APPENDIX A

OREGON DEPARTMENT OF FISH & WILDLIFE GUIDELINES AND CRITERIA FOR STREAM-ROAD CROSSINGS

Authority

ORS 498.351 and ORS 509.605, et al, require any person, municipal corporation or government agency placing an artificial obstruction across a stream to provide a fishway for anadromous, food and game fish species where these are present. Fish passage accommodations will be required on any stream, regardless of size, perennial or intermittent, if it is utilized by fish during any significant period of the year. In addition, ODFW may recommend fish passage accommodations at structures constructed in any stream that has a history or potential for fish production if applicable ODFW Basin Fish Management Plans call for the establishment or re-establishment of these populations.

A local Oregon Department of Fish and Wildlife (ODFW) representative should be contacted to determine fish presence and identify fish passage needs at proposed road-waterway crossing projects if such is in question. Project proponents should assume that accommodations for fish passage will be required at any road crossing regardless of stream size if no determination is requested.

Although it is the landowner's responsibility to install and maintain required fish passage structures, it is the policy of ODFW to provide assistance on request to the extent possible. Generally, proposed designs should be reviewed by ODFW prior to finalization of project plans.

Fishway Design: Philosophy, Theory and Practice

When designing fish passage facilities, the following biological variables should be considered:

X Species of fish present
X Life stages to be impacted
X Migration timing of affected species/Life stages

The local ODFW district biologist may be contacted for this information.

Fish passage design is normally based on the weakest species or life stage present that requires upstream access and should accommodate the weakest individual within that group. Management objectives and other relevant factors may, however, direct deviation from this standard. For instance, passage needs of undesirable species (e.g., brook trout in bull trout habitat) may not be accommodated based on other over-riding management objectives. Also, if juveniles, generally the weakest life stage of a species, would use habitat above a culvert for an insignificant portion of the year, ODFW may conclude that only spawning fish (stronger adults) need to be accommodated and that the culvert need not be designed at the higher (juvenile) standard.

Conventions

As used in these discussions of standards, designs and criteria, the "entrance" and "exit" of a culvert or fishway is from the fish's perspective as it moves upstream. Thus, the "entrance" refers to the downstream portion of the structure while the "exit" is the upstream end. "Inlet" and "outlet" refer to water entering and leaving a culvert or fishway.

Hydrologic Considerations and Calculations

It is not considered necessary or practical to design culverts to pass fish at flood stage or continually. Fish generally move after flood peaks pass. Acceptable hydraulic design of culverts includes selection of appropriate design flow from which the flow characteristics can be derived by hydraulic analysis. The low flow depth design should be based on the 2-year, 7-consecutive-day low flow discharge or the 95% exceedence flow for the migration period of the fish species of concern. The high flow design discharge should be the flow that is not exceeded more than 10% ($Q_{10\%}$) of the time during the months of adult migration. That flow can be approximated by

$$Q_{10\%} = 0.18 \text{ X } (Q_2) + 36$$

for cases where the 2-year flood event (Q_2; in cfs) is greater than 44 cfs. For cases where Q_2 is less than 44 cfs, the design flow can be approximated as equaling Q_2.

Criteria for Upstream Movement of Adult Fish

Adult anadromous fish generally expend approximately 80% of their stored energy reserve during normal upstream migration to suitable spawning areas. Undue exertion or delay at stream-road crossings due to unsuccessful passage attempts at inadequate (blocking) structures can lead to reduced spawning success and pre-spawning mortality.

Where fish passage is required by ODFW (in general, wherever fish are present), the following guidelines shall be utilized for preliminary design. Design flows for culvert passage are calculated based on monthly periods when fish migrate.

<u>Maximum Water Velocities</u>

Table 1: Average Water Velocity (fps) at High Flow Design Discharge for:

Culvert Length (ft)	Salmon & Steelhead	Adult Trout (>6")	Juvenile salmonids
Under 60'	6.0	4.0	2.0
60 to 100'	5.0	4.0	2.0
100 to 200'	4.0	3.0	see note below
200 to 300'	3.0	2.0	see note below

over 300'	2.0	1.0	see note below

Note: For juvenile fish, only designs incorporating streambed simulation solutions will be considered for culverts over 100' in length. Streambed simulation refers to the situation where substrate and flow conditions in the crossing structure mimic the natural streambed above and below the structure.

Table 1 presents the hydraulic criteria for the design of culverts for passage of salmonids. Satisfaction of these criteria is essential to the adequacy of a culvert installation to meet fish migration needs. These criteria are based on several references.

In a natural stream channel, the average water velocities indicated in Table 1 are often exceeded. The diversity of natural channel beds and formations, however, provides paths of access with suitable depths, velocities and resting opportunities with only brief exposure to excessive conditions. Velocity requirements noted above may be exceeded within structures with natural beds upon approval by the ODFW Fish Passage Coordinator, Portland.

