Section 10

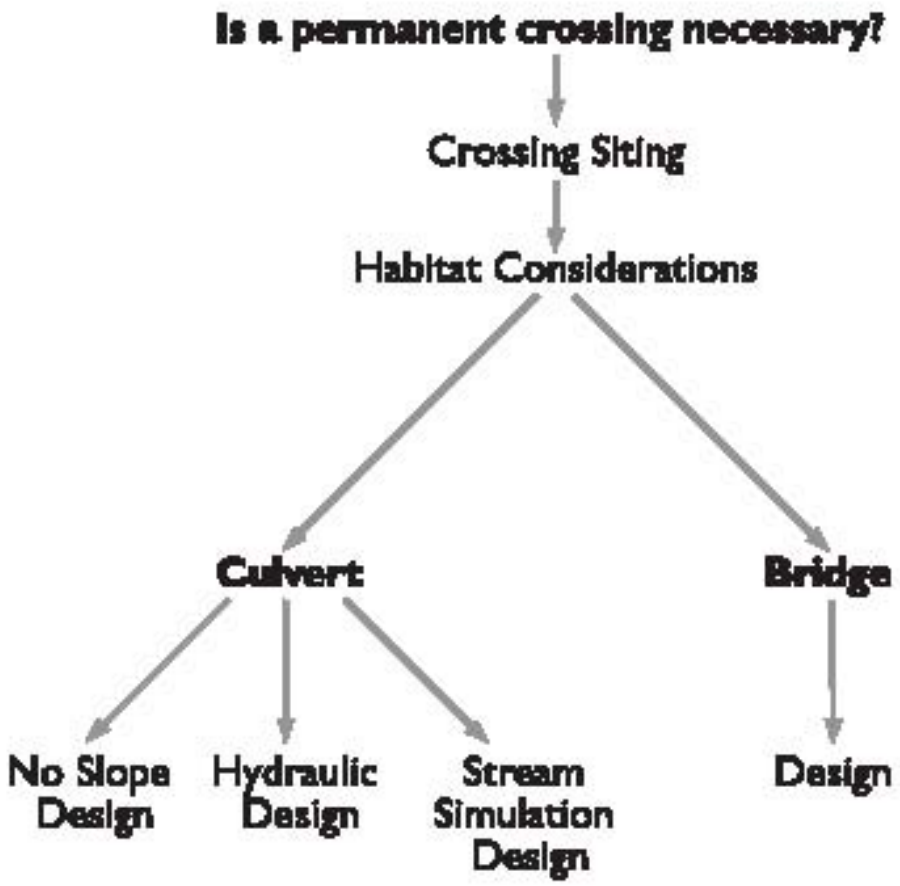
Fish Passage

Fish Passage Criteria

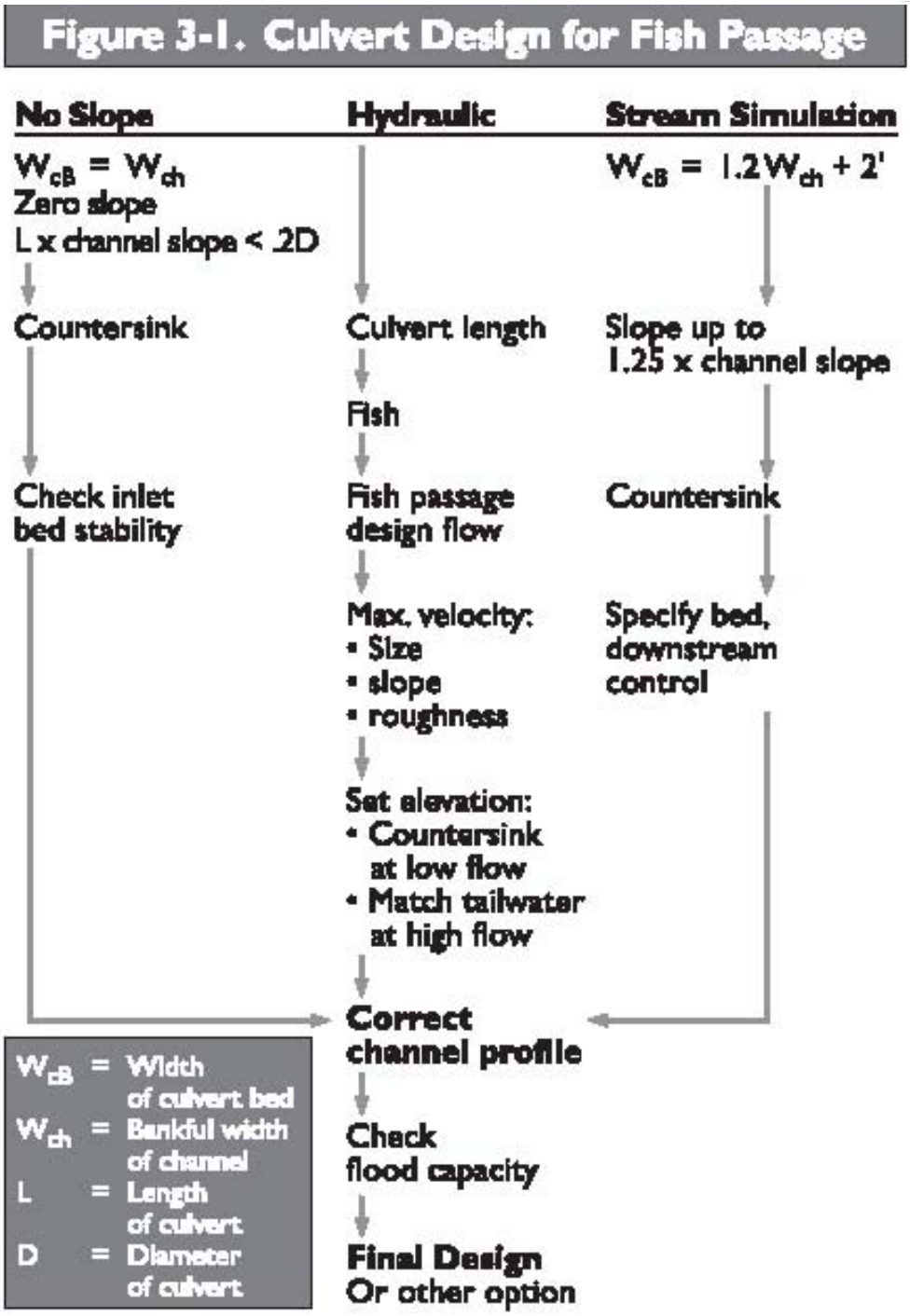
Design of Road Culverts for Fish Passage

2003

