Oregon Department of Forestry's Stream Crossing Monitoring Protocol: Fish Passage and Streamflow Design

A supplement to the Oregon Department of Forestry's Best Management Practices Compliance Audit Project

Version 2.2
REVIEW DRAFT

Prepared by:
Liz Dent
Oregon Department of Forestry
Forest Practices Monitoring Coordinator

The Oregon Department of Forestry's Stream Crossing Monitoring Protocol: Fish Passage and Stream Flow Design

A supplement to the Oregon Department of Forestry's Best management practices compliance audit project

Version 2.2

Review Draft

Introduction

The Oregon Department of Forestry (ODF) is conducting a Best Management Practices Compliance Audit Project (BMPCAP). This is a monitoring program which ODF has been directed to do, both through the governor's "Oregon Plan" for the recovery of salmon and watersheds, and at the direction of the Oregon State Board of Forestry.

The term "Best Management Practices" (BMP's) refers to forest practice rules and regulations that are designed to maintain water quality during forest operations. The BMPCAP is a three-year project that is primarily looking at how the department, landowners and operators are implementing the forest practice rules. The project may reveal areas where forest practice rule language can be clarified, administration of the rules can be improved, or where additional landowner and operator education is needed.

Monitoring stream crossings for fish passage and flow design is one of three components of the BMPCAP. This document is a supplement to the "*Oregon Department of Forestry's Best Management Practices Compliance Audit Project, version 3.0*" (Dent, June 1998). The purpose of this document is to describe the field methods used to assess fish-passage and stream-flow designs at stream crossings of newly constructed or reconstructed roads.

For greater detail on the overall BMPCAP project design and methods please refer to "*Oregon Department of Forestry's Best Management Practices Compliance Audit Project, version 3.0*" (Dent, June 1998). The document describes the field-based audit of operations near waters of the state. Also described is a survey-based audit of customers and administrators of the forest practice program. Opportunities to improve the program will be identified through the survey.

The 1998 field season was used to implement a stream crossing pilot study on fish-bearing streams. Fish passage and peak flow data was collected at a total of 57 sites. The protocol was found to be efficient and repeatable. Some minor changes were incorporated for the 1999 season including a less detailed material size classification table, additional readings with the level to estimate countersinking depth, outlet drop height, and overflow dip capacity, and more detailed information collected from the landowner regarding crossing design strategies and sediment retention strategies. The pilot data was used to report preliminary findings on compliance with the forest practice rules and guidelines regarding fish passage and peak flows. Between the 1999 and 2000 field season, the goal is to collect data on at least 100 crossings over fish bearing streams. From this data, the final fish passage compliance report will be compiled.

Objectives

The objectives of this stream-crossing portion of the BMPCAP are to evaluate implementation of ODF forest practices rules concerning fish passage and peak flows. Effectiveness of these practices will eventually be evaluated in a separate project. Fish passage and streamflow regulations are addressed in the forest practice administrative stream-crossing rules (OAR 629-625-320). In summary the rules state that stream

crossings installed after September 1st 1994, shall be installed to allow for migration of adult and juvenile fish at times when movement normally occurs in that stream. In addition, crossings shall be designed to pass a 50-year peak flow event. In order to meet these objectives we will answer the monitoring questions listed below.

Monitoring Questions

Have stream crossing structures on newly constructed and/or reconstructed roads been designed and installed to provide fish passage according to ODF guidelines?

Have stream-crossing structures on newly constructed and/or reconstructed roads been designed to pass a 50-year stream flow event or greater?

Methods

Site Selection

One hundred fish-bearing stream sites will be randomly selected from a population of 1580 notifications in 1998. The selection will be stratified by ODF districts and by landowner class. Each district sample will be stratified by the total number of notifications for each landowner type (industrial, non-industrial, or other) with road construction activities occurring within 100 feet of waters of the state. To ensure adequate representation across the state, we will randomly select 5% from each ODF district or a minimum of five sites per district. Some of the sites in this population will not meet the needs of the study for one of the following reasons: the stream is not a type F stream, the operation did not take place, and/or there is not a stream crossing. In these instances, a new site will be selected.

