STREAM INVENTORY HANDBOOK

LEVEL I & II

APPENDIX REFERENCE IN TEXT

PACIFIC NORTHWEST REGION
REGION 6
2006 ~ Version 2.6

CONTENTS

CHAPTER 1
Introduction/Overview

BACKGROUND

Periodic, recurring inventories are an integral part of the fish habitat and watershed management programs and form the foundation for effective program management. Inventories should produce comparable information, both between administrative units, as well as across time. They will generate the baseline information that will be used to support a variety of management activities, including, but not limited to; watershed analysis, timber sales, range allotments, special use permitting, and fish habitat and watershed restoration programs. They will also serve as the basis for stream monitoring and evaluation programs. Specifically, inventories will identify existing aquatic and riparian conditions, identify factors limiting the productive capabilities of habitats, measure attainment of meeting stream habitat objectives, and help to assess cumulative watershed effects. The inventories can be used to monitor and refine Land Management Plan Standards and Guidelines.

The Pacific Northwest Region (Region 6) stream inventory is designed on a hierarchical scale to provide the user the opportunity to choose an inventory protocol which meets the data needs for the questions asked. Level I is the basic in-office procedure which identifies standard attributes of the watershed/stream to be analyzed. Its primary objective is to document and consolidate sources of general knowledge of the stream system. Level II is an extensive stream channel, riparian vegetation, aquatic habitat condition and biotic inventory on a watershed-wide scale. This level is to be used to determine the "pulse" or condition of a system during low flow conditions. Level III is an intensive field inventory designed specifically to answer a particular question (i.e., monitoring, project level planning and project design, etc.).

This handbook provides standards for both the level I (office inventory) and level II (field inventory). A level II inventory requires the completion of a level I as a prerequisite. The protocol identifies core attributes that are necessary to evaluate the condition of the stream (mandatory for collection), and non-core, Forest optional attributes. Forests have the flexibility to add attributes to the protocol to meet their needs; however, unit costs and target allocations/accomplishments will be based on the Regional protocol.

Region 6 has produced a recommended protocol for level III inventories, but the methods are not included in this handbook. By contrast, it is recognized that a standardized approach to level IV is inappropriate due of the large variation in data needs that exist. Therefore, procedures for level IV are open to development at the District, Forest, or research unit level.

The purpose of both the level I and level II inventories is to identify existing stream channel, riparian, and aquatic ecosystem conditions on a watershed scale. As inventories are completed and repeated over time, the information generated by them can be useful in measuring changes in stream channel conditions and determining attainment of habitat management objectives, provided stringent quality control administration occurs. In this context, the inventory can be applied as a basic "monitoring" tool.

INVENTORY ATTRIBUTES

Key attributes of the Region 6 level I and II stream inventories were developed considering the following concepts:

Driven by questions that are to be addressed. Identification of management questions formed the basis for the content of the inventory. The ability to address questions consistently and comparably across units has been demanded of the United States Department of Agriculture, Forest Service (FS) by both users and managers of the resources. Inventory and analysis procedures were developed to provide the information necessary to answer those questions.

Contains a consistently applied set of core attributes. The level I and II inventories contain data attributes that were identified by an interagency interdisciplinary team as the most critical for defining stream channel, riparian vegetation, and aquatic resource condition. The core data attributes are likely to be key elements in any future inventory process and can be used to drive a number of aquatic/channel classification systems.

Quantifiable through direct observation. Where practicable, the level II inventory generates quantitative measurements and estimates of channel conditions and habitat attributes.

Statistically valid approach. The level II inventory meets assumptions for standard statistical analysis and results in estimates with known boundaries of error for habitat unit dimensions. It follows a stratified random sampling design and permits extrapolation of known, measured attributes throughout the watershed.

Repeatable. This protocol provides a statistically defensible method for evaluating and minimizing the observer bias inherent in the visually estimated dimensions for habitat units. Quantitative measures for streamflow, bankfull channel dimensions, bank instability, and substrate are intended to further reduce surveyor bias and sampling error. These considerations are intended to reduce the inherent variability surrounding many of the attributes so that replication of sampled attributes will be meaningful across time and space.

Coordinated with other resource areas and management entities. The procedures for these inventories represent an integrated approach between FS watershed and fisheries disciplines in defining stream channel, riparian vegetation, and aquatic resource conditions at the watershed scale. It has been reviewed and is compatible with similar aquatic inventories developed by state agencies, specifically the Oregon Department of Fish and Wildlife (ODFW) and Timber, Fish and Wildlife (TFW) in Washington State. It has been developed as the aquatic companion to the FS Integrated Resource Inventory (IRI), and is comparable with other FS stream inventories developed in Regions 1, 4, and 5. It contains the recently completed “Core Data Standards” developed by an interagency team for implementation of the Northwest Forest Plan.

Cost efficient. The Region-wide average cost to complete this survey is $1,400 per mile. Local conditions such as stream size, channel complexity, location, etc. and contracting of services contribute to a range of costs around this value. These estimates include data collection, data entry, analysis, and report writing. Costs can be considerably higher as Forests add optional attributes that are not considered in the annual allocation of funds from the Region.

ESTABLISHING FOREST PRIORITIES

The stream inventory program is an institutionalized component of the fisheries and watershed programs. A rate of 10 percent of fish-bearing streams per year is prescribed and offers a program that is responsive to management needs. This infers a 10-year re-inventory recurrence interval for all fish-bearing streams.

Forests should consider the following factors in setting priorities for stream inventory:

- Tier 1 and Tier 2 Key Watersheds where Watershed Analysis is to be completed in the near future.
- Sensitivity of fish stocks present.
- Habitat/watershed vulnerability or sensitivity; watersheds that are particularly vulnerable or sensitive to management activities should be a high priority.
- Level of planned activity in the watershed.
- Management plan development (e.g., Wild and Scenic Rivers designation) or agency coordination/cooperation.
- Relative importance of a watershed in terms of fish production or use.
- "Representativeness" of a watershed to others for stratification and extrapolation of information to those systems that are lower priority.
- Size/feasibility of detecting change and managing that change (i.e., it is more difficult to detect change in larger systems and frequently more difficult to mitigate those effects).
- Wilderness or watersheds representing intact, hydrologically functioning systems; to be used in developing numeric ranges for attributes which quantify "Desired Future Conditions."

STREAM INVENTORY PROGRAM MANAGEMENT

Data management. The Regionally developed SMART database has been replaced by the nationwide Natural Resource Inventory System (NRIS). The NRIS database consists of several modules; one of which, WATER, is further divided into four sub-modules. Two of these submodules, Aquatic Inventory (AI) and Aquatic Biota (AB) will store the data collected during Stream Inventory.

Like all electronic software, training is required to ensure the quality of data entered to the database. This handbook identifies the necessary protocols designed to ensure quality data is collected in a standardized fashion. While two companion instructional manuals, *User Guide to NRIS WATER* and *R6 AI/AB Data Entry Guide* are available for guiding the entry of field data into AI and AB, it is essential that all data entry personnel receive formal training in NRIS before attempting to enter field data into the AI and AB sub-modules of the NRIS database.

A series of standard summary tables has been developed within the NRIS database. The tables provide the basic information necessary to characterize stream condition, habitat, and function. Forests and Districts are encouraged to do additional data analysis to explore specific habitat relationships and develop more effective ways of presenting the information. Additional analysis can be done most efficiently by downloading the stream inventory data into a personal computer (PC) environment.

PROGRAM ADMINISTRATION AND QUALITY CONTROL

Stream inventory data are increasingly used to make significant resource management decisions. As such, the reliability and credibility of the information is paramount. Past program reviews have identified potential problems in program management and significant changes have occurred to address these deficiencies. In order to ensure the highest quality of information is provided through the inventory, program and quality control standards have been developed. The following items should be viewed as minimum standards in the annual implementation of the program.

Program Administration

- Forest and District Program Managers ensure data are collected according to standard protocol, the data analyzed, and reports written in a timely fashion.
- Forest and District Program Managers will develop an operational understanding of the inventory protocols.
- Either the Forest hydrologist or fisheries biologist will attend the annual Regional training session.
- Each Forest will establish a stream inventory quality control contact person.
- Each Forest will supplement Regional training with Forest-level training and orientation to ensure comprehension and proper application of the Regional inventory procedures.
- Each Forest will develop a “test reach” as part of Forest-level training.
- See the *R6 Stream Habitat Inventory Quality Assurance/ Quality Control Manual* for specific information on setting up a Quality Control Program.

Pre-Inventory Training Phase

- Each survey member will be given a handbook for review and will be accountable for techniques and terms.
- The context of the level II in the four level hierarchical inventory program will be understood.
- Training in basic map and air photo interpretation for each surveyor will be documented.
- Training in the use and maintenance of necessary equipment for each surveyor will be documented.

Field Inventory Training Phase -- Prior to beginning of the field portion of stream inventory, all crews must demonstrate a proficiency in completing these tasks:

- How to complete all field forms.
- How to take a measured streamflow.
- How to place temperature recording devices.
- How to make bankfull determinations.
- How to conduct a Wolman pebble count.
- How to sample fish populations and correctly identify both fish and amphibian species.
- How to check data sheets to catch chronic data recording errors.
- How to reduce observer bias in estimates of habitat dimensions.

Post-Inventory Training Phase

- How to error-check recorded data.
- How to correctly label slides and photographs.
- How to develop final inventory maps.
- How to enter data to AI and AB.
- How to analyze NRIS AI/AB reports.
- How to write draft reports.

A STANDARD PROTOCOL

Can the survey be repeated? To ensure an affirmative answer, a standard protocol has been adopted for surveys on fish bearing-streams. These protocols are designed to produce a valid and repeatable survey regardless of the surveyors.

Requirements of this standard protocol include:

- An office inventory is the first step.
- Each survey is divided into stream segments called reaches.
- Field surveys occur only during minimum streamflows.
- Stream discharge is measured at least once.
- All habitat lengths of the mainstem channel must be measured.
- All habitats are identified as one of 9 basic types (see number 2 of **Channel Unit Types** under Channel Unit Form, page 35).
- At least 10 pools and 10 riffles must be “measured habitats”.
- Ten percent of pools and riffles must be “measured habitats”.
- Two pebble counts are completed for each reach.
- A biological survey determines the range of fish species throughout the section of inventoried stream.
- NRIS AI/AB, a national database, is the final home for all standard stream inventory data.
- A formal report is written for each stream surveyed.

Exceptions to the Standard Protocol: There are very few exceptions to the standardized methods described throughout this handbook. Management units (forests, districts, National Scenic Areas) are free to collect habitat data in addition to the core attributes integral to this region wide process.

Appendix C of this handbook catalogs the most common "Forest Options".

It is permitted to break the standard protocols for only one reason – SAFETY.

Some examples of safety concerns include:

1. The stream may be too large to safely walk the centerline (or thalweg).
2. A bedrock gorge may provide no safe passage.
3. A stream may be too brushy to walk through the stream safely.

Any deviations from the standard protocols must be documented in the field notes (Remarks Form). These deviations must also be described in the formal stream inventory report.

PRESENTATION OF INFORMATION

The preferred format for summarizing and presenting stream inventory data is the stream inventory report. It contains two basic components, which provide information in a legible, understandable format to two distinct audiences: Line and Staff personnel within the FS and the technical specialists.

The executive summary highlights the condition and identifies the issues, concerns, and opportunities within the watershed for line and staff. The target audience for the main body of the report is the technical specialist. It contains summaries of the quantitative data collected as well as field observations and the resulting conclusions on stream condition, habitat interrelationships, and potential factors limiting fish production. The information is summarized at both the reach scale and the drainage basin scale.

The foundation for every report resides in sound interpretation of the available historic data wedded to habitat information obtained during the field inventory. Rather than merely a regurgitation of numbers and figures in the summary tables, interpretation should include investigating the interrelationships that exist between the data attributes (e.g., number of channel-width pools (slow water units) per mile, number of functional pieces of large woody debris (LWD) larger than 24 in. diameter per mile, stream reaches where stream temperature exceeds state standards). Correlations of pools per mile to riparian vegetation condition and to the amount of large woody debris can aid in identifying potential habitat deficiencies in aquatic systems. These same relationships offer an indication of rehabilitation potential for a stream and its riparian vegetation.

Although basic data interpretation can be completed by the individuals conducting the stream survey, all reports should have journey-level fish biologist or hydrologist review and concurrence. The section of the report addressing management implications should be written by the journey-level professionals. A good understanding of the interrelationship of the physical and biological conditions of a stream is needed in order to develop sound, realistic management interpretations and recommendations.

HANDBOOK CONTENT

The Stream Inventory Handbook provides instructions for conducting the level I and level II stream inventories. It contains three sections: Office Procedures (level I), Field Procedures (level II), and Appendices.

User's Guides for the NRIS WATER AI and AB database is issued as a separate document.

Office Procedures: This section contains the specific instructions for completing the office phase, or level I inventory. Information collected from the office phase is placed on Survey Form and Preliminary Reach Form. The purpose of completing Survey Form is to familiarize the surveyors with the historical use and natural history of the landscape drained by the inventoried stream. The purpose of completing Preliminary Reach Form is to delineate preliminary stream reaches and create a field map which includes access points for the field inventory. The field phase (level II) will validate or amend the reaches first delineated on Preliminary Reach Form. Preliminary Reach Form will be retained with the stream folder as documentation of the level I inventory. The level I will also identify potential access points and danger areas.

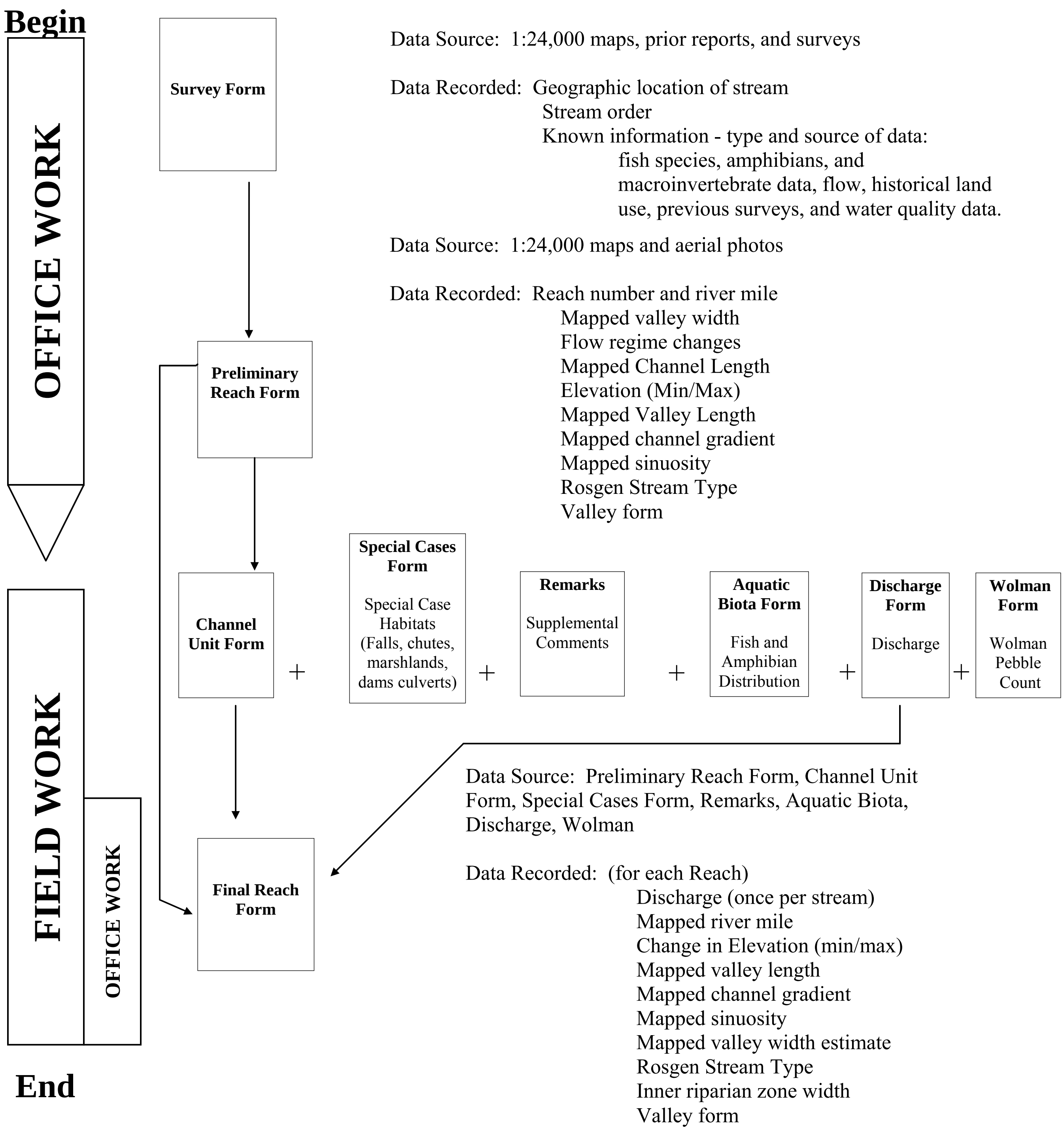
Field Procedures: The field phase (level II) is the nuts and bolts of the stream inventory process. The level II utilizes the following forms: Final Reach Form, Channel Unit Form, Special Cases Form, Remarks Form, Aquatic Biota Form, Discharge Form and Wolman Form. They are used to gather information on the physical attributes of the stream and its riparian condition. The Final Reach Form also has attributes that are derived from field data, but are more easily completed in the office. The Aquatic Biota Form documents fish and amphibians observed during the survey. The Discharge Form records stream discharge; the Wolman Form is used to characterize the streambed substrate in riffles. Data gathered during the field phase is used to assign a letter designating the dominant Rosgen Stream Type of each reach.

Appendices: The appendices contain specific information that support a number of the data attributes collected in both the office and field phases.

Forms: A total of 9 forms are completed as part of the inventory. Copies presented in this handbook are provided as masters from which your working copies can be made. **Please note**: Waterproof, smudge-proof forms can be developed by using opaque transparencies rather than paper as the base medium. These are relatively inexpensive, and can be mass-produced on most photocopy machines.

The following figure presents a view of the inventory process that includes a timeline and flow chart outlining the relationship between the suite of forms used in the course of completing a stream inventory.

Figure 1: Flowchart showing the order that Data Forms are used



CHAPTER 2
Office Procedures Level I Inventory - Identification Level

OBJECTIVES
The objective of the office phase is to provide the field crews with a general introduction to the stream targeted for inventory. This is accomplished through assembly and summarization of any data that has been previously collected for the basin. This information is used to tentatively stratify the stream into stream order and stream reaches. A reach is a relatively homogeneous section of stream containing attributes of common character. Review of the information compiled by the office phase will be extremely valuable in selecting sampling intervals for measured habitats, planning stream access logistics, summarizing initial hydrologic information, and initially identifying perennial and fish-bearing streams. The statistical validity of this inventory process was first described in “Estimating total fish abundance and total habitat area in small streams based on visual estimation methods” (Hankin and Reeves 1988).

Aerial photo analysis and the use of maps of suitable scale (i.e., 1:24,000) will enable the survey team to identify, at an acceptable level of resolution, such attributes as mapped channel gradient, mapped sinuosity, vegetative types in riparian and upslope areas, watershed acres, floodplain widths, tributary confluences, and watershed characteristics. **This analysis of maps and aerial photos should also be used to identify potential danger spots such as steep terrain, waterfalls and to identify safe parking areas.** The maps assembled during this process will be of great value to the crews in the field. An effective field map(s) will show tributary streams, road crossings, access points, and general location of notable geologic features and unique characteristics. These characteristics will be used by the field crew to accurately locate reach breaks and features in the basin. The Latitude, Longitude Identification (LLID) also needs to be identified through NRIS Water. How to obtain this information will be detailed later in this manual. An ArcView or ArcMap user on the forest who is familiar with the location of the stream route coverage can also be consulted.

STANDARDS
The office phase level I inventory provides information only as accurate as the scale and accuracy of the maps, photos, and any previously collected data. Accuracy is also affected by the human error introduced when measuring the attributes required. Use only 1:24,000 scale USGS topographic maps to determine the measurements for the mapped attributes of both the Preliminary Reach Form and the Final Reach Form. Any measurements should be confirmed with a map wheel, dot grid, or other standard method of measurement.

EQUIPMENT/INFORMATION NEEDED

- → Aerial Photos /Topographic Maps -Scale of 1:24,000.
- → Planimeter/Map Wheel.
- → Calculator.
- → Watershed Codes from FSH 2509.24.
- → Hydrological Data-flow, temperature, turbidity, macroinvertebrate, etc.
- → Geological Information-Geological province, landform type, etc.
- → Historical Land Use Information (i.e. - road density, range allotments, timber management, private lands, recreation, wilderness).
- → Past Stream Surveys-US Bureau of Fisheries, FS, USDI Bureau of Land Management (BLM), State, etc.
- → Level I Inventory Forms - Office Phase.
  - - Survey Form
  - - Preliminary Reach Form.

PROCEDURE

The office phase requires the completion of the Survey Form and the Preliminary Reach Form. Much of the information for Preliminary Reach Form can be collected from aerial photos, orthophotographs, and 1:24,000 scale USGS topographic maps. Each attribute is identified in **BOLD** text and is followed by instructions on how to measure or collect information on the attribute.

At the end of many attribute descriptions is an example intended to illustrate a valid entry.

PLEASE NOTE THAT THE INSTRUCTIONS FOR COMPLETING THE HEADER FOR EVERY FORM USED IN THE LEVEL I AND LEVEL II INVENTORIES ARE LISTED ONLY IN THE SECTION OF CHAPTER 2 LABELED "SURVEY FORM INSTRUCTIONS." ATTRIBUTES A THROUGH I ARE THE SAME FOR EVERY FORM. Where additional header information is required, specific instructions are given for that form.

Should questions arise concerning any phase of the inventory process, consult with the local hydrologist and/or fisheries biologist. It is their role to supply answers and clear direction during the inventory process.

PRODUCTS

A level I inventory (office phase) is completed for every stream designated for a level II inventory. The level I process will produce:

- A list of existing information previously collected on the stream and drainage basin.
- A completed Survey Form.
- A completed Preliminary Reach Form.
- A draft copy of a 1:24,000 scale USGS topographic map of the target stream that shows preliminary reach breaks, access points, road crossings (culverts, bridges, etc.), known dams and diversions, and other points of interest that will help orient the field crews to

the stream to be inventoried. Forests are encouraged to develop and adopt a consistent set of map symbols, which encode stream channel and riparian conditions of concern to the management of each Forest.

- A safety map identifying potential hazardous areas such as steep terrain, waterfalls and identifying safe access points into the stream.

SURVEY FORM

R6-2500/2600-10.

SURVEY FORM INSTRUCTIONS

A. STATE: Enter the appropriate 2-letter code:
Oregon...........OR
Washington....WA

B. COUNTY: Enter appropriate County Name.

C. FOREST: Enter appropriate two-digit code for the Forest or Forest name.

D. DISTRICT: Enter appropriate two-digit code for the District or the District name. (e.g., 03)

E. STREAM NAME: Enter the name of the stream inventory. (e.g., Salmon Creek)

F. 4th LEVEL HUC CODE: Refer to FSH (Forest Service Handbook) 2509.24 to determine the correct 4th level Hydrologic Unit Code (HUC) for the watershed. Enter only the first four 2-digit fields (Hydrologic Region, Hydrologic Subregion, Accounting Unit, and Cataloging Unit). Refer to Appendix A for a more detailed explanation. (e.g., 17,09,03,01)

5th and 6th CODE: The 5th and 6th level HUC's are the identifiers for the watershed (5th HUC) and subwatershed (6th HUC). Contact your hydrologist or GIS specialist for assistance in correctly identifying the NFS code. (e.g., 10 3)

G. USGS QUAD: Enter the name of the registered USGS Quadrangle containing the stream mouth or point where it leaves the Forest. This is the 1:24,000 (2.64-inch) scale USGS topographic map. (e.g., Stinker Mountain)

H. SURVEY DATE: Enter the date the field survey began. Be sure it is the actual date level II is initiated using the following format: MM/DD/YYYY. (e.g., 07/10/2000).

I. NAME: Persons filling out the Survey Form will record the initial of their first name as well as their complete surname (e.g., J. Smith). NOTE: This attribute **WILL NOT** be entered into the AI database version of the Survey Form.

The following attributes are not individually entered into AI. Rather the information is designed to provide direction for the office phase of inventory. The most significant information gathered should be entered as "Remarks" to the Survey Form.

1. **WATERSHED AREA**: Calculate the area of the basin above the mouth of the target stream to the nearest 250 acres. If the inventory begins at a point upstream from the mouth, determine the drainage basin above that point. This measurement is made on a 1:24,000 scale USGS topographic map by first identifying the ridgelines that define the drainage basin, and then calculating the area using a dot grid or planimeter. Consult your GIS experts since they can calculate watershed area more accurately through digitizing the area. If GIS is available, record watershed area to the nearest 10 acres. (e.g., 1200 acres)

2. **FISH AND AMPHIBIAN SPECIES AND DATA SOURCE**: Starting from the left, record dominant or management-emphasis fish species as well as any threatened, endangered, or sensitive amphibian species known to be in the basin. The species codes consist of the first two letters of the genus and the first two letters of the species names. See Chapter 3 for a list of the standard species codes for freshwater fishes and amphibians of Washington and Oregon. If no data exist, write "Nothing on record." (e.g., ONTS, ONKI, ONMY, ONCL)

3. **FLOW DATA**: Enter in narrative form, the historical flow data available for the stream. List all sources, such as USGS gauging stations, Forest monitoring sites, IFIM studies, etc., and the dates that data were collected. If no data exist, write "Nothing on record." ((e.g., USGS Gaging Stn. #14146500 is located 0.2 RM from mouth; ave. flow for JUL = 260 cfs).

4. **WATER QUALITY DATA**: Review files for any quantitative physical or chemical data. Reference the type and source of information and year data were collected. If no data exist, write "Nothing on record." (e.g., ODFW max/min stream temp. during JUN-SEP: 1970-88)

5. **MACROINVERTEBRATE DATA**: Enter, in narrative form, the type and source of previous information on the presence, distribution, and abundance of macroinvertebrates in the stream to be inventoried. Examples include analysis conducted by the Aquatic Ecosystem Analysis Lab, local forest studies, etc. If no data exist, write "Nothing on record." (e.g., 1990 survey by Taxon, Inc. reported that chironomids comprised 65% of the biomass in pools and riffles, and the remaining 35% were split relatively evenly among six other insect taxa.)

6. **PREVIOUS SURVEYS**: Reference the source of the information, level of survey, and year accomplished. If no data exist, write "Nothing on record.” (e.g., 1965 Blue River RD survey of culverts included the three culverts on this stream.)

7. **HISTORICAL LAND USE DATA**: Record here any useful historical information you have accumulated regarding activities in the drainage basin and stream network (e.g., old photos, interviews on file, splash dams, mining, literature, etc.). Also review the Forest's Historical Land Use Atlas - see an Archeologist for this document. If no data exist, write "Nothing on record.” (e.g., Railroad built in 1930-33 for logging. Rails removed and railbed rebuilt as sealed road in 1965, active logging in upland since 1965, and map of units by age of cut is available.)

8. **COORDINATION**: Verify participation or coordination with other agencies or interest groups for the present inventory. Explain the groups participating and their work to be accomplished. (e.g., WDFW will inventory the private land sections of the stream, has agreement with owners, will use R06 protocol.)

9. **REMARKS**: Use this space to elaborate on the above attributes. Note apparent watershed problems, special features or habitats, fish stocking information, management problems, studies, critical habitats, special land allocations, etc. (e.g., 45% of drainage basin is in private hands, permission has been denied for inventory of stream through Clark Timber Co. lands.)

PRODUCTS OF THE SURVEY FORM PROCESS

1. Completed Survey Form.
2. Review of available historical records and information on the drainage basin in which the stream to be inventoried is found.