Figure 1-1. Road Crossing Design Process



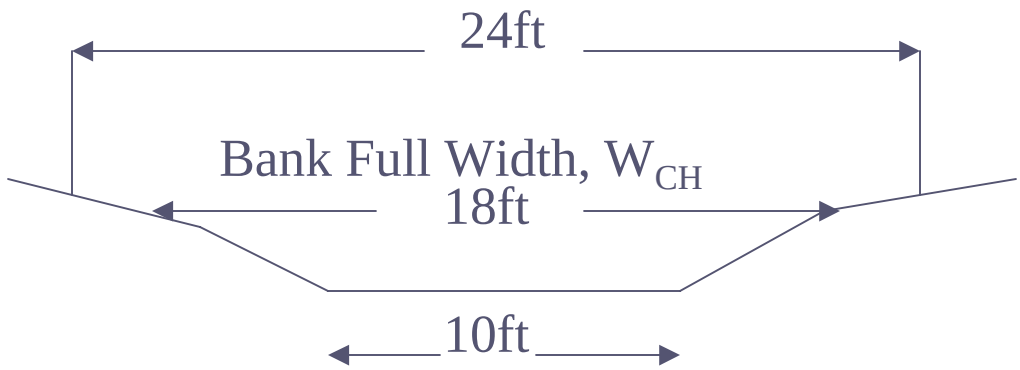
A generalized approach to selecting road-crossing options.



A general flow chart of the culvert design process.