Field Methods

The following methods were drawn from three documents:

- *Oregon Department of Forestry's Best Management Compliance Audit Project, Version 3.0* (Dent, 1998),
- ODF memorandum titled *Interim fish passage guidance at road crossings* (Robison, June 16, 1995), and
- *Oregon Road/Stream Crossing Restoration Guide: summer 1998 draft* (Oregon Plan for Salmon and Watersheds, 1998).

The following measurements and information will be taken at all fish-bearing stream crossings for each site. Refer to figure 3 for a schematic of features.

GENERAL INFORMATION

Notification Number: From notification

Road number: If there isn't one use NA.

Road name: If the road does not have a name, then assign a name (perhaps after a nearby stream, or harvest unit).

Georegion: Coast, South Coast, Interior, Blue Mountains, East Cascades, West Cascades, or Siskiyou
Legal: Township, range, and section
Landowner: Industrial, Non-industrial, or Other (State, county, non-profit, etc.)
Operation: Construction or Reconstruction
Year (4 digits): completion date of roadwork.

Reason for reconstruction: Flood Repair, Reopen, Oregon Plan, Maintenance, Other

Photo documentation: #1 looking upstream with jump in photo, #2 inside the barrel looking upstream, and #3 looking downstream at inlet

Crossing Identification: notification number.

Structure Location: GPS reading or latitude and longitude from a map if a reading is not possible.

Stream classification: Taken from notification or written plan when available, checked with ODF fish presence maps.