SURVEY FORM Page: ____ of ____
R6-2500/2600-10

A. State __________ B. County __________ C. Forest __________ D. District ____________

E. Stream Name ______________________________

F. 4th HUC Code ____, ____, ____, ____ 5th ____ 6th _____

G. USGS Quad ______________________________

H. Survey Date ____/___/_______ I. Name ______________________________
MM/DD/YYYY

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1. Watershed Area __________________ Acres
2. Fish and Amphibian Species ______________________________
   Data Source ______________________________
   ____
3. Flow Data ______________________________
   ____
   ____
4. Water Quality Data ______________________________
   ____
5. Macroinvertebrate Data
   ____
   ____
6. Previous Surveys
   ____
   ____
7. Historical Land Use Data
   ____
   ____
8. Coordination ______________________________
   ____
   ____
9. Remarks ______________________________
   ____

PRELIMINARY REACH FORM

R6-2500/2600-20

The Preliminary Reach Form is used to stratify the stream into preliminary reaches. This is done with information gleaned from GIS layers, topographic maps, orthophotographs, and aerial photographs. If the stream to be inventoried has been surveyed before, review the reaches identified in the historic stream inventory reports to identify preliminary reaches.

The repository for the data you collect during a stream inventory is entered into NRIS Water AI/AB. The inventory data is attached to a GIS layer displaying the network of perennial streams, and this GIS layer is referred to as *"stream routes"*. In this network of streams, one channel is identified as the mainstem. The line that displays this mainstem channel in the *stream routes* layer is assigned a set of numbers that uniquely labels this route; the label is called an LLID (latitude/longitude identifier). Each route that represents a tributary to the mainstem is its own GIS stream route, and each tributary is assigned its own unique LLID.

While channel and valley characteristics are integral to the selection of preliminary reaches,

A reach must be entirely within one GIS-defined stream route

No reach that includes segments of more than one GIS stream route (LLID) can be identified in NRIS. While a given route may consist of more than one reach, surveyors must ensure that a preliminary reach is not a fusion of multiple GIS stream routes. A single GIS stream route per reach is fundamental to a valid analysis of the field data collected within the reach.

Surveyors must first find their stream targeted for survey as it is displayed in NRIS Water. While the focus of this handbook is to provide a general foundation for designing and completing a valid stream inventory, training for the use of NRIS Water AI/AB must be sought elsewhere but Appendix D has instructions on how to find your GIS stream route. Your District or Forest fisheries biologist and/or your GIS analyst will be able to assist you in displaying the GIS stream route for your target stream. Once the surveyors are certain of the GIS stream route, all preliminary reaches of your target stream must lie entirely within that stream route. If the survey continues upstream of the end of the stream route, the surveyed stream segment upstream of the route must be a separate survey attached to its own GIS stream route.

Be aware that previously surveyed reaches that spanned more than one GIS stream route cannot be resurveyed as a single reach. Regardless of the path a survey takes through a stream network, each reach is a subset of a GIS stream route; a reach is never a fusion of multiple GIS stream routes (LLID's).

Characteristics along a specific GIS stream route that should be used to initially select stream reach breaks are changes in: mapped valley width estimates, mapped channel gradient, mapped sinuosity, and streamflow due to large tributaries (see figure 2). Development of a mapped longitudinal profile (i.e., mapped gradient) from the 1:24,000 scale USGS topographic map will identify major gradient changes useful in establishing the starting and ending points for each reach. These preliminary reaches should closely correspond to the level I Rosgen Stream Types (i.e., A, B, C, D, DA, E, F, and G).

The recommended minimum length for all reaches is 0.5 miles. Reaches shorter than 0.5 miles require a greater commitment of time and effort to ensure the reach is adequately characterized by the data. All riffles (fast water) must be treated as "measured riffles" in any reach less than 0.5-mile long. In addition, at least one Wolman pebble count must be completed in these short reaches.

These reach endpoints will be verified, refined, or modified by the field crew during the level II (field phase) inventory, and these field-verified reaches will be accurately translated onto the field maps and/or aerial photographs. When the field portion of the reach inventory is complete, the information from the Preliminary Reach Form will be used to complete the Final Reach Form; once the Final Reach Form has been completed, the Preliminary Reach Form will be retained in the stream folder as originally completed.

NOTE: Preliminary Reach Form data will not be entered into the AI database.

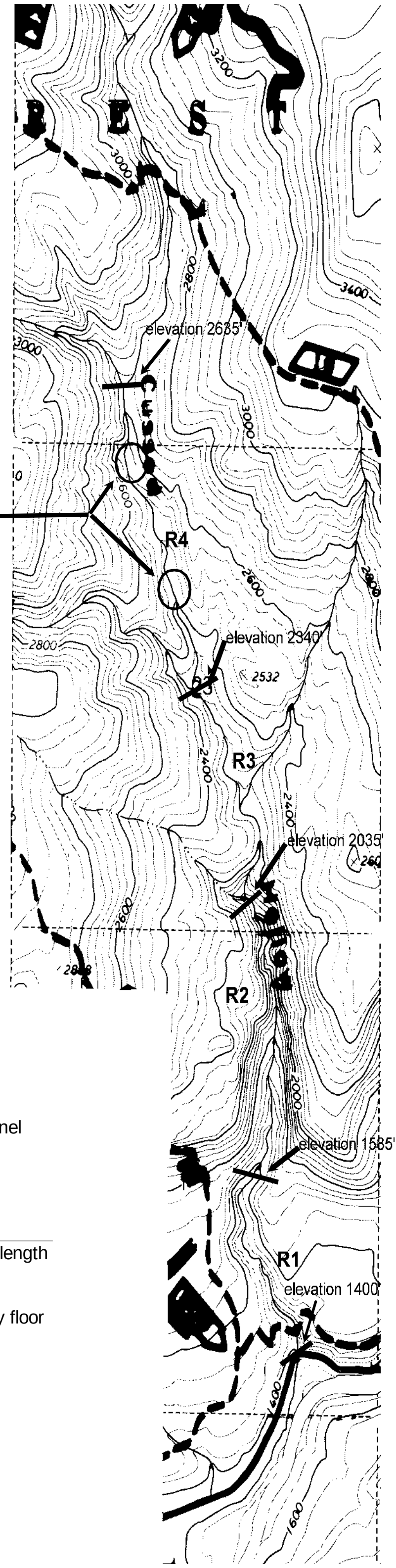
PRELIMINARY REACH FORM INSTRUCTIONS

Fill out a Preliminary Reach Form for each stream reach:

NOTE: INSTRUCTIONS FOR COMPLETING PRELIMINARY REACH FORM HEADER (ATTRIBUTES A - H) ARE LISTED IN THE SURVEY FORM INSTRUCTIONS on Page 13. ATTRIBUTE I INSTRUCTIONS ARE BELOW.

I. LLID – Latitude/Longitude identifier. As described above the LLID needs to be identified before the survey begins. The data steward for NRIS Water AI/AB can do this. This is the person who will be entering the data for the survey and the information should be obtained from the GIS layer in the NRIS AI/AB database.

Figure 2: River basin characteristics derived from a 1:24,000 scale USGS topographic map



General area where you will do the pebble counts in Reach 4 (i.e. ,1/3 and 2/3 of reach length)

Reach 4

Stream channel length = 3872 ft.

Mapped channel gradient = $\frac{(2635-2340)}{3872} \times 100 = 8\%$

Valley length = 3520 ft

Sinuosity = 3872/3520 = 1.1

Reach 3

Stream channel length = 2816 ft.

Mapped channel gradient = $\frac{(2340-2035)}{2816} \times 100 = 12\%$

Valley length = 2640 ft

Sinuosity = 2816/2640 = 1.1

Reach 2

Stream channel length = 3520 ft.

Mapped channel gradient = $\frac{(2035-1585)}{3520} \times 100 = 13\%$

Valley length = 3168 ft

Sinuosity = 3520/3168 = 1.1

Reach 1

Stream channel length = 2288 ft.

Mapped channel gradient = $\frac{(1585-1400)}{2288} \times 100 = 10\%$

Valley length = 1936 ft

Sinuosity = 2288/1936 = 1.1

mapped channel length = mapwheel channel length

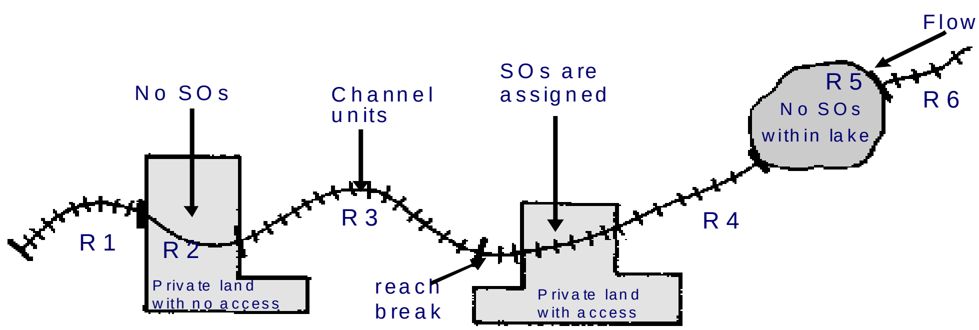
mapped channel gradient = $\frac{\text{elevation change}}{\text{mapped channel length}}$

mapped valley length = midline of valley floor

sinuosity = $\frac{\text{mapped channel length}}{\text{mapped valley length}}$

1. SEGMENT ID: Enter the segment ID number (reach number) beginning at the lowest point of the proposed inventory. Number the segments (reaches) sequentially in an upstream direction. If access is denied to portions of the stream, which are privately owned, treat the private land section as a separate reach (see figure 3). If permission to inventory the private land is secured, do not break out that portion of the stream as a separate reach. Whenever a lake occupies a valley section between two portions of the stream to be inventoried, treat the lake as a separate reach in a fashion identical to private land/no access. The pool upstream of a beaver dam is not a lake, and this type of pool is not considered as a separate reach. The pool upstream of a beaver dam is simply a slow water (pool) habitat. Use standard geomorphic characteristics as described above to delineate the reach breaks in all other cases. Reaches that are less than 0.5 miles long are acceptable provided all riffles within the reach are treated as measured riffles. A Wolman pebble count is still required in reaches that are shorter than 0.5 miles long.

Figure 3: Example of how SOs are assigned (or not assigned) within private land inholdings and within lakes



2. MAPPED RIVER MILE: Enter river mile (RM) at both the starting and ending point of each reach. Use designated Environmental Protection Agency (EPA) river miles if available. If the EPA river mile for the start of the survey is unknown, begin the mileage measurement at the mouth of the stream, starting with RM = 0.0. Whenever the starting point of a stream inventory is not at the mouth of the inventoried stream, the river mile location of the startpoint will reflect the mapped distance of the startpoint upstream from the mouth of the surveyed stream. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (e.g., Reach 1: RM 0.0 to 1.1; Reach 2: RM 1.1 to 4.0; Reach 3: RM 4.0 to 5.2). Use a map wheel to calculate river miles. The technique is to follow the "blue line" channel course as drawn on the 1:24,000 scale USGS topographic map. Record to the nearest 0.1 RM.

3. MAPPED VALLEY WIDTH ESTIMATE: Enter the estimated average width of the floodplain or valley bottom as determined from the 1:24,000 scale USGS topographic maps and from aerial photographs. The estimate is derived from interpreting 1:24,000 scale USGS topographic maps and aerial photographs of the valley. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley. The objective is an estimate within 10 percent of the actual average valley floor width for the reach. Elevation contour lines cross the line defining the stream. Use the midpoint along the stream between contour intersections to make your estimate of the valley width. An estimate is made for each reach.

4. FLOW REGIME CHANGE: Note any large tributaries to the inventoried stream. These may offer excellent reach breaks if the tributary drains a basin similar in area to the drainage basin of the inventoried stream upstream of the confluence with the tributary. Reaches can be stratified by significant changes in flow, while other variables remain the same. Enter yes Y or no N if this is used for reach delineation purposes.

5. MAPPED CHANNEL LENGTH: Using a map wheel, determine the "blueline" channel length between the preliminary reach breaks for each reach.

6. CHANGE IN ELEVATION (MIN/MAX) : Estimate the elevations at the upstream and downstream endpoints of the reach by reading the contour lines on the map. Unless the contour lines cross the stream at the end point of a reach, interpolation will be necessary. Enter the downstream elevation as the minimum and enter the upstream elevation as the maximum elevation for the reach.

7. MAPPED CHANNEL GRADIENT: Use GROSS changes in gradient to develop preliminary channel reach breaks. Long homogeneous lengths of similar gradient may delineate a reach. However, other attributes can temper the stratification. Channel gradient for Preliminary Reach Form will be calculated by dividing the elevation gain (high elevation contour minus low elevation contour) by the mapped channel length for each reach. Make sure that the elevation change and the mapped channel length are both expressed in feet.

8. MAPPED VALLEY LENGTH: Enter the estimated valley length determined from the 1:24,000 scale USGS topographic maps. Mapped valley length is defined as the distance along the midline of the valley floor between the endpoints of a reach. Similar to mapped channel length, the measurement for valley length is made with a mapwheel. It is not a straight line between reach breaks. Instead, mapped valley length is a curved line connecting the topographic contours as they cross the valley floor.

9. MAPPED SINUOSITY: Enter the estimated sinuosity for the delineated reach. This is calculated by dividing the mapped channel length between reach endpoints by the mapped valley length between the same reach endpoints. Both mapped channel length and mapped valley length must be expressed in the same units of measure to derive map sinuosity.

10. ROSGEN STREAM TYPE: Use the values derived from the investigation of the 1:24,000 scale USGS topographic maps and aerial photographs to assign a level I Rosgen Stream Type to each preliminary reach. Previous inventories on the same stream channel may provide additional insight concerning potential reach breaks.

11. STREAM ORDER [Forest Option]: Utilizing the Strahler method, identify stream order (see Appendix B) of the lowest most reach. A first order stream is the smallest fingertip "blueline" tributary. A first order channel can appear as either a dotted or solid "blueline" channel on a 1:24,000 scale USGS topographic map. (e.g., 3)

12. REMARKS: A description of the reasons for ending the reach should be provided. These reasons will be validated during the level II survey.

13. VALLEY FORM [Forest Option]: Enter appropriate code (1 through10) that best describes the valley form. Examples are: wide, glaciated U-shaped valley; steep, narrow V-shaped valley; broad, flat plain; alluvial outwash; etc. (See Appendix C-page 79).

PRODUCTS OF PRELIMINARY REACH FORM PROCESS

1. Completed Preliminary Reach Form, which includes a preliminary Rosgen Stream Type[1] for each reach.
2. Field-ready 1:24,000 scale USGS topographic map identifying preliminary reach breaks, private land holdings, and potential access points

[1]Reference: Rosgen, D.L. *Applied River Morphology.* Wildland Hydrology, 1996.

PRELIMINARY REACH FORM Page: ____ of ____

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A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. 4^{th} HUC Code ____, ____, ____, ____ 5^{th}_____ 6^{th} ______

G. USGS Quad ______________________________

H. Survey Date ____/___/______ I. LLID ______________________________

MM/DD/YYYY

1. Segment ID _________	1. Segment ID _________
2. Mapped River Mile From _______ To _________	2. Mapped River Mile From _______ To _________
3. Mapped Valley Width Estimate (ft) ___________	3. Mapped Valley Width Estimate ______________
4. Flow Regime Change ____________________	4. Flow Regime Change ____________________
5. Mapped Channel Length ____________________	5. Mapped Channel Length ______________
6. Change in Elevation Min _________ Max ______	6. Change in Elevation Min ________ Max_______
7. Mapped Channel Gradient ______________	7. Mapped Channel Gradient ______________
8. Mapped Valley Length ______________	8. Mapped Valley Length ______________
9. Mapped Sinuosity ____________________	9. Mapped Sinuosity ____________________
10. Rosgen Stream Type ____________________	10. Rosgen Stream Type ____________________
11. Remarks:________________________________	11. Remarks:________________________________
12. Stream Order:____________________________	12. Stream Order:____________________________
13. Valley Form (Forest Option) ________________	13. Valley Form (Forest Option) ________________

CHAPTER 3

Field Procedures: Level II Inventory-Aquatic Ecosystem Inventory

OBJECTIVES

The level II inventory is the basic tool for determining the quality and quantity of aquatic habitat and to obtain estimates of basic riparian and hydrologic conditions. The objective of the level II inventory is to provide a generally quantitative characterization of aquatic (fish/water) and riparian conditions at a watershed scale **in a safe manner.**

SAFETY

Stream inventory, as with any outdoor work can have its hazards. Safety is always the first concern when performing any job. Safety hazards and precautions are to be addressed in a Job Hazard Analysis (JHA). An example JHA can be found in Appendix G. Inventory crews are required to complete the following safety measures prior to going in the field:

- Receive proper training in first aid and CPR, and possess valid certifications for both techniques,
- Receive specific training on radio or satellite phone communications that apply to the field site,
- Prepare a map during the Level I, the office phase of the inventory, that Identifies safe access points and potential danger spots,,
- Review the appropriate JHA with their supervisor,
- Obtain the proper safety equipment such as a personal first aid kit, waders,, stream boots with felts and corkers,
- Complete the check-out procedures, and provide an estimate for the crews return,
- Complete the daily vehicle safety inspection,
- Possess and carry a valid driver’s license.

A tailgate safety session should occur each day before any field work begins to identify potential hazards for that day.

Hazards that may be encountered and need to be addressed in the JHA may include but are not limited to:

- Steep terrain, bedrock canyons, waterfalls,
- Loose rocks in the stream, slipping or falling,
- Debris jams,
- High flows,
- High wind producing falling trees or branches,
- Bees, ticks, poison plants, water-borne pathogens,
- Separation from your partner,
- Thunderstorms,

- Hypothermia,
- Heat Exhaustion,
- Hazardous roads,
- Vehicle breakdown,
- Sunburn,
- Getting lost,
- Illegal activities (Marijuana plantations, methamphetamine labs),
- Drowning.

STANDARDS

Standards for the field phase are intended to obtain consistent quantitative data. Specific standards for the procedure to accomplish the level II inventory are listed below. Data collected shall be at least as accurate as specified in the Region 6 protocol presented in this handbook. All the attributes described in this protocol are mandatory, unless clearly stated as a "Forest option."

1. The observer is the field crew person assigned to make the visual habitat width and depth estimates. The observer must continue to make the estimates of habitat dimensions until there is a minimum of 10 measured slow water units and 10 measured fast water units. Once this minimum number of measured habitats is attained, the observer can be replaced at the start of the next reach**. DO NOT CHANGE THE OBSERVER MIDWAY THROUGH A REACH! IF A CHANGE IN OBSERVER IS NECESSARY, CHANGE AT THE START OF A NEW REACH BREAK! IF THE STREAM TO BE SURVEYED IS RELATIVELY SHORT (LESS THAN 2.0 MILES), IT IS IMPERATIVE THAT THE SAME OBSERVER MAKE ALL THE HABITAT DIMENSION ESTIMATES FOR THE ENTIRE STREAM.** Following these directions is critical for establishing the correction factor for visual estimates vs. actual measurements for each observer.

2. **To develop statistically valid correction factors, a minimum of 10 slow water units and 10 fast water units will be measured for <u>each</u> <u>observer</u> on each stream.**

3. On longer streams, where the required number of measured habitats is assured, the minimum sampling frequency for slow water and fast water channel units will be 10 percent**. On shorter streams, the frequency of measured units may need to be greater than 10 percent to achieve the minimum number of measured units as specified in #2 above.**

4. If a certain channel unit type is uncommon (e.g., slow water) 100 percent of those channel unit types may have to be measured to achieve the required 10 measured units/channel unit type. Consultation with the District hydrologist and/or fisheries biologist is highly recommended during the process of choosing a sampling frequency.

5. The first unit of each channel unit type to be measured will be selected randomly. For example, if the team decides to measure slow water units at a frequency of 1:5, five playing cards (ace through five) are shuffled by the recorder. The observer then selects one of the cards **WITHOUT LOOKING AT THE CARD'S VALUE,** and the recorder records the card picked. To continue the example, if the recorder picks the "two," the first slow water unit measured is the second slow water unit in the survey (S2), and every fifth slow water unit after the second slow

water unit is also measured (S7, S12, S17, S22, etc.). In a similar fashion, the sampling frequency for fast water units is decided and the first measured fast water unit is randomly chosen. **There shall be no sampling of measured channels units at a frequency less than 10 percent. Do not roll dice to determine random starts.**

6. The thalweg length of every channel unit shall be measured, not estimated. The thalweg is simply the path most water takes as it flows through each channel unit; it is the deepest trough from upstream to downstream. The only acceptable deviations from this protocol are for reasons of safety.

7. A biological survey must be completed across the same section of stream that will be surveyed for channel units. That is, the segment of stream that receives a physical survey (i.e. channel unit dimension, etc) must also be biologically surveyed. The only acceptable biological sampling methods include: electroshocking, snorkeling, seining, and hook and line. Biological sampling must occur in every measured slow water unit and every other measured fast water unit.

8. A long-term recording thermograph must be placed in a slow water unit near the starting point (downstream most point of the survey in Reach 1), and the thermograph must operate correctly between mid-June and late-September. The thermograph must be calibrated before installation. The device is then placed in the deepest part of the channel to ensure submersion as flows drop. The chosen site should not occur near the inflow from a cold spring where thermal mixing is questionable. A hand-held thermometer reading shall be taken at the time the thermograph is installed.

9. A system of photographs shall be established for the stream reach. The beginning, ending, and representative channel unit types for each reach shall be photographed and documented, with a reference to SO and channel unit type photographed entered in the Remarks Form.

10. A working map will be developed during the office procedure that will facilitate and expedite the field procedures' portion of the survey. This working map has been described in CHAPTER 2, OFFICE PROCEDURES: LEVEL I INVENTORY - IDENTIFICATION LEVEL (page 12 of this manual). Field notes and observations shall be noted on this map, since this map will serve as the foundation for a final survey map to be included in the stream inventory report.

EQUIPMENT/INFORMATION NEEDED

- Level II Survey Forms (Final Reach Delineation, Channel Unit Form, Special Cases, Remarks, Aquatic Biota, Discharge, Wolman Pebble Count) as appropriate.
- 30 cm ruler for Wolman pebble counts or gravelometer.
- Pencils.
- Clipboard.
- 1:24,000 scale USGS topographic maps.
- USGS quadrangle maps, orthophotographs, GIS stream layer maps, and aerial photographs.
- 150-foot tape measure (an additional 150-foot tape measure may be necessary if the surveyed stream's floodprone zone is wider than 200 ft).

- Good quality, heavy duty scale stick or stadia rod.
- Camera.
- Water velocity meter.
- Long-term recording thermographs for each inventoried stream.
- Thermometer.
- Abney level, hand level, or peep site.
- Plastic strip flagging and grease pencil/marker for use as needed.
- Waders/Hip boots with felt or corkers.
- First Aid kit...a bee sting kit is a recommended element.
- Polarized sunglasses.
- Hardhat
- Radio.
- Snorkel, mask, wetsuit or drysuit.
- Backpack electroshocker.
- Bankfull pins and tension clamps (for measuring bankfull dimensions).

PROCEDURES

There are three phases needed to complete a level II survey: (1) preplanning before starting field work (see level I); (2) field measurements (field phase) which include reach location data and channel unit data for every reach sampled (Final Reach Form, Channel Unit Form, Special Cases Form, Remarks From, Aquatic Biota Form, Discharge Form, and Wolman Pebble Count Form); and (3) data entry, analysis, and summarization or reporting.

PRODUCTS

The level II inventory will produce:

- Completed Final Reach Forms for each reach delineated during the field phase which will include a determination/validation of the level I Rosgen Stream Type for each reach.
- Completed entries to the appropriate field forms for each channel unit assigned an SO.
- At least one streamflow determination near the downstream end of the inventoried stream.
- An accurate field map (1:24,000 scale USGS topographic series) which labels reaches, tributaries, and other significant features discovered during the field phase.
- A completed stream data file in AI which includes all entries made to the Final Reach Form, Channel Unit Form, Special Cases Form, Remarks From, and Aquatic Biota Form).
- A coherent stream inventory report that includes an executive summary, a basin summary, reach summaries, summary data tables; all of which should lead to sound data analysis and recommendations; these recommendations are an essential element of any level II inventory.

FINAL REACH FORM

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The purpose of the Final Reach Form is to document the final reach boundaries for the inventoried stream. Surveyors are required to determine the validity of preliminary reach breaks originally chosen in the office. The upstream endpoint of each preliminary reach must be evaluated in the field. The survey team is free to change the reach breaks to reflect the conditions the team observed during the field survey of channel units (i.e., habitats). Valley and channel conditions are used to evaluate the preliminary reach endpoints. It is the surveyors' task to answer the question, "Are the valley and/or channel conditions upstream of the preliminary reach break substantially different from the conditions already observed downstream?" If the team expects the upstream character to differ substantially from the conditions they observed downstream, the preliminary reach endpoint is accepted, and a new reach is begun.

Identifying the stream you will survey on the GIS "stream routes" layer is a fundamental step in choosing preliminary reaches (see Chapter 2, Preliminary Reach Form). Each of your preliminary reaches must have only one LLID associated with it. Many streams have flow conditions in their headwater reaches that do not necessarily match the GIS route for the surveyed stream. Should the team decide to survey a tributary that they believe has better habitat than the upstream portion of their routed stream, their original survey ends at the tributary junction. A completely independent survey of the tributary stream begins at the tributary's mouth, and this new survey can be divided into as many reaches as the surveyors deem appropriate. This new survey can continue upstream as long as it follows the GIS stream route for this tributary. Remember, while there may be many reaches within a stream survey,

A reach must be entirely within one GIS-defined stream route

Anytime the survey team decides to switch to a different routed stream, the initial survey ends and a new survey begins.

The majority of the attributes on the Final Reach Form are calculated using maps. If the preliminary reach breaks determined in the office are validated in the field, the mapped values assigned to the preliminary reaches will be used to complete the corresponding mapped values on the Final Reach Form.

Whenever surveyors do not accept the preliminary reach endpoints, the survey team must calculate new mapped values for the changed reaches. These mapped values include river mile, channel length, change in elevation, valley length, channel gradient, sinuosity, valley width estimate, and stream order; and these attributes are best calculated in an office setting. The Rosgen Stream Type requires the analysis of bankfull and floodprone dimensions collected on individual fast water channel units (i.e., riffles, rapids, cascades, and runs) before a category can be chosen. However, certain attributes of the Final Reach Form should be completed in the field at the same time that the decision to begin a new reach is made. These field attributes include observer, recorder, the date the reach was completed, reach number, the beginning and ending sequence order (SOs) of the reach, and inner riparian zone width (valley form is a Forest option).

It is also required that the survey team describe the reasons for ending the present reach in the "Remarks" section of this form.

It is mandatory that the field data for the Final Reach Form shall be entered IN THE FIELD as soon as the reach endpoint is determined.

Reaches shall begin and stop on specific channel units (i.e., slow water units and fast water units) that are part of the mainstem stream and have accompanying sequence order numbers (SOs). After those terminal units have been identified, final reach stratification can occur.

It is imperative to end and start all reaches at channel units that can be specifically identified on the ground. Future surveys of the same stream will likely use the same reach end points provided they can be found. Photographs of each reach break will assist future surveyors locate the reach end points (e.g., stream tributary confluence, waterfall, road crossing, cliff, etc.).

Again note that each observer must measure a minimum of 10 channel units of each channel unit type **and** 10 percent of each channel unit type they have observed per stream; hence, the number of observed/measured pairs is independent of stream reach. Once an observer has committed to calling a reach, they must complete it.

Fill out a Final Reach Form for each stream reach.

NOTE: INSTRUCTIONS FOR COMPLETING THE FINAL REACH FORM HEADER (ATTRIBUTES A - H) ARE LISTED IN THE SURVEY FORM INSTRUCTIONS page 14.

FINAL REACH FORM INSTRUCTIONS

1. CONTACTS (OBSERVER/RECORDER): Using a first initial and surname format (e.g., S.SWEET)**,** enter the name of the observer. This person must make all the visual estimates of channel unit width for the entire reach. Enter the name of the person recording for the reach using the same format.

2. DATE: Enter the date that the level II inventory on the reach was completed. Use the format MM/DD/YYYY (e.g., 07/23/2001).

3. SEGMENT ID: Enter the segment identification number for each reach beginning at the downstream end (or startpoint) of the inventoried stream. Stream reaches are incremented sequentially in an upstream direction.

4. SEQUENCE ORDER (SO): Enter the starting and ending SOs for each reach **(e.g., Reach 1 = SO 1-55, then Reach 2 = SO 56-126, etc.).** This information is extracted from the Channel Unit Form, following final reach delineation. In the case of private land where no access has been granted, DO NOT assign any SOs for the reach (enter 0), resume sequential SO numbers at the next reach. The following is an example of a stream crossing private land in which access has been denied: Reach 1, SO = 1-203; Reach 2 (Private), SO = (enter 0); Reach 3 (Public), SO = 204-365, etc.).