Minimum Depth at Low Flow Discharge

For non-embedded culverts, minimum water depth during expected fish passage periods shall be:

- X Twelve (12) inches for adult steelhead and chinook salmon;
- X Ten (10) inches for salmon other than chinook, sea-run cutthroat trout and other trout over 20 inches in length; and
- X Eight (8) inches for trout under 20 inches, kokanee and migrating juvenile salmon and steelhead.

For embedded (stream simulation) culvert designs, minimum depth at low flow discharge during expected fish passage periods must meet or exceed conditions found in the adjacent natural channel.

Entrance Jump; Maximum Vertical Height

A backwatered or partially submerged culvert entrance is preferred but the following maximum jumps are allowable where justified:

- X One(1) foot for salmon and steelhead adults
- X Six (6) inches for trout and kokanee adults and salmon and steelhead juveniles.

The above are also the maximum jump heights when a series of jumps and pools are required.

In cases where entrance jumps are planned, a jump pool of at least 1.5 times the jump height or a minimum 2 feet deep must be provided.

When planning for any jump into a culvert, project designers must show why the culvert could not be designed with no jump.

Criteria for Upstream Migration of Juvenile Salmonids

Upstream juvenile migration occurs in response to instream habitat conditions, predation and population pressures. Juvenile migration and redistribution is a means for increased survival and optimizing production. An obstruction to juvenile migration can limit production both upstream and downstream from the barrier.

Juvenile salmonids, by virtue of their small size, are less capable swimmers when compared to adults. Therefore, maximum water velocity, jump and swimming distance criteria are necessarily lower than those for adults.

Preferred Road-Stream Crossing Structures

Where fish passage facilities are required by ODFW, the following structure types shall be considered for use in the displayed order of preference:

1. Bridge (with no approach embankment into the main channel)
2. Streambed simulation strategies using a Bottomless Arch or embedded culvert designs
3. Streambed simulation strategies using embedded round metal or concrete box culvert designs
4. Non-embedded culvert; placed at less than 0.5% slope
5. Baffled culvert (various designs); placed at 0.5% to 12% slope or a structure with a fishway.

Again, streambed simulation refers to the situation where substrate and flow conditions in the crossing structure mimic the natural streambed for fish passage flows.

The landowner or agency must justify their proposed structure type if a more preferred structure type is not selected.

General Considerations

At any given flow, slope is an important factor affecting water velocity in culverts. Culvert size also affects velocities, especially when a structure is considerably undersized and a head (pooling above culvert) is developed.

Gradients (slope) for non-embedded, non-baffled culverts shall not exceed 0.5% unless a tailwater situation exists to backwater the culvert to a suitable depth for its length. Properly baffled or weired culverts are appropriate for steeper gradients depending on design. Structures with fishways (i.e., fish ladders or culverts with weir-type baffles) generally will be required where culvert gradients exceed 5% and streambed simulation is not employed.

Corrugated metal culverts are generally preferred over smooth-surfaced culverts. Deep corrugations are preferred over shallow corrugations.

Bottomless arches and all styles of embedded culverts shall be placed at or near the same gradient as the natural streambed and shall be at least as wide as the active stream channel (i.e., no lateral encroachment on the active stream channel). All embedded culverts (round or arch) must be embedded one foot deep or at least 20% of its height, whichever is more.

When deciding between bottomless arch and embedded culvert designs, the primary consideration is foundation substrate. If considerable bedrock is

present, an open bottom arch is generally the appropriate choice; embedding a culvert would require extensive excavation. Where deep unconsolidated gravel and cobble is present, failure (undermining) of a bottomless arch foundation is a major concern.

Hydraulic controls may be required to (1) improve culvert entrance and exit conditions (e.g. using a beveled inlet configuration; providing resting pools at culvert entrance and exit), (2) concentrate low flows, (3) prevent erosion of stream bed and banks, or (4) allow passage of bedload material. The need for, and design of, these project features should be developed in consultation with ODFW.

If water-crossing structures are placed in spawning areas, they must incorporate mitigation measures, as necessary, to achieve no-net-loss of spawning area.

Trash racks are discouraged at culvert inlets. But if necessary, these should be installed only above the high passage flow water level.

For culverts over 200 feet in length, illumination may be required. Contact the ODFW Fish Passage Coordinator, Portland, for a case-specific determination.

Water Crossing Structures

Bridges

Properly installed bridges pose the least impact on crossed water courses and are, therefore, generally preferred by ODFW. Bridges are appropriate at any stream gradient. It is understood that bridging costs can be relatively high and that project costs is a valid consideration when evaluating road-stream crossing alternatives.

Culverts

Where fish are present and passage is a concern, culverts shall be designed and constructed to provide adequate fish passage (as per criteria stated herein) for those species and Life stages determined to be present. High water velocity, shallow water depth within the culvert, excessive vertical drop at the culvert outlet and debris blockages are the most frequent causes of fish passage problems at culverts. Therefore, culverts must be designed and constructed to avoid these defects.