S	Small
M	Medium
L	Large

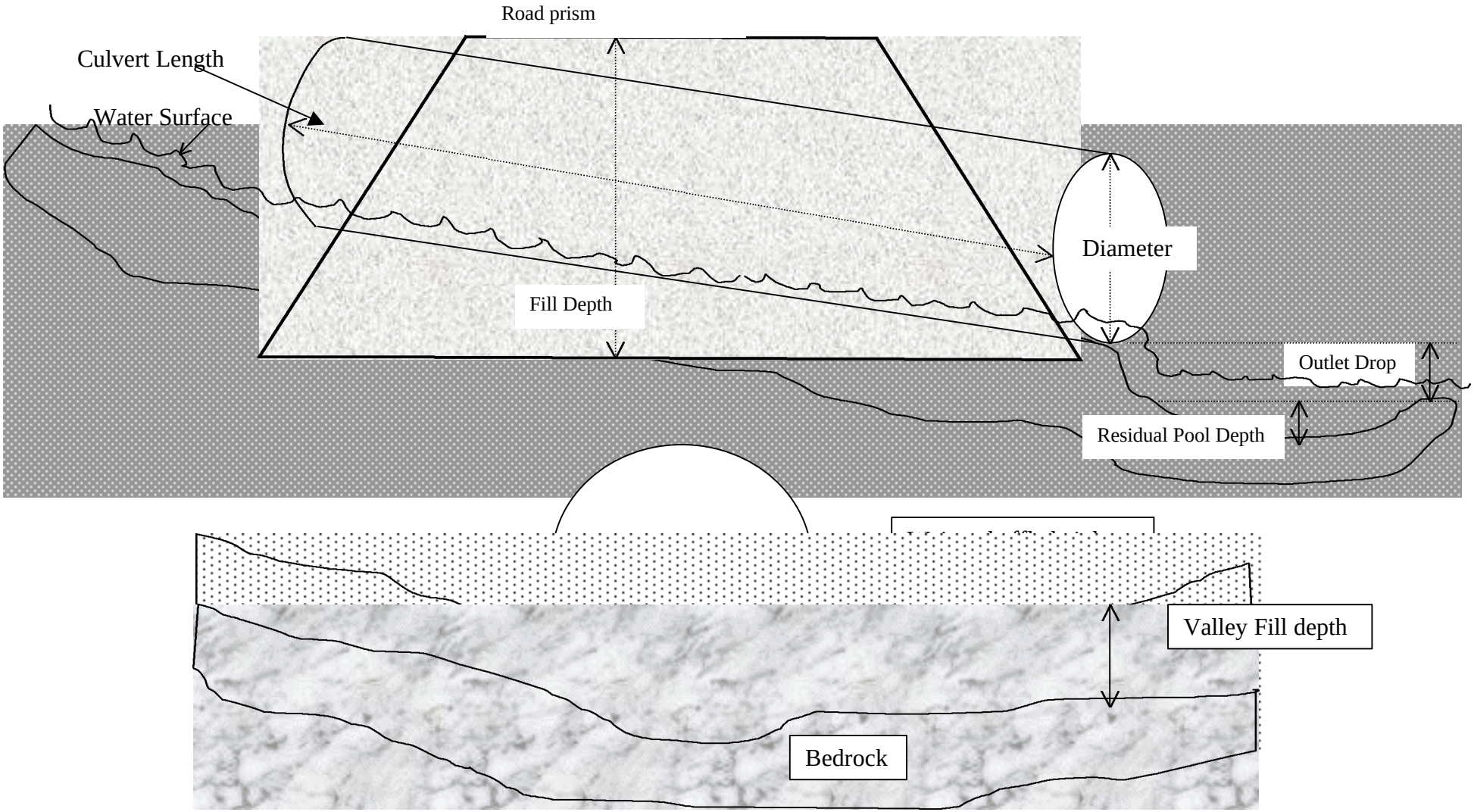


Figure 1. Culvert schematic and measurements for monitoring fish passage and 50-year flow design.

STRUCTURE INFORMATION

Crossing Shape (code):	RC	Round Culvert
	PA	Pipe Arch
	OA	Open-Arch
	BR	Bridge
	FD	Ford
	OT	Other

Structure size Diameter (in) and length (ft) for round culvert,
Length, Rise and span (ft) for arches,
Span (ft) for bridge or ford.

Resulting culvert gradient (%): measured with a transit level. Crew will record the elevation at each end of the culvert and divide by culvert length. Where the culvert inlet is beveled, care must be taken to ensure that the culvert length measured corresponds to the length over which the transit level measurements were observed.

Culvert condition: will be described as good, mechanical damage, rusted, bottom out, collapsed or other (specify).

Footing condition: for bridges and open-bottom arches will be described as

ST	Stable
ER	Eroding
FL	Failing

OVERFLOW DIP MEASURES

Overflow dip: may be used on roads built on wide flood plains (use NA if not present). Using a transit level the crew will measure the elevation of the structure, the lowest elevation of the dip, and the elevation of the lowest point controlling the capacity of the overflow dip. The width of the overflow dip is measured from the height of the lowest point controlling the overflow dip capacity to the opposite side of the dip.

Overflow dip ***road surface*** *armor (code):* Using the codes in table 1, classify the size of material used to armor the road surface of the dip (may be more than one, but no more than three).

Overflow dip ***road fill*** *armor size:* Using the codes in table 1, classify the size of material used to armor the road fill associated with the dip (may be more than one but no more than three codes). This is recorded separately for the downstream and upstream sides of the crossing.

Table 1. Codes used for size classification of material used in road fill armor, road surface armor, stream crossing structures, and channel substrate.

Code	Material	Size description
BD	Bedrock	Bigger than a car/continuous layer
BL	Boulders	Basketball to car-sized
CB	Cobble	Tennis ball to basketball
GR	Gravel	Ladybug to tennis ball
FN	Fines	Silt/clay muck to visible particle;gritty
NO	---	None
NA	---	Not applicable

Overflow dip road surface condition:

ST	Stable
ER	Eroding
FL	Failing

Overflow dip road fill condition:

ST	Stable
ER	Eroding
FL	Failing

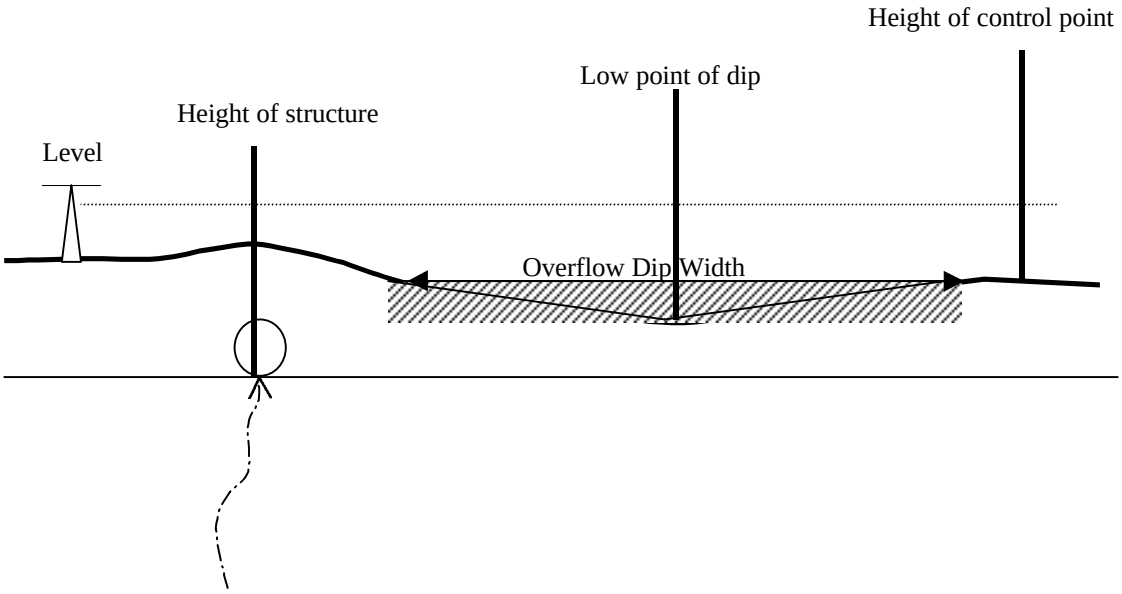
Dip width: The width of the overflow dip is measured from the height of the lowest point controlling the overflow dip capacity to the opposite side of the dip.

Distance from dip to structure: Measured from the center of the crossing structure to the lowest point in the dip.

Dip low point: Lowest point in the overflow dip relative to the crossing structure as measured with the level.

Dip control point: Lowest point of the two upper boundaries of the overflow dip controlling the capacity of the overflow dip.

Overflow Elevation (ft): The difference between the height of the culvert bottom and the height of the bottom of the overflow dip.



OUTLET MEASURES

Outlet drop (ft): the difference between the heights of the downstream control point (controlling the residual[1] water surface) and the culvert outlet as measured with a level. If residual water surface is above the bottom of the culvert, these measurements will have a negative value.

Residual pool depth (ft): max depth of residual pool below the outlet drop.

Outlet mitigation structure type[2]

GW	Gabion weirs
RW	Rock weirs
WD	Woody debris
WR	Wood and rock
NO	None
OT	Other, explain

Intent: According to the landowner/crossing designer, was the intent of the outlet structure to mitigate an outlet drop (OD), to backwater the culvert (BA), to retain sediment within the culvert (SR), or other (OT, explain).

Backwatering (ft): Length of backwatering within the pipe due to outlet mitigation.

Outlet mitigation drop (ft): measured from the residual water surface of the structure to the residual water surface below the structure. If more than one structure (multiple weirs) there will be a measure between each structure.

[1] Residual pool is defined as the remaining pool that exists when riffles are de-watered
[2] Mitigation structures are installed downstream of culverts to back water into the culverts or to retain sediment.

Distance between outlet mitigation and crossing (ft): Measured from the outlet to the mitigation structure, if there are multiple structures crew will document distance between them.

Condition of outlet structures:

ST	Stable
BE	Bank erosion around structure
UC	Actively undercutting structure
SD	Sediment deposition behind structures has filled to elevation of outlet

Stream condition of structure: Wetted: water flows over the residual nick point
De-watered: Structure has no water flowing over the residual nick point

BAFFLE MEASURES

Baffle design:

WB	Weir baffles
OF	Offset weir
PW	Porior design notch weir
NW	Notch Weir
MW	Multiple weirs
SR	Sediment Rack
OW	1 Outlet Weir only
OT	Other
NO	None

Distance between baffles (ft): average for multiple weirs.

Distance between last baffle and outlet (ft): Measured from the base of the last baffle to the outer edge of the culvert.

Height of Baffle: measured at the highest point of the baffle.

Depth of Baffle Notch (ft): measured from top of baffle to base of notch.

ROAD FILL MEASURES

Road fill depth (ft): in vertical feet from the outside edge of the road surface to the original channel measured on the downstream side of the crossing with a transit level.

Road Fill Armor (code): Using the codes in table 1 classify the size of material used for armoring the road fill on the upstream and downstream side of the crossing.

CHANNEL AND VALLEY MEASURES

Stream channel gradient (%): Measured with a clinometer upstream from the influence of the crossing inlet.

