Conduct Reach Reconnaissance

The reach reconnaissance is a preliminary walk-through of the sensitive reach before selecting the start of the sensitive reach and starting the pass sequence to collect data.

Make sure to stay out of the water on the reach reconnaissance so that attributes that will be measured later are not disturbed.

A reach reconnaissance should be conducted whenever the reach is unfamiliar or its validity is uncertain. It can even be a good idea to do a reconnaissance on a familiar reach when time permits.

Key observations to make on the reach reconnaissance are as follows:

- Reach validation – observe whether or not the sensitive reach delineated in the office is valid for inventory by considering the following:
- Stream type – if there are anomalies in geomorphic characteristics of the reach, apply the following rule:
“10% Rule”: If inclusions of different channel types or other anomalies are less than or equal to ten percent of the sensitive reach, include them in the Sensitive Reach. If they compose greater than ten percent of the reach length, break the channel into separate sensitive reaches. For example, a 1,300 m low gradient meadow stream channel has a moderate gradient bedrock section of 70 m midway in the reach. Since this is less than 10% of the reach length, include it as part of the reach.
- Stream tributaries – observe if there is an increase in stream order and/or substantial streamflow along the reach. If so, break it into separate reaches.
- Abnormalities – determine if there are any other unusual circumstances that would render the reach invalid. This could be a change in the character of the reach from some recent disturbance, a lack of suitable cross-section locations, or some other change in status of the reach.
- Reach overview – observe the character and condition of SCI attributes. This is often very useful when later measuring attributes. For example, what are the characteristics of pools and riffles in the reach (numbers, length, etc.), are there many candidate cross-section sites, are streambanks generally stable, and does the reach have a high or low width-to-depth ratio?
- Reach length estimation – if the reach length needs to be changed based on findings of the reach reconnaissance, estimate the length of the revised reach by pacing or GPS.
- Candidate cross-section locations – it may be useful to flag runs within fast water habitat types as candidate locations for cross-section, width-to-depth, and entrenchment measurements during the reach reconnaissance. Although this can be done on Pass 1, it may make that pass more efficient if done at this time.
- Bankfull width estimation – observe bankfull stage indicators in several locations along the reach. Visually estimate average bankfull width for the reach, or measure it where possible without entering the water (i.e., using log crossings). This will identify the minimum length of LWD to count (if large wood is counted), and provide an understanding of bankfull stage when later measuring cross-sections, width-to-depth, and entrenchment.
- Aquatic fauna – look for herptofauna and fish since they are often found during the first walk up a stream reach.

Step 2. Document the Start of the Sensitive Reach

Once the reconnaissance pass has been made the precise location of the start of the sensitive reach can be identified and documented (georeference, benchmark/bearing/distance, photographs and permanent monument). This will provide sufficient information for others to come back in subsequent years and find the start of the sensitive reach. Identification and documentation of this site is essential for long term monitoring.

Step 3. Collect Stream Data

The SCI four-pass sequence is described below. Each pass consists of a list of attributes to be measured, tasks, and equipment needed. In some cases, tasks conducted on one pass set up attribute measurements on the next pass.

There are 10 SCI Forms to be completed for each sensitive reach surveyed. Refer to Appendix G for sample forms and instructions. The form numbers applicable to each pass are identified below. Note that Form 1, Sensitive Reach Layout, is filled out when the survey is completed. Form 10, Photo Log and Comments, is filled out as the survey progresses. Photos are required when filling out forms 1, 2 and 5, and comments can be entered at any time.

Equipment required for each pass is described below. A complete equipment list for conducting SCI is provided in Appendix B.

Pass 1. (Upstream – Sensitive Reach)

Attributes to Measure:

- 1) Macroinvertebrates
- 2) Particle Size Distribution
- 3) Stream Temperature (optional attribute)
- 4) Large Woody Debris (LWD)

Forms Needed:

Form 1 – Sensitive Reach Layout (may be completed after reach inventory)

Form 2 – Macroinvertebrates

Form 3 – Particle Count

Form 4 – Cross-section and Width-to-depth Candidate Sites, and LWD

Form 10 – Sensitive Reach Photo Log (for Form 1 and 2 photos)

Tasks:

- 1) Conduct macroinvertebrate sampling in the first four riffles upstream of the start of the sensitive reach that meets the riffle identification criteria in the macroinvertebrate protocol. In order to maintain an undisturbed streambed when sampling this attribute, stay out of the water until this attribute is measured. Record macroinvertebrate information on Form 2.
- 2) Conduct particle count in the same four riffles where macroinvertebrate sampling occurred. Record data on Form 3.
- 3) Measure stream temperature (optional attribute) by installing a thermograph at the start of the sensitive reach. Note: there is no form for this attribute.
- 4) Measure the length of the sensitive reach along the thalweg using a hip chain.
- 5) While measuring the length of the sensitive reach, record the following information on Form 4:
 - a. Candidate locations for cross-sections and width-to-depth/entrenchment measurements within fast water habitat units. Number these sites progressively and mark with survey flags.
 - b. Large woody debris.
- 6) At the end of the sensitive reach, select sites for the cross-section and width-to-depth/entrenchment measurements. If more than three fast water habitat units are identified, randomly select three for cross-section measurements. From any remaining candidate sites, randomly select up to five for width-to-depth and entrenchment measurements. If three or fewer candidate sites have been identified measure them all as cross-sections (width-to-depth/entrenchment measurements are not taken).