Culverts may be approved for placement in small streams without extensive hydraulic analysis if placed on a flat gradient (0.5% or less) and achieve minimum depth requirements. Where culvert installation is not feasible at a flat gradient, the culvert design shall consider design criteria outlined earlier.

Construction Considerations and Conditions

Culverts and associated fill should be designed using standard engineering design practices to maintain structural integrity to the 100-year flow.

Disturbance of the bed and banks should be limited to that necessary to place the culvert, embankment protection and any required channel modification associated with the installation. All disturbed areas should be protected from erosion within seven (7) calendar days of completion of the project using vegetation or other means. The banks should be revegetated within one year with native or other approved woody plant species. Live stakes should be planted at a maximum interval of three feet (on center) and maintained as necessary to ensure 80% survival.

Approved structures should be constructed in the dry whenever possible. Where significant live flow exists, isolation of the construction site from stream flow is required by techniques such as:

< the installation of a bypass channel, a flume or culvert
< the installation of a sheetpile or sandbag wall
< the use of a water-filled cofferdam
< by pumping the stream flow around the site

Exception may be granted if siltation or turbidity is reduced to acceptable levels by means approved by ODFW.

Any fish stranded in the construction area or diversion reach shall be safely moved to the flowing stream. A local ODFW representative should be contacted to determine if the fish need to be moved.

Any wastewater from project activities and dewatering shall be routed to an area outside the ordinary high water line to allow settling of fine sediments and other contaminants prior to being discharged back into the subject stream.

If in-water excavation is anticipated, timing of same shall conform to ***Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources*** unless an exception is approved by ODFW.

APPENDIX B

Oregon Revised Statutes
Fish Passage

ORS 498.351 Fishway required for artificial obstruction across body of water. (1) Except as otherwise provided by law, no person shall construct, operate or maintain any dam or artificial obstruction across any body of water in this state in which **game fish** exist unless the person provides a fishway in such location and of such design as the State Fish and Wildlife Commission determines will provide adequate upstream and downstream passage for fish at the dam or obstruction.

(2) If the State Fish and Wildlife Commission determines that a fishway required by subsection (1) of this section does not provide adequate passage for fish, the State Fish and Wildlife Commission shall so notify the person who constructed or who operates or maintains the dam or obstruction. The notice shall also specify the manner in which the fishway is inadequate, and shall require the person who constructed or who operates or maintains the dam or obstruction to make appropriate alterations, specifying a reasonable time for the completion thereof.

(3) A person required to alter a fishway pursuant to subsection (2) of this section may file with the Water Resources Commission a protest against the alteration requirements on the grounds that such alterations are not in the public interest. A person who protests pursuant to this subsection must file the protest with the Water Resources Commission not later than the 10th day after the date of the notice of alteration requirements from the State Fish and Wildlife Commission.

(4) Within a reasonable time after receiving a protest, the Water Resources Commission shall give notice to the protestant and the State Fish and Wildlife Commission and hold a hearing to determine whether the fishway alterations are in the public interest. In making the determination, the Water Resources Commission shall approve, disapprove or approve with modifications the fishway alterations required by the State Fish and Wildlife Commission. In making the determination, the Water Resources Commission shall consider the state water resources policy and the considerations set forth in ORS 536.310[1].

(5) If the person required by this section to make alterations to a fishway fails to make the alterations in the manner and within the time required by the State Fish and Wildlife Commission or the Water Resources Commission, as the case may be, the State Fish and Wildlife Commission may remove the dam or obstruction, or any parts thereof.

(6) No person who has constructed or who operates or maintains a dam or artificial obstruction for which a fishway is required by this section shall fail to keep the fishway free from obstruction to the passage of fish. However, no prosecution for violation of this subsection shall be commenced unless the violation continues after the State Fish and Wildlife Commission has given written notice of the violation to the person who is to be prosecuted. Every day of violation of this subsection after the date written notice was given to the person to be prosecuted constitutes a separate offense.

<Formerly 498.268>

[1]Purposes and policies to be considered in formulating state water resources program

ORS 509.605 Fishways required over artificial obstructions; approval by director; failure to complete fishway. (1) Except as otherwise provided in ORS 498.351[2] or 509.640[3] or 509.645[4] or the state water resources policy formulated under ORS 536.295[5] to 536.350[6], it is unlawful for any person, municipal corporation, political subdivision or governmental agency to construct or maintain any dam or artificial obstruction across any stream in this state frequented by **anadromous or food fish** without providing a passageway for such fish over the dam or artificial obstruction as near the main channel as practicable.