5. DISCHARGE: Enter actual measured discharge recorded in cubic feet per second. At a minimum, take one measured discharge in the first reach near the starting point of the survey. If a tributary is estimated to contribute greater than 20 percent of the main channel flow and the reach length is at least 0.5 miles long downstream of the tributary, note approximate amount of flow in "Remarks" and consider beginning a new reach. If additional measured flows are desired, they should be measured near the downstream end of each reach. See Chapter 4 of this handbook for instructions on determining streamflow. Record streamflow to the nearest 0.01 cfs.

6. MAPPED RIVER MILE: Enter river mile (RM) at both the starting and ending point of each reach. Use designated Environmental Protection Agency (EPA) river miles if available. If the EPA river mile for the start of the survey is unknown, begin the mileage measurement at the mouth of the stream, starting with RM = 0.0. Whenever the starting point of a stream inventory is not at the mouth of the inventoried stream, the river mile location of the startpoint will reflect the actual distance of the startpoint upstream from the mouth of the surveyed stream. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (e.g., Reach 1: RM 0.0 to 1.1; Reach 2: RM 1.1 to 4.0; Reach 3: RM 4.0 to 5.2). Use a map wheel to calculate river miles. The technique is to follow the "blue line" channel course as drawn on the 1:24,000 scale USGS topographic map. If a reach is less than 0.5 mile in length, all fast water units of the reach must be treated as measured fast water units; and at least one Wolman pebble count must be completed for the reach. Record to the nearest 0.1 RM.

7. MAPPED CHANNEL LENGTH: Enter the mapwheel value for the field-verified reach length. Trace the line defining the stream channel on the 1:24,000 scale USGS topographic map.

8. CHANGE IN ELEVATION (MIN/MAX): Estimate the elevations at the upstream (max.) and downstream (min.) endpoints of the reach by reading the contour lines on the map. Unless the contour lines cross the stream at the end point of a reach, interpolation will be necessary.

9. MAPPED VALLEY LENGTH: The mapped valley length will be determined after the reach delineation has been verified or changed in the field. This is a valley line distance between the two endpoints of the reach, utilizing the 1:24,000 scale USGS topographical map and map wheel. The distance is determined by using the map wheel to trace an imaginary midline of the valley floor from the startpoint of the reach to the endpoint of the reach. Mapped valley length is not a straight line, but a curved line formed by connecting the topographic contours. These contours normally form a "V" or a "U" as they cross the valley floor. Record the value to the nearest 0.01 miles.

10. MAPPED CHANNEL GRADIENT: Calculate the mapped channel gradient for the reach from a 1:24,000 scale USGS topographic map once the final reach boundaries have been delineated. Subtract the river mile estimate for the upstream end of the reach from the river mile estimate for the downstream end of the reach to determine the mapped channel length. Estimate the elevations at the upstream and downstream endpoints of the reach by reading the contour lines on the map. Calculate the gradient by subtracting the lowest elevation from the highest, and dividing that change in elevation by the mapped channel length. Mapped stream channel length is a distance measured by tracing the "blueline" stream channel on a 1:24,000 scale USGS topographic map. Mapped channel length is the river mile length of the reach expressed in feet.

11. MAPPED SINUOSITY VALUE: Sinuosity is calculated for each reach using a 1:24,000 scale USGS topographic map. Divide the estimated value for mapped channel length discussed in the previous paragraph by the mapped valley length discussed in the above **#9**. Since a stream channel is at least as sinuous as its valley floor, the value derived must be equal to or greater than 1.0. Record the value to the nearest 0.01.

12. MAPPED VALLEY WIDTH ESTIMATE: Enter an estimate of the average valley floor width for the reach. The estimate is derived from interpreting 1:24,000 scale USGS topographic maps and aerial photographs of the valley. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley. The objective is an estimate within 10 percent of the actual average valley floor width for the reach. Elevation contour lines cross the line defining the stream. Use the midpoint along the stream between contour intersections to make your estimate of the valley width. Record the estimate to the nearest 10 ft.

13. ROSGEN STREAM TYPE: Enter the Rosgen level I letter designator which best fits the conditions observed for the stream reach (e.g. A). The methodology is defined in *Applied River Morphology*, Rosgen, D., 1996. Copies of this text have been distributed to every National Forest in the Pacific Northwest Region. Consult your local hydrologist and/or fisheries biologist for further clarification.

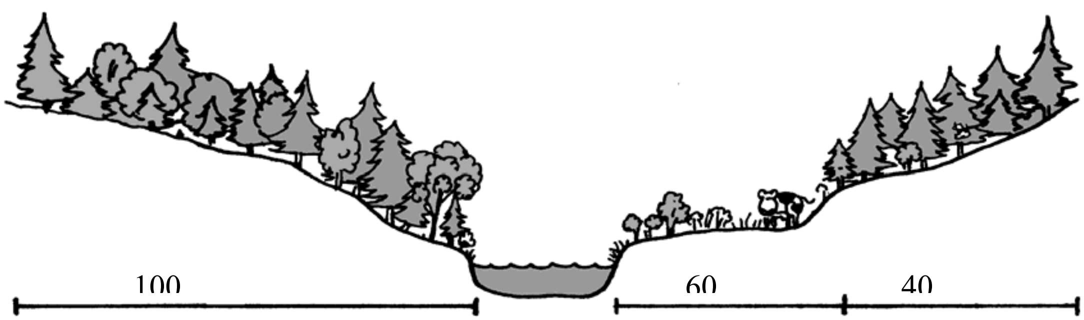
14. REMARKS: Write down any comments important to the aquatic or riparian resources. This is a good place to clarify some of the entries made to Final Reach Form. In particular, a description of the reasons for ending the reach should be included, as should a description of the location (SO and Channel Unit Type Number) of any thermographs placed in the reach. Other comments may include left and right bank designations used for the survey; nearby landslides associated with the reach; road fords within the reach; an estimate of juvenile fish habitat availability; a list of amphibians or other wildlife observed in the reach; problems at culverts on tributaries to the reach; the general condition of the upland slopes; and how well shaded is the reach's wetted channel (e.g., Broke reach at trib contributing 30% to flow, near-riparian grazing widespread and shade provided by trees is spotty, 3 steelhead redds discovered on flanks of point bars).

15. STREAM ORDER [Forest Option]: Utilizing the Strahler method, identify stream order (see Appendix B) of the lowest most reach. A first order stream is the smallest fingertip "blueline" tributary. A first order channel can appear as either a dotted or solid "blueline" channel on a 1:24,000 scale USGS topographic map. (e.g., 3)

16. INNER RIPARIAN ZONE WIDTH: The riparian zone investigated in this inventory is an area on either bank, which is 100-feet wide. The inner riparian zone is the portion of that 100 feet which is characterized by a vegetative condition that is different from the remainder of the riparian zone. It is often the case that vegetation changes dramatically as the distance from the bankfull channel increases. True water-adapted plants may only occur very near the wetted channel. Alternatively, the inner riparian zone may describe an area in which ground-disturbing flows occur with sufficient frequency that mature conifers are quite rare, and a distinct hardwood zone is identifiable. The estimate of inner riparian zone width is the average width along both banks from bankfull to the distinct change in vegetation. The outer zone is calculated by subtracting the inner zone from 100 feet. For example, if the inner zone for the reach is estimated to be 60-feet wide, then the outer riparian is 40-feet wide (see figure 4). Forests have the option to designate a single riparian zone, and in such a case, enter 100 feet as the inner riparian zone width. (e.g., 100)

17. VALLEY FORM [Forest Option]: Enter valley form code which best describes the average condition for the reach. The designations are based on valley floor width and the gradients of the valley sideslopes. See Appendix C—Page 79, for figure.

Figure 4: Examples to help you decide how to designate the inner riparian zone width



Example 1: no clear vegetation zones are apparent, so use one zone=100 feet if the condition is the same on both bank's vegetation zones.

Example 2: designate an inner vegetation zone if you expect to encounter a change in vegetation due to elevation (e.g. terraces), altered habitat (roads), or other management activities (harvest, grazing).

Remember that during the survey, both sides of the stream will have the same inner vegetation zone for the entire reach.

FINAL REACH FORM Page: ____ of ____

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A. State _________ B. County __________ C. Forest __________ D. District ___________

E. Stream Name ____

F. 4th HUC Code ____, ____, ____, ____ 5th ____ 6th ____

G. USGS Quad ____

H. LLID ____________________________________

1. Contacts: (Observer/Recorder)	1. Contacts: (Observer/Recorder)
OBS:_________________________	OBS:_________________________
REC:_________________________	REC:_________________________
2. Date ____/____/______	2. Date ____/____/______
3. Segment ID ______	3. Segment ID ______
4. Sequence Order (SO)	4. Sequence Order (SO)
From ______ To _________	From ______ To _________
5. Discharge _________________________	5. Discharge __________________________
6. Mapped River Mile From ______To_____	6. Mapped River Mile From ______To______
7. Mapped Channel Length _____________	7. Mapped Channel Length _______________
8. Change in Elev. Min: ______Max:______	8. Change in Elev. Min: ______Max:________
9. Mapped Valley Length ______________	9. Mapped Valley Length ________________
10. Mapped Channel Gradient ___________	10. Mapped Channel Gradient _____________
11. Mapped Sinuosity Value _____________	11. Mapped Sinuosity Value ______________
12. Mapped Valley Width Estimate ________	12. Mapped Valley Width Estimate _________
13. Rosgen Stream Type ________________	13. Rosgen Stream Type _________________
14. Remarks_________________________	14. Remarks__________________________
____________________________________	_____________________________________
____________________________________	_____________________________________
____________________________________	_____________________________________
____________________________________	_____________________________________
____________________________________	_____________________________________
15. Stream Order _______________________	15. Stream Order _______________________
16. Inner Riparian Zone Width_____________	16. Inner Riparian Zone Width_____________
17. Valley Form________________________	17. Valley Form________________________

CHANNEL UNIT FORM

R6-2500/2600-22

The following items should be recorded on the Channel Unit Form for the channel units to be surveyed. Each Forest should establish a standard for "right bank" and "left bank" orientation (see figure 5 to clarify the importance of distinguishing the banks of the stream). This orientation shall remain consistent over the forest once established. NOTE: the USGS standard establishes orientation while looking downstream.

There are three potential estimated dimensional attributes. They are average channel unit width, maximum channel unit depth, and pool crest depth. The first three attributes will be measured at every "nth" unit (“nth units” are also referred to as “measured units”); maximum pool crest depth will be measured at every slow water unit. The measured information will be placed in the data categories on the Channel Unit Form directly below each corresponding estimated value for that channel unit. In addition, items 12-28 are to be entered on the same line (row) of the Channel Unit Form as the measured dimensions of the measured channel units.

NOTE: INSTRUCTIONS FOR COMPLETING THE CHANNEL UNIT FORM HEADER (ATTRIBUTES A - G) ARE LISTED ON THE SURVEY FORM INSTRUCTIONS ON PAGE 13.

CHANNEL UNIT FORM INSTRUCTIONS

H. REACH NUMBER: Reaches shall be numbered sequentially, with the first reach beginning at the downstream startpoint of the survey, usually at the mouth of the stream, with each succeeding reach's startpoint coinciding exactly with the previous reach's endpoint (e.g., 1, 2, 3, etc.).

THE FINAL REACH BOUNDARIES MAY CHANGE FOLLOWING VERIFICATION DURING THE FIELD PHASE. PRIOR TO COMPUTER DATA ENTRY, FINAL DELINEATION MUST OCCUR, AND THE TRUE REACH NUMBER MUST BE ASSIGNED TO THE RESPECTIVE CHANNEL UNITS. (SEE FINAL REACH FORM)

When starting a new reach, record the data on a new Channel Unit Form, page 53. This will facilitate data entry and minimize data entry errors.

MAKE SURE SOs LISTED ON THE FINAL REACH FORM COINCIDE WITH THE SOs ON ALL THE CHANNEL UNIT FORMS COMPLETED FOR EACH REACH BEFORE YOU BEGIN DATA ENTRY TO THE NRIS AI.

I. SAMPLING FREQUENCY: Enter the chosen frequency for sampling the measured channel unit. For example, if sampling slow water and fast water channel unit types at a 20 percent frequency, enter 1/5 (1/5 = 20/100 = 20%) for both channel unit types.

The Sampling frequency must be sufficient to ensure at least 10 slow water units and 10 fast water units AND 10 percent of all slow water units and all fast water units are sampled as measured channel units for each observer on each stream.

On longer streams where the required numbers of measured units can be met, a minimum of 10 percent of slow water and fast water units is recommended. Shorter streams may require a much greater sampling frequency to achieve the necessary number of measured units. If a certain channel unit type is uncommon (i.e., slow water units under certain stream conditions), it is possible that 100 percent of those channel units must be measured to achieve the minimum of "10 measured units" of both channel unit types.

Refer to **#5** of the **"STANDARDS"** section in the beginning of this chapter for a discussion of how to randomly designate the first slow water unit and first fast water unit to be treated as measured channel units.

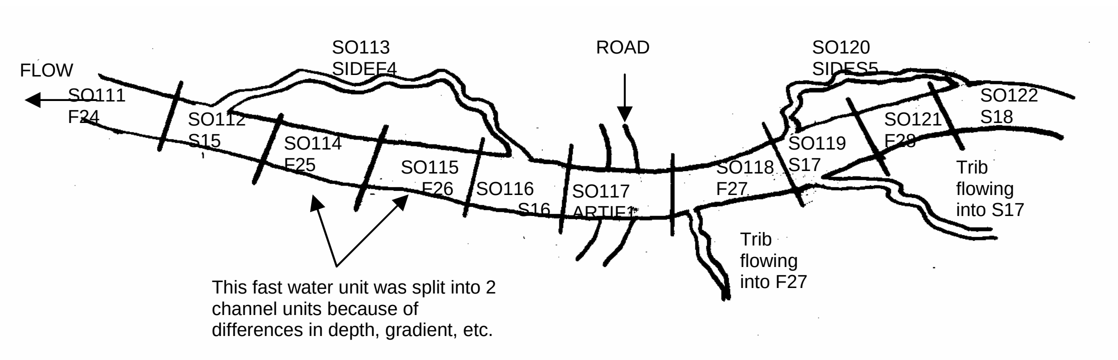
The asterisk (*) on the CHANNEL UNIT FORM denotes the additional channel unit attributes that require entries for measured units. **DO NOT** fill in these data categories in the rows for non-measured (estimated) channel units.

1. SEQUENCE ORDER (SO): Enter a unique sequence order number for each channel unit. SOs should be entered in the same order as channel units are encountered in the field survey, beginning with the first channel unit and incrementing sequentially as new channel units are encountered moving upstream, (e.g., 1, 2, 3, etc.).

The numbering sequence shall remain consistent throughout all reaches, (if Reach 1 ends at SO #203, then Reach 2 shall begin at SO #204). There are only two exceptions: a reach of private land to which access has not been granted, and a lake which occupies a middle segment of the surveyed stream channel (see figure 3). In either case, a reach number is assigned to the private land and to the lake; but no SOs are assigned to either of those two reaches. Sequential assignment of SOs resume in the next upstream reach (e.g., if Reach 2 is private land, no access, then SOs are as follows: Reach 1 = SO 1 to 203; Reach 2 has no SOs assigned; Reach 3 = SO 204 to 251...).

All side channels (SIDEF or SIDES) with streamflow at the time of the survey should be treated as an individual channel unit and assigned an individual SO number. They should be assigned the next incrementally higher SO than the main channel unit into which they flow. When multiple channel units (side channels) converge upon the mainstem channel unit at exactly the same place, number them in a clockwise order while facing upstream (see figure 5).

Figure 5: How to designate channel unit SO's for a stream with side channels and tributaries.



2. CHANNEL UNIT TYPE AND NUMBER: Enter the channel unit type and number for each unit. An expanded set of acceptable slow water and fast water channel units are listed in Appendix C: Forest Options (page 82). Valid channel unit codes include:

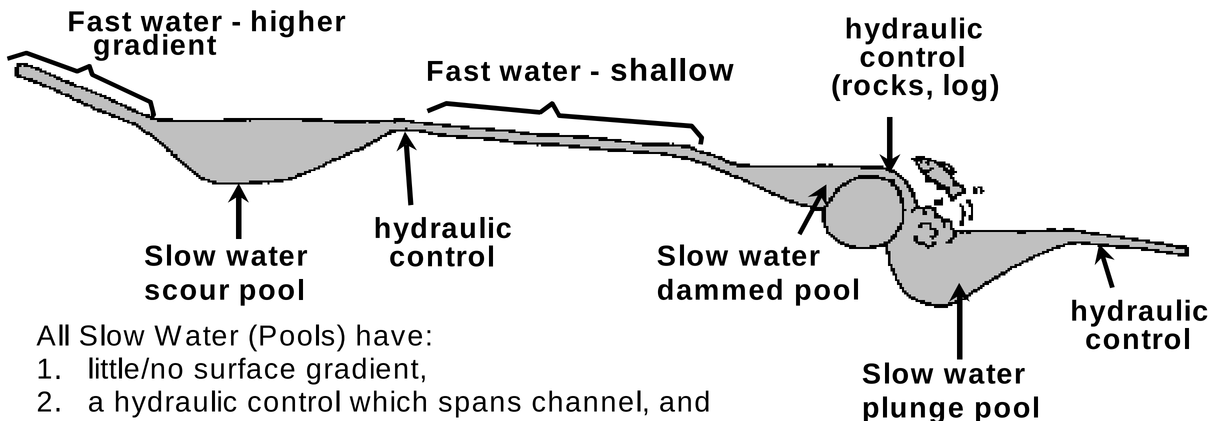
- **S** = Slow Water (Pool)
  - **SD** = Dam Pool
  - **SS** = Scour (Plunge) Pool
- **F** = Fast Water (Riffle)
  - **FT** = Turbulent
  - **FN** = Nonturbulent
- **SIDES** = Slow Water Side Channel (Side channel dominated by pool habitat)
- **SIDEF** = Fast Water Side Channel (Side channel dominated by riffle habitat)
- **CHUNITD (can be coded with D only)** = Dry Main Channel
- **ARTIF** = culverts, dam, (Special Cases Form)
- **WF** = Waterfall (Special Cases Form)
- **CH** = Chute (Special Cases Form)
- **CHUNITM** = Marshlands (Special Cases Form)

NOTE: The codes above are for field data only. Entry into the AI database will utilize the full name of the channel unit.

Channel unit type numbers will be assigned sequentially as the inventory progresses upstream. Both SOs and channel unit numbers are lowest near the downstream end (= startpoint) of the inventory, regardless of channel unit type. The reach number has no bearing on how numbers are assigned to channel units (e.g., if Reach 1 ends at S25, the next slow water unit encountered would be in Reach 2, and it would be designated S26.)

In order to consider a channel unit type as a separate unit, the channel unit length must be equal to or greater than the wetted width. The **ONLY** exceptions to this rule are special case channel units and channel-spanning plunge pools (see figure 6).

Figure 6: Basic distinctions between slow water and fast water units



All Slow Water (Pools) have:
1. little/no surface gradient,
2. a hydraulic control which spans channel, and
3. a residual pool depth.

All Fast Water (Riffles) have:
1. Gradient > 0%
2. Usually has emergent substrate
3. Surface Turbulence

Slow water plunge pools of this type typically are located downstream of a debris jam or log which spans the wetted channel. Such a condition causes a slow water unit to be scoured during high flow events. These slow water units must span the width of the wetted channel, but they need not be longer than their average width.

For all channel units other than channel-spanning plunge pools and Special Case channel units, if the wetted length of a channel unit (measured along the thalweg) is not greater than the average wetted width, do not consider it as a separate unit. For extremely long channel units, (e.g., fast water units approaching 900 feet in length) consider dividing them into smaller more manageable lengths. Use the endpoints of side channels attached to the fast water unit, changes in streambed composition, or stream gradient in the fast water unit to divide a long fast water unit into shorter fast water units. Assign each of the sections of fast water unit a **different** SO and channel unit number (e.g., a survey team decides to split a 1245 ft. section of a stream into three consecutive fast water units: a 455 ft. fast water unit (SO 20, F10), a 530 ft. fast water unit (SO 21, F11), and a 260 ft. fast water unit (SO 22, F12).

Measured channel units are **NOT** unique channel units. A measured channel unit is **NOT** assigned its own SO. Rather, the SO assigned to the estimated channel unit is shared by the measured channel unit as well. Prefix each measured channel unit with an "M" so that these are apparent during data entry. (Example: SO 45, S23 = estimated channel unit, SO 45, MS23 = measured values for the same channel unit). Only slow water unit (S) and fast water unit (F) channel types will have both estimated and measured attributes.

BRAIDS: A series of three or more roughly parallel channels structured during bankfull flow and separated from each other by unstable islands. Vegetation on these unstable islands is typically non-woody annual plants, very young seedlings, or willow. Bankfull flow will frequently cut new braids across these unstable islands. These secondary channels offer very poor winter refuge for juvenile salmonids, yet may offer high quality spawning opportunities for large adults. It is conceivable that during low flow, a single channel may be wet while the additional braids are dry. These should be considered fast water units and the width is the sum of the average wetted channel widths for each of the multiple channels with flowing water. A comment will be made in the remarks section that this was a braided section.

SIDE CHANNELS (SIDES/SIDEF): Enter only wetted length, average wetted width, and maximum depth. Determine whether the side channel is dominated by fast water (SIDEF) or slow water (SIDES) and code appropriately. A side channel is separated from the mainstem channel by a stable island. A stable island in a forested stream is usually colonized by woody plants. Woody plants other than willows are excellent indicators of the stability of an island. In reaches characterized by meadows, a well-developed layer of soil atop the island indicates a stable secondary (side) channel. But the best indicator of stability is the presence of bankfull indicators at an elevation below the surface of the island. If the island is not inundated during bankfull flows consider the island stable even if the island has no vegetation at the time of survey. These stable secondary channels offer very important rearing habitat for juvenile salmonids. Do not assign an SO to dry side channels. Do not break out individual channel units (slow water units, fast water units) within side channels. If a flowing side channel has a dry section, record only the length of the channel that is wet, and in “Remarks” record the estimated length of dry side channel section. Also record in “Remarks” both the bank of the mainstem channel into which the side channel flows, and the upstream mainstem channel unit where the origin of the side channel is located.

TRIBUTARIES are not assigned their own channel unit. Enter the data on a data line below the SO where the tributary enters. For tributaries record temperature (degrees Celsius) and the time it was taken. Estimate a percent of flow contributed by the tributary to the mainstem streamflow below the tributary. Record the estimated flow contribution, the gradient of the tributary, and which bank the tributary intercepts. If possible, identify the tributary on the field map.

DRY MAIN CHANNEL (CHUNITD OR D): Enter only the length of the inventoried mainstem stream channel that is dry at the time of the survey. Enter 0 for wetted width. Large woody material within the bankfull channel of a dry channel segment is potentially mobile during high flow events. Any LWD within the bankfull a dry main channel will be tallied according to its dimensions and recorded.

SPECIAL CASES (culverts, dams, marshlands, waterfalls and chutes) will be designated in several ways. Artificial structures (culverts and dams) are assigned an SO and designated by the code “ARTIF”. Falls (WF), chutes (CH), and marshlands (CHUNIT) will be assigned an SO and coded appropriately. Information will be entered on both the Channel Unit Form and the Special Cases Form for all the above channel units. Enter the appropriate SO, channel unit sequence type and number, length, and wetted width of the channel unit to the Channel Unit Form. The remaining information is entered on the Special Case Form. Instructions for completing the Special Case Form is found in this chapter under the heading **“Special Cases Form (Culverts, Dams, Falls, Chutes, and Marshlands."**

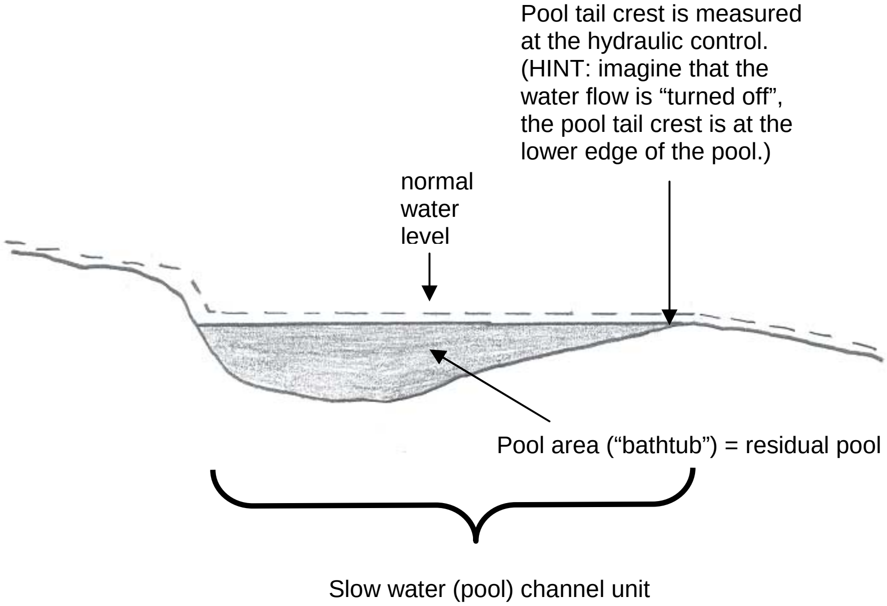
3. MAXIMUM DEPTH: Enter the measured maximum depth for each channel unit to the nearest 0.1 ft. The maximum depth will be measured wherever that depth is less than 4 ft. In those channel units in which maximum depth exceeds 4 ft., an estimate of maximum depth will be made. Maximum depth can be easily measured in most channel units with a depth rod if the depth is less than 4 ft.

4. AVERAGE DEPTH [Forest Option]: Estimate the average depth in fast water units only. This is an ocular estimate, and implementation is a Forest-level decision.

5. POOL CREST DEPTH: Enter the maximum measured depth to the nearest 0.1 ft. at the pool tail crest for every slow water unit channel unit. This location is at the point where the water surface slope breaks into the downstream fast water unit or plunges to a slow water unit below the upstream slow water unit. Measure the maximum depth at this location along the width of the hydraulic control feature that forms the slow water unit. The hydraulic control can be viewed as a dam holding back the slow water unit's water. This "dam" is rarely a straight line across the downstream end of the slow water unit; rather it usually forms an irregular curve.

To identify the location of the maximum depth along the hydraulic control (pool tail crest), visualize a condition in which streamflow has almost stopped, but a trickle of water is still exiting the slow water unit (see figure 7). That point is the maximum depth at the pool tail crest. This measurement is for calculating residual pool depth (e.g., maximum depth minus pool tail crest depth = maximum residual pool depth). The depth will be measured at each slow water unit and estimated wherever the maximum depth at pool tail crest exceeds 4 ft.

Figure 7: How to visualize where the pool tail crest occurs.



6. **FORMED BY (Forest Option):** Record what type of material or obstruction is creating the pool. See Appendix C, pg 80 for more detail.

7. CHANNEL UNIT LENGTH: Measure the length of mainstem channel unit; the dimensions of side channels may be estimated. Channel unit length is a measured dimension for slow water units, fast water units, dry channels, chutes, marshlands, culverts, and dams. These channel units may not be estimated for length. Channel unit length is a measurement of thalweg length. The thalweg is the line of greatest depth from downstream to upstream through the channel unit; it is rarely a straight-line dimension (see Appendix F, page 9.03 for a definition of thalweg). Since the length of all slow water units and fast water units are measured, there is no need to re-measure length as part of the measured channel unit analysis.

The observer is required to drag a measuring tape behind them as they walk upstream. As the observer searches for the maximum depth in the channel unit, the dragged tape will trail behind them in the thalweg. The recorder simply waits at the downstream end of the channel unit until one of two things occurs. Either the observer has determined the upstream end of the channel unit, or the observer has dragged all of the tape upstream.

Measuring the length of side channels is a forest option.