7) At the end of the sensitive reach, select the survey segment if the sensitive reach is greater than 1,000 m. If the sensitive reach is longer than 1,000 m, randomly locate the survey segment within the sensitive reach. To do so, subtract 1,000 m from the length of the sensitive reach just measured (the survey segment is 1,000 m). For example, if the sensitive reach is 1,750 m long, subtracting 1,000 m equals 750 m. Use a random number table (Appendix D), or a calculator to generate a random number between 0 and 750. The selected number is the distance from the downstream end of the sensitive reach where the survey segment will begin. Thus, if the selected random number is 350 m, the survey segment begins at 350 m upstream from the start of the sensitive reach and ends at 1,350 m along the 1,750 m sensitive reach.

Equipment Needed:

- Metric tape
- Forms
- Gravel template
- Survey flags
- Pencils/markers
- Camera
- Depth rod
- Hip chain (string machine)
- Thermograph (optional)
- Macroinvertebrate sampling apparatus (separate equipment list)

Pass 2. (Downstream – Sensitive Reach)

Attributes to Measure:

- 1) Cross-section
- 2) Bankfull Stage
- 3) Water Surface Gradient
- 4) Width-to-depth Ratio
- 5) Entrenchment

Forms Needed:

Form 5 – Cross-section and Water Surface Gradient

Form 6 – Cross-section Diagram and Location Sketch

Form 7 – Width-to-depth Ratio and Entrenchment Ratio

Form 10 – Sensitive Reach Photo Log (for Form 5 photos)

Tasks:

- 1) Progressing along the pass, locate the cross-sections and the width-to-depth ratio/entrenchment sites that were randomly selected.
- 2) Identify bankfull stage in the immediate area of each cross-section and width-to-depth/ entrenchment sites so that it can be properly located when conducting measurements. Make sure to look for bankfull stage at several locations to increase the confidence that bankfull stage has been identified correctly.

- 3) Take cross-section and water surface gradient measurements at the selected cross-section sites. Record all data, plus calculations of width-to-depth and entrenchment ratios, on Form 5. Diagram and sketch each cross-section on Form 6.
- 4) Measure width-to-depth and entrenchment ratios at selected sites on reaches with more than three candidate sites. Record the data on Form 7.

Equipment Needed:

- Metric tape
- Two depth rods with levels
- Forms and pencils
- Permanent benchmark equipment (rebar and caps, etc.)
- Flagging or survey flags
- Hand level and tripod, or survey level and tripod
- String/string level
- Camera
- Bankfull identification survey flags or flagging
- Clamps

Pass 3. (Upstream – Survey Segment)

Note: Photograph the start and end of the survey segment on reaches greater than 1,000 m. It is important that these locations are documented for future measurements of the segment. Take photographs up and downstream, from both banks, and at any other location that will help relocate the sites.

Attributes to Measure:

- 1) Habitat Types
- 2) Pools
- 3) Pool Tail Surface Fine Sediment

Forms Needed:

Form 8 – Pools and Pool Tail Surface Fine Sediment

Tasks:

- 1) Continuously measure fast and slow water habitat units from the start to the end of the survey segment.
- 2) Record pool data at each pool (slow water habitat unit): maximum depth, pool tail crest depth, and if the pool is wood-formed.
- 3) Measure the percent of pool tail surface fine sediment at each pool.
- 4) Record all data on Form 8.
- 5) Flag the end of the survey segment to note the starting point for the start of Pass 4.

Equipment Needed:

- Metric tape
- Forms
- Pencils
- Depth rod

- Hip chain (string machine)
- Pool tail fine sediment grid
- 2 mm diameter pointer (engineering survey flag rod is 2 mm diameter)
- Viewing tube

Pass 4. (Downstream – Survey Segment)

Attributes to Measure:

- 6) Streambank Stability
- 7) Stream Shading
- 8) Streamshore Water Depth
- 9) Bank Angle
- 10) Aquatic Fauna

Forms Needed:

Form 9 – Streambank Stability, Stream Shading, Streamshore Water Depth, Streambank Angle, Aquatic Fauna

Tasks:

- 1) Measure the first four attributes listed above at each of 50 equally spaced transects in the survey segment. (Recall that streamshore water depth and streambank angle are measured only on low gradient reaches with fine textured streambanks).