(2) The director shall examine, from time to time, all dams and artificial obstructions in all waters of this state frequented by anadromous or food fish. If in the opinion of the director there is not a free passage for such fish over any dam or artificial obstruction, and except as otherwise provided in ORS 509.640, the director may notify the owner or occupant thereof to provide free passage within a reasonable time with a durable and efficient fishway, of such form and capacity and in such location as shall be determined by the director. Except as otherwise provided in ORS 509.645, no owner or occupant of such dam or artificial obstruction shall fail to complete such fishway to the satisfaction of the director within the time specified.

(3) Any person, municipal corporation, political subdivision or governmental agency shall, prior to construction of any dam or artificial obstruction in any waters of this state, obtain a determination from the director as to the need or lack of need for passage for anadromous or food fish. If the director determines that a fish passage facility is needed, approval of the proposed plans and specifications for such facility must be obtained from the director prior to construction of the dam or artificial obstruction.
<Amended by 1955 c.707 s49; 1963 c.178 s1; 1965 c.570 s131; 1973 c.723 s123>

ORS 509.610 Maintenance of fishway required. (1) Subject to ORS 509.645[7], when the director requires a fishway to be provided pursuant to ORS 509.605[8], the owner or occupant of a dam or artificial obstruction shall keep the fishway in repair and open and free from obstruction to the passage of anadromous or food fish at all times.

(2) Each day of neglect or refusal to comply with subsection (1) of this section, after notification in writing by the director, constitutes a separate offense.
<Amended by 1955 c.707 s52; 1965 c.570 s132>

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[2]Fishway required at artificial barrier; game fish

[3]mitigating/substituting with a hatchery

[4]Protests to WRC

[5]Conditions for uses additional to those for which waters classified in basin program

[6]Delivery of water resources statement to certain public bodies

[7]Filing protest with Water Resources Commission

[8]Fishways required over artificial obstructions

ORS 509.620 Condemning inadequate and ordering new fishways. Where in the judgment of the commission, any fishway is inadequate, as constructed under ORS 509.605 or otherwise, the commission may condemn the fishway and order a new fishway installed in accordance with plans and specifications determined by the commission.

ORS 509.625 Power of commission to inspect artificial obstructions and have fishways constructed. (1) The commission may determine or ascertain by inspection of any dam or artificial obstruction whether it would be advisable to construct, or order the construction pursuant to ORS 509.605 by the owners thereof, of fishways over the dam or obstruction. The commission may construct or order the construction, pursuant to ORS 509.605, of such number of fishways in any stream inhabited by anadromous or food fish as is deemed adequate to provide a good and sufficient passageway for such fish.

(2) Where a fishway has heretofore been constructed with or without the approval of the commission and has proved useless or inadequate for the purposes for which it is intended, the commission may improve or rebuild such fishway. However, such construction or reconstruction shall not interfere with the prime purpose of the dam or obstruction. This subsection shall not be construed to require the improvement or rebuilding of fishways by the commission.
<Amended by 1955 c.707 s53; 1963 c.232 s1; 1965 c.570 s133>

ORS 509.640 When dams to be provided with hatchery facilities. (1) If in its opinion the height of a dam in any of the rivers or streams of this state will make a fish ladder or fishway thereover impracticable, the commission, in lieu of the requirement of a fishway under ORS 509.605 (2) and subject to ORS 509.645, may require that the owner of the dam:

(a) Convey to the state a site of the size and dimensions satisfactory to the commission, at such place as may be selected by the commission.

(b) Erect thereon a hatchery and hatchery residence, according to plans and specifications to be furnished by the commission.

(c) Enter into an agreement with the commission, secured by a good and sufficient bond, to furnish all water and light, without expense, to operate the proposed hatchery.

(2) Except as otherwise provided in ORS 509.645, no owner of the dam shall fail to comply with subsection (1) of this section to the satisfaction of the commission within a reasonable time specified.

(3) This section does not apply to:

(a) Dams constructed prior to February 18, 1921, in streams to a height where the construction of a fish ladder is impracticable, provided an agreement has been entered into and executed with reference to the construction and maintenance of such dam between the commission and the owners thereof.

(b) Dams, for the construction of which permits have been granted by the commission under this section as it existed prior to the 1955 amendment of this section. Such dams are subject to and governed by this section as it existed prior to the 1955 amendment of this section.
<Amended by 1955 c.707 s54>

ORS 509.645 Filing protest with Water Resources Commission; review and determination by Water Resources Commission as to whether fishway or hatchery facilities in public interest. (1) Any owner or occupant of a dam or artificial obstruction may file a protest with the Water Resources Commission within 10 days after receipt of notification from the director as provided in ORS 509.605 (2), or within 10 days after receiving notice of the requirement by the State Fish and Wildlife Commission under ORS 509.640, on the ground that providing the dam or artificial obstruction with a fishway or providing the dam with hatchery facilities as required by the State Fish and Wildlife Commission, as the case may be, would impair or be detrimental to the public interest.

