EXHIBIT F3

FISH PASSAGE ENHANCEMENT

Description: Fish migration is a natural life cycle function found in most species. The migration is necessary for the fish to spawn, feed, grow and seek refuge from predators. Many streams and rivers have both natural and manmade barriers that prohibit natural migration. Natural barriers can include waterfalls, large rapids and shallow flows. Manmade barriers can include water diversion structures, dams, and some types of culverts. All barriers can lend to habitat fragmentation and limit natural migration patterns.

Fish passage design is often an important component in stream restoration efforts. Fish passage may be run-of-the-river where a steep drop or barricade is replaced by a series of small steps, or fish passage may require a separate by-pass around barriers. Most fish passage structures enable fish to circumvent barriers by swimming and/or leaping up a series of relatively low steps. The velocity of water at the downstream end of the structures needs to be high enough to attract the fish but not so high that the fish cannot navigate the structure. Also, the velocity throughout the structure needs to vary, allowing for resting locations before the fish makes the consecutive leaps / swims upstream.

Fish passage structures and designs vary depending upon the species, river system and ultimate goals of the restoration project. In Grand County streams, opportunities for fish passage enhancement are generally at irrigation diversion structures and Windy Gap. At irrigation headgates, it is not uncommon for diverters, under low flow conditions, to regraded the channel bottom to improve diversions. The regrading efforts not only disturb the aquatic habitat in the immediate vicinity of the headgate, but often creates fish passage impediments especially when done under low flow conditions. One possible restoration opportunity would be to reconstruct and lower the headgates, possibly in combination with a grade control structure, to improve diversions.

Another opportunity for improving fish passage in Grand County is to create a by-pass around Windy Gap. This by-pass would be relatively large in capacity and provide not only a connectivity with the upstream reaches but also reduces or eliminates reservoir storage, thus eliminating contact with high nutrient loading and temperatures typical of todays conditions at Windy Gap. This concept will require extensive consideration and evaluation of the pump intake design, channel design, property issues etc.

Lastly, with in the study area there are several permanent diversion structures that result in barriers to fish movement. These could be addressed with by-pass channels design specifically for fish passage, or alternatively reconstructed as a stepped structure with each step being negotiable by the species of concern. Two examples in Grand County, both on the Fraser River include the diversion structure for municipal water intake at Granby, immediately downstream of U.S. Highway 40; and the concrete drop at the NCWCD gaging station immediately upstream of Windy Gap and the Colorado River confluence.

Details and design procedures for fish passage enhancement can be found in "*Technical Note 14-N: Fish Passage and Screening Designs"* from the Natural Resources Conservations Services (NRCS) Stream Restoration Design Handbook, 2005. Several photos of examples follow.

Applicability: Fish passage structures are applicable in locations where the difference in elevation created by the barrier can be overcome in a practical manner. The structures are best suited where alterations to the stream do not cause adverse impacts to the overall stream health (i.e. disruption to geomorphology, increase in flood elevations, etc).

Pros and Cons:

1. Pros of fish passage structures:
    a. Aquatic habitat becomes less fragmented as historic habitat becomes accessible
    b. Provides more natural life cycle patterns for the fish species
    c. Can be constructed to coincide with the existing barrier
2. Cons of fish passage structures:
    a. Construction can be labor intensive and can be expensive

Fish passage structure with sorting facility (under construction)

Fish by-pass channel (stepped)

Low flow stepped boulder fish passage structure

By-pass fish passage at culvert