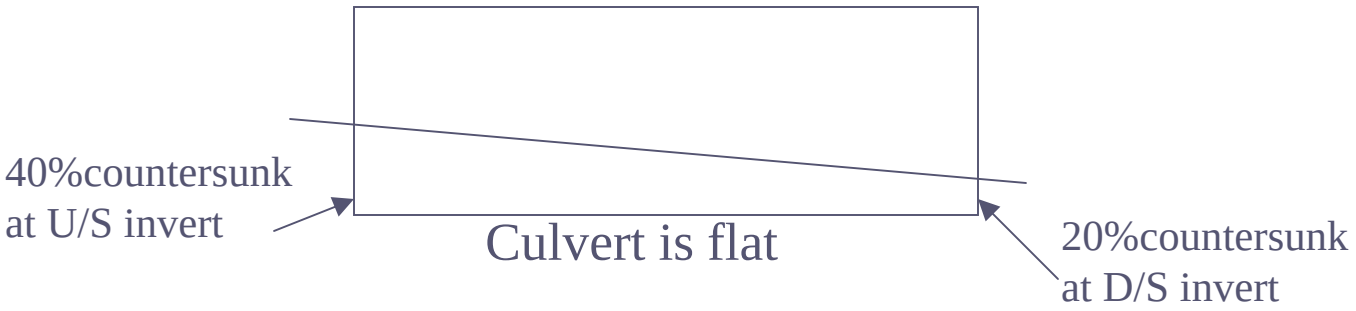
Fish Passage Criteria

Stream Simulation



Wculv bed = 1.2 Wchan bed + 2
= 1.2(18) +2
= 23.6 use 24ft span

Zero Slope



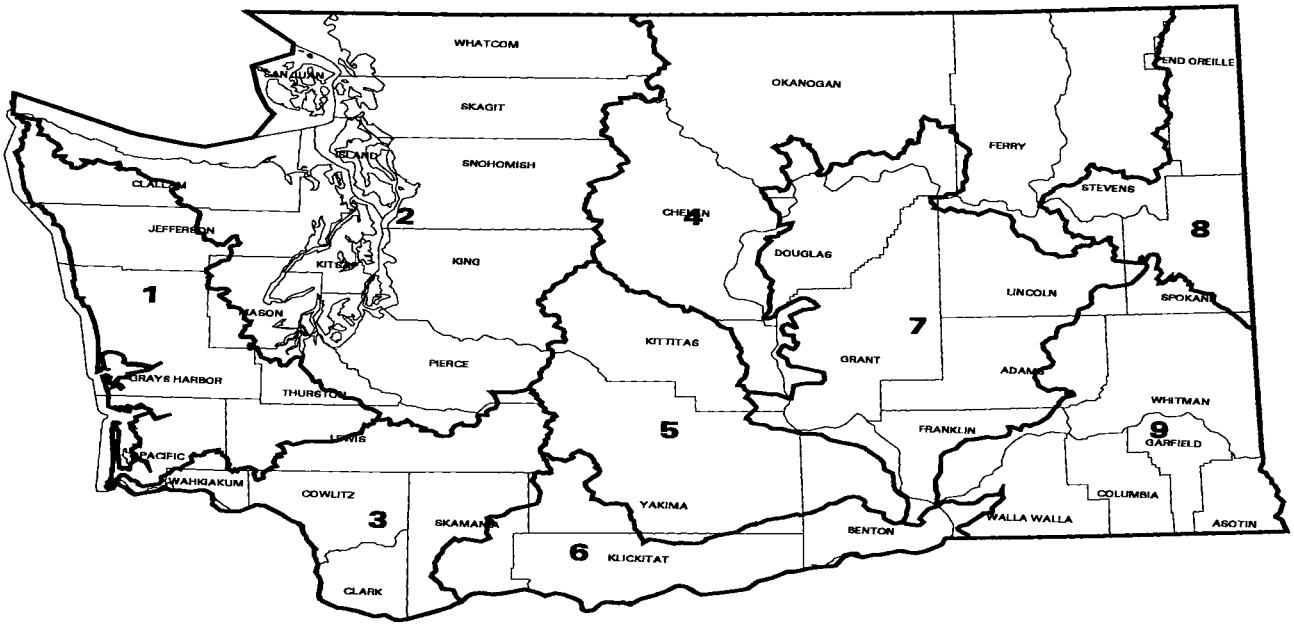
Wculv bed = Wchan bed

Fish Passage Criteria

Region	Elevation	Land Use	Season	Equation
1	< 1000’ < 1000’	Rural Rural	Winter Spring	$Q_{fp} = 6.99\ A^{0.95}\ I^{1.01}$ $Q_{fp} = 2.25\ A^{0.85}\ I^{0.95}$
2	< 1000’ < 1000’ > 1000’ > 1000’ < 1000’ < 1000’	Rural Rural Rural Rural Urban Urban	Winter Spring Winter Spring Winter Spring	$Q_{fp} = 0.125\ A^{0.93}\ P^{1.15}$ $Q_{fp} = 0.001\ A^{1.09}\ P^{2.07}$ $Q_{fp} = 141\ A^{0.72}$ $Q_{fp} = 3.25\ A^{0.76}\ P^{0.48}$ $Q_{fp} = 0.052\ A^{0.96}\ P^{1.28}$ $Q_{fp} = 0.003\ A^{1.10}\ P^{1.60}$
3	< 1000’ < 1000’ > 1000’ > 1000’	Rural Rural Rural Rural	Winter Spring Winter Spring	$Q_{fp} = 0.67\ A^{0.95}\ P^{0.82}$ $Q_{fp} = 0.014\ A^{0.87}\ P^{1.42}$ $Q_{fp} = 0.278\ A^{1.41}\ P^{0.55}$ $Q_{fp} = 3.478\ A^{0.85}\ P^{0.38}$
4 - 9	All	Both	Both	New Equations ***Region 4-9 have changed***

A = area in square miles

I = 2yr 24hour P= Mean Annual Precipitation



Fish Passage Criteria

Table 7. Regression equations for estimating fish passage design flows at ungaged streams in eastern Washington

[Q, fish passage design flow, in cubic feet per second; A, total drainage area, in square miles; P, mean annual precipitation, in inches; a, regression constant; b and c, regression coefficients; –, regression coefficient not determined]

Region	Number of stations used in analysis	Regression equation	Constant a	Coefficients b	Coefficients c	Standard error of estimate, log 10	Standard error of estimate, percent
1	59	$Q = aA^bP^c$	0.0178	0.900	1.68	.319	84
2	18	$Q = aA^b$	9.45	.836	–	.353	97
3	23	$Q = aA^bP^c$	1.64	.657	.799	.195	47
4	15	$Q = aA^b$	5.97	.589	--	.391	112
5	19	$Q = aA^b$	4.89	.690	--	.362	100
6	33	$Q = aA^bP^c$	.772	.764	.663	.179	43