(2) Within a reasonable time after the filing of the protest under subsection (1) of this section, the Water Resources Commission shall hold a public hearing thereon. The Water Resources Commission shall give written notice of the hearing to each owner or occupant of the dam or artificial obstruction,

who is known to or can be reasonably ascertained by the Water Resources Commission, and to the State Fish and Wildlife Commission at least 10 days prior to the hearing.

(3) The Water Resources Commission, after the hearing, shall make a determination as to whether providing the dam or artificial obstruction with a fishway or providing the dam with hatchery facilities as required by the State Fish and Wildlife Commission, as the case may be, would impair or be detrimental to the public interest. The determination shall be binding upon each owner or occupant of the dam or artificial obstruction and the State Fish and Wildlife Commission. The determination shall approve the requirement of the fishway or the hatchery facilities, as the case may be, approve the requirement subject to conditions specified in the determination or disapprove the requirement. If each owner or occupant of the dam or artificial obstruction complies with the determination, such owner or occupant shall be deemed not in violation of ORS 509.605 or 509.640, as the case may be.

(4) In determining whether providing the dam or artificial obstruction with a fishway or providing the dam with hatchery facilities as required by the State Fish and Wildlife Commission, as the case may be, would impair or be detrimental to the public interest, the Water Resources Commission shall have due regard for:

(a) The state water resources policy formulated under ORS 536.295 to 536.350.

(b) The considerations set forth in ORS 536.310.

(5) In the event protests are filed with the Water Resources Commission under both subsection (1) of this section and ORS 498.351, the Water Resources Commission may consider and determine the protests in a combined proceeding under this section and ORS 498.351.

<1955 c.707 s51; 1973 c.723 s124>

ORS 509.910 Injunction to prevent certain violations; jurisdiction; service on corporation. (1) The State Fish and Wildlife Commission may maintain an action for an injunction to enjoin and restrain any person, municipal corporation, political subdivision or governmental agency of this state from violating any of the provisions of ORS 509.130, 509.140, 509.505, 509.605, 509.610, 509.615 and 509.625.

(2) Any action authorized by this section shall be tried in the circuit court of the county in which the violation occurs.

(3) If the defendant is a corporation with its principal office and place of business in a county other than in which the waters flow or are situated, such action shall be deemed an action of local nature and service of summons made on a corporation in any county where the corporation has its principal office and place of business. If it is a foreign corporation, service may be made on the statutory agent but if there is no such statutory agent then upon the Secretary of State as in other cases provided by law.

<1963 c.303 s1; 1977 c.242 s8; 1979 c.284 s16>

APPENDIX C

MEMORANDUM OF UNDERSTANDING

This MEMORANDUM OF UNDERSTANDING is made and entered into by and between the Oregon Department Of Transportation (ODOT), Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), Division of State Lands (DSL), the Federal Highway Administration (FHWA), and the Oregon Department of Forestry (ODF).

WITNESSETH

RECITALS
The purpose of this Memorandum of Understanding is to demonstrate agreement to use the provided set of criteria and guidelines when designing or consulting on projects which may affect fish passage. By agreeing to these criteria and guidelines, individual regulatory project approvals regarding fish passage issues will be expedited.

Whereas:

1 ORS 196.800-196.990 and ORS 390.805-390-925 require landowners, including government entities, to provide for fish passage at in-channel structures where game, food and anadromous fish species are present. By statute, the Fish and Wildlife Commission (FWC) and the Oregon Department of Fish and Wildlife (ODFW) are responsible for periodic inspection for blockages;

and

2. ORS 541.605 - 541.695 and 541.990 require a permit for the removal, filling or movement by artificial means (alteration) of material within the bed or banks of the waters of the state unless otherwise exempted. Permits are issued for these activities under the authority of the Director of the Division of State Lands (DSL);

and

3. ODOT, ODFW, ODF, National Marine Fisheries Service (NMFS), and Federal Highway Administration (FHWA) have jointly developed and approved the required criteria and guidelines to follow when designing for fish passage on any construction project. These criteria and guidelines attached hereto and marked Exhibit 'A', are, by this reference, made a part hereof.

and

4. If said criteria and guidelines for fish passage are followed in project design and construction, the regulatory review and approval times by ODFW and DSL will be substantially reduced.

Memo of Understanding

Oregon Department of Transportation
Oregon Department of Fish and Wildlife
Oregon Department of Agriculture
Division of State Lands
Oregon Department of Forestry
Federal Highway Administration

Therefore:

1. The parties agree:

a) To adopt said criteria and guidelines set forth in Exhibit A when designing, constructing and consulting on projects affecting fish passage;

2. ODOT and ODFW agree:

a) To enter into an Intergovernmental Agreement. This agreement will specify how ODFW will provide technical assistance on project or maintenance related issues that may impact salmonids or their habitat, with such assistance subject to ODFW funds available for such purposes.

b) Said technical assistance agreement shall be in effect for three years at which time ODOT will review the need for additional technical services from ODFW and shall enter into a supplemental agreement if needed.