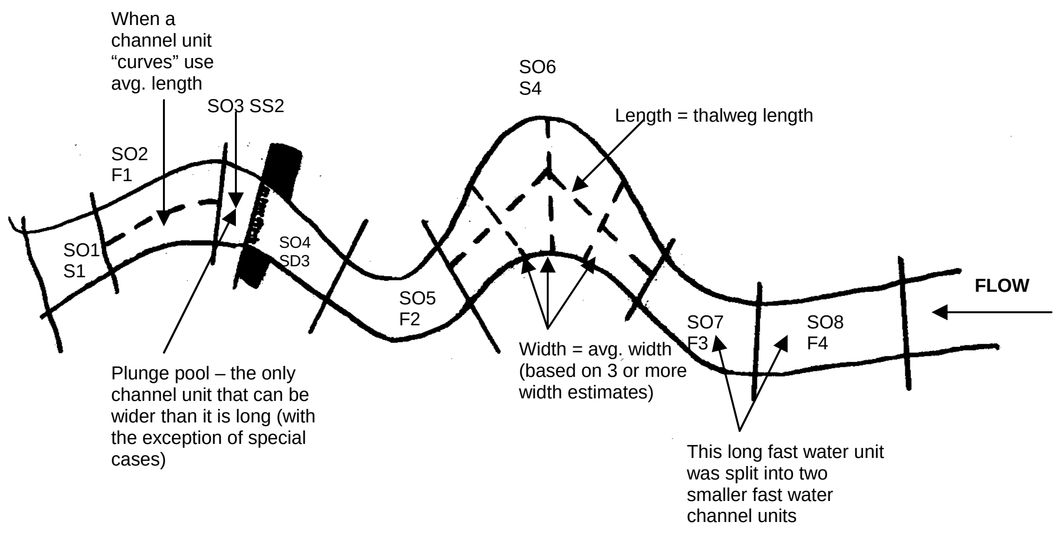
Estimates of length may replace measurements only when safety is in question. Such safety concerns may occur in streams too large or deep to wade the thalweg. An impassable bedrock falls or stream too brushy to see where you are walking are also examples of conditions in which channel unit lengths may be estimated.

How a forest chooses to measure channel unit length is a Forest Option. See Appendix C, Page 79 for a method of measuring channel unit length that has received extensive field testing. These methods are not required but measuring channel unit length for all channel units except side channels is mandatory.

A string box is not an acceptable measuring tool for channel unit length for several reasons. First, the string assumes straight-line positions between points of string attachment rather than following the thalweg. Second, if the string is not kept taut it is easy for the current to pull out an unknown amount of string. There are also possible calibration problems with the string stretching in the rain or with the string box losing its accuracy from beginning to end of a roll of string. The string line also is a hazard to wildlife whenever it is left streamside. Measuring tapes of 100 ft. or greater length, unattached to a reel, are preferred because the tape tends to stay in the thalweg as the observer moves upstream. Measure and record channel unit length to the nearest foot.

8. CHANNEL UNIT WIDTH: Enter the visually estimated average wetted width for each channel unit to the nearest foot. The observer decides where to measure channel unit width in the measured channel unit, but only the recorder knows the measured value. Enter the measured values for channel unit width to the nearest foot, or to the nearest tenth of a foot if the wetted channel width is less than 10 feet (see figure 8).

Figure 8: Channel unit width and length measurements

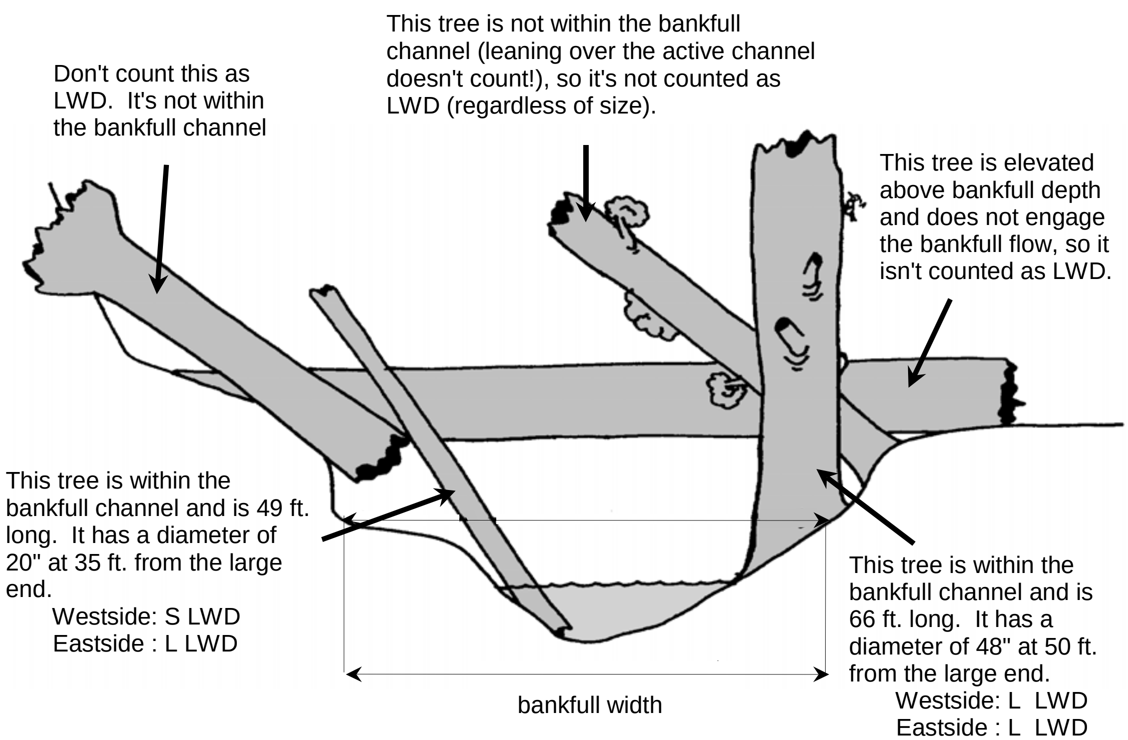


9, 10, 11. PIECES OF LWD: Enter the number of pieces of large woody debris (LWD) within the bankfull channel for each mainstem channel unit. The presence of LWD in the bankfull channel decreases the force of high flow events, tends to capture substrate, offers cover for fish and refuge from the force of storm events. Large woody debris also slows the movement of organic matter (leaves, twigs, and drifting macroinvertebrates) allowing aquatic organisms to more efficiently process and retain the nutrients available in organic debris.

To be included, the tree bole or root swell of live or dead trees must interact with the streamflow at bankfull conditions. The bole of a tree is the trunk of a tree, and is known by its gentle taper from the bottom to the top of the tree. The root swell is the portion of the tree between the roots and the bole; root swell is the fusion of individual roots, creating a sharply tapered portion of the tree. The stump of a tree is largely root swell. The roots are the subterranean branched network of a tree.

If a log or tree leans over the bankfull channel or spans the wetted channel, but does not interact with the streamflow during bankfull conditions, do **<u>NOT</u>** count it as LWD (see figure 9). The approximate numbers of potential LWD (i.e., leaning trees or channel-spanning logs above bankfull flow) are appropriately recorded on the Remarks Form.

Figure 9: Classifying a tree as large woody debris (LWD) is dependent on whether or not the tree is at least partly within the bankfull channel



If only the roots of a tree intercept bankfull flow, the tree is not counted as LWD. Enter the number of pieces of large woody debris in each of the three size classes; Small, Medium, and Large. Use the following minimum diameter and length criteria:

<u>Eastside Forests</u> (east of the High Cascades):

(9) L = Diameter > 20 in, at a length of 35 ft. from the large end (Mandatory)
(10) M = Diameter > 12 in, at a length of 35 ft. from the large end (Mandatory)
(11) S = Diameter > 6 in, at a length of 20 ft. from the large end (Forest option)

<u>Westside Forests</u> (west of the High Cascades):

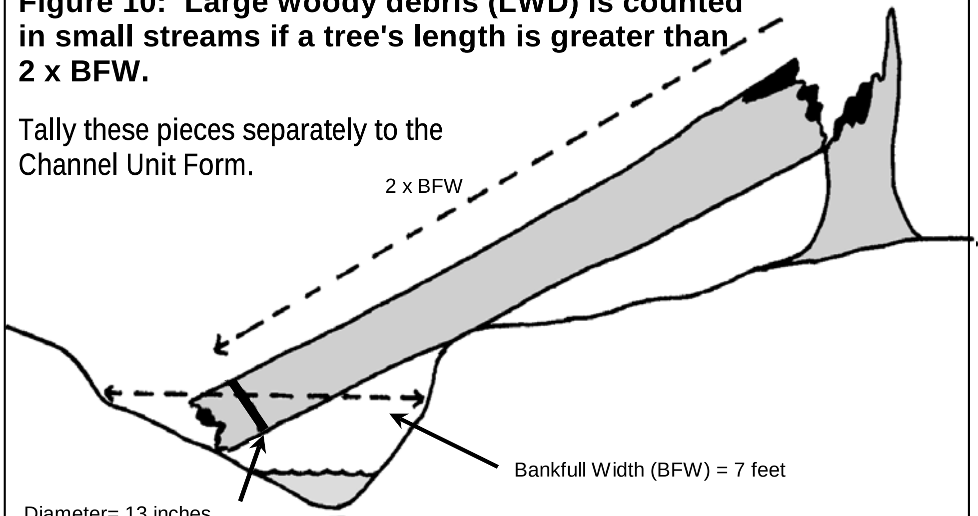
(9) L = Diameter > 36 in, at a length of 50 ft. from the large end (Mandatory)
(10) M = Diameter > 24 in, at a length of 50 ft. from the large end (Mandatory)
(11) S = Diameter > 12 in, at a length of 25 ft. from the large end (Forest option)

If a piece of large wood does not meet the length criteria listed on the previous page, but is longer than twice the average bankfull width for the reach, count the piece in the appropriate size class. Measure the minimum diameter at a distance from the large end equal to twice the average bankfull width for that channel unit. The diameter size criteria do not change regardless of the length of the piece of large wood (see figure 10).

Tally the LWD counts separately on The Channel Unit Form for LWD meeting the standard length criteria from LWD that is shorter than the standard lengths but longer than twice the average bankfull width. Separating these tallies will facilitate sharing data with other agencies and groups using different methods for assessing large wood.

Figure 10: Large woody debris (LWD) is counted in small streams if a tree's length is greater than 2 x BFW.

Tally these pieces separately to the Channel Unit Form.



This tree is 15 ft. long, which does not meet the normal minimum length criteria for LWD. But, because it is at least twice as long as the BFW, it is counted as LWD. The size class of LWD is based on the diameter of 13 inches at a distance from the large end equal to twice the BFW of the habitat unit.

For this example:
Eastside: medium LWD
Westside: small LWD

Make note of logjams and rootwads in the bankfull channel on the Remarks Form. It is important to remember that LWD encountered in a channel unit type treated as a Special Case channel unit will be recorded in the AI database. Therefore, those pieces must be recorded with the Special Case channel unit on the data sheet.

The following instructions (12 through 28) refer to measured channel unit attributes ONLY.

12. BANKFULL WIDTH (BFW): Enter the MEASURED bankfull width at each measured fast water unit. Bankfull is defined as the high streamflow event occurring on average every 1.5 years. This streamflow forms and maintains the channel over time. Select sections of fast water units that have a straight and relatively narrow channel since such sites offer the clearest bankfull indicators. The banks along the site selected for measuring BFW must be free of obstructions which cause high flow backwater across the entire channel. An area with an undercut bank is also a very poor choice for bankfull determination since bank slumping will give a false reading of bankfull conditions. An actively eroding bank is another unreliable site for measuring bankfull flow.

Bankfull is identified by interpreting the evidence of bankfull flow atop the banks of the stream. The most consistent indicators of bankfull flow are the areas of deposition; the top of these deposits define the active floodplain. These deposits are often known by the change in particle size. Other indications of bankfull flow are less reliable. But by using all of the evidence, accurate bankfull measurements can be obtained. The other bankfull indicators include: a change in vegetation (i.e., from none to some, or from herbaceous to woody); a change in bank topography (a change in slope of the bank above the water's edge); a line defining the lower limit of lichen colonization; a stain line visible on bare substrate; a defined scour line (exposed roots, etc.); a line of organic debris on the ground (but NOT debris hanging in vegetation!).

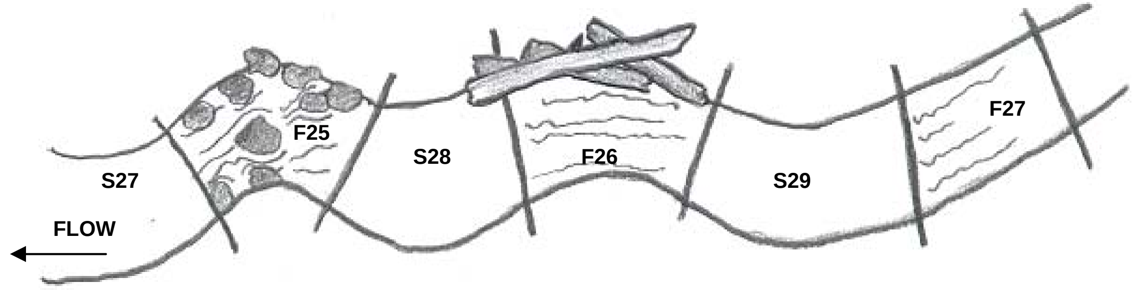
Stretch a measuring tape taut, level, and perpendicular to the thalweg across the channel at the elevation of the clear bankfull indicators. Enter the measurement of BFW to the nearest 0.1 ft.

If clear indicators of bankfull flow are absent in the measured fast water unit, no bankfull or floodprone measurements should be taken. However, the remaining measured attributes should still be determined for the measured fast water unit before proceeding to the next upstream channel unit. The surveyors must then investigate each succeeding fast water unit for clear indicators of bankfull flow. Once bankfull indicators are discovered, the surveyors will make the bankfull and floodprone determinations at that fast water unit and enter the data with that channel unit. A "remark" should be made indicating the measured bankfull information is in conjunction with a previous measured unit where no bankfull indicators were found.

For example, assume the survey team is sampling every sixth fast water unit as a measured fast water unit, and F23 is the next designated measured fast water unit. However, F23 occurs on a channel bend, and the team determines there is no appropriate place along F23 to identify bankfull conditions. Therefore, the next fast water unit, F24, is carefully investigated for bankfull indicators. Assuming clear indicators are present, an appropriate site is chosen along F24 for bankfull measurements. The next measured fast water unit remains F29 (23 plus 6) and the sampling scheme for measured fast water units is unchanged: F23, F29, F35, etc. See figure 11 for a different example.

Fig. 11: An example showing what to do if a "measured fast water channel unit" does not have any clear indicators of bankfull width.

Assume you randomly selected F5 as your first measured fast water channel unit, and you are using a 1:5 (I.e., 20%) frequency. This established the sequence of F5, F10, F15, F20, F25, etc., as measured fast water channel units.



Oh, Oh, F25 is the "measured" fast water channel unit where you're supposed to determine bankfull. But you discover there are no clearly visible bankfull indicators. When that happens, measure the average wetted width, measure any unstable banks, collect vegetation data, and record the temperature/time in F25. But you must search for clear bankfull indicators in the next fast water channel unit.

In this example, F26 also lacks clear bankfull indicators because of a debris jam on the right bank. So you continue to the next fast water channel unit, where you find clearly visible bankfull indicators. Therefore, bankfull and floodprone measurements are recorded with channel unit F27. However, the original sequence of measured fast water channel units remains unchanged. The next measured fast water channel unit will be F30.

13. MAXIMUM BANKFULL DEPTH (max BFD): At the same time average bankfull depth is determined, measure and record the maximum bankfull depth along the stretched tape. This will inevitably be found along the thalweg in the wetted channel. It is simply the maximum elevation measured between the tape measure and the streambed. Record the measured value to the nearest 0.1 ft (see figure 12).

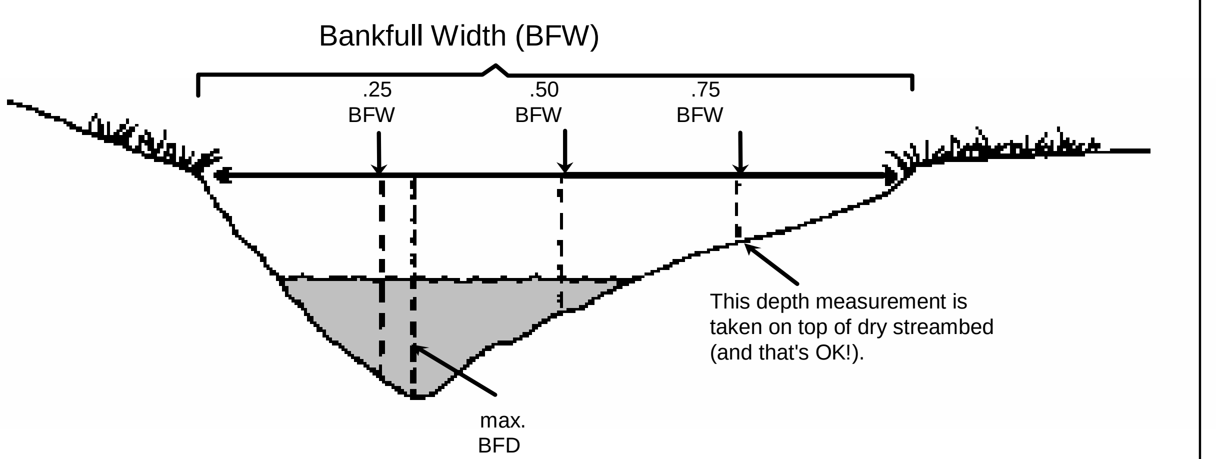
14. FLOODPRONE WIDTH (FPW): The floodprone width is determined by extending the floodprone elevation across the valley floor (see figure 13). The floodprone width is the width of the valley floor inundated during a flood, which occurs approximately every 50 years. To determine floodprone width, pieces of flagging could be temporarily tied to vegetation atop both sides of the channel, at a height equal to the floodprone depth. A measuring tape could then be stretched level, at the same elevation as the flagging elevation, across the valley floor until the tape touches the ground on either side of the stream.

If the floodprone width is less than 2.5 times the bankfull width at that location, measure to the nearest foot. If the floodprone width is greater than 2.5 times the bankfull width at that location, simply estimate the floodprone width. The ratio of floodprone width to bankfull width is referred to as the entrenchment ratio, and this ratio is useful in refining the level I Rosgen Stream Type for each reach.

15, 16, 17. BANKFULL DEPTH (BFD1, BFD2, BFD3): At each measured fast water unit, measure the bankfull depth at 25 percent of BFW, 50 percent of BFW, and 75 percent of BFW. This is the measured height from the streambed to the measuring tape stretched taut and level across the channel at a height equal to bankfull flow. These measurements will be made at the same location as the site for bankfull width (BFW). Record each bankfull depth (BFD) measurement to the nearest 0.1 ft.

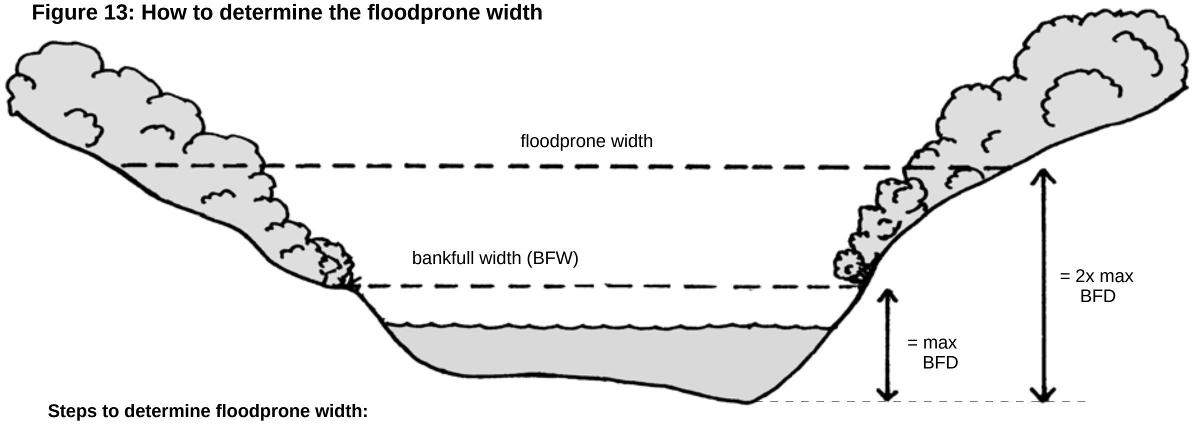
It is expected that some of these measurements will be made outside of the wetted channel atop dry streambed since the surveys are performed under low streamflow conditions. See figure 12 for a visual depiction of the process.

Figure 12: Where to measure bankfull depths (BFD) in order to determine the average BFD and maximum BFD



Average BFD = depth @ (.25 BFW + .50 BFW + .75 BFW)/3
Maximum BFD = depth along same measuring tape distance

Figure 13: How to determine the floodprone width



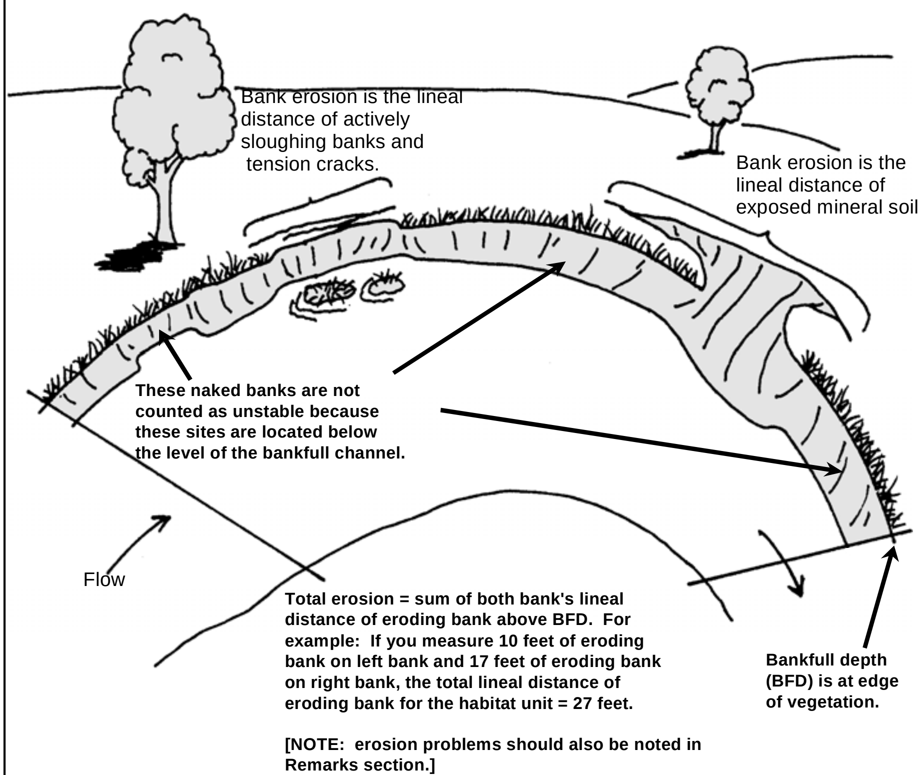
Steps to determine floodprone width:

1) Measure max bankfull depth (BFD) (on the bankfull transect).
2) Determine floodprone depth = 2 x max BFD.
3) Stretch tape across stream at height of floodprone depth, (Keep that tape level!) and measure distance between floodprone banks = floodprone width.

[Note: entrenchment ratio = (floodprone width)/(bankfull width)]

18, 19, 20. UNSTABLE BANKS: Measure the lineal distance of actively eroding banks along both sides of every measured channel unit and tally separately (left bank, right bank, total for both banks). Bank stability is a measure of actively eroding banks at an elevation above the bankfull stream margin. That is, naked substrate within the bankfull channel is the normal condition due to the dynamic nature of the bankfull channel, and is not necessarily an indication of eroding banks. An eroding bank is characterized by any one, or a combination of the following factors provided they occur at an elevation above the bankfull flow: bare exposed colluvial or alluvial substrates, exposed mineral soil, evidence of tension cracks, or active sloughing (see figure 14). A bank that is composed of only cobbles and gravels may, nonetheless, be stable; the sand, silt and clay components no longer present in a naked bank may be quite resistant to erosion. If there is no sloughed material perched atop the lower banks, do not consider a naked bank unstable. Record to the nearest foot.

Figure 14: Bank stability is the sum of the lineal distance actively eroding banks on both sides of each measured channel unit



BANK STABILITY IN NON-MEASURED MAINSTEM CHANNEL UNITS: It is required to measure, not estimate, all lengths of bank instability observed along measured pools and measured riffles. Surveyors are encouraged to measure the lengths of all banks judged to be unstable at the time of the survey.

21, 22, 23. RIPARIAN VEGETATION (INNER ZONE): The width of the inner riparian zone is variable by reach and specified on the Final Reach Form. Once a width for the zones has been established, that distance must be maintained throughout the reach. Aerial photographs are usually sufficient to establish the average inner riparian zone width for each reach identified during the level I (office phase) inventory. A level II inventory seeks to characterize the average condition of the riparian vegetation for each reach. It is from the description of each measured channel unit's vegetative condition that the average for the reach is determined.

It is a "Forest Option" to designate either a single 100-ft. wide riparian zone or two adjacent riparian zones (inner and outer zones) totaling 100 ft. in width. If a Forest chooses to characterize a single riparian zone, the data is entered to the columns labeled "Riparian Vegetation (Inner Zone)," and the remaining columns for vegetation labeled "Riparian Vegetation (Outer Zone)" are left blank.

21. CLASS: Enter the existing riparian vegetation successional class within the inner zone of each measured channel unit. Use the following diameter codes to describe the riparian successional class (see Appendix E for illustration and definitions of successional stages). It is rare for riparian forests to consist of a single successional (i.e., seral) class. The task is to define from an overhead (i.e., bird's-eye) view which successional class occupies the most overstory area within the inner zone width along both banks of the measured channel unit. It is the average of both banks' condition.

DIAMETER CLASS

NV = No Vegetation (bare rock/soil, dbh not applicable)
GF = Grassland/Forb Condition (dbh not applicable)
SS = Shrub/Seedling Condition (1.0 _ 4.9 in. dbh)
SP = Sapling/Pole Condition (5.0 _ 8.9 in. dbh)
ST = Small Trees Condition (9.0 _ 20.9 in. dbh)
LT = Large Trees Condition (21 _ 31.9 in. dbh)
MT = Mature Trees Condition (32 in. dbh)

If no overstory layer is present and the dominant vegetation in the inner zone is in seral class GF, enter GF for (seral) Class. If the dominant vegetation in the inner zone is in seral class SS, enter SS for (seral) Class.

22. OVERSTORY: Enter the dominant overstory species of vegetation growing in the inner zone for each measured channel unit, using the species codes listed below. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the inner zone along both banks of the measured channel unit. It is the average of both banks' condition.

If the seral class in the inner riparian is SP, ST, LT, or MT, use the following codes to identify the dominant overstory species. Forests may add to this list to include additional vegetation species. At a minimum, HX and CX can be used to denote hardwoods and conifers respectively.

Hardwood:
HA = Alder
HB = Bigleaf maple
HC = Cottonwood, ash, poplar
HD = Dogwood
HE = Elderberry
HL = Liveoak, canyon
HM = Madrone
HO = Oak, Oregon white, California black
HQ = Quaking aspen
HT = Tanoak
HV = Vine Maple
HW = Willow
HX = Other/unknown

Conifer:
CA = Subalpine fir, mountain hemlock, whitebark pine
CC = Cedar, western red
CD = Douglas-fir
CE = Subalpine fir _ Engelmann spruce
CF = Fir, silver and noble
CH = Hemlock, western
CJ = Juniper
CL = Lodgepole pine, shore pine
CM = Mountain Hemlock
CP = Ponderosa pine, Jeffrey Pine
CQ = Western white pine
CR = Red fir
CS = Spruce, Sitka
CT = Port-Orford-cedar
CW = White fir, grand fir
CY = Yew
CX = Other/Unknown

If there is no clear dominant species of tree in the overstory layer, then enter one of these three conditions as dominant: shrub/seedling, grass/forb, or no vegetation**.**

SHRUB SEEDLING HEIGHT [Forest Option]: Forests have the option of designating the height class of the shrub seedling class wherever no dominant overstory species is present. For example, if shrubs between 5 and 10 feet tall are the dominant successional class in the inner zone, the entry for dominant overstory species would be SS3 (see Eastside example below). Shrub height classification is an optional field and applies only to seral class SS. Use the following categories:

1 = 0 ft. - 2 ft.
2 = 2 ft. - 5 ft.
3 = 5 ft. - 10 ft.
4 = > 10 ft.