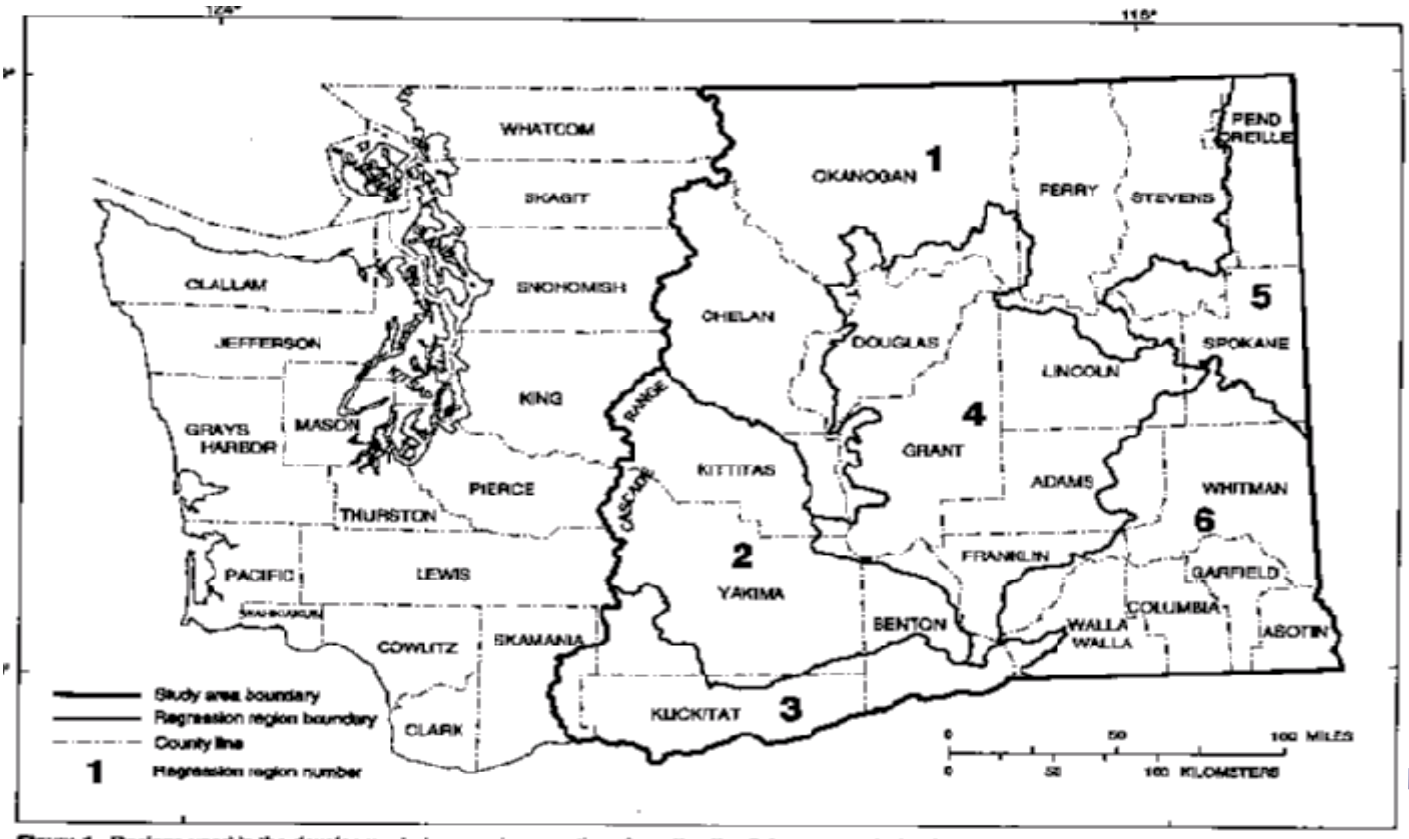
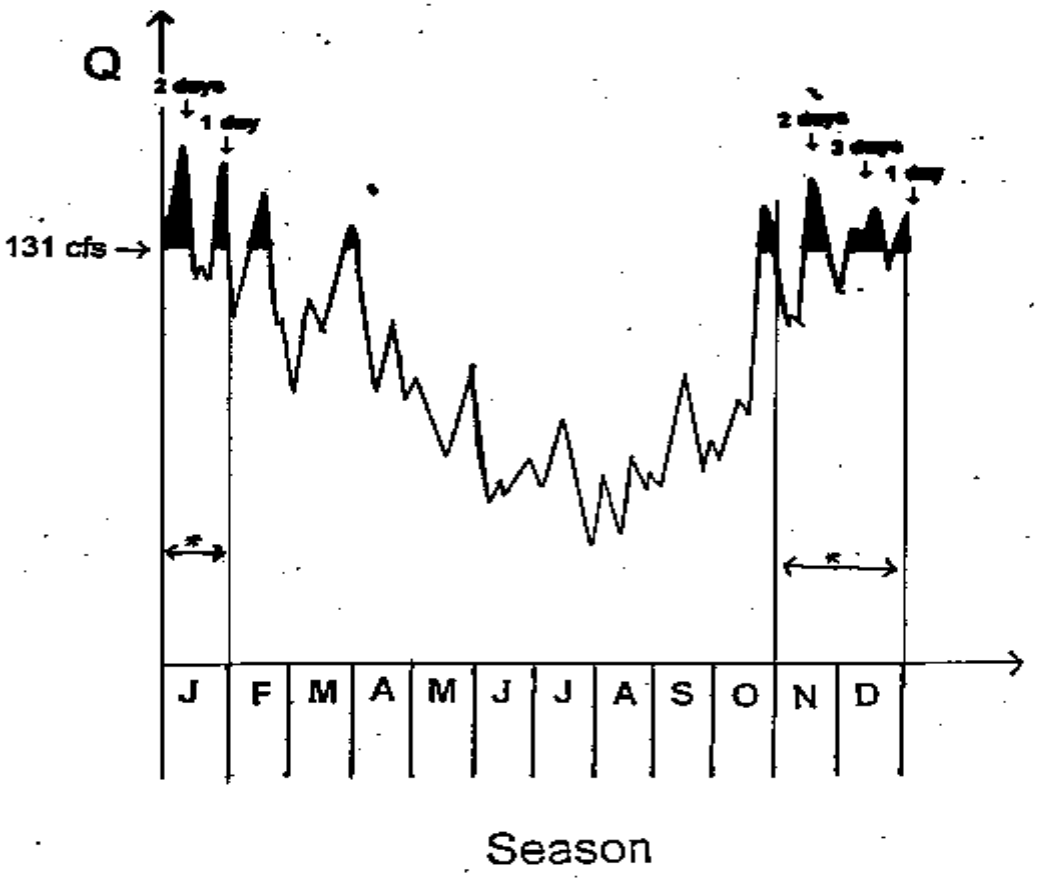