3. ODFW and DSL agree:

a) To expedite "Removal-Fill" permit application review and approval for construction projects if the implementing party is following the approved set of fish passage criteria and guidelines shown in Exhibit A,

and

b) Agree that interim guidance by Oregon Department of Forestry (see Exhibit B attached hereto) meet the requirements of Exhibit A and are sufficient in the context of meeting fish passage requirements on state and private forest lands under the authority of the Forest Practices Act.

Oregon Department of Transportation
Oregon Department of Fish and Wildlife
Oregon Department of Agriculture
Division of State Lands
Oregon Department of Forestry
Federal Highway Administration

This Memorandum of Understanding will be reviewed, and revised if necessary, every five years by all parties. No revision shall be binding to any party without the written consent of the party.

The terms of this Memorandum of Understanding may be terminated by mutual consent of the parties or by written notice from any party to the others within thirty days.

_____
Tom Lulay, Technical Services Branch Mgr.
Oregon Department of Transportation

Date_____

_____
Rudolph A. Rosen, Director
Oregon Department of Fish and Wildlife

Date_____

_____
Pau1 R. Cleary, Director
Division of State Lands

Date_____

_____
James E. Brown, State Forester
Department of Forestry

Date_____

_
_____
Phil Ward, Asst. Director
Oregon Department of Agriculture

Date_____

_____
Hank Honeywell, Div. Administrator
Federal Highway Administration

Date_____

Appendix D

Proposed Criteria for reviewing written plans for fish passage

1. Written Plan Checklist

A. Physical Information:

1. Location of stream crossing
- Road name/number
    - Legal description
    - Georegion

2. Size of basin above crossing.

3. Calculation of 50 year peak flow.

4. Culvert data:
    - Type (circular, pipe-arch, box, arch, baffled)
    - Material (corrugated metal, plastic)
    - Size (diameter, span, rise)
    - Length

For fish bearing streams (all fish bearing stream crossings require written plans)

5. Existing stream gradient (percent):
    - Requiring a channel profile may be appropriate with some installations.
    - Rule-of-thumb; channel profile should be a minimum distance of 100 feet downstrean and upstream of installation site
    - For replacement installations where sediment deposition has artificially flattened the channel upslope of the inlet, estimate "natural" stream channel gradient.

5. Resulting culvert gradient (percent): This is the design slope of the resulting culvert after installation.

6. Stream channel data:

- Bed material of the existing stream (for streambed simulation designs only): Note the predominant sediment type in the stream and the predominant type in the middle of the stream where water velocities are greater.

- Active channel width of existing stream (for streambed simulation designs only): See guidance manual on how to determine and measure active channel width.
- Depth of fill material associated with stream. Estimate the depth of streambed channel fill material. Streambed channel fill refers to layers of unconsolidated gravel, sand, cobble, and other sediment that lie over the top of the bedrock.

9. Information on downstream backwatering structures (for culverts placed flat and backwatered designs or any other designs requiring outlet work).

10. Degree of sinking and embedding (for streambed simulation designs that use sinking): Depth and sizes of material embedding the culvert and depth of sinking. Please refer to fish passage restoration guide for minimum values.

11. Calculation of flow capacity of crossing structure versus flow potential of watershed.

Information needed for bridges and open bottomed structures:

These alternatives require calculations to insure that flow capacity with freeboard are adequate to pass a 50 year flow. Information on how to do this calculation includes determining a design representative channel cross-section under the bridge and getting an average stream slope measurement. Open bottom designs not placed on bedrock footings need information on stream width compared to crossing width as well as information regarding material underneath the footings.

B. Justification for alternative chosen (i.e. is there information on which design strategy will be used with some reasoning on why the alternative was chosen and why the designer thinks it will work?)

In the fish passage restoration guide there are several alternatives given, did the designer pick one or a combination of alternatives?

C. Are the design specifications within the limits presented in Table 1?

1. Are the slopes chosen within the acceptable range?
2. Is there adequate sinking specified if a countersunk culvert?
3. Does the valley fill depth estimated match with the design alternative chosen? For instance, if an open bottom design is chosen with concrete footings was the valley fill depth shallow?