Notes on delineating transect intervals:

- The interval between transects is determined by dividing the length of the survey segment by 50 (e.g., an 800 m survey segment would yield a 16 m interval).
 - Transect intervals must always be at least bankfull width. Lesser intervals compromise the independence of the individual measurements. For example, if a survey segment is 150 m and the bankfull width is 5 m, the correct interval would be 5 m and 30 transects would be established. Spacing 50 transects at 3 m intervals is incorrect. Though the statistical confidence may decrease with fewer than 50 transects, the independence of the measurements is retained.
- 2) Record any aquatic fauna observed at each transect. Denote by species codes in Appendices C and D.
 - 3) Record all data on Form 9.

Equipment Needed:

- Depth rod
- Pencil
- Form 9
- Solar pathfinder
- Metric tape
- Clinometer

Supplemental Pass (Upstream – Survey Segment)

This is the recommended time to do V^* if this optional attribute is measured. It is very intensive and thus was not recommended for measurement during Pass 3 when pools were measured. V_w^* would be measured in the slow water habitat units that were

measured in Pass 3. Refer to the V^*_w publication for instructions on measuring this attribute.

C. Post-Field Procedures

Step 1. Data Check

After data collection is completed, the crew leader should thoroughly check the data forms in the field. Make sure Form 1 has been completed before leaving the reach. Data entries should be complete and legible. There should be documentation of photographs taken at the start and end of the sensitive reach and survey segment, at channel cross-sections, and at the macroinvertebrate sample sites. If some data was not collected, adjustments to procedures had to be made for any reason, or if there were questions about the site or sampling during data collection, they should be noted on the data sheets.

An office review of all data shall be conducted. This review should include any comments or questions on the data sheets, as well as an initial review of the data to check for obvious errors, or results that might require follow up. Data should be checked to make sure it is complete and legible, and ready for electronic entry. Back-up documentation (maps, location notes, photographs) should also be checked for presence and accuracy.

Step 2. Data Entry

Data entry will be made into the Water Module of the NRIS database.

D. Remeasurement of SCI Reaches

One of the primary objectives of SCI is to assess changes in streams over time such as before and after implementation of management activities. SCI reaches are often established for this purpose. SCI reference reaches can also be remeasured to determine if change has occurred without the influence of management. Reference reaches can be compared for changes over time and/or with applicable non-reference reaches.

Remeasurement of SCI reaches requires some additional tasks and quality control considerations not involved when initially establishing a reach. The focus of these tasks is (1) to reduce, to the greatest degree possible, measurement error so that changes over time can be detected and (2) to document differences between repeat measurements that should be considered when evaluating data (i.e., flow conditions at the time initial and repeat measurements were conducted).

Consider the following when planning, taking the measurements, and evaluating data from remeasured reaches:

Review the reach file from previous measurements. This will provide information on the location of the sensitive reach and survey segment, riffles for bioassessment, particle counts, and monumented cross-sections. Comments should be reviewed to see if prior measurements were altered in any way, and to see what time of year and during what flow conditions the reach was measured. In addition, photos from previous surveys will usually be very helpful.

It is recommended that copies of the original and subsequent survey data sheets be taken to the field during the resurvey. That way, decisions about problems that may be encountered in the field can be informed with data from the prior surveys.

If the sensitive reach is longer than 1000 meters, use the survey segment randomly selected during the initial survey. Do not randomly select different survey segments during repeat measurements.

Prior to conducting the repeat measurements, compare the SCI protocols used in each previous survey. Most SCI protocols have remained constant since earlier versions of the protocol, but some protocols have changed. Primary among these is the particle count. Initially, a 100 count using a zig-zag traverse of the lower extent of the sensitive reach was used. The current protocol employs a count of 400 particles from four riffles at the downstream extent of the sensitive reach. If the monitoring plan indicates the particle counts are a primary attribute of interest for data analysis, then consideration should be given to supplementing the current protocol with a particle count using the zig-zag protocol. At the least, this change must be noted in comments to the repeat survey, so it will be recognized during data evaluation and analysis.

Pool data should also be evaluated during repeat measurements. In some stream systems, pools are difficult to consistently identify. In these cases they do not clearly meet (or differ from) the criteria provided in the SCI protocol, and substantial differences can occur in defining pools between crews and over time. Differences in the number of pools measured in a reach will influence not only estimates of pool frequency, but also residual pool depths, and pool tail fines (since different areas and amount of area will be measured). To reduce error, data from previous surveys can be reviewed to see where pools were identified. Obviously, these data will include pool lengths and depths. It is not necessary to duplicate pool "calls" made during previous surveys. It is necessary to recognize differences and note them, so that such differences can be taken into account during data analysis and interpretation.

In summary, remeasurement of SCI reaches is as important as the initial survey. In doing so, it is key to understand the history of the initial and any subsequent surveys. In addition, care must be given to conducting an accurate assessment of current conditions and evaluating differences between surveys over time and in any changes in protocols.