Channel Substrate: Upstream of the influence of the culvert inlet, characterize the size of the channel substrate using the codes described in table 1.

Bankfull flow width (ft): measured at the average annual high water mark upstream from the influence of the culvert inlet.

Stream/valley fill (code): This refers to the layers of unconsolidated gravel, sand cobble, and other sediment that lie over the top of the bedrock. It is measured from the parent material or bedrock to the top of the deposit.

NF No fill: (mostly bedrock channel, possibly point bar deposits and terrace-like sediment deposits < 5 feet high, may be valley- wall constrained)
SF Shallow fill: (limited bedrock plus cobble/gravel/sand channel with narrow floodplain and terraces 5-10 feet high)
DF Deep Fill: (no bedrock showing in channel, broad, well-developed floodplain)

Valley type (code):
NV Less than 3 x channel width or < 100 feet (on a side)
WV Wide valley: greater than 3 x channel width or >100 feet (on a side)

INLET MEASURES

Inlet opening (%): as compared to design opening area

Inlet design (code):
NM Not mitered.
MI Mitered
OT Other

Inlet Drop (Yes/No): Note if there is an inlet drop.

NATURAL-BED OR COUNTERSUNK DESIGNS

Sediment pattern (code): For natural-bed or countersunk structure designs give a qualitative description of how material is arranged in the structure. Use NA for structures that are not designed to collect sediment (baffled culvert, bridge).

SS Simulated streambed (channel type forms such as bars and sinuosity, material contiguous)
CR Contiguous rock fill (rock contiguous throughout the structure)
SR Sparse rock fill (rock in culvert but not contiguous)
NM No material in culvert
MO Material in outlet, but barren at inlet.
NA Not applicable

Bed material in Structure (code): For natural-bed or countersunk structure designs document the size of material (listed in table 1) for the length of the crossing. There may be more than one but no more than three. Use NA for structures that are not designed to collect sediment (baffled culvert, bridge) and NO if there is no material in the culvert.

Direction of counter-sinking:	IN	Inlet
	OT	Outlet
	BO	Both
	NO	neither

Depth of countersinking (ft): Quantitative measurement at location of countersinking. This measure is the difference between a level height taken at a point within 5-10 feet of the culvert inlet representing the streambed elevation and a height taken at the bottom of the culvert. Negative values indicate that the culvert is countersunk.

Countersunk (yes/no): A qualitative assessment as to whether or not the pipe was countersunk.

FORD MEASURES

Outlet jump (ft): Measured from outlet to residual water surface.

Residual Flow Depth (ft): Measured at the deepest point in the ford to the residual water surface.

Residual Pool Depth (ft): Measured at the deepest part of the pool downstream of the crossing when present to the residual water surface.

Material Type: Rock, Other (explain)

Material Size used for the ford upstream, at the crossing and downstream of the crossing (code): characterize the size of material in each location as described in Table 1. There can be more than one but no more than three.

Minimizing Sediment

Filtering: distance between crossing and last cross drain structure (waterbar, grade shift, pipe) upslope from the crossing.

Armor at road drainage site (code): Using the codes listed in table 1, characterize the size of material used to armor the ditch outlet at the site of the crossing.

Road surface condition: Describe the section of road draining into the stream crossing as:

GD	Good
RU	Rutted
GU	Gullied
FL	Failing

FIFTY-YEAR RECURRENCE FLOW

For all crossings:

Area upstream of the crossing (square miles): will be measured from a 7.5 minute topographic map.

Baffled/embedded culverts:
Height of baffle or embedded material (ft): measured at inlet or where cross-section represents the average constriction.

Bridges (Figure 2):

Bridge Type:	LS	Log stringer
	RR	Railroad Car
	MI	Metal I-beam
	CC	Concrete

Bridge Span (ft): Measured from one side of the stream to the other.