23. UNDERSTORY: Enter the dominant understory species growing in the inner riparian zone for each measured channel unit, using the species codes listed below. Each Forest must decide what defines the understory, and how to estimate conditions in this riparian vegetative layer. Contrasting views of understory include what species are likely to replace the canopy dominants with time and presently are sapling/pole versus what is the vegetative site potential where the understory is likely to be small shrubs.

Examples:

The examples depend on how Forests interpret the understory component of riparian vegetation and in no way restrict Eastside and Westside forests to the methods described in the examples.

Eastside _ If seral stage in the inner zone is Grassland/Forb, with grasses dominant with a few shrubs 3 ft. tall: the entries for Class/Overstory/ Understory might be GF/SS2/GF. If seral stage is shrub/seedling dominant, with shrub/seedlings 30 ft. tall and alder subdominant the riparian vegetation might be categorized as SS/SS4/HA.

Westside _ Seral stage is large trees with Douglas-fir dominant in the overstory and western hemlock dominant in the understory, the designation for riparian condition might be LT/CD/HA.

24, 25, 26. RIPARIAN VEGETATION (Outer Zone)

24. CLASS: Enter the existing riparian vegetation successional (i.e., seral) class within the outer zone of each measured channel unit. Use the diameter codes described in #21 (see Appendix D, pg 90 for an illustration and definitions of successional stages). The task remains the same as described for the inner riparian zone. Define from an overhead (i.e., bird's-eye) view which seral class occupies the most overstory area within the outer zone width along both banks of the measured channel unit. It is the average of both banks' condition. Whenever a Forest chooses to characterize a single riparian zone, it is considered an inner zone of 100 ft. In such a case, there is nothing recorded for the “Riparian Vegetation (Outer Zone)”.

25. OVERSTORY: Enter the dominant overstory species of vegetation growing in the outer riparian zone for each measured channel unit, using the species codes listed for #22 and #23. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the outer riparian zone along both banks of the measured channel unit. It is the average of both banks' condition. Forests again have the option to designate the height class of shrub/seedling wherever that seral class is the dominant overstory component (see #22 for an explanation).

26. UNDERSTORY: Enter the dominant understory species growing in the outer riparian zone for each measured channel unit. Use the species codes listed for #22 and #23. It is the task of individual Forests to define the characteristics of the understory of interest to them.

27, 28. WATER TEMPERATURE:

27. DEGREE: Take stream temperatures within the mainstem channel at every measured unit. Enter to the nearest Celsius degree. Submerge the thermometer for at least 1 minute to allow a handheld thermometer to adjust to the water temperature.

NOTE: Temperatures should be recorded for ALL measured units in degrees Celsius.

Stream temperatures should also be recorded for each tributary encountered and entered to the “Remarks” section for the mainstem channel unit into which the tributary flows.

28. TIME: Enter the military time when temperatures are taken, and record the time to the nearest hour (e.g., 1400).

It bears repeating for emphasis that every stream to be surveyed shall have a long-term temperature recording device installed in a slow water unit near the start point of the inventoried stream that will record water temperatures from mid-June through late-September.

29, 30, 31, 32, 33. STREAMBED SUBSTRATE [Forest Option]: Enter the visually estimated percent that each size class of substrate comprises of the wetted streambed area. This estimate is made only after the observer has walked the length of the entire channel unit. If any of the size classes of substrate listed below constitute at least 10 percent of the area of the streambed, record the percent in the appropriate column, in increments of 10 percent, each size class supplies to the surface of the streambed. Each Forest has the option to collect estimates of streambed substrate or to disregard these qualitative attributes.

Caution: There is a tendency for observers to over-estimate the percent of streambed which is cobble or greater in size. Surveyors under-estimate the contribution to area made by the edgewater streambed. The margins of most channel units tend to have a streambed comprised of smaller substrate than commonly found in deeper portions of the channel unit.

Use the following size classes:

SA = Sand, Silt, and Clay	(<0.08 in....<2 mm.)	(smaller than "BB")
GR = Gravel	(0.08 _ 2.5 in....2 - 64 mm.)	("BB" to tennis ball size)
CO = Cobble	(2.5 _ 10 in....64 - 256 mm.)	(tennis ball size to basketball size)
BO = Boulder	(10.0 - 160 in....256 - 4096 mm.)	(basketball to small car)
BR = Bedrock	(>160 in. >4096 mm.)	(larger than a small car)

CHANNEL UNIT FORM

R6-2500/2600-22

pg :_____________ of ___________

A. State:____________ B. County______________________ C.Forest:__________________________ D. District___________________________

E.Stream Name____________________________ F. 4th HUC Code ___,___,___,___5th_____6th_____

G. USGS Quad____ H. Reach # ____

I. Sampling Frequency: F___________________________ S_______________________________ J. Survey Start Date __________________________

K. Contacts: REC:____________________________________ OBS:_______________________________________ mm/dd/yyyy

Channel Units								Woody Material			Bankfull Measurements						Unstable Banks			Riparian Vegetation (Inner Zone)			Riparian Vegetation (Outer Zone)			Water Temp		Streambed Substrate (Forest Option)				
Seq.	Channel Unit Type & No.	Max Depth	Avg Depth	Pool Crest Depth	Formed By	Length	Wet Width	L 2x	M 2x	S 2x	BF Width	Max BF Depth	FPW	BFD1	BFD2	BFD3	Total Length	Length Left	Length Right	Class	Over story	Under story	Class	Over story	Under story	°C	Time	SA	GR	CO	BO	BR
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

SPECIAL CASES FORM (CULVERTS, DAMS, FALLS, CHUTES, AND MARSHLANDS)
R6-2500/2600-23

This form is intended to encompass both manmade and natural special case units. It will be used to document specific information on manmade units such as culverts (road crossings encountered during the survey) and dams. Culverts and dams are to be noted on the general Channel Unit Form as an “ARTIF" channel unit type. Natural features include information on falls, chutes, and marshlands. These are aquatic channel units that do not fit the standard channel unit types entered to the Channel Unit Form.

Braided channels will not be identified as separate channel unit types but should be identified as fast water channel units and be described in the “Remarks” as a braided channel.

Definitions:

CULVERTS: A pipe or arch buried by road fill material through which a stream flows beneath a road.

FALLS: An essentially vertical drop in the channel bed that results in a waterfall. This is considered a fast water unit. It is a Forest-level decision as to what height of the drop constitutes a Special Cases channel unit.

CHUTES: A section of the channel, usually constrained by bedrock, that results in a funneling of stream flow through a narrow constriction. This is considered a fast water unit.

DAMS: Specific **human-made** structures to impound water.

MARSHES: A water-saturated, poorly drained wetland area either permanently or periodically inundated with water. It has no discernable bankfull channel.

Large wood that engages bankfull flow within a special case channel unit is viable LWD. Tally and record with the appropriate channel unit.

NOTE: INSTRUCTIONS FOR COMPLETING THE SPECIAL CASES FORM HEADER (ATTRIBUTES A - H) ARE LISTED IN THE SURVEY FORM INSTRUCTIONS, Page 13.

1. REACH NUMBER: Enter the reach in which the culvert is located.

2. SO NUMBER: Enter the SO number assigned to the special case and entered on the Channel Unit Form.

3. CHANNEL UNIT TYPE AND NUMBER: Like other channel units of an inventoried stream, culverts and other special case channel units are sequentially numbered from downstream to upstream. For example, every culvert is assigned an “ARTIF” as the prefix to the

ARTIF unit number. The same process applies to each of the Special Case channel units: falls (WF), chutes (CH), marshlands (CHUNITM), and dams (ARTIF).

4. TYPE OF STRUCTURE (applies only to culverts): Indicate the type of culvert by writing in the appropriate type from the diagram at the bottom of the data sheet. (e.g., open arch)

5. LENGTH OF STRUCTURE or CHANNEL UNIT: Lengths will be entered on the Channel Unit Form as well as the Special Cases Form.

> **Culverts**: Enter the length of the culvert measured along the bottom of the culvert from the outlet to the inlet. Record to the nearest 1 ft.
> **Dams**: Length is measured parallel to the stream flow, and width is measured perpendicular to the stream flow. Record to the nearest 0.1 ft.

6. DIAMETER OR WIDTH: Enter the measured diameter or width of the structure (culverts and dams). If an arch, open arch, box, or open box, measure maximum width. Enter average wetted width for a falls, chute, or marshlands.

7. GRADIENT: Enter the measured gradient as a percent slope using a hand level, abney level, or peep site. Measurement of slope using a clinometer is not acceptable. Gradient is required for culverts, falls, and chutes. Gradient is optional for marshes and dams. Enter the gradient of the Special Case channel unit in percent slope, to the nearest percent. This can be determined most easily by dividing the height of the Special Cases channel unit by the channel unit's length (rise/run).

8. JUMPING DISTANCE (Culverts and falls): Enter the measured height from the surface of the stream to the culvert's lip (downstream end) or the top of the falls.

9. SPILL POOL DEPTH (Culverts and falls): Enter the depth of the pool (slow water unit) downstream of the channel unit. A spill pool is a pool immediately downstream of a falls or culvert.

10. HEIGHT (Falls, chute or dam): Enter the height of the special case channel unit. Height is the vertical difference between the water level at the downstream end of the falls, chute, or dam from the water level to the upstream end of the special case unit.

11. BAFFLES PRESENT: Baffles are flow detectors that create velocity breaks inside the culvert; these velocity breaks provide resting areas for fish migrating upstream. Record Y for Yes, N for No to indicate the presence or absence of baffles in the culvert.

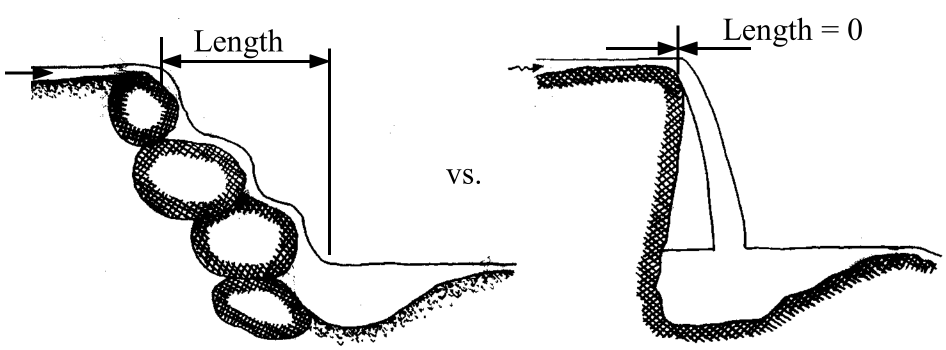
12. MIGRATION BARRIER: Record Y for Yes, N for No to indicate if the channel unit is a barrier to fish passage.

13. REMARKS: Enter any pertinent comments for the feature. (e.g., falls is actually a series of three steps with no intervening slow water units)

Required attributes for Special Cases

Falls:	Height, wetted width, and gradient are required.
Chutes:	Length, width, height, and gradient are required. Height is defined as the elevational change between the bottom and the top of the chute. To calculate chute height using an Abney level, measure the slope angle of the chute in degrees. The height equals the product of the length of the chute multiplied by the sine of the angle.
Dams:	Length, width, and height are all required. Length is measured parallel to the stream flow, and width is measured perpendicular to the stream flow.
Marshes:	Both length and width of the valley floor in a marshland condition are required.
Culverts:	Type of structure, Length of structure, width of structure, gradient of structure, jumping distance, spill pool depth, baffles present, migration barrier

Figure 15. A contrast between a waterfall with length and a waterfall with no length.



The waterfall on the left is formed of boulders; provides no resting habitat between the plunge pool downstream and the habitat upstream of the falls. The boulder falls has channel length, while the bedrock waterfall on the right plunges over a vertical lip. The bedrock falls has no length.

SPECIAL CASES FORM

(Culverts, Dams, Falls, Chutes, and Marshlands)
R6-2500/2600-23

A. State __________ B. County __________ C. Forest _________ D. District _________
E. Stream Name ____
F. 4th HUC Code ____, ____, ____, ____ 5th ____6th_____
G. USGS Quad ____
H. Survey Date _____/___/_______ I. Contacts: Observer:___________________________Recorder:___________________________
MM / DD / YYYY

Reach #	Sequence Order #	Channel Unit Type and No.*	Type of Structure (culverts)**	Length of Structure or Channel Unit (ft)	Diameter or Width (ft)	% Gradient	Jumping Distance (ft)	Spill Pool Depth (ft)	Height (ft)	Baffles Present (Y or N)	Migration Barrier (Y or N)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13

*Channel Unit Type = ARTIF (Culvert, Dam), WF (waterfall), CH (Chute), ND (Marshlands)

**Type of Structure (for culverts only). This data entered into Remarks area in AI only

Round Pipe (RP) Box (BX) Arch (AR) Open Arch (OA) Open Box (OB) Elliptical (EL)

REMARKS FORM
R6-2500/2600-25

The function of the Remarks form is to provide additional space, if needed, for any comments concerning channel unit condition, observed biota, riparian condition, upland condition, etc. that won't fit in the "Remarks" space provided on some of the field forms (Final Reach Form, Special Cases Form, and Aquatic Biota Form). Consider developing codes for recurring comments (such as RW for a root wad); this will assist in querying data at a later time.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM REMARKS FORM HEADER (ATTRIBUTES A - H) ARE LISTED ON THE SURVEY FORM INSTRUCTIONS, pg 13)

1. REACH NUMBER: Enter the number of the reach where the observation is made.

2. SEQUENCE ORDER (SO): Enter the SO for the channel unit that is the focus of the remark as listed on the Channel Unit Form.

3. CHANNEL UNIT TYPE AND NUMBER: Enter the channel unit type and number of the channel unit that is the focus of the comment as listed on the Channel Unit Form.

4. REMARKS: Enter your comments regarding any of the above evaluations and photos; or geomorphological, hydrologic, or biological observations here. For culverts, dams, falls, chutes, and marshes use the Special Cases Form to document specific information regarding these features. Other suggested features to note are:

Fish passage: jams, barriers, fish habitat improvement opportunities, etc.

Watershed concerns: landslides, erosion areas, streambank damage, watershed rehabilitation potential, etc.

Braided Channel: When a fast water unit has a series of three or more roughly parallel channels structured during bankfull flow and separated from each other by unstable islands the area is considered a braid. These secondary channels offer very poor winter refuge for juvenile salmonids, yet may offer high quality spawning opportunities for large adults. A comment shall be made in the remarks section that this fast water channel unit was a braided section.

LWD: Debris jams, large amounts of wood that are too short or too small in diameter to be tallied in the small category, wood accumulations above bankfull.

Bankfull dimensions: not measured in a measured riffle. A comment identifying the fast water unit used to determine bankfull and floodprone dimensions must be made whenever the actual measured fast water unit lacks clear bankfull indicators.

Other: diversions, mining, dredging, filling, riprap, undocumented campsites, etc. Also identify reaches that are within Wild and Scenic rivers and wilderness areas.

Tributaries: Note the channel unit at the confluence, estimated tributary discharge, the channel gradient of the tributary immediately upstream of mouth, and the percent contribution to the flow of the mainstem stream.

End of Survey: Note the reasons for ending the inventory at a given point. The upstream endpoint for the inventory must be geographically defined so that the point can be reestablished in the future. If possible, mark beginning and end of each reach with a metal tag attached to a tree and describe the location of the tag in "Remarks" section. This information will give the reviewer insight as to the reasoning for ending the survey, and will minimize the need to re-examine that point in the watershed. (e.g., riparian buffers intact, 10-yr old revegetation on upland R.BANK slope)

REMARKS FORM
R6-2500/2600-25

Page: ____ of ____

A. State __________ B. County ___________ C. Forest ___________ D. District ____________

E. Stream Name ____

F. 4th HUC Code ____, ____, ____, ____ 5th ____6th_____

G. USGS Quad ____

H. Survey Date ____/______/______
MM/DD/YYYY

Reach No.	SO	Channel Unit Type and No.	Remarks

AQUATIC BIOTA FORM
R6-2500/2600-30

This form is to be used to document the range and distribution of aquatic-dependent species identified during the inventory. Although the focus is on those species that are dependent on water for all life stages (fish), amphibians are to be noted. Sampling methods will focus on those specific to collecting/observing fish species. The sampling intensity may vary between Forests, but the minimum biological survey effort is to sample every measured slow water unit and every other measured fast water unit. Snorkeling, electroshocking, hook and line, or seining are the only acceptable methods of biological survey.

Identification of aquatic species is carried to the taxonomic level of which the observer is sure. Ideally, genus and species is sought, since the objective is to determine the species distribution across the stream section surveyed. Stealth during your approach to a target channel unit may increase the chances for identification of the species present.

Identify species only when directly observed. If individual organisms are measured or their lengths estimated, the units of measure must be millimeters.

SAFETY

All safety issues addressed in the Field procedures section on pg 24 also pertain for daytime snorkeling, night snorkeling, snorkeling in swift water, and electroshocking. In addition, all snorkelers must be able to swim and be certified by the Forest Dive Safety Officer (this person will ensure that each snorkeler has the proper training and skills to perform the assigned tasks). A JHA specific to the activity must be prepared prior to that activity taking place. A tailgate safety session must be held as part of each day's biotic inventory efforts. Additional hazards specific to snorkeling and electroshocking such as the following need to be addressed:

- Hypothermia,
- Entanglement, especially in debris jams,
- Electrocution,
- Drowning,
- Disorientation during night snorkeling,
- Fatigue while driving at night.

NOTE: INSTRUCTIONS FOR COMPLETING THE AQUATIC BIOTA FORM HEADER (ATTRIBUTES A -H ARE LISTED IN THE SURVEY FORM INSTRUCTIONS (page 13).

H. SURVEY DATE: Enter the date the biological survey was performed.

I. REACH NUMBER: Enter the number of the reach where sampling occurred.

J. WATER and AIR TEMPERATURE (^{o}C)/TIME: Enter water and ambient air temperature (in degrees Celsius) at time of biological survey.

K. SAMPLING METHOD: Circle the method used for collection/identification.

1. SEQUENCE ORDER (SO): Enter the Sequence Order number as listed on the Channel Unit Form of the channel unit in which the fish and/or amphibian identification occurred.

2. CHANNEL UNIT TYPE AND NUMBER: Enter the channel unit type and number assigned to the SO described in #1 (above) as listed in the Channel Unit Form.

3. DATE/TIME START: Date and time (MM/DD/YYYY: HH:MM (24 hour clock)) sampling occurred and/or commenced.

4. DATE/TIME END: Date and time (MM/DD/YYYY: HH:MM (24 hour clock)) sampling ended.

5. SPECIES: If only identified to genus, enter the first 2 alpha characters of the genera, and denote species by XX. If identified to species, enter the first two letters of the genus, followed by the first two letters of the species. These codes are shorthand for the Aquatic Biota Form. Data entry into NRIS AB will require the user to choose the correct scientific name.

Example: Two snorkelers see several juvenile trout but neither can identify if they are rainbow (*Oncorhynchus mykiss*) or cutthroat trout (*Oncorhynchus clarkii*). The observations are entered to NRIS AB as *Oncorhynchus.*

Amphibian species can be treated in an identical manner using a four-letter code designating genus and species for all amphibians encountered. There are two field guides that can provide surveyors with excellent color photos, a species description, a brief discussion of habit and habitat, and distribution maps for each amphibian species: *Amphibians of Oregon, Washington and British Columbia: A Field Identification Guide*, by Charlotte C. Corkran and Chris Thoms and *Amphibians of Washington and Oregon: The Trailside Series,* by William P. Leonard et al. (e.g., SACO)

6. SIZE CLASS [Forest Option]: Enter sizes of individual fish in increments of 100 millimeters.

7. REMARKS: Enter comments regarding any of the evaluations and document photos. Additional comments might include geomorphic, hydrologic, or biological observations. (e.g., several stream restoration structures in this reach offering excellent cover for juvenile trout)

While the FS is responsible for the stewardship of habitat for fish and amphibians, it is the state agencies that remain empowered to protect the species. Both Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife require personnel engaged in sampling fish populations obtain a permit. A federal permit is required to snorkel, seine, or electroshock in any stream that has fish or wildlife with federal status as “threatened” or "endangered." The U.S. Fish and Wildlife Service has jurisdiction over resident fish and wildlife; NOAA Fisheries is the permitting agency for salmon and other anadromous fish.

PARTIAL LIST OF FISH AND AMPHIBIAN SPECIES

CODE	GENUS AND SPECIES	COMMON NAME
CAXX	*Catostomus* sp.	Unknown sucker
COXX	*Cottus* sp.	Unknown sculpin
GAAC	*Gasterosteus aculeatus*	Threespine stickleback
GIBI	*Gila bicolor*	Tui chub
JUVL	....	Unknown juvenile salmonid
ONCL	*Oncorhynchus clarkii*	Cutthroat trout
ONGO	*Oncorhynchus gorbushcha*	Pink salmon
ONKE	*Oncorhynchus keta*	Chum salmon
ONKI	*Oncorhynchus kisutch*	Coho salmon
ONMY	*Oncorhynchus mykiss*	Steelhead, Rainbow, Redband trout
ONNE	*Oncorhynchus nerka*	Sockeye salmon
ONTS	*Oncorhynchus tshawytscha*	Chinook salmon
ONXX	*Oncorhynchus* sp.	Unknown salmon/trout
PRWI	*Prosopium williamsoni*	Mountain whitefish
PTOR	*Ptychocheilus oregonensis*	Northern squawfish
RHCA	*Rhinichthys cataractae*	Longnose dace
RHXX	*Rhinichthys* sp.	Unknown dace
SACO	*Salvelinus confluentus*	Bull trout
SAFO	*Salvelinus fontinalis*	Brook Trout
SATR	*Salmo trutta*	Brown Trout

AMPHIBIANS

CODE	GENUS AND SPECIES	COMMON NAME
AMGR	*Ambystoma gracile*	Northwestern salamander
AMTI	*Ambystoma tigrinum*	Tiger salamander
ASTR	*Ascaphus truei*	Tailed frog
BAWR	*Batrachoseps wrighti*	Oregon slender salamander
BUBO	*Bufo boreas*	Western toad
BUWO	*Bufo woodhousii*	Woodhouse's toad
DICO	*Dicamptodon copei*	Cope's giant salamander
DITE	*Dicamptodon tenebrosus*	Pacific giant salamander
ENES	*Ensatina eschoscholtzii*	Ensatina
PLEL	*Plethodon elongatus*	Del Norte salamander
PLDU	*Plethodon dunni*	Dunn's salamander
PSRE	*Pseudacris regilla*	Pacific chorus frog

RAAU	*Rana aurora*	Red-legged frog
RABO	*Rana boylii*	Foothill yellow-legged frog
RACA	*Rana cascadae*	Cascades frog

AMPHIBIANS (cont.)

CODE	GENUS AND SPECIES	COMMON NAME
RAPI	*Rana pipiens*	Northern leopard frog
RAPR	*Rana pretiosa*	Spotted frog
RHCAS	*Rhyacotriton cascadae*	Cascade torrent salamander
SPIN	*Spea intermontana*	Great Basin spadefoot
TAGR	*Taricha granulosa*	Roughskin newt

MACROINVERTEBRATE TAXA

Ephemeroptera	Mayflies
Odonata	Dragonflies and Damselflies
Plecoptera	Stoneflies
Trichoptera	Caddis flies
Gastropoda	Gastropods, slugs, snails
<u>Diptera</u>	Midges
<u>Heteroptera</u>	Water striders
Coleoptera	Beetles
Megaloptera	Dobsonflies, fishflies, hellgrammites alderflies
Astacidae	Crayfish

AQUATIC BIOTA FORM
R6-2500/2600-30

Page: ____ of ____

A. State __________ B. County __________ C. Forest _________ D. District _________
E. Stream Name ____
F. 4th HUC Code ____, ____, ____, ____ 5th ____6th_____
G. USGS Quad ____
H. Survey Date _____/___/_______ I. Reach Number _____________
MM / DD / YYYY
J. Water Temperature (°C)/Time ____________________ Air Temperature (°C)/Time ______________________
K. Sample Method (circle method used for collection/identification) : Seine (S) Snorkel (N) Electroshock (E) Hook & Line (H)

SO	**Channel Unit Type and No.**	**Species Code**	**Date/Time Start**	**Date/Time End**	**Size Class** **[Forest Option]**	**Remarks**
1	2	3	4	5	6	7

CHAPTER - 4

Specialized Field Procedures: Discharge and Wolman

STREAM HABITAT DATA DISCHARGE FORM

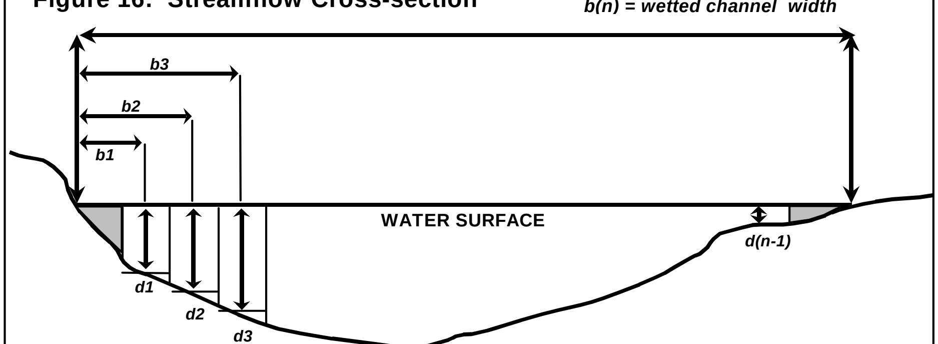
R6-2500/2600-31

The level II stream inventory is designed to identify habitats during low streamflow conditions. On most streams in the Pacific Northwest, low flow occurs in the summer. Habitats with only slight turbulence during low flow conditions are often quite turbulent as streamflow (discharge) increases. Stream discharge must be completed within 10 calendar days of beginning the physical habitat inventory. By measuring discharge at the beginning of the field inventory, mangers are able to compare inventories completed during different years on the same stream.

Stream discharge (Q) is the volume of water passing a cross-section per unit of time and is generally expressed as cubic feet per second (cfs). Discharge is simply the velocity multiplied by the cross-sectional area of the stream (Q=VA). Cross-sectional area is the vertical plane of water filling the channel, and this plane is always perpendicular to the thalweg. Area is approximated by dividing the wetted cross-section into subsections. The depth and width of each subsection are determined. Velocity is measured in each subsection using a current meter. The discharge for each subsection is calculated and the subsectional discharges are summed to derive a total stream discharge.

The figure below displays the mid-section method for dividing the stream cross-sectional area into subsections. The distance "b_n" is the width of the wetted channel. The distance, "b_1," represents the distance from the initial point ("O") to the location of the first depth and velocity measurements. The dotted lines indicate the vertical boundaries of each subsection, with the measured depth and velocity of each subsection occurring along the midline of the subsection.

Figure 16: Streamflow Cross-section



Three rectangular subsections are displayed by depth and distance from the water's edge to the midline of each subsection. The shaded triangles represent the stream margin, with a depth too shallow to measure velocity. The stream margins make a negligible addition to streamflow.

The best place to measure discharge is where laminar flow dominates and the flow is perpendicular to the cross-section. These conditions exist in gravel dominated fast water units or the shallow portions of pools near their pool tail crests. Seek a cross-section where smaller substrates dominate (cobble or finer) and turbulence is minimized.

Water in a channel flows at different rates depending on its location, so the area of the cross-section is divided into subsections, with one or more measurements taken for each. At least 25 to 30 subsections are needed for most channels, and no more than 10 percent of the total discharge (Q) should pass through any subsections. Add additional subsections for broad or structurally complex cross-sections.

For computing the area, the mid-section method (see figure above) uses the vertical line of each measurement as the centerline of a rectangular subsection; boundaries fall halfway between the centerlines. Discharge in the triangular subsections at the waters edge, where the water is too shallow to allow a meter reading, are negligible in terms of total discharge.

Multiply the mean velocity for each subsection by the area of the subsection to compute the discharge (Q_n) for the subsection. Sum all subsection discharges to get the total discharge (Q) for the cross-section.

The field procedure is much like measuring elevations along the cross-section, except a current meter is used instead of a stadia rod. A two-person crew works best, one to operate the current meter and one to take notes. In high gradient or deep streams, use appropriate safety precautions.

CURRENT METERS

Meters commonly used to measure current velocity include: Marsh-McBirney, Swoffer, Price AA, and Pygmy. Some brands have rotating cups, while others have a pair of electronic contacts on a small head. Older models read out revolutions of the cups by clicking or buzzing into a headset. Newer models have a digital read-out.