Table 1. Water Crossing Structures and fish passage design acceptance/rejection conditions for ODF written plans

Alternative	Accept	Further Review	Reject/Resubmit

Bridges	Can be used over all slopes. Bridges need to be adequately sized to pass 50 year peak flow with adequate freeboard. As a rule of thumb bridges span should be at least as wide as stream.	
Open bottomed culverts	Can be used over all slopes. Needs to be adequately sized A rule of thumb is span should equal or exceed bankfull stream width	While an open arch will always meet fish/water passage requirements if adequately sized, in situations where the channel area has thick valley fill material the existing channel installation can become expensive as well as damaging to the environment. For this reason further review is often required in these instances.
Streambed Simulation	Stream grade is less than or equal to 8% Stream gradient is greater than 8%.	Concerned that embedding is not adequately described.
Sunken Culverts	Culvert gradient is less than or equal to 6.5%. Width/span of the culvert meets or exceeds bankfull width. Adequate depth of valley fill is indicated. If culvert is placed at stream grade over 4% the culvert gradient is less than stream gradient meaning the inlet is planned to be sunk more than outlet. Embedding is planned and material meets or exceeds material size in the stream. The culvert is sunk adequately minimum two feet or more.	Resulting culvert gradient is greater than 6.5%. Hard bedrock is near surface meaning the culvert can not be sunk in stream. The details of the plan do not indicate what the slope, valley width, or stream width is. There is inadequate detail sizing. Concerned about possible bedrock below the surface. The plan indicates the culvert is less than bankfull width but meets the 50 year flow requirement on embedding or how culvert will be installed.
Culvert placed flat	Stream gradient is less than 2.0%. Difference in elevation between inlet and outlet on existing stream grade is less than one foot. Resulting culvert gradient is less than 0.5% and installation description details how they will control and measure culvert gradient. Downstream weir will back up water 8 inches.	The culvert gradient is over 0.5%. Downstream weir does not back up eight inches of water. Overall stream gradient is greater than 2.5%. Overall stream gradient is measured over long distances minimum 100 feet above and below crossing. Difference in culvert gradient is greater than one foot. Plan calls for excavating a significant amount of upstream deposited material. Overall stream slope is greater than 2%. Concerned about downstream weir.

Table 1. (Cont.) Water Crossing Structures and fish passage design acceptance/rejection conditions for ODF written plans

Alternative	Accept	Further Review
Culvert with backwatering	Overall stream gradient less than 4%. Resulting culvert gradient is less than 2%. Difference in elevation between downstream and upstream end of culvert no more than one foot. Height of downstream weir greater than bottom of inlet and at least eight inches greater in elevation than outlet end. Detail is given on how weirs will be installed.	Concerned about excessive drops of downstream weirs. Log wiers with more than six inches drop or rock weirs greater than one foot drop. Resulting culvert gradient greater than 2%.
Baffle/Weir Culvert		Always require further review. In general should be developed by Specialist with hydraulic Skills.
Fords	Demonstrated that road is extremely low traffic. Ford has hardened cobbles and approach that has diversion structures on it. Amount of fill is not excessive as to create a fish passage barrier.	Concern about approaches. Concern that excessive material at the ford may create an artificial blockage.

Reject/Resubmit
Stream gradient is greater than 4%. Inlet elevation is greater than top elevation of downstream weir. Plan lacks sufficient detail about location of weirs.
If stream slope is greater than 12%. If resulting culvert slope is greater than 12%.
Streams that are low gradient with mucky bottoms. Roads that may moderate to heavy traffic.

Appendix E

Step by Step "Cookbook" for culverts placed flat and for embedded sunken culverts

Introduction

1. Based on monitoring and field visits the two most common solutions to provide fish passage at road crossings on Oregon forestlands at this time are placing the culvert flat or providing for natural streambed simulation by sinking and sometimes embedding a round or pipe-arch culvert. For this reason, this appendix was developed to give a step by step guide on how to use these two methods. For any forest operation a notification must be filed. If the road fill is over a fish bearing stream then a written plan must be submitted. In submitting the written plan, the Road /Stream Crossing Restoration Guide (6/8/99) must be used to develop the written plan. Before going to the added expense of doing a written plan and installing a more carefully designed crossing, check to make absolutely sure the stream is fish bearing.

Steps for the Culvert Placed Flat Option

1. Get required information about the stream at and near the location of the stream crossing (p. 34-37 Road/stream crossing guide). Of key interest for this design is if the stream is low gradient (less than 2.5%). Another consideration is that if the stream width at normal high water is greater than about 15 feet, a bridge may be a better option as culvert prices increase greatly as their sizes increase.

2. Design Assumptions:

   - Adequate valley fill material present to place culvert on and to countersink up to a foot or two.
   - Overall stream gradient is less than 2.5%. Placing a culvert flat for streams with slopes greater than this can be problematic and is outside the scope of the Road/Stream Crossing Restoration Guide.