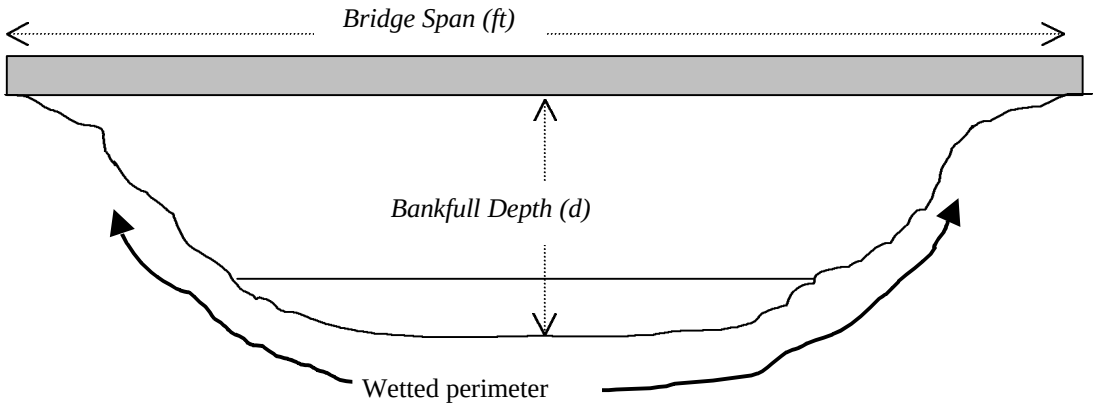


Figure 2. Schematic of measurements needed for calculating flow capacity of bridge design.

Bankfull depth – d (ft): measured from channel bed to the bottom of the bridge (this measure will be used to calculate wetted perimeter and cross-sectional area) every 0.5 feet on streams with a wetted width less than 10 feet and every foot on streams 10 feet and greater. Ability of the bridge to pass 50-year stream flow event will be calculated assuming 3 feet of freeboard.

Increment: Record the increment used to measure depth.

Distance from left bank (ft): Record distance from left bank, taking a measure every 0.5 feet on streams less than 10 feet and every foot on streams 10 feet and greater (this measure will be used to calculate wetted perimeter and cross-sectional area).

Written Plans

A copy of the written plan will be made for each site. Two documents have recently described guidelines for what should be included in a written plan. The first was an ODF Memorandum circulated within the department and to landowners and operators. The subject was: *Interim fish passage guidance at road crossings*, (E. George Robison, June 16, 1995). The information in the ODF memorandum was duplicated in a section (pages 12-14) of the document titled: O*regon road/stream crossing restoration guide: summer 1998 draft* (Oregon Plan for Salmon and Watersheds, 1998). The following checklist was developed for assessing written plans, based on the June 16, 1995 ODF memorandum and the stream crossing restoration guide.

Crossings
Location: Legal description
Structure: Round culvert, pipe arch, open bottom, bridge, ford, Overflow dip, other
Structure size: Diameter, length, rise, and span
Existing stream gradient
Resulting culvert gradient
Bed material in stream channel
Valley fill information
Outlet mitigation
Inlet condition

Peak-flow related data
Cross-sectional data: Detailed stream channel cross-section data (bridges and open-bottom arches): wetted perimeter, cross-sectional area

Watershed size: Size of watershed above stream crossing for 50-year peak flow calculation

Quality Assurance/Quality Control

There is a detailed section on this topic in the *Oregon Department of Forestry's BMP Compliance Audit Project* (Dent, 1998). The Oregon Department of Forestry's Hydrologist and Monitoring Coordinator will train the fish-passage crews. On a subset of sites, two crews will measure the same sites to test repeatability of the methods.

Data will be collected on standardized field data sheets. A file will be kept for each site containing a copy of the written plan, map showing the site location, any relevant paperwork, and field data sheets. Field data will be entered into a computer database on an ongoing basis.

Reports

A preliminary report will be prepared and presented to the Oregon Board of Forestry in 1999 along with the overall BMP Compliance Audit Findings. The project will be continued in 1999 and possibly 2000, with a final report by 20001.

References

Dent, Liz. 1998. *Oregon Department of Forestry's Best management practices Compliance Audit Project, version 3.0*. Oregon Department of Forestry, 2600 State Street, Salem, Oregon, 97310. 69 pp.

Oregon Plan for Salmon and Watersheds. *Oregon Road/Stream Crossing Restoration Guide: Summer 1998 Draft*. 1998. Governor's Watershed Enhancement Board. 255 Capital St. N.E., Salem, OR, 97310-0203. 52 pp.

Robison, E. George. 1995. Interim fish passage guidance at road crossings. June 16 1995. Oregon Department of Forestry, 2600 State Street, Salem, Oregon, 97310. 14 pp.