APPENDIX D

REVISED BASE-FLOW RECOMMENDATIONS FOR THE YAMPA RIVER

U.S. Fish and Wildlife Service
Mountain-Prairie Region (6)
Denver, Colorado

Approved: _____
Regional Director, Region 6, U.S. Fish and Wildlife Service

Date: _____

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U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado

The following information is provided as the basis of flow recommendations for the Yampa River during the base-flow period (July-February). It formally supplements and amends previous flow recommendations of the U.S. Fish and Wildlife Service (Service) for the Yampa River (Modde and Smith 1995). The amended recommendations are intended to serve as the basis for instream flow augmentation from July through February as outlined in *A Management Plan for Endangered Fishes in the Yampa River Basin* (Roehm 2003).

Background

The Service first attempted to develop flow recommendations for the Yampa River in 1989 (Tyus and Karp 1989), in which the authors identified the life history and general habitat needs of the Colorado squawfish (now commonly known as the Colorado pikeminnow), humpback chub, razorback sucker and the bonytail. The report made some general observations about flows that appeared to be beneficial to the endangered fish based on historical hydrologic conditions. Although the report did not provide any discrete flow recommendations for the Yampa River, it identified a need to maintain both inter- and intra-annual variability typical of historical hydrographs. Flow recommendations were to be developed separately in a stand-alone document.

After completion and acceptance of this report, the Service released what was known as Phase II flow recommendations for the Yampa River on November 9, 1989. The Phase II report relied upon the biological information from Tyus and Karp (1989) and took into consideration water-project depletions backcast over historical monthly hydrologic records for the Yampa River to develop monthly flow recommendations at Deerlodge Park. The Phase II flow recommendations proved to be too general, and because they were based on flows at Deerlodge Park, they did not correlate with flows at the Maybell gage, which historically has been used for stream-flow accounting.

Modde and Smith (1995) developed flow recommendations for the Yampa river that updated interim recommendations for the Yampa River, which were promulgated by the Service in 1990 based on a review of biological data on endangered fishes developed by Tyus and Karp (1990). The approach used by Modde and Smith (1995) was selected following the failure of an Instream Flow Incremental Methodology (IFIM) Physical Habitat Simulation (PHABSIM) to demonstrate predicative cause-and-effect relationships between instream flows and distribution of endangered fishes in the Green River Basin (Rose and Hann 1989). Flows recommended in the Modde and Smith 1995 report relied heavily on biological information presented by Tyus and Karp (1989), but also included information generated by endangered fish monitoring activities carried out by the Upper Colorado River Endangered Fish Recovery Program; an instream flow report by Dr. Jack Stanford (Stanford 1993); a comparison by The Nature Conservancy of estimated historic and undepleted Yampa River flows at Maybell (O'Brien 1987); and generally accepted, published ecological principles.

The primary goal of the Modde and Smith 1995 report was to maintain a relatively natural hydrograph. High spring flows were identified as necessary to support biological processes, with relatively stable base flows to support fish through the late summer, fall and winter based upon natural variability (Table 1).

Table 1. Monthly base-flow targets (cfs) based on 80% exceedance of estimated undepleted daily flows[1] of the Yampa River at Maybell, Colorado (Modde and Smith 1995).

NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
172	157	187	221	305	1150	4153	3326	175	125	45	88

[1] Hydrosphere 1995

In their report entitled *Determination of Habitat Availability, Habitat Use, and Flow Needs of Four Endangered Fish in the Yampa River Between August and October*, Modde et al. (1999) took a new approach to estimate instream flow needs of the endangered fishes in the Yampa River during the base-flow period. After testing several approaches, the authors selected a curve-break analysis to estimate base-flow targets for the Yampa River. This approach simulated habitat availability at several different base-flow levels to identify available amounts of three different meso-habitats— riffles, runs and pools— as a function of discharge. Riffles are considered to be most sensitive to changes in stream flow. They also contribute significantly to the production of macroinvertebrates that serve as the basis of a food web for the endangered fishes. Therefore, habitat data from riffle transects were used in this analysis. The curve break was determined by plotting the availability of several important habitat parameters, such as depth, velocity and wetted perimeter (y-axis) against stream flow (x-axis) for each transect; calculating a linear regression of these data; and determining at what flow a residual (difference) between the curve and regression line was greatest. Using this methodology, an average curve break of all riffle transects, 93 cubic feet per second (cfs), was determined to be the target base flow for the Yampa River from August through October. The study concluded that flows of 93 cfs or greater would be sufficient to maintain instream riffle habitats critical for production of prey organisms for the endangered fishes during this period. However, the study also concluded that flows of this magnitude need only be achieved at their historical frequencies and durations. In other words, Yampa River flows had fallen below 93 cfs in the past and may do so in the future, as long as they do not fall below 93 cfs more frequently or for longer periods than had occurred in the past under otherwise similar hydrologic conditions (Modde et al. 1999).

Base-flow Recommendation

By adopting the Modde et al. (1999) August through October base-flow target of 93 cfs in an historical context, the Service has, in effect, modified its 1995 recommendations (Modde and Smith 1995; Table 1). Moreover, gage data indicate that Yampa River flows at Maybell occasionally have fallen below 93 cfs in July, as well as from November through February. Therefore, for the purpose of developing a base-flow augmentation strategy, the Service extended the base-flow period to include July through February. However, the Service recognizes that winter flow needs of the endangered fishes are not as clearly understood and, given these uncertainties, cannot justify extending the 93-cfs flow target beyond October. Nor can the Service reaffirm its 1995 winter flow recommendations based exclusively on statistical analyses of historical data, without

any biological nexus. Therefore, as a contingency