2. If the gradient is low then size the culvert for the 50 year peak flow (page 54-64). Keep in mind that if you are in a wide flood plain (see page 62-63) then you can size the culvert for the 1-2 year peak flow and an overflow dip to carry the excess water. (OAR 629-625-320(3))

   In sizing the culvert, the following steps must be done:

   A. Determine the watershed size in square miles (p. 58)

B. Multiply the watershed size times the runoff factor from the runoff map (p. 56-57) to get the streamflow expected . Note a large scale version for the runoff map for western Oregon can be obtained from ODF state or local field offices.
C. If the culvert is to be placed flat via countersinking the inlet into the streambed then you must oversize to compensate for the degree of countersinking that will occur at the inlet (p. 60-61). You must also oversize to compensate for 8 inches of backwatering. For instance, if a culvert is 50 feet long and the stream is 2% gradient then you must counter sink one foot to place the culvert flat, plus there is the 8 inches that is needed for backwatering. This creates a loss of 12” + 8” = 20”. If the culvert is a 60 inch round culvert this means that 33% of the diameter is lost to flow capacity (20”/ 60” ~ 30%) which corresponds to about a 30% loss in cross-sectional area. You must, by trial and error , check the culvert size on Table 6 (p. 57) in light of the cross-sectional area loss until you have a size equivalent to the diameter required to pass the 50 year flow. In determining the length of the culvert you can assume a side slope angle of 1.5 to one. Knowing the length is important as it helps determine the degree of countersinking which in turn is a factor in sizing.

3. This design requires a downstream weir. The weir can be made from wood or from boulders. A design diagram for boulder weirs and considerations for all weirs is given in the Road/Stream Crossing Restoration Guide (p. 51). The weir should back water up into the culvert eight inches. The top of the weir should be eight inches greater in elevation than the invert of the culvert. The total drop associated with a weir should be less than six inches for a log weir and less than one foot for a rock/boulder weir. A description of the weir(s) to be installed should be included in the written plan.

4. For installation, the culvert must be placed at or less than 0.5 %. Because of settling concerns we strongly recommend that the culvert be placed flat 0%. It is important to use a level or comparable device to insure that the bed that the culvert is placed on is indeed flat. The bed should also be stable and the under bed and haunches be compacted to prevent settling.

Steps for the Streambed Simulation using sinking and embedding option

1. Get required information about the stream at and near the location of the stream crossing (p. 34-37 Road/stream crossing guide). Of key interest for this design is if the stream is moderate gradient about 1.5-8%. If the stream width at normal high water is greater than about 15 feet, a bridge may be a better option. The cost of a large diameter culvert may approach that of a bridge. The valley fill material should be ~~is~~ of adequate depth.

2. Design Assumptions:

- Valley fill depth is deep enough sinking the culvert into streambed.
- Culvert will be sunk into streambed minimum 20% of culvert rise or 18 inches (whichever is greater) for pipe-arch culverts and minimum 40% of the diameter or two feet (whichever is greater) for round culverts. For box shaped culverts the pipe-arch minimums apply.

- Overall stream gradient is less than 8%.

3 Pick a culvert whose span or diameter matches the stream channels active channel width (see p. 36-37 on how to determine widths). Note the culvert cross-sectional area, given in table 6, page 59.

4. Determine countersink depth.

Criteria

a. circular culverts the greater of: 0.4 times diameter, or 2 feet.
b. pipe-arch culverts the greater of 0.2 times rise, or 18 inches.
c. Box culverts the greater of 0.2 times width or 18 inches.

<u>For channel slopes 0 to <=4%:</u>

Countersink as per criteria 4a, 4b or 4c. Outlet and inlet inverts are sunk to the same depth.

<u>For channel slopes 4 to <=8%:</u>

1. Start at culvert outlet, countersink as per criteria 4a or 4b. Determine outlet invert elevation relative to some datum.

2. Determine depth to countersink at inlet
   Elevation inlet invert=(culvert length) * [(channel slope-1.5%)/100] + elevation outlet invert. Note use the inlet countersunk values for calculations in step 5.

5. Calculate "effective cross sectional area" (ECSA) and the flow capacity of the culvert

ECSA= [(Culvert cross-sectional area for chosen culvert (step 3)] * [1-(percent loss in cross sectional area/100)]

Note: The loss in cross-sectional area is determined using Table 7 on page 61. The cross-sectional area for given culvert sizes can be found in Table 6 (p. 59) or by using equations for cross-sectional area on page 60.

Flow capacity is then determined by comparing the cross-sectional area determined with the corresponding max flow in culvert on Table 6. For instance an 84 inch round culvert has a cross-sectional area of 38.5 ft^2 and a maximum flow 262 cfs. To determine the flow of odd sizes simply interpolate between the given cross-sectional areas.

6. Check culvert size to make sure it passes the 50 year flow:

a. Determine the watershed size in square miles (p. 58)

b. Multiply the watershed size times the runoff factor from the runoff map (p. 56-57) to get the streamflow expected . Note a large scale version for the runoff map for western Oregon can be obtained from ODF state or local field offices.
c. Check to see that the effective cross-sectional area found in step 5 and its flow capacity is equal to or greater than the 50 year peak flow determined in 6b.

7. If the flow capacity of the culvert is less than the 50 year event up-size the culvert and redo steps 4-6.