Most current meters mount on a top-setting rod, which allows the current meter to be easily set to the correct depth. Top-setting rods are recommended for discharge measurement because they make the process simpler and quicker.

Examine the meter before going into the field, and read the manufacturer’s instructions. Some meters (i.e., Price AA and Pygmy meters) will require a spin test before each measurement; a short series of strong breaths on a Pygmy should yield a minimum spin of 30 seconds. Or perhaps even test it in running water--using a nearby stream, irrigation ditch, or a garden hose aimed at the cups. Check the batteries providing power to the digital read-out, and take spares. Calibrate your meters prior to the field season. If you have more than one meter, compare results from the same cross-sectional point, and calibrate the meters as necessary. Meter calibration services are available from the USGS and universities.

PROCEDURE FOR CURRENT VELOCITY MEASUREMENT

1. Stretch a measuring tape between the endpoints of your wetted channel, perpendicular to the flow and suspended above the water. The location of the measuring tape is the cross-section, and as such, it is acceptable to rearrange the streambed to promote laminar flow. It is best to remove the larger streambed particles causing irregular flow both upstream and downstream of the tape before beginning to measure velocity with the meter.

After streambed manipulation, divide the distance between the waters edges by 25 (at least) to set the interval for metering (e.g., the water surface is 22 feet across, 22 ÷ 25 = an interval of 0.88 feet, which can be rounded down to 0.8 to ensure a minimum of 25 subsections). Use closer intervals for the deeper parts of the channel or wherever you suspect flow through the subsection to exceed the 5 percent limit.

2. Record the time of day that discharge measurement was begun. Start at the waters edge, the recorder will call out the distance from waters edge to the center of the first subsection. The observer will place the rod and meter at that distance without touching the measuring tape. The observer will stand in the stream at least 15 inches downstream of the rod to reduce the potential of turbulence affecting the velocity measured by the current meter. Hold the rod in a vertical position with the meter directly into the flow. The observer will then call out the depth, then the velocity.

3. To take a reading, the meter must be completely under water, facing into the current, and free of interference. The meter may be adjusted slightly upstream or downstream of the tape measure to avoid cobble, boulders, or other obstructions. The recorder will call out the calculated distance for each velocity reading; however, the observer is free to change that distance (e.g., take velocity and depth readings at closer intervals through the thalweg).

- Take one or two velocity measurements at each subsection.
- If depth (d) is less than 2.5 ft., measure velocity (v) once for each subsection at 0.6 times the total depth (d) measured from the water surface (e.g., if d is 2 ft., measure at 1.2 ft. from the water surface, or 0.8 ft. above the bottom).
- If depth (d) is greater than 2.5 ft., measure velocity (v) twice, at 0.2 and 0.8 times the total depth (e.g., if d is 3 ft., measure at 0.6 ft. and 2.4 ft. from the water surface). The average of these two readings (+) is the velocity for the subsection.
- Allow enough time for each reading--a minimum of 40 seconds for most meters. The observer calls out the distance, then the depth, and then the velocity. The note taker repeats it back as it is recorded; this provides a check on the team’s communication. Readings from some meters are simply a count of revolutions by the meter and must be converted by the note taker, while others read out digitally in feet-per-second.

4. The recorder will calculate the partial stream discharge for each subsection, and finally sum all of the subsectional discharges to determine the total discharge of the stream. If any of the subsections has a discharge greater than 10 percent of the stream’s total discharge, the “problem” subsections will be further divided into smaller subsections such that none of these smaller partitions will exceed the 10 percent limit.

5. The observer will measure new depths and velocities at the midline of each of these smaller subsections. The recorder will calculate the partial stream discharge in each of the small subsections and sum these values. This new sum will replace the sum of discharges for all original subsections carrying more than 10 percent of the total stream discharge, and a new stream discharge will then be calculated.

COMPUTING DISCHARGE

When the velocity measurement is complete, calculate the total discharge (Q). Determining total discharge accurately is a complex issue, and a variety of methods and equations exist. The mid-section method is currently recommended by the USGS.

The following formula defines the basic method for calculating discharge:

$$Q = 3 \, (a \, v)$$

Where Q is the total discharge; a is the area of a rectangular subsection, the product of width (w) and depth (d) for that subsection; and v is the mean velocity of the current in a subsection.

1. Using the mid-section method, compute the area (a_n) of each subsection:

$$a_n = d_n \, \frac{b(n+1) - b(n-1)}{2}$$

Where b is distance along the tape from the initial point. "Lost" discharge in the triangular cross-sectional areas at the water's edges is assumed to be negligible.

2. Next, multiply the subsectional area (a_n) by the mean velocity (v_n) for the subsection; the result is the subsectional discharge (Q_n). If only one velocity measurement was taken at 0.6 depth, that value is the mean velocity (v_n). If two measurements (v_1 and v_2) were taken at 0.2 and 0.8 depth, compute the mean value as:

$$v_n = \frac{v_1 + v_2}{2}$$

3. To compute the discharge for each subsection, use the equation:

$$Q_n = a_n \, v_n$$

Where:

Q_n= discharge for subsection n,
a_n= area of subsection n, and
v_n= mean velocity for subsection n.

The calculation is repeated for each subsection, as shown below:

$Q_1 = a_1 \, v_1$, $Q_2 = a_2 \, v_2$, $Q_3 = a_3 \, v_3$, and so on...

4. The subsection products are then added to get total discharge (Q):

$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$ and so on...

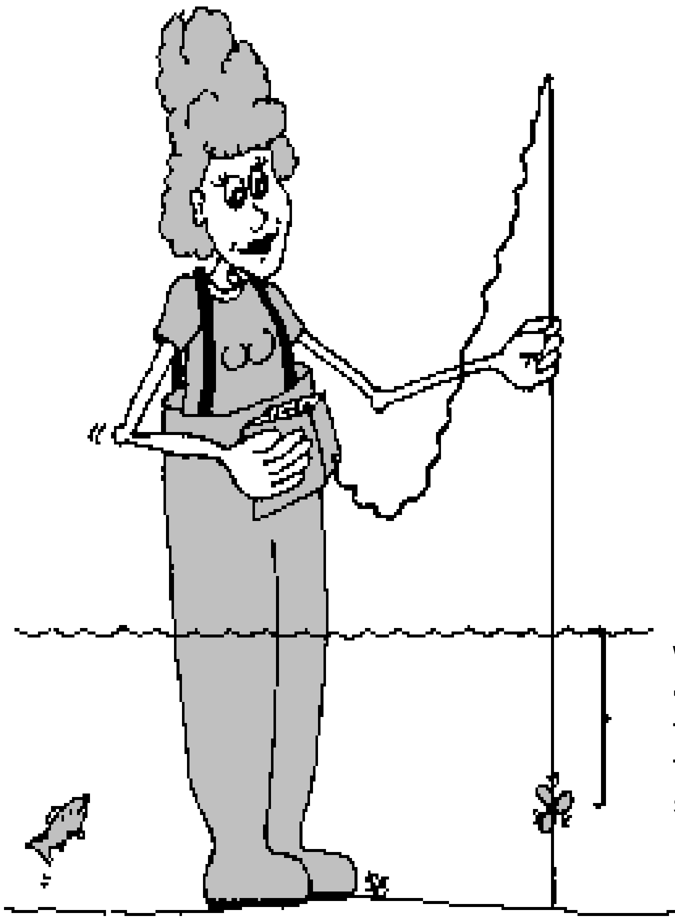
Thus, total discharge (Q) equals the sum of all subsectional discharges (3 (a v)), as stated earlier in the basic equation:

$$Q = 3 \, (a \, v).$$

If you have any questions about this computation, draw a hypothetical cross-section, assign current velocities (from 0 to 5 ft. per second) to each subsection, assign a depth to the midline of each subsection, and work out a sample discharge before going to the field. Field crew members should understand this procedure and be able to compute sample discharges before field work begins.

Reference: Harrelson, C.C, C.L. Rawlins and J.P. Potgondy, *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, General Technical Report RM-245, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Co. 1994.

Figure 17: Water velocities are measured at 6/10 of the water column depth



Water velocities (in depths < 2.5 feet) are taken at 6/10 of the water depth (i.e., 6/10 of the distance from the waters surface to the bottom).

DISCHARGE FORM Page: ____ of ____
R6-2500/2600-31

A. State __________ B. County __________ C. Forest __________ D. District ____________

E. Stream Name ____

F. 4th HUC Code ____, ____, ____, ____ 5th _____6th _____

G. USGS Quad ____

H. Survey Date ____/_____/_____ I. Survey Time:_________________
MM / DD / YYYY

J. Observer/Recorder ____

K. Meter Type ________________ L. Remarks ______________________________________

Distance from initial point (ft)	Width (ft)	Depth (ft)	Observation Depth (ft)	Revolu-tions	Time in Seconds	Velocity at point (ft/sec)	Velocity Mean in Vertical (ft/sec)	Area (ft^2)	Discharge (cfs)

WOLMAN FORM

R6-2500/2600-32: WOLMAN PEBBLE COUNTS

PROCEDURE

The Wolman pebble count will be performed two times in each stream reach identified during the level I (office phase) inventory as delineated on the field map. One pebble count will be completed at approximately one-third and a second pebble count will occur at two-thirds of the total reach length. The fast water unit chosen for each pebble count should possess what is perceived to be normal conditions for fast water units already inventoried in that reach. The fast water unit chosen for the Wolman pebble count need not be a measured fast water unit. It is the surveyor's task to determine the normal condition of fast water units in each reach. The survey team needs to continually evaluate the following questions.

- What water level gradient is normal in the fast water units; less than 4 percent, greater than 4 but less than 10 percent, or greater than 10 percent?
- What substrate types best represent the reach; bedrock is common, cobble and gravel dominate, sand/silt/clay is common, etc.?
- Is LWD a common component of fast water units?
- Are the banks actively eroding in most fast water units?
- Are side channels commonly associated with riffles in the reach?

While the answers to these questions may change as more of the reach is observed, these channel characteristics will provide guidance in selecting a riffle that is representative or average for the reach. The first Wolman pebble count is performed in a representative riffle located at one-third of the reach's length; the second Wolman pebble count is performed in a riffle that is representative of the reach at two-thirds of the reach's length.

The pebble count technique (Wolman 1954) has long been used by geomorphologists, hydrologists, and river engineers to characterize rivers which flow on coarse material and are wadable during low flows. The procedure has recently been recognized by fishery biologists as a better alternative to characterize substrate than the visual estimation techniques commonly used in fisheries and instream flow studies. In addition, pebble counts are used on many National Forests as monitoring tools to evaluate entry of fine sediment into streams.

For monitoring purposes, a selected site is often measured for several years. Generally, individuals are interested in measuring changes to surface fines (i.e., sand, silt, or clay) due to management activities such as timber harvest, fire, or road construction. It is widely accepted that an increase in fines in stream channels is detrimental to fisheries.

Several different schemes can be adopted to provide the minimum 100 tallies of substrate. One transect of 100 equally-spaced tallies can be selected, or two transects of 50 tallies each, or any combination that is linear and equates to at least 100 samples of the streambed. It is common to tally an excess of 100 samples, but avoid having less than 100. The transects must run from one edge of the bankfull channel to the opposite edge of the bankfull channel. These transects need not be perpendicular to the flow, but they must span the entire bankfull channel, with both the first and last substrate tally of each transect occurring at bankfull stage. Do not limit the sampling to the wetted channel! A zigzag set of transects is commonly employed through the chosen riffle.

As the channel dimensions decrease and habitats become smaller, it may be difficult to perform a complete Wolman pebble count in a single riffle. In such cases, it is quite acceptable to perform some of the tallies in slow water units, provided the transect chosen does not intentionally avoid the deeper portions of the slow water unit. Whenever slow water units are included in the Wolman pebble count, the percent of tallies in slow water units should approximate the percent that slow water unit habitat comprises of the total habitat of the reach.

THE PEBBLE COUNT TECHNIQUE

A pebble count consists of a random selection of at least 100 particles from the streambed. Individual pebbles can be selected from a grid system, but more commonly pebbles are selected from the toe of the boot along a toe-to-heel transect which traverses the stream from bankfull stage to bankfull stage. The intermediate axis of each pebble, defined as neither the longest nor the shortest of three mutually perpendicular axes of a particle, is measured. The intermediate axis can be visualized as that dimension of the pebble which controls whether or not it would pass through a soil sieve.

The greatest source of bias in pebble counting is associated with the manner in which observers pick up particles. The natural tendency is to select larger rocks. To avoid this, observers will need to consistently use a fixed reference point, such as a mark on the tip of a boot, and a fixed point on the tip of the finger that descends into the water to select the particle for measurement. To limit the visual bias towards larger substrate, the observer should extend their finger over the boot without looking until the streambed is touched. The first particle touched by the tip of the finger will be measured. Because the technique requires physically picking up particles, it is commonly limited to wadable streams. Particles too large or too well cemented into the streambed to be removed must be estimated. Whenever possible, measure the lesser of the two exposed axes and record in the appropriate size class. In certain situations, the depth of the channel may impede sampling. Surveyors are encouraged to determine the dimensions of their boots so that the boots' width and length may be used as a surrogate for a millimeter ruler.

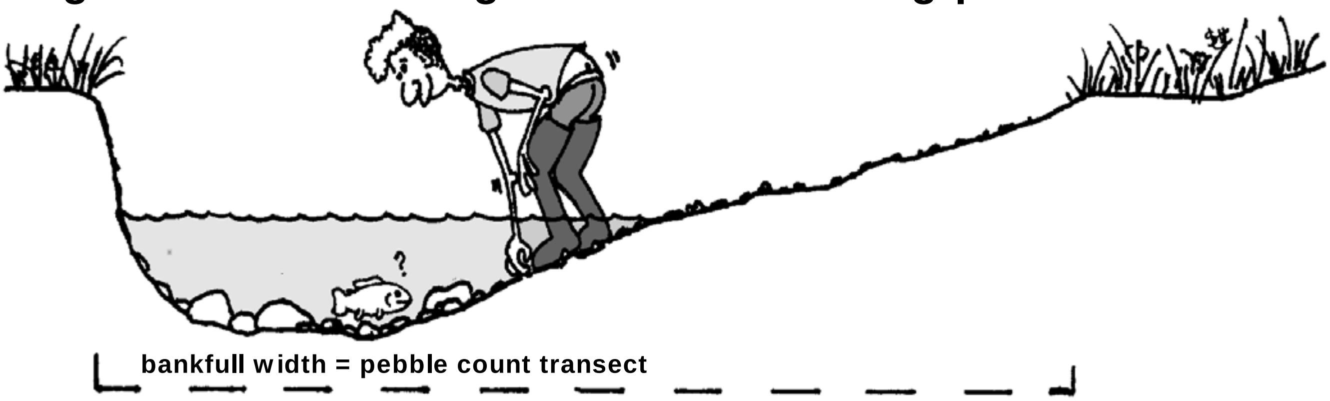
Pebbles down to 2 mm in size (very coarse sand) will be directly measured and tallied in the appropriate size class. Sand, silt, and clay particles will be tallied as "less than 2 mm". Wolman pebble counts also have a built-in bias against fine sediment due to the precision of selecting individual pieces of substrate. Numbing due to cool stream temperatures, low visibility in turbulent water, and our visual bias for larger substrate reduce the ability to accurately record fines (sand, silt, and clay) as streambed substrate tallies. By carefully lifting the finger from the streambed, the observer can reduce the bias against fine sediment. If a plume or cloud of fine sediment is released as the finger lifts, the tally should be in the "less than 2 mm" size class. Caution should be taken to recognize the difference between the organic material coating many streambed particles (= algal scum) and fine inorganic sediment resting atop larger particles of the streambed.

The number of pebbles in each size class will be tabulated and converted into percentages. Data will be plotted as a cumulative size distribution curve. "Cumulative percent finer" will be plotted on the y-axis, and "particle size" expressed as the upper limit of each size range will be plotted on the x-axis. "Particle size" classes and cumulative percent finer versus size are shown on The Wolman Form. While any bedrock encountered as tallies during the Wolman procedure should be recorded, the tallies are not graphed. This is due to the absurdity of graphing an "upper limit" to the size of bedrock. In such cases, the graph will form an asymptote at the cumulative percent finer than 4096 mm.

The resulting frequency distribution represents the percent of the streambed covered by particles of a certain size since each pebble represents a portion of the bed surface. Results are theoretically equivalent to size distributions obtained from bulk samples.

The entire width of the bankfull channel is investigated, and the rocky particles of the streambed are grouped by their size. A frequency distribution by size class is graphed, and the resultant curve is used to make inferences about channel dynamics. During bankfull flows, it is expected that all particles smaller than the median value (D_{50}) displayed on the curve will be mobile, and this same value further refines the Rosgen channel type for that reach. In a similar sense, particles larger than the 84th percentile (D_{84}) will comprise the immobile portion of the streambed during bankfull discharge.

Figure 17: General guidelines for doing pebble counts



Pebble Count "Hints":

1) Always begin a transect at the edge of the bankfull channel and end each transect at the opposite edge of the bankfull channel.
2) Measure at least 100 "pebbles" (but, don't stop measuring until you reach the end\ of the transect atop the bankfull indicator).
3) Measure the first "substrate element" you touch at each designated sample location.
4) Substrate is measured across the intermediate axis, (neither the longest nor shortest of the three mutually perpendicular axes).
5) Pebble counts are usually done in riffles (twice per reach).
6) If you don't get 100 measurements on a transect, continue to do transects within the riffle until you meet or exceed 100 measurements.
7) Two pebble counts should be done for each reach, in riffle habitats. The riffles should be located about 1/3 and 2/3 of the total length of each reach. Use your map (developed during the completion of the Preliminary Reach Form) to locate the section of stream in which the sample riffles will be located.

*** for additional information, see Harrelson, et al. 1994.**

References:
King, R, Potyandj, J. 1993. *Statistically Testing Wolman Pebble Counts: Changes in Percent Fines!* Stream Notes, USDA Forest Service.
Rosgen, D.L. 1996. *Applied River Morphology.* Wildland Hydrology,
Wolman, M.G. 1954. *A method of sampling coarse river-bed material.* Transactions of the American Geophysical Union. 35(6): 951-9

WOLMAN FORM Page: ____ of ____
R6-2500/2600-32

A. State _________ B. County ________ C. Forest __________ D. District _________

E. Stream Name____.

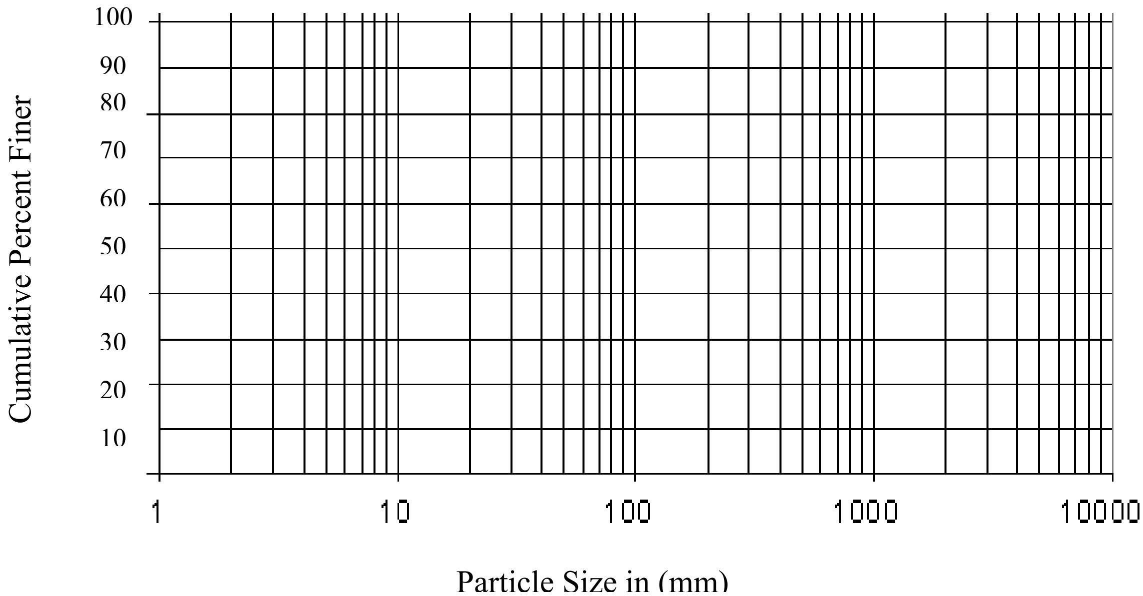
F. 4th HUC Code ____, ____, ____, ____ 5th _____6th _____

G. USGS Quad ____

H. Survey Date ____/______/______
MM / DD / YYYY

PEBBLE COUNT							
SO #:		Channel Unit #		# of Transects:			
Surveyor:				Reach:			
Inches	PARTICLE	Millimeters		Particle Count	**Total #**	**Item %**	**% Cum**
<.08	. Sand	< 2	S/C/S				
.08 -.16	Very Fine	2 -4					
.16 - .22	Fine	4 -5.7	G				
.22 - .31	Fine	5.7 - 8	R				
.31 - .44	Medium	8 -11.3	A				
.44 - .63	Medium	11.3 - 16	V				
.63 - .89	Coarse	16 -22.6	E				
.89 - 1.26	Coarse	22.6 - 32	L				
1.26 - 1.77	Vry Coarse	32 - 45	S				
1.77 -2.5	Vry Coarse	45 - 64					
2.5 - 3.5	Small	64 - 90	C				
3.5 - 5.0	Small	90 - 128	O				
5.0 - 7.1	Large	128 - 180	B				
7.1 - 10.1	Large	180 - 256	B				
10.1 - 14.3	Small	256 - 362	B				
14.3 - 20	Small	362 - 512	L				
20 - 40	Medium	512 - 1024	D				
40 - 80	Large	1024 -2048	R				
80 - 160	Vry Large	2048 -4096	S				
	Bedrock		BDRK				
				Totals:			
	Total Tally:						

Cumulative Percent Finer vs Particle Size- Logarithmic Graph:

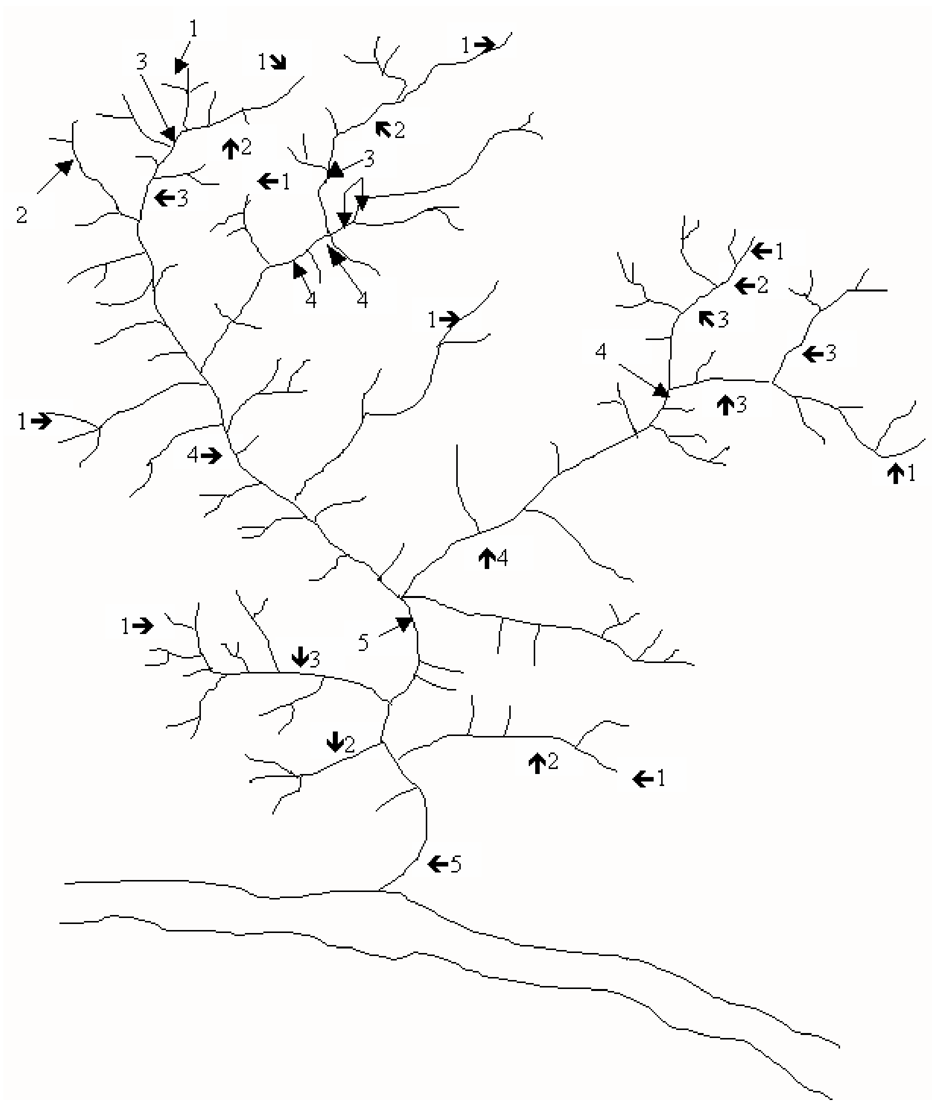


APPENDIX A
Watershed Codes

Nationally, the USDI Geological Survey and the Water Resources Council have established a coordinated watershed delineation and coding system which is referred to as the Hydrologic Unit Codes (HUC). This system is hierarchical and is comprised of Region, Subregion, Accounting Unit, and Cataloging Unit. The Accounting Unit is generally referred to as a river basin and the Cataloging Unit is usually known as a subbasin. An example of this type of coding is:

Region	Pacific Northwest	17
Subregion	Middle Columbia	1707
Basin (Accounting Unit)	Deschutes River	170703
Subbasin (Cataloging Unit)	Upper Deschutes River	17070301
Watershed	Tumalo Creek	1707030105
Subwatershed	Lower Tumalo Creek	170703010502

APPENDIX B
Stream Orders



Use 1:24,000 scale topographic map–count bluelines only.

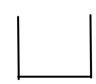
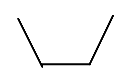
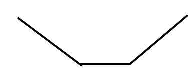
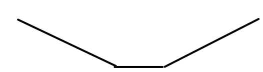
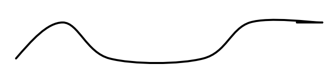
Stream order: The designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network: the smallest, unbranched, intermittent tributaries, terminating at an outer point, are designated order 1; the junction of two first-order streams produces a stream segment of order 2; the junction of two second-order streams produces a stream segment of order 3; etc. Use of small-scale maps (<2"/mile) may cause smaller streams to be overlooked, leading to gross errors in designation. Ideally, designation should be determined on-the-ground or from large-scale air photos.

APPENDIX C
Forest Options

Each Forest is empowered to decide whether certain reach or habitat attributes will be investigated. The following is a list of those options. Forests are encouraged to gather any data they feel is relevant, but it must be recognized that the core data attributes of the Region 6 protocol discussed in Chapter 2 of this handbook are mandatory, unless expressly labeled as a "Forest Option." It is expected that any deviations from the stated Region 6 methods will be completely described in the final stream inventory report mandated for each inventoried stream.

FINAL REACH FORM

VALLEY FORM CODES: The number codes are used to characterize the floodplain width and upland slopes of each reach and recorded on Final Reach Form (see accompanying diagram).

		VALLEY FORM CODES	VALLEY CROSS-SECTION
Code	Type	Side Slope	
1	Box-like canyon	Steep: > 60%	
2	Narrow V-shaped floor width < 100 ft.	Steep: > 60%	
3	Moderate V-shaped floor width < 100 ft.	Moderate: 30-60%	
4	Low V-shaped floor width < 100 ft.	Low: < 30%	
5	U-shaped floor width > 100 ft.	Moderate to steep: > 30%	
6	Trough-like open short slope lengths	> 30%, mostly 30-60%	
7	Broad, trough-like	Low: < 30%	
8	Narrow flat-floored floor width 100-300 ft.	Moderate to steep: > 30%	
9	Moderate flat-floored floor width 300-600 ft.	Moderate to steep: > 30%	

INNER RIPARIAN ZONE WIDTH: Forests can choose to designate the inner riparian zone as 0 ft. wide. This choice is appropriate for a reach or stream, but not for individual habitats. The outer riparian zone width then becomes 100 ft., and 0 ft. is recorded on Final Reach Form to describe the inner riparian zone width for that reach.

