10. UPSTREAM JUVENILE FISH PASSAGE

10.1 Introduction – Upstream Juvenile Fish Passage

Upstream juvenile fish passage is necessary at some passage sites, where inadequate conditions exist downstream for rearing fish. In a ladder that uses only a portion of the river flow for *upstream fish passage*, juvenile passage may require special and separate provisions from those designed to optimize adult passage. However, adult fish passage should never be compromised to accommodate juvenile passage.

Criteria are specific standards for fishway design, maintenance, or operation that cannot be changed without a written waiver from NMFS. For the purposes of this document, a criterion is preceded by the word "must." In general, a specific criterion can not be changed unless there is site-specific biological rationale for doing so. An example of biological rationale that could lead to criterion waiver is a determination or confirmation by NMFS biologists that the smallest fry-sized fish will likely not be present at a proposed screen site. Therefore, the juvenile fish screen approach velocity criterion of 0.4 ft/s could be increased to match the smallest life stage expected at the screen site. A guideline is a range of values or a specific value for fishway design, maintenance or operation that may change when site-specific conditions are factored into the conceptual fishway design. For the purposes of this document guidelines are preceded by the word "should." Guidelines should be followed in the fishway design until site-specific information indicates that a different value would provide better fish passage conditions or solve site-specific issues. An example of site-specific rationale that could lead to a modified guideline is when the maximum river depth at a site is 3 feet, as compared to the design guideline for a fishway entrance depth of 6 feet. In this example, safe and timely fish passage could be provided by modifying the guideline to match the depth in the river. It is the responsibility of the applicant to provide compelling evidence in support of any proposed waiver of criteria or modification of a guideline for NMFS approval early in the design process, well in advance of a proposed Federal action. After a decision to provide passage at a particular site has been made, the following design criteria and guidelines are applicable, in addition to those described throughout Section 3.

10.2 Design – Upstream Juvenile Fish Passage

As discussed in Section 4.2, it is recommended that a 1.0 to 1.5 foot *hydraulic drop* from entrance pool to *tailwater* is used for *fishway* entrance design. Attraction of adult salmonids to a *fishway* entrance is compromised with decreased head drop at a *fishway* entrance, unless all of the streamflow is passed through the entrance. *Fishway* attraction (i.e., fishes' ability to locate the *fishway* entrance downstream of the dam) is the critical design parameter for an *upstream passage facility*. Previously, many of the *fishway* entrances on the Columbia River operated with 0.5 foot of *hydraulic drop* (measured from the entrance pool water surface to *tailwater* surface). After extensive laboratory and field studies, it was conclusively determined that higher velocities, which directly relate to the amount of *hydraulic drop* through the entrance, provide better attraction of adult salmonids than did lower velocities. This determination resulted in making hydraulic adjustments to *fishway* entrances so that they operated with 1.0 to 1.5 feet of *hydraulic drop*, instead of 0.5 feet. Subsequent radio telemetry studies verified that passage

times decreased as a result. Thus, there is a clear basis for designing entrance pool to *tailwater* differentials between 1.0 to 1.5 feet for adult salmonid passage.

Within the Northwest Region of NMFS (which includes the states of Washington, Oregon, and Idaho), there are varying requirements for juvenile passage. NMFS will consider the appropriate design requirements as applicable. Lower required *hydraulic drop* between pools is not going to provide an obstacle to adult fish, provided that the facility satisfies entrance design requirements of Section 4.2. When juvenile fish passage is required, the *fishway* should meet the guidelines listed in Table 10-1. However, the *fishway* entrance must operate per the guidelines and criteria listed in Section 4.4 when adult salmonids are present.

10.2.1 General Criteria and Guidelines – Upstream Juvenile Passage

Given the reported swimming speeds for juvenile coho salmon and observed leaping capabilities, submerged ports or pipes should be avoided when designing passage facilities for juvenile fish, except for inlet and outlet conditions. *Fishway*s should be designed as pool and chute or roughened channel, with drops not to exceed the criteria listed in Table 10.1. In addition to the *hydraulic drop*, calm water in the pools and a low velocity just upstream of the *weir* crest is important. *Weir*s should be designed as sharp crested, where the head over the *weir* is two times the breadth.

Table 10-1. Juvenile Upstream Fish Passage Guidelines

Upstream Juvenile Fish Passage Guidelines			
Fish Size (mm)	Maximum hydraulic drop over fishway weir (ft)	Maximum hydraulic drop at fishway entrance and exit (ft)	Velocity for swimming distances less than 1 foot, (ft/s)
45 to 65	0.7	0.13	1.5 to 2.5
80 to 100	1	0.33	3 to 4.5

Powers (1993) indicated that pool volume criteria such as described in Section 4.5.3.5 are critical to ensuring appropriate passage conditions. The pool volume criteria described in Section 4.5.3.5 defines a maximum turbulence threshold based on energy dissipation within the volume of a fishway pool. If this threshold is exceeded, a turbulent barrier to adult fish may be created. For optimal juvenile fish passage, this pool volume should be doubled.

Hydraulic design for juvenile upstream passage should be based on representative flows in which juveniles typically migrate. Recent research indicates that providing for juvenile salmon passage up to the 10% annual exceedence flow may cover the majority of flows in which juveniles have been observed moving upstream.

In some situations, it may be feasible to operate a ladder entrance with a decreased *hydraulic drop* at times when adult salmon are not present and at 1 to 1.5 feet during the adult salmon upstream migration. The feasibility of doing this often entails making a judgment call on the timing of adult passage when often little or no information is available, and if it is available, it may change from year to year. In other situations, it may be appropriate to provide multiple *fishway* entrances that operate independently, according to the desired *hydraulic drop*. One

entrance may operate to attract adult fish and convey the appropriate volume shape of attraction jet and velocities and another entrance may operate at a lower differential and convey flow over a *weir*.