Figure 1. Regions used in the development of regression equations for estimating fish passage design flows at ungaged streams in eastern Washington

Fish Passage Criteria

10% Exceedance Flow



* A 131 cfs flow occurred 9 days total during the 90 days of an average winter migration period (November - January), therefore:

131 cfs = $Q_{10\%}$ Exceedance

II-3

Fish Passage Criteria

Allowable Culvert Flow Velocities to Provide Fish Passage

Culvert Length in meters (feet)	Resident Trout	Pink Salmon Chum Salmon	Chinook Salmon Coho Salmon Sockeye Salmon Steelhead Trout
< 20 (< 60)	1.2 $^{m}/_{s}$ (4.0 $^{ft}/_{s}$)	1.5 $^{m}/_{s}$ (5.0 $^{ft}/_{s}$)	1.8 $^{m}/_{s}$ (6.0 $^{ft}/_{s}$)
20 to 30 (60 to 100)	1.2 $^{m}/_{s}$ (4.0 $^{ft}/_{s}$)	1.2 $^{m}/_{s}$ (4.0 $^{ft}/_{s}$)	1.5 $^{m}/_{s}$ (5.0 $^{ft}/_{s}$)
30 to 60 (100 to 200)	0.9 $^{m}/_{s}$ (3.0 $^{ft}/_{s}$)	0.9 $^{m}/_{s}$ (3.0 $^{ft}/_{s}$)	1.2 $^{m}/_{s}$ (4.0 $^{ft}/_{s}$)
> 60 (> 200)	0.6 $^{m}/_{s}$ (2.0 $^{ft}/_{s}$)	0.6 $^{m}/_{s}$ (2.0 $^{ft}/_{s}$)	0.9 $^{m}/_{s}$ (3.0 $^{ft}/_{s}$)

- Maximum velocities listed in chart shall occur during the 10% exceedence flow. Therefore Q10% = Qfp
- Full culvert must be placed with invert below natural channel by a depth to 20%-50% of the rise of the culvert.
- Full culverts must provide a flow depth of 1ft during the 2year 7 day low flow.
- Bottomless culvert should span the natural channel when practical, Stream Simulation option

Fish Passage Criteria

Culvert Design Flows

Circular, Box, Pipe Arches

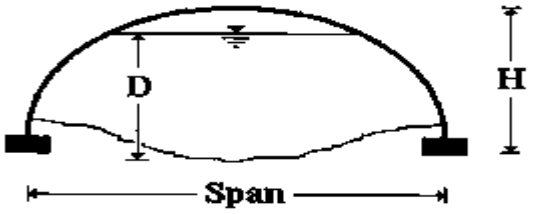
Q_{25} : HW/D $\leq$ 1.25

Q_{100} : No Roadway Overtopping

$Q_{10\%}$: Allowable Velocity (If Required)

Bottomless Arches

Q_{25} : 1' Debris Clearance

Q_{100} : D $\leq$ H

$Q_{10\%}$: Allowable Velocity (If Required)