FLOW REGIME: Forests are free to characterize the nature of a reach with respect to the streamflow conditions observed at the time of the survey. Three choices are possible: perennial, intermittent, and ephemeral. Since the stream channels receiving a level II survey are usually fish-bearing, it is likely that most streams will be characterized as perennial. The data is entered to NRIS Water AI at the Reach tab using the "Regional Variables" button.

CHANNEL UNIT FORM

FORMED BY: Forests have the option of identifying the force creating each channel unit. NRIS AI provides a pull down menu of potential habitat-forming forces. While the option exists to choose a force forming each channel unit, the option is most generally applied to pools.

Below is a table identifying the most common pool forming forces for the range of pools (slow water channel units) available in NRIS AI. Region 6 supports the use of the second level of channel unit identification (see Channel Unit Type above). The table below identifies the channel unit to the third level of channel unit identification. However, the third level can easily be collapsed to the second level by removing the last two letters of the channel unit code. For example, a beaver dam pool at the third level of channel unit identification is coded SDBV. To reduce this to the second level of channel unit identification, the code becomes SD (a slow water channel unit formed upstream of a dam).

<table>
<tr><th>FORMED BY (the force)</th><th>FORMED BY CODE</th><th>CHANNEL UNIT CODE</th><th>DESCRIPTION</th></tr>
<tr><td>Beaver</td><td>BV</td><td>SDBV</td><td>Slow water, the beaver pool upstream of a beaver dam</td></tr>
<tr><td rowspan="3">Wood</td><td rowspan="3">WD</td><td>SDDD</td><td>Slow water, the pool upstream of a woody debris jam</td></tr>
<tr><td>SSPL</td><td>Slow water, the plunge pool downstream of a woody debris jam</td></tr>
<tr><td>SSMC</td><td>Slow water, the mid-channel pool scoured beneath woody debris that has not formed a sediment trapping dam</td></tr>
<tr><td rowspan="2">Bedrock</td><td rowspan="2">BR</td><td>SSTR</td><td>Slow water, trench pool…a deep slot scoured in a bedrock dominant streambed</td></tr>
<tr><td>SSLS</td><td>Slow water, pool scoured against bedrock outcrop forming the streambank, the bedrock forces a change in the direction of streamflow causing scour</td></tr>
</table>

FORMED BY (the force)	FORMED BY CODE	CHANNEL UNIT CODE	DESCRIPTION
		SSPL	Slow water, pool scoured downstream of a bedrock lip forming the streambed, the bedrock lip often creates a waterfall
Boulder	BO	SDLS	Slow water, landslide dam pool upstream of coarse sediment that has dammed the stream
		SSPL	Slow water, pool scoured immediately downstream of the coarse sediment that has completely dammed the stream (the “dam” is a transverse bar of boulders and finer substrate)
		SSMC	Slow water, channel-spanning pool scoured immediately downstream of one or more boulders that have partially dammed the stream
Stream Bend	SB	SSLS	Slow water, pool scoured against a streambank, the bank forces a change in in the direction of streamflow causing scour
Tributary	TR	SSCV	Slow water, pool scoured at a channel convergence by the addition of a tributary’s streamflow
Culvert	CU	SSPL	Slow water, pool scoured downstream of a culvert’s lip, the concentration of streamflow in the culvert causes scour downstream
Dam	DA	DA	A human-built structure intended to create pooling or slack water upstream
		SD	Slow water, the pool upstream of a human-built dam
		SSPL	Slow water, the plunge pool downstream of a human-built dam
Restoration	RS	(variable)	Slow water, channel-spanning pools created through restoration efforts
Other	OT	Not applicable	Slow water, cause not one of the above

CHANNEL UNIT TYPE: Forests have the option of using the Hawkins method of habitat designation (Hawkins, et al. 1993[2]). Hawkins refers to stream habitats as channel geomorphic units that are characterized initially as either fast water or slow water habitats. These channel units are equivalent to riffles and pools. Fast water channel units are further subdivided into turbulent fast water and non-turbulent fast water channel units. In a corresponding fashion, slow water channel units are subdivided into slow water formed by scour (scour pool) and slow water formed by damming (dam pool). Hawkins offers a third level of channel unit distinction by subdividing turbulent fast water, non-turbulent fast water, scoured slow water, and dammed slow water in the following way:

FIRST LEVEL (& code)	SECOND LEVEL (& code)	THIRD LEVEL	CHANNEL UNIT CODE	CHANNEL UNIT DESCRIPTION
Fast Water (F)	Turbulent (FT)	Cascade	FTCC	A riffle with stream gradient greater than 10%
		Rapid	FTRP	A riffle with stream gradient greater than 3% but less than10%
		Riffle, Low Gradient	FTRF	A riffle with stream gradient less than 3%
	Non-Turbulent (FN)	Run	FNRN	Unit has a homogeneous streambed, no residual depth, laminar flow, nearly no stream gradient…a glide
		Sheet	FNSH	A unit that has bedrock or hardpan clay as its streambed, very shallow flow, a noticeable stream gradient
Slow Water (S)	Dam (SD)	Beaver	SDBV	A beaver pool upstream of a beaver dam
		Debris	SDDD	A pool upstream of a woody debris jam…the jam has captured sediment raising the streambed
		Landslide	SDLS	A pool upstream of a landslide that has entered the stream… the added sediment has raised the streambed
	Scour (SS)	Convergence	SSCV	A pool scoured at a channel convergence by the addition of a tributary's streamflow
		Lateral Scour	SSLS	A pool scoured against a streambank, the bank forces a change in the direction of streamflow causing scour

FIRST LEVEL (& code)	SECOND LEVEL (& code)	THIRD LEVEL	CHANNEL UNIT CODE	CHANNEL UNIT DESCRIPTION
Slow Water (S)	Scour (SS)	Mid-channel	SSMC	A mid-channel pool scoured beneath woody debris or downstream of one or more boulders that have partially dammed the stream
		Plunge	SSPL	A plunge pool downstream of one of these conditions: • a woody debris jam • a waterfall • a transverse bar of substrate • a human-built dam • a culvert
		Trench	SSTR	A pool scoured in bedrock or hardpan clay in which all of the depth is parallel to the long axis of the habitat. Most of the width of the habitat is substantially shallower than the trench

NRIS AI permits individual Forests to select the channel unit type that matches the surveyors' level of confidence about the hydrologic and biologic forces creating the channel units. Forests are empowered to choose the level (first, second, third) of channel unit designation suited to either their management needs or their confidence in their surveyors' capabilities.

The minimum channel unit identification must distinguish fast water channel units (riffles) from slow water channel units (pools). Each of the various channel unit types listed above have been assigned unique one, two, or four-letter codes to be used on the Channel Unit Form. The letter codes are simply shorthand for the channel unit types available in NRIS AI.

PLUNGE POOL HABITAT: Forests are empowered to establish minimum criteria for considering a plunge pool (slow water channel unit formed by plunge) a distinct habitat. Examples of potential criteria include:

- setting a minimum residual pool depth for plunge pools
- classifying only those pools below a channel-spanning accumulation of LWD
- neglecting plunge pools occurring in reaches with valley gradients more than 10 percent

Plunge pools are extremely common in headwall streams. Such streams are often dominated by a complex of stairstep-pools, which are actually a series of plunge pools below transverse bars of cobble and boulder. Establishing a minimum criteria for plunge pools may permit surveyors to more efficiently characterize these high gradient reaches.

LWD IN SIDE CHANNELS: Forests are free to count functional large woody debris in side channels. The same criteria apply to woody debris in these secondary channels as applies to the mainstem channel. That is, surveyors must use the three standard R06 size classes and the wood must engage the bankfull channel of the side channel. Since most side channels have a narrower bankfull width than their companion mainstem channel, the twice bankfull width rule may apply, and wood that is shorter than the standard lengths may be counted. See the discussion of LWD in Chapter 3 for greater clarification of LWD. The counts can be entered to NRIS Water AI at the Channel Unit tab.

HABITAT LENGTH: The **method** used to measure channel unit length is a Forest option. The following discussion is a recommended procedure for measuring habitat length of mainstem channel units. Let us assume the observer has arrived at the upstream end of the habitat, and has signaled their arrival to the recorder. The recorder reads the length of tape between the two surveyors, and then moves upstream to join the observer. The observer waits at the break between habitats so that the recorder will know the precise location of the transition to the next habitat. The surveyors will then share their habitat observations before they begin the next upstream habitat.

Some habitats, typically fast water units, will exceed the length of the measuring tape used by the surveyors. It is the recorder's task to remain aware of the tape as it is dragged upstream. When the end of the tape reaches the position of the recorder, they must immediately signal the observer to stop moving upstream. The observer must then either wait for their partner to join them, or the observer can mark their position in the stream before renewing the survey of this long habitat. An effective marker might be a long piece of plastic flagging atop a boulder with a piece of cobble anchoring the flagging. The recorder then moves upstream, retrieves the flagging, and positions themselves in the thalweg lateral to the marker.

The recorder remains in their new location until, once again, one of two situations occurs: either the observer has determined the upstream end of the habitat, or the end of the tape is once again at the feet of the recorder. In this stepwise fashion, the thalweg length of a long habitat will be accurately measured through measuring adjacent habitat segments and summing the segments' lengths. Very long habitats are difficult to characterize; surveyors are encouraged to break long fast water units into channel units of less than 500 ft.

A drag tape will on occasion snag in the streambed or on woody debris. Usually, a gentle tug by either surveyor will free the measuring tape. To increase the team's efficiency in using the drag tape method, remember these points:

- Only the length of mainstem habitats must be measured; the dimensions of side channels and tributaries may be estimated.
- The observer should stay in the thalweg, dragging the tape measure as they walk upstream.
- Never move downstream while dragging the tape; it will surely snag.
- Anchor the upstream end of the tape at the bank before you leave the main channel or move downstream.
- Develop non-verbal cues for communicating with your partner (a whistle is useful).

Use a separate measuring tape for all other habitat dimensions (e.g., measured wetted width, bankfull width, floodprone width, and bank stability).

Measuring the length of side channels or tributaries is also a Forest option.

AVERAGE DEPTH: Forests can choose to estimate the average depth in riffles to better characterize the channel condition. The estimate is recorded on the Channel Unit Form.

STREAMBED SUBSTRATE: Forests have the choice to estimate the streambed composition by particle size class for every mainstem aquatic habitat. Forests can choose to apply this to the low flow or the bankfull channel. There are five size classes of substrate distinguished by diameter:

Sand:	< 0.08 in.	(< 2 mm)
Gravel:	0.08 to 2.5 in.	(2 - 64 mm)
Cobble:	2.5 to 10 in.	(64 - 256 mm)
Boulder:	10 to 160 in.	(256 - 4096 mm)
Bedrock:	> 160 in.	(> 4096 mm)

If a size class is estimated to comprise less than 6 percent (rounded up to 10 percent) of the total streambed area inundated at the time of the inventory, disregard that size class. If any of the five size classes makes up at least 10 percent of the area, list its contribution in 10 percent increments. The streambed substrate estimate should total 100 percent for each inventoried habitat.

SHRUB/SEEDLING HEIGHT: Forests have the option of recording the shrub/seedling height code in place of the dominant species in the overstory component of both riparian zones. The codes are:

1: 0 to 2 ft. tall
2: 2 to 5 ft. tall
3: 5 to 10 ft. tall
4: > 10 ft. tall

UNDERSTORY DOMINANT SPECIES: Forests must decide what question is of greatest concern. The two most likely questions are:

> What tree species dominates the understory component and is likely to replace the overstory dominant tree species if no disturbance removes the overstory?
> What species would likely dominate the understory if human impacts were removed?

BANK STABILITY IN NON-MEASURED MAINSTEM HABITATS: It is required to measure, not estimate, all lengths of bank instability observed along measured pools and measured riffles. Surveyors are heartily encouraged to measure the lengths of all banks judged to be unstable at the time of the survey.

OPTIONAL FIELDS ON THE CHANNEL UNIT FORM: These fields are present on the Channel Unit Form to facilitate gathering data of specific interest to individual Forests. Examples of such attributes are percent of stream shaded, percent of riffle habitat possessing pool character, estimated area of available spawning gravels/cobbles, or substrate embeddedness.

RIGHT BANK/LEFT BANK: Each Forest must decide bank orientation. The two options for assigning bank orientation vary based on which direction you are facing: upstream or downstream.

FIELD MAP SYMBOLS: Forests are strongly encouraged to develop and adopt a suite of map symbols which all survey teams would use to better characterize the inventory observations. These symbols should record the important conditions in the aquatic, riparian, and upland components of the drainage basin.

MEASURED CHANNEL GRADIENT: Forests have the option of measuring the gradient of the stream in tandem with the identifying individual channel units. Measured channel gradient is defined as the slope of the surface of the water.

Stream gradient is a very useful tool for describing stream morphology. Hydrologists typically need accuracy within ½ of a percent or less. Measured channel gradient is also essential to more accurately determine the Rosgen stream type of a reach. Clinometers are not this accurate and thus are not acceptable for measuring stream gradient. Abney levels and hand levels are appropriate tools for measuring channel gradient as part of a level II survey. The following describes stream gradient plus two methodologies for obtaining stream gradient with either an Abney level or hand level.

Channel gradient and stream slope are used synonymously. Slope is the rise over the run. The "rise" of a stream channel is the elevational change between two points. The "run" of the stream channel segment is the distance between the same two points. Channel gradients for Level II surveys will measure the slope difference of the water surface for a distance of approximately 100 feet of stream thalweg, provided that the 100 feet chosen is typical of the reach. Certain reaches may be too sinuous or too brushy to permit two adjacent 50-foot segments to be measured. In such cases, the longest available length of channel that is typical of the reach should be chosen.

Rosgen stream types vary with gradient. Stream types C and E have channel gradients of less than two (2) percent. In those stream types, it is unlikely that you will encounter many fast water channel units (riffles) that are more than 100 feet in length. These stream types also tend to be quite sinuous, and fast riffles comprise roughly 50% of the channel's length. In Rosgen C and E stream types, it is acceptable to include a pool (slow water channel unit) in the length of stream chosen for measurement of stream gradient.

For streams with a mapped channel gradient greater than ten (10) percent, a system of step-like pools with very short connecting riffles is common. In these high gradient streams, it is acceptable to include slow pools in the length of stream used for measuring water level gradient.

For Rosgen B stream type, all measurements of channel gradient should be taken in riffles. Since the riffles chosen for Wolman pebble counts are selected as representative of the reach, they would provide excellent sites for measured channel gradient.

Remember, the ideal location for measuring the channel gradient is a site that is typical of the reach. Two measurements of channel gradient are the minimum number of samples necessary to characterize the reach.

Channel Gradient Formula:

% Gradient = [Change in Elevation / Thalweg Length] X 100

Example 1: A fast water channel unit is measured and the difference in rod readings is 1 foot for 100 feet of measured length of thalweg. Determine the percent gradient.

% Gradient = [1 foot / 100 feet] X 100 = 1%

Example 2. A step-pool system is measured and the rod reading difference is 2.5 feet within 75 feet of measured length. Determine the percent gradient.

% Gradient = [3.2 feet / 75 feet] X 100 = 4.3% slope

Note: While average slope for fish-bearing reaches is almost always less than 25%, the slope of individual channel units can be greater than 100%. For nearly vertical waterfalls, the slope may be 1000% or greater.

Hand Level Method: To use the hand level, both the total change in elevation (rod reading difference), and the total thalweg distance must be measured.

1) A rod or walking stick (now referred to as the pivot staff) is used to hold a fixed height for the hand level at a location between the upstream measurement point and the downstream measurement point. The pivot point should provide a clear line-of-sight to the two measurement points, 50 feet upstream of the pivot point and 50 feet downstream. The height of the hand level on the pivot staff cannot change, although the pivot staff must be free to turn to obtain the two sets of gradient measurements.
2) Set the base of the pivot staff at the surface of the water.
3) Measure the thalweg distance upstream, approximately 50 feet.
4) At the upstream location, hold the level rod (now referred to as the depth rod) so that the base of the depth rod at the surface of the water.
5) Looking through the peephole of the hand level, tilt the hand level until the bubble is centered. Shoot the upstream depth rod and obtain the reading. The crewperson holding the depth rod may want to move their hand up and down the rod until the person with the hand level sights their partner's hand…the partner holding the depth rod then reads the height.
6) Keeping the pivot staff in the same location, the person holding the pivot staff turns and faces downstream.
7) The person with the depth rod moves downstream approximately 50 feet.
8) Measure the thalweg distance downstream from the pivot staff to the depth rod.
9) Set the depth rod at the downstream location, and place the base of the depth rod at the surface of the water.
10) With the hand level at exactly the same elevation along the pivot staff as it was for the upstream shot, look through the peephole of the hand level, tilt the hand level until the bubble is centered, and take the downstream rod reading. Again, the crewperson holding the depth rod may want to move their hand up and down the rod until the person with the hand level sights their partner's hand…the partner holding the depth rod then reads the height.
11) The difference between the two rod readings equals the total change in elevation.
12) The total thalweg distance between the upstream point and the downstream point is summed.
13) These two measurements are applied to the formula above to obtain the stream gradient.

Abney Level Method: An Abney level is independent of distance, and thus, distance does not need to be measured. However, all measurements should be taken on thalwegs that are approximately straight, and the location of the Abney level (the pivot staff location) should be in the center of the length of channel that is measured. The Abney level is not developed for curves or meanders.

1) Locate a straight reach of stream channel, both upstream and downstream of a center point.
2) Measurements will be taken from the center point location.
3) Obtain a rod that is approximately 5 feet high (now called the pivot staff).
4) Mark an elevation on a second rod, the depth rod, at a height equal to the point along the pivot staff where the Abney level will be held.
5) Set the pivot staff at the surface of the water.
6) Hold the Abney level at the chosen elevation along the pivot staff.
7) Move the depth rod upstream so that the base of the depth rod is at the surface of the water.
8) Looking through the peephole of the Abney level, turn the adjusting screw on the Abney level until the bubble in the Abney level is centered. The crewperson holding the depth rod may want to set their finger at the set elevation along the depth rod (the same elevation as the Abney level on the pivot staff).
9) Read the slope, in percent, from the Abney level.
10) Keeping the pivot staff in the same location, the person holding the pivot staff turns and faces downstream.
11) Move the depth rod downstream the same distance it was moved upstream.
12) Set the base of the depth rod at the surface of the water.
13) Looking through the peephole of the Abney level, turn the adjusting screw on the Abney level until the bubble in the Abney level is centered. The crewperson holding the depth rod may want to set their finger at the set elevation along the depth rod (the same elevation as the Abney level on the pivot staff).
14) Read the slope, in percent, from the Abney level.
15) Add the two slopes together and divide by 2 to obtain the average gradient for the reach.

APPENDIX D
Finding Your GIS stream route

The USDA Forest Service, Pacific Northwest Region provides a series of short courses in the use of NRIS for data entry and analysis. However, for those that have access to a PC equipped with the NRIS software, but have not had a chance to obtain formal training in NRIS Water, follow the bullet steps below to determine the entire GIS stream route of your stream selected for inventory. But to use this tool, you will need to know at least the 4th HUC Code for the watershed in which your stream lies.

Assumptions: you have no training in NRIS Water; there is no NRIS software loaded on a PC designated for your use; you know the correct name of the stream; you have a clear understanding and representation of the length of stream targeted for survey;

- Click on the Windows "START" button located on the taskbar (at the bottom of most desktop screens).
- Place cursor on "Forest Service" in the pop-up START menu.
- Shift cursor to the right atop "NRIS" in the Forest Service pop-up menu.
- Shift cursor to the right again atop "Water" the NRIS pop-up menu.
- Shift cursor to the right again and click on the "Water v1.1.1i" button.
- For Username: in the "Logon" window, type a forward slash (i.e., /).
- hit the tab button.
- For Password: in the "Logon" window, simply hit the tab button again.
- For Database: in the "Logon" window, type idb.
- Click on the "Connect" button at the bottom of the "Logon" window.
- The NRIS Water Module, Main Menu will open, and a window with a HUC tree (equipped with a scroll bar on the right) will appear on the left side of the Main Menu window.
- Navigate through the HUC tree to find the 4th Level HUC for your target stream, continue to expand the tree to the 6th Level HUC if possible, and click on the appropriate HUC code in which your stream occurs (e.g., the 4th Level HUC 17060101 Hells Canyon).
  - ✓ …or enter the 8-digit code for your 4th Level HUC in the upper right hand block labeled "HUC" (or enter the 12-digit code for the 6th Level HUC if your GIS "Watershed" layer is defined to the 6th Level HUC).
- Click on the "Find" button to the right of the HUC block (the HUC code you have typed will also appear in the block to the left of the HUC block…the HUC identified in the left hand block is where NRIS will take you).
- Click on "Aquatic Inventory" from the set of function buttons to the right of the HUC tree.
- Inspect the names of streams listed in the "Stream Name" column; they have a specific case, and the style of case was decided by whomever built the GIS "stream routes" layer. You will need to match the case you observe.

- On the toolbar at the top of the window, click on the all black binoculars icon for “Enter Query” (it’s to the left of the lightening bolt binoculars icon for Execute Query)…the columns for Stream Name, HUC, and LLID will turn light blue).
- Place cursor in the first block beneath “Stream Name” and type the first 3 or 4 letters of the name of your target stream, then type a % sign attached to the end of the letters you have typed; no spaces should be placed between the letters and the percent sign. Remember to use the same case as you observed when you inspected the column labeled “Stream Name” (e.g., Bea%).
- On the toolbar at the top of the window, click on the lightening bolt binoculars icon for ”Execute Query”…a list of streams within your HUC that begin with the letters you typed will appear in the column labeled Stream Name (e.g., Beach Creek, Beargrass Creek, Beatle Creek).
- Click on the name of your stream in the “Stream Name” column…if blue rectangle appears in the row for your stream you are ready.
- On the toolbar at the top of the window, click on the right hand globe icon called “GIS Display”.
- A “GF – Xstart Client Startup Info” window will appear…Host is the GIS server (mainframe computer)…User ID is likely to be someone else if you have never used NRIS before.
- Type in their “Password”…and wait…patiently…
- Click on “Yes” and/or “OK” to any dialog windows that may open…eventually, two GIS layers will load, “stream routes” and “Watershed”.

…and highlighted in orange is the route that defines your target stream

- Use one of several tools found in the toolbar at the top of the ArcView window to expand the view of your target stream so that the view fills the screen.
- If desired, add other GIS layers to increase the detail of the view…you will need to know the names of the GIS layers and their file location (talk to your GIS expert).

Compare the ArcView display of your target stream with the quad map (or other) representation of the same stream. If your planned survey deviates at all from the route displayed in GIS, the portion of the planned survey that does not align with the GIS stream route must be a separate survey.

APPENDIX E
Successional Class Codes

Grass/Forb	Shrub/ Seedling	Sapling/Pole	Small Tree	Large Tree	Mature Tree
Approximate stand age (years)					
0 0	5	15	30	80	200 — 700
	Height Class 1: <2' 2: 2'–5' 3: 5'-10' 4: >10'	Diameter Size: < 8"	Diameter Size: < 8"-20.9"	Diameter Size: 21"-32"	Diameter Size: >32"
GF	SS	SP	ST	LT	MT

Code:

NV = No Vegetation.
The no vegetation condition is characterized by the predominance of bare soil or naked rock.

GF = Grass/Forb condition
The grass/forb stand condition lasts 2-5 years and occasionally as long as 10 years. Shrubs and some trees that sprout are not yet dominant.

SS = Shrub/Seedling condition
The shrub stand condition often lasts 3-10 years but may remain for 20-30 years if tree generation is delayed. Tree regeneration may be common, but trees are generally less than 10-ft. tall and provide less than 30 percent of crown cover.

SP = Sapling/Pole condition
The open sapling/pole condition occurs when trees exceed 10 ft. in height and are between 5 in. and 8.9 in. dbh.

ST = Small Tree condition
The small tree condition has very little ground vegetation because of closed crown canopy. Average stand dbh is 9 in. to 20.9 in.

LT = Large Tree condition
The large tree condition is characterized by trees with an average dbh of 21 in. to 32 in. dbh. An understory of shrubs and young shade-tolerant trees is present.

MT = Mature Tree condition
The mature tree stand conditions are characterized by old live trees, snags, down woody material, and the replacement of some of the long-lived pioneer species such as Douglas-fir by shade-tolerant species such as western hemlock. Size is generally greater than 32 in. dbh

APPENDIX F
Stream Inventory Glossary

This stream inventory glossary (and the acronym dictionary which follows the Aquatic Glossary), include terms and acronyms used in the body of the Stream Inventory Handbook. The purpose of both of these references is to foster greater understanding of the process and the specifics of stream inventory as defined by the Pacific Northwest Region.

ABNEY LEVEL: A hand held level equipped to measure changes in gradient. These changes in slope are measured in both degrees and percent.

ACCESS POINTS: Locations along the road network used by survey crews to enter or exit the valley of the inventoried stream.

ALLUVIAL: Relating to all deposits resulting directly or indirectly from the sediment transport of streams deposited in riverbeds, flood plains, lakes, fans and estuaries.

AQUATIC HABITAT: (see habitat)

BAFFLES: Deflectors that change the direction of flow or velocity of water through a culvert. Baffles are intended to reduce water velocity and provide passage for fish.

BANKFULL: A term used to describe streamflow which occurs on average once every 1.5 years. Flows of this magnitude transport the most sediment over time. Bankfull flows are the discharge responsible for maintaining the present channel shape. In channel types possessing a well-developed floodplain (e.g., Rosgen streamtype C), bankfull is the stage or streamflow that just overtops the channel's banks and begins to inundate the floodplain.

BANKFULL INDICATORS: The channel attributes created during bankfull flow and visible during low flow conditions. The best indicator of bankfull flow is the deposits of streambed material which remain after a bankfull event. The top of these depositional features closely approximates the height of bankfull flow. Other indicators of bankfull are: the lower limit of perennial vegetation (this may be a change in the species of moss), a change in the streambank's slope, a change in the particle size of the streambank, undercut banks (the top of the undercut is usually slightly lower than the bankfull stage), and the presence of stain lines or the lower extent of lichen colonization on the banks.

BANKFULL STAGE: The water level elevation during a bankfull discharge. This elevation leaves a signature on the channel in the form of depositional areas and distinct streambank slopes. The line of permanent vegetation along a stream is often a close approximation of the bankfull stage.

BOLE: (see tree bole).

BLUELINE CHANNEL OR STREAM: An ephemeral, intermittent or perennial stream which appears as a blue line or dotted blue line on a blueprint copy of a 1:24,000 scale (2.64 in.: mile) USGS topographical map.

BRAIDED CHANNEL: A habitat characterized by the presence of at least three channels running roughly parallel to each other and appearing distinct at flows less than bankfull. At bankfull stage, the islands separating the multiple channels are overtopped, and the channel appears to be a single broad channel. This braided condition describes the Rosgen streamtype D. This is not a separate channel unit. It will be designated as a fast water unit and a remark should accompany it in regards to its braided condition.

The islands separating the braids are characteristically unstable due to their inundation and reformation during bankfull flows. The evidence of this instability is the lack of well-established perennial vegetation atop the islands. A braided channel is the result of a sediment supply that exceeds the power of the stream to transport all of the sediment through a specific channel segment.

CHANNEL: A Stream. The term may be used to describe the mapped stream, the wetted "low flow" condition, or the stream at bankfull.

CHUTE: A narrow, confined channel through which water flows rapidly. The streambed of a chute is usually composed of bedrock, but may sometimes be made of hard clay. Streamflow is usually laminar through the chute.

COLLUVIAL: Relating to loose deposits of soil and rock moved downslope by gravity alone, rather than by force of flowing water.

COVER: In the sense of cover for fish, anything that provides protection from predators or reduces adverse conditions of streamflow and/or seasonal changes in metabolic costs is an attribute providing cover. Instream cover may be provided by substrate, turbulence, undercut banks, woody material, vegetation, or depth. Cover can also be provided by overhanging vegetation or woody debris elevated above the wetted channel. Aquatic organisms use cover for escape, feeding, hiding, or resting. Collecting cover data is a forest option.

Cover for fish is not to be confused with "streambed cover" (an attribute of R06 methods for stream inventory, 1990 to 1994). Streambed cover sought to answer the question, "how well armored are the lower banks to erosion?", and had no direct relation to cover for fish.

CULVERT: A pipe made of metal, concrete, or other material that transports water and sediment beneath a road. Unlike a bridge, a culvert is constructed by burying the pipe in fill material transported to the site. Culverts can be barriers to the upstream movement of fish for several reasons: the length of the culvert or the gradient of the culvert may cause the fish to fatigue and be carried downstream; the velocity of the flow through the culvert may exceed the fish's burst speed; and the height from the surface of the water to the outlet of the culvert may exceed the ability of the fish to jump.

DAM: A human-made structure intended to impound streamflow.

DIAMETER CLASS: As applied to riparian vegetation, diameter is measured or estimated at breast height (DBH) above the ground. The diameter size class is the range of DBH expressed in inches.

In contrast, the diameter of LWD (large woody debris) is measured at the appropriate distance from the large end of the log (see discussion of LWD in Chapter 2 of this handbook.

DISCHARGE: The volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per sec. (cfs) or as cubic meters per sec. (m^3/sec.). Syn: Streamflow.

DESIRED FUTURE CONDITION: An explicit description of the physical and biological characteristics of aquatic and riparian environments believed necessary to meet fish, aquatic ecosystem, and riparian ecosystem objectives.

DOT GRID: A transparent acetate sheet imprinted with regularly spaced dots forming a grid. The dotted sheet is placed atop a map, and the area of the drainage basin is estimated by counting the dots which fall inside the perimeter of the drainage basin.

DRAINAGE BASIN: A part of the surface of the earth that is occupied by a drainage system. This system consists of a surface stream or body of impounded surface water together with all tributary surface streams and impounded surface water. Additionally, a drainage basin always includes the upland slopes which deliver runoff from precipitation directly to the stream network.

DRY MAIN CHANNEL: A habitat characterized by the lack of flowing water during a low flow (level II) survey. This condition is common in intermittent streams. A dry main channel may also occur as a result of water withdrawals, and is sometimes seen in recent deposits of course sediment at the mouths of a stream. A dry side channel is not considered a habitat for the purposes of a level II survey.

ECOREACH: The NRIS Water term used to describe our normal reaches; this term becomes relevant during data entry. Ecoreach applies to any reach defined by geomorphology. It is a reach that has defined ecological and physical characteristics that remain more or less consistent throughout the length of the reach. A repeating pattern of habitats is the result of relatively consistent flow, gradient, valley floor width, and sinuosity; and the assemblage of species present usually reflects this homogeneity of conditions. (Also see Reach).

ENDPOINTS: (see reach endpoints/startpoints).

ENTRENCHMENT: The ratio of the floodprone width to the bankfull width. As the ratio approaches 1.0, the degree of entrenchment increases. Rosgen streamtypes C, DA, and E have low entrenchment and broad floodplains. In contrast, Rosgen streamtypes A, B, F, and G have high values for entrenchment and poorly developed floodplains.

EPHEMERAL: A reach that transports surface water only during storm events. The channels of ephemeral reaches tend to be well vegetated with little or no evidence of scour or deposition.

FALLS: A geomorphic stream channel feature that consists of essentially a vertical drop of water over bedrock or boulders.

FLOOD: Any flow that exceeds the bankfull discharge of a stream or channel. In certain channel types (e.g., Rosgen stream types C, DA and E) discharges greater than bankfull spill out onto a floodplain. In entrenched channel types, flood flows remain constrained by the channel banks.

FLOODPLAIN: The depositional zone near a stream which receives flood water and deposits during streamflows that exceed the bankfull discharge. Floodplains are constructed under the current conditions of flow and precipitation. Entrenched streams tend to lack well-developed floodplains because the water and sediment transported during streamflows which exceed the bankfull stage remain confined within the banks of the channel, rather than being dispersed across a wider valley.

FLOODPRONE WIDTH: The portion of the valley floor potentially inundated during a 50-year flood event.

FOREST OPTION: Optional inventory attributes. Individual forests will decide whether or how to collect these attributes.

GIS: Geographic Information System. GIS produces spatial representations of the condition of the landscape: roads, streams, vegetation, etc.

HABITAT: A channel-wide segment of a stream which has a distinct set of characteristics. A list of potential habitats includes: pools, riffles, side channels, dry main channels, tributaries, culverts, falls, chutes, dams, braided channels, and marshes. Pools and riffles can be thought of as slow water and fast water habitats. These two habitat types can be further classified into subtypes using channel attributes such as turbulence, gradient, position, etc. (See Hawkins, et al. 1993. A hierarchical Approach to Classifying Stream Habitat Features. Fisheries, Vol. 18, No. 6.)

HYDRAULIC CONTROL: A generally sinuous line at the downstream end of a pool where the flow is constricted and stream depth decreases. The top of any channel-spanning obstruction is a hydraulic control if streambed substrate has accumulated upstream of the obstruction forcing streamflow to crest the obstruction. Examples are bedrock outcrops, gravel or cobble bars, log weirs, or beaver dams.

INTERMITTENT: A reach that transports surface water seasonally as a result of runoff or snowmelt, but is dry during the low flow season. Evidence of seasonal flow is an unvegetated or partially vegetated channel possessing depositional and scour features. The uppermost reaches of perennial streams are often intermittent.

JOURNEY LEVEL PROFESSIONAL: A specialist functioning without a mentor. All program managers regardless of their management unit (e.g., District or Forest) are journey level professionals.

JUMP HEIGHT: The vertical distance a fish would have to jump to pass into a culvert outlet from the downstream habitat. Syn: jumping distance height.

LAMINAR FLOW: Non-turbulent flow. Flow in which the volume of water moves downstream in a fashion similar to water in a smooth pipe, with the particles of water moving parallel to each other. Such conditions are ideal for measuring streamflow. Conditions approximating laminar flow are most commonly found just upstream of a pool tail crest or through a chute.

LARGE WOODY DEBRIS: Live trees or downed wood that intercept bankfull flow in a substantial fashion and are large enough to influence the formation of habitats. For a tree or a downed piece of wood to count as large woody debris, either the root swell or the tree bole must engage bankfull flow; and the wood must be at least 12 inches in diameter at 25 ft. from the larger end of the tree for Westside streams; for Eastside streams wood must be at least 6 inches in diameter at 20 ft. from the larger end of the tree.

LINE (OFFICERS): The operational hierarchy of the Forest Service which includes the District Rangers, Forest Supervisors, Regional Foresters, and the Chief of the FS. These are the individuals empowered to make the decisions about what management activities occur on the landscape.

LONGTERM TEMPERATURE RECORDING DEVICE: An electronic tool with the capacity to accurately record temperatures over an extended period of time. When these devices are used as part of a stream inventory, they must be submersible, digital probes that will record temperatures at least every half hour throughout the summer. These probes are placed in the streams in late June and then retrieved in early October.

LOW FLOW: The base flow of a stream. In the Pacific Northwest, low flow occurs on most streams in late summer. It is at low flow conditions that pools and riffles appear most distinct.

MAINSTEM CHANNEL: The main thread of a stream from its mouth to its upstream origin. The mainstem channel is composed of channel-wide habitats such as pools, riffles, dry channels, culverts, falls, chutes, etc. These mainstem channel habitats are linked in a linear fashion to adjacent mainstem habitats, and occasionally linked to secondary channel habitats. Examples of secondary channel habitats are side channels and tributaries.

MAP WHEEL: Instrument used to determine distances on a map. The wheel of the instrument is rolled along a given line on a map. The distance traveled by the wheel is calibrated to the scaled distance of that map (e.g., 2.6 in. = 1 mi.), and a mapped distance is determined.

MARSHLAND: Land characterized by soils that are water-saturated at least part of the year. This wetland lacks a well-defined bankfull channel.

ORACLE: A relational database used throughout the US Forest Service for information management. SMART is an application of the ORACLE database designed to manage data collected during stream inventory.

ORTHOPHOTOGRAPH: A photograph having properties of orthographic projection (i.e., the image displacements caused by camera tilt and relief of terrain are removed from a conventional perspective photograph).

OVERSTORY: The dominant tree species in the vegetation canopy layer as determined from a birds-eye (aerial) view.

PEEP SITE: A small hand level.

PERENNIAL: A reach that transports surface water year-round. Segments of dry channel may occur within an otherwise flowing reach, but such a channel is designated perennial until no aquatic habitat exists upstream.

PLANIMETER: An instrument used to measure the area of any figure by tracing the perimeter of the figure. The area of a drainage basin can be accurately calculated by tracing the perimeter of a drainage basin with a planimeter.

PLUNGE POOL: A channel-spanning pool habitat in which the scour element maintaining the depth of the pool is a channel-wide obstruction such as a bedrock falls or a debris jam over which streamflow plunges. A plunge pool must span the width of the wetted channel but need not be longer than its width.

POINT BAR: Sediment deposited on the inside bank of a bend in a stream. Most sediment is moved and deposited during storm events. Point bars are zones of low energy, that is, zones of deposition. A lateral scour pool is usually present alongside the point bar

POOL (SLOW WATER): A portion of the stream that usually has reduced surface turbulence and has an average depth greater than riffles when viewed during low flow conditions. The bowl or tub appearance of pools is the result of high flow scouring the streambed. A pool may at times contain substantial surface turbulence at the upstream end, but always has a hydraulic control present across the full width of the channel at the downstream end.

This hydraulic control functions as a dam, which retains water in the pool even after streamflow ceases. This retained water is referred to as the residual pool. Residual pool depth is the difference between the maximum pool depth and the maximum depth along the downstream hydraulic control.

RANGE OF NATURAL CONDITIONS: The lowest and highest values a system could reach for any given ecological parameter. The effects of human intervention during the historical time frame are intentionally not included in the determination of the range of natural conditions.

REACH: A relatively homogenous section of stream having a repetitious sequence of habitat types and relatively uniform physical attributes such as channel slope, habitat width, habitat depth, streambed substrate, and degree of interaction with its floodplain. **NOTE**: The NRIS Water term used to describe reaches that are not defined solely by geomorphology; this term becomes relevant during data entry. Reach applies to segments that have starting and/or ending points that were chosen based on other reasons such as private land on which access to survey has been denied. This is a discretionary reach, that still has a spatial dimension, but it is not defined entirely by ecological and physical characteristics.

REACH ENDPOINTS/STARTPOINTS: The beginnings and ends of all reaches. The endpoint of a reach is the start point of the reach upstream. Every endpoint occurs at the upstream end of a habitat.

RESIDUAL POOL: The pool that persists at the instant the stream stops flowing out of the pool. Residual pools are isolated from each other by dry mainstem channel.

RIFFLE (FAST WATER): A portion of the stream with increased water velocity. Streamflow during low flow discharge is intercepted by partially or completely submerged obstructions to produce relatively high surface turbulence, and this turbulence often is seen as pockets of whitewater. Stream channel gradient is greater in riffles than in pools. Riffles are an inclusive term for low gradient riffles, moderate gradient rapids, and high gradient cascades.

RIPARIAN VEGETATION: Vegetation growing on or near banks of a stream or body of water on soils that exhibit some wetness characteristics during some portion of the growing season. This also includes near-stream vegetation which either offers shade to the stream or could supply the stream with large woody debris (LWD).

RIPARIAN ZONE: The area between a stream or other body of water and the adjacent upland slopes. This zone is identified by soil characteristics and distinctive vegetation. It includes wetlands, the near-shore vegetation surrounding lakes, the portions of flood plains and valley bottoms that support riparian vegetation. The riparian zone also includes those portions of the upland which have the potential to deliver large woody debris (LWD) to the stream channel.

For the purpose of a level II stream inventory, riparian zone refers to the 100 ft. strip of landscape paralleling the channel on both banks, although it is acknowledged that the true riparian zone is usually wider than these 100 ft.-wide strips.

ROSGEN STREAM TYPE: The Rosgen classification system defines stream channels based on the level of investigation. The office phase (level I) of stream inventory permits surveyors to assign a letter label (alpha class: A, B, C, D, DA, E, F, or G) to each stream reach. These labels attempt to distinguish the broad landscape differences in stream character due to valley gradient, valley width, and the apparent sinuosity of the stream observed on 1:24,000 scale USGS maps and aerial photography. Field measurements are essential to refine these landscape-level channel designations.

ROOTS: The branching network of a plant which both anchors the plant in the ground and transports nutrients and water to the stem from the ground. Exposed roots within the bankfull channel have very little impact on streamflow.

ROOT SWELL: The portion of a tree in which the root tissues are replaced by stem tissues. This region of the tree is distinctly broader than the stem, or tree bole, above it. The majority of the mass of a tree stump is root swell. Bankfull streamflow is significantly altered by the presence of just the root swell of a tree within the bankfull channel.

SAMPLING METHOD: The technique used to determine the biota using a channel unit (habitat) or the riparian area bordering the channel unit. Acceptable methods include snorkeling, seining, angling (hook and line), and electroshocking. A permit is required for electroshocking in both Washington and Oregon. Contact WDFW or ODFW respectively for specific information on the permitting process.

SCALE STICK: Synonymous with depth rod, a pole possessing tenth-of-foot increments and used to determine habitat depth.

SENSITIVITY: As applied to watersheds and fish stocks, is the degree of resiliency each possesses to changes in their conditions. That is, sensitivity is a reflection of how persistent certain physical or biological conditions are to different impacts on the system.

SERAL STAGE: The dominant vegetative condition of a particular location. For stream inventory, seral stage refers to the diameter size class of the vegetation that best describes the riparian zone. Seral is synonymous with succession, the process of plant communities to replace one another. For example, following a forest fire, longer-lived and taller woody plants gradually replace the grass/forb pioneer species that colonize a landscape after a fire until the forest is disturbed again.

SIDE CHANNELS: A lateral (i.e., secondary) channel with an axis of flow roughly parallel to the mainstem channel. This secondary channel transports water from an upstream confluence with the mainstem channel to a downstream confluence with the mainstem channel.

The island formed by the side channel and the mainstem channel is stable and not likely to be inundated during bankfull discharge. Persistent woody vegetation other than willow is evidence that the island is stable and that the secondary channel is a side channel. In certain circumstances, woody plants may be absent from a stable island. But in those cases, a well developed soil and vegetation will be present, and the vegetation will endure bankfull discharges.

For purposes of the level II field inventory, side channels that have no flow during low flow conditions, that is, they are dry at the time of the survey, are not designated as channel units nor are they analyzed in the NRIS database.

SINUOSITY: The ratio of stream channel length to valley floor length determined at the reach scale. Using a map wheel, the stream channel length is traced on a map between the two endpoints of a reach. The map wheel is then used to trace the distance between the same two points along an imaginary line occupying the middle of the valley floor. Channels with sinuosities of 1.5 or more are called meandering.

STADIA ROD: A rod divided into 0.01 ft. increments which is used to accurately determine differences in elevation.

STAFF (OFFICERS): The lead personnel from each section (e.g., Budget and Finance, Engineering, Natural Resources, Recreation, Contracting, etc.) of any management unit within the USDA Forest Service. Management units include Districts, Forests, Regions, and the Washington Office. Staff officers report directly to the line officers of their management unit. The responsibilities of staff officers include recommendations to their line officers as well as guiding the operations of programs and technical activities within their section.

STREAMFLOW: The volume of water passing through the cross-sectional area of a channel per unit time. Syn: discharge.

STREAM ORDER: A numbering convention for stream channels that reflects the degree of stream network-branching upstream of a given point along the stream. See accompanying Appendix B for an illustration.

STREAM ROUTE: The term used in GIS (Geographic Information system) to refer to a digitally mapped stream. The mapped stream is a series of line segments, called arcs, that all share a common identifier.

TENSION CRACKS: Visible cracks or fractures in the surface of the soil. These fractures are the result of gravitational stresses pulling the soil apart, and these cracks are visible clues of soil instability.

TERRACE: A terrace is an abandoned floodplain. Terraces are the result of a stream cutting vertically down, forming a new, active floodplain within the new cut. Terraces are then left elevated above the active floodplain.

TIER 1 KEY WATERSHED: A watershed containing habitat for potentially threatened stocks of anadromous salmonids or other potentially threatened fish such as bull trout.

TIER 2 KEY WATERSHED: A watershed with an area greater than 6 square miles possessing high quality water; such water is often the source for municipal water supplies.

THALWEG: The longitudinal (upstream to downstream) line of maximum depth within a stream channel. The deepest point in any channel cross section will occur in the thalweg.

TRANSVERSE BAR: An accumulation of coarse sediment oriented more or less perpendicular to the direction of streamflow. Transverse bars persist at low flow conditions, but are the result of scour just downstream as stormflow decreases. The long axis of a transverse bar often mimics some channel obstruction, such as a bedrock outcrop or a large downed tree.

TREE BOLE: The stem of the tree above its broadened base (= root swell). The tree bole is the portion of the tree harvested for lumber. Like the root swell, the tree bole of a large enough tree can substantially alter streamflow during bankfull events.

TRIBUTARY: A secondary channel system that occupies a distinct drainage basin and has a unique headwater origin. The drainage basin of a tributary is a portion of the larger drainage basin of the mainstem channel.

TURBULENCE: The motion of water where local water velocities fluctuate. The direction of flow changes abruptly and frequently at any particular location, resulting in the disruption of laminar flow. Turbulent water has an uneven surface. Subsurface water is often obscured in highly turbulent water by air bubbles entrained in the water (i.e., whitewater).

UNDERSTORY: The trees, shrubs or herbaceous species that compose the layer of vegetation below the overstory.

WATERSHED ANALYSIS: A systematic procedure for characterizing ecological processes to meet specific management and social objectives. The process integrates prehistoric and historic land use patterns with the natural processes that have shaped the landscape. Watershed analysis is appropriately applied to drainage basins of approximately 20-200 square miles.

WETLANDS: Lands where saturation with water is the dominant factor determining the nature of soil development. Water saturation influences the types of plant and animal communities living in the soil and on its surface. Wetlands possess soils or substrates that are at least periodically saturated with or covered by water. The vegetation of wetlands is distinct from the vegetation of adjoining areas that are elevated above the zone of inundation.

GLOSSARY OF STREAM INVENTORY ACRONYMS AND ABBREVIATIONS

AB: Aquatic Biota (a sub-module within the WATER module of NRIS…it is the repository of the biotic data collected in tandem with the physical channel unit inventory)

AI: Aquatic Inventory (a sub-module within the WATER module of NRIS…it is the repository of the physical channel unit data)

BFD: Bankfull depth

BFW: Bankfull width

BLM: Bureau of Land Management (an agency within the US Department of the Interior)

BO: Boulder (a field code for boulder in the "Formed By" and the "Ocular Substrate" attributes.

BR: Bedrock (a field code for bedrock in the "Formed By" and the "Ocular Substrate" attributes of the Channel Unit Form).

BV: Beaver (a field code for beaver in the "Formed By" attribute of the Channel Unit Form).

CFS: Cubic feet per second

CH: Chute (a field code for chute in the "Channel Unit Type" attribute of the Channel Unit Form).

CHUNIT: Dry mainstem channel (a field code for dry mainstem channel in the "Channel Unit Type" attribute of the Channel Unit Form).

CO: Cobble Bedrock (a field code for cobble in the "Ocular Substrate" attributes of the Channel Unit Form).

CU: Culvert (a field code for a culvert in the "Formed By" and the "Channel Unit Type" attribute of the Channel Unit Form).

DA: Dam (a field code for a human-built dam in the "Formed By" and the "Channel Unit Type" attribute of the Channel Unit Form).

DBH: Diameter at breast height (a rough measure of the age of a tree)

EPA: US Environmental Protection Agency

F: Fast water (a field code for a fast water channel unit (riffle) in the “Channel Unit Type” attribute of the Channel Unit Form).

FN: Fast water, non-turbulent (a field code for a fast water, non-turbulent channel unit in the “Channel Unit Type” attribute of the Channel Unit Form).

FNRN: Fast water, non-turbulent, a run (a field code for a fast water, non-turbulent channel unit (i.e., a run) in the “Channel Unit Type” attribute of the Channel Unit Form).

FNSH: Fast water, non-turbulent, a sheet (a field code for a fast water, non-turbulent channel unit (i.e., a sheet) in the “Channel Unit Type” attribute of the Channel Unit Form).

FS: USDA Forest Service

FSH: Forest Service Handbook (an exhaustive information resource used by all FS units)

FT: Fast water, turbulent (a field code for a fast water, turbulent channel unit (riffle) in the “Channel Unit Type” attribute of the Channel Unit Form).

FTCC: Fast water, turbulent, cascade (a field code for a fast water, turbulent, cascade channel unit (riffle cascade) in the “Channel Unit Type” attribute of the Channel Unit Form).

FTRF: Fast water, turbulent, riffle (a field code for a fast water, turbulent, low gradient riffle channel unit in the “Channel Unit Type” attribute of the Channel Unit Form).

FTRP: Fast water, turbulent, rapids (a field code for a fast water, turbulent, rapids channel unit (riffle rapids) in the “Channel Unit Type” attribute of the Channel Unit Form).

GIS: Geographical Information System (a digital mapping system)

GR: Gravel (a field code for gravel in the “Ocular Substrate” attributes of the Channel Unit Form).

HUC: Hydrologic Unit Code (eight digits that identify a subbasin as unique)

IBM: FS computer network

IFIM: Instream Flow Incremental Methodology (a process for determining the minimum streamflow needed to sustain fish populations)

IRI: Integrated Resource Inventory

LLID: Latitude Longitude Identification (a system of using the location of the mouth of each stream to assign the stream a unique number. The LLID is a unique identifier for the stream).

LWD: Large woody debris (downed woody material intercepting bankfull streamflow and large enough to remain in the system during normal flow conditions)

ND: Marshlands (a field code for marshlands in the "Channel Unit Type" attribute of the Channel Unit Form).

NMFS: (see NOAA)

NOAA: National Oceanic and Atmospheric Administration. (Parent agency of NOAA Fisheries. NOAA Fisheries is also known as National Marine Fisheries Service (NMFS)).

NRIS: Natural Resource Inventory System (a nationwide database developed by the Forest Service).

ODFW: Oregon Department of Fish and Wildlife

OT: Undesignated (a field code for an unknown force causing a habitat to be formed; used in the "Formed By" attribute of the Channel Unit Form).

R06: Region 6 (Pacific Northwest Region of the USDA Forest Service)

RD: Ranger District (each National Forest is composed of several Ranger Districts)

RM: River mile (stream channel distance measured from the stream's mouth, typically expressed in units of tenths of a mile)

RS: Restoration (a field code for an stream restoration efforts causing a habitat to be formed; used in the "Formed By" attribute of the Channel Unit Form).

S: Slow water (a field code for a slow water in the "Channel Unit Type" attribute of the Channel Unit Form).

SA: Sand (Gravel (a field code for sand in the "Ocular Substrate" attributes of the Channel Unit Form).

SB: Stream bend (a field code for stream bend used in the "Formed By" attribute of the Channel Unit Form).

SD: Slow water, dammed (a field code for a slow water, dammed in the "Channel Unit Type" attribute of the Channel Unit Form).

SDBV: Slow water, dammed by beaver (a field code for a slow water, beaver pool in the "Channel Unit Type" attribute of the Channel Unit Form).

SDDD: Slow water, dammed by woody debris (a field code for a slow water, debris jam pool in the "Channel Unit Type" attribute of the Channel Unit Form).

SDLS: Slow water, lateral scour (a field code for a slow water, lateral scour pool scoured by a change in the direction of streamflow as water velocity changes at a streambank; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

SIDEF: Fast water, side channel (a field code for a side channel that is more or less riffle-like used as a "Channel Unit Type" attribute of the Channel Unit Form).

SIDES: Slow water, side channel (a field code for a side channel that is more or less pool-like used as a "Channel Unit Type" attribute of the Channel Unit Form).

SMART: Stream Management, Analysis, Reporting and Tracking (the database application in ORACLE designed specifically for level II stream inventory)

SO: Sequence order (the numerical label for all stream channel units; it is assigned in order as the channel units are encountered)

SSCV: Slow water, scoured by convergence (a field code for a slow water, convergence pool scoured by a tributary's added flow in the "Channel Unit Type" attribute of the Channel Unit Form).

SSMC: Slow water, scoured at mid-channel (a field code for a slow water, mid-channel pool scoured by a partial channel blockage; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

SSPL: Slow water, scoured at mid-channel (a field code for a slow water, mid-channel pool scoured by a partial channel blockage; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

SSTR: Slow water, scoured at mid-channel (a field code for a slow water, mid-channel pool scoured by a partial channel blockage; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

TFW: Timber, Fish and Wildlife (a cooperative venture in Washington state which includes private and public partners whose goal is to smooth the path to ecosystem management)

TR: Slow water, scoured trench (a field code for a slow water, trench pool scoured into bedrock; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

USDA: US Department of Agriculture (the Forest Service is an agency within this federal Department)

USDI: US Department of the Interior (the Bureau of Land Management, the National Park Service, and the Geological Survey are agencies within this federal Department)

USGS: US Geological Survey (an agency within the US Department of the Interior)

WD: Woody debris (a field code for woody debris used in the "Formed By" attribute of the Channel Unit Form).

WDFW: Washington Department of Fish and Wildlife

WF: Waterfalls (a field code for waterfalls used in the "Channel Unit Type" attribute of the Channel Unit Form).

APPENDIX G
Stream Inventory JHA

Below you will find a JHA specific to Stream Inventory. This is just an example and a separate, more detailed JHA will be developed for other activities such as snorkeling and electroshocking that details the hazards for those specific activities.

Job Hazard Analysis		
USDA Forest Service	1. Primary Job - Stream Surveyor	2. Location - Mt. Hood National Forest/Gifford Pinchot NF/CRGNSA
	3. Unit - Fisheries	4. Name of Analyst - Catherine Serres
	5. Job Title of Analyst - Fish Biologist	6. 5/24/2006
	8. Hazards	**9. Abatement Actions**
Back-country Travel	All Hazards	Never travel or work alone in isolated areas without a radio and a detailed emergency plan, Inform coworkers, supervisors, and family or roommates of destination and estimated return time on checkout board. Plan ahead. Select safe routes. Exercise good judgment. Always stay within sight or calling distance of your partner.
	Hiking Injuries	Provide yourself with prudent field attire, which shall include a sturdy pair of 8" high top, lace type boots with lug and high traction soles, long-sleeve cotton shirts, straightcut work pants, heavy socks, work gloves, and rain gear.
Communications	All Hazards	Knowledge of proper radio procedures Carry radio in a plastic bag, keep batteries charged and carry an extra battery pack.
Driving to the survey site	General Driving Hazards	Supervisory emphasis on Driving Safety. Drive the Speed Limit! Discussion/video/class on defensive driving Perform regular maintenance checks: oil, gas, tire pressure, etc.
	Logging Road Hazards	Check with Ranger District for Roads that are not driveable due to slides, debris, active logging, etc.
	Getting lost or stuck	Check route and know route before starting survey. Carry all pertinent maps and aerials, and a compass. Sign out before leaving for the field indicating your destination and route. Plan to return by 1730.

Surveying	Medical Emergencies/ Injuries which include Animal bites/Stings, Toxins, Hypothermia, Heat Exhaustion, Bone Breaks, Joint Sprains or Strains.	Emphasis on tailgate stretches before survey start. Knowledge of personal physical limitations. (Don't take chances!) Carry more than enough water, food and warm clothing and emergency blanket. Do a safety checklist before leaving for the field and before leaving your vehicle to go into the field. A safety checklist will be incorporated into your equipment checklist and will be provided for you. First Aid and CPR training. Carry a first aid kit in the field.
	Preventative Field Gear	Wear boots with proper ankle support. Review walking techniques in the Health and Safety Code Handbook (selected pages provided). Wear proper surveying gear which includes, either cork-soled waders or wading shoes (provided by the government); orange field vest; long-sleeve shirt; long pants; and, when appropriate gloves and rain gear. Hardhats are mandatory Forest Service field gear. Each surveyor must be in possession of a hardhat on any field visit. Especially on windy days, a hard hat can prevent injuries. Do a safety equipment check list before leaving the office and before leaving the vehicle to go into the field.
Fire		Keep fire tools in vehicle. Know the proper radio procedure for fire sightings. Have proper Forest Service-type field boots in vehicle at all times. Have hard hat in vehicle at all times.
Snorkeling		Watch for hazards in the water such as woody debris and large boulders. Be aware of swift current and use good judgment. Always work in pairs. Wear appropriate gear (wetsuit, hood, mask and snorkel) to prevent hypothermia.
10. Approved by		11. Title: 12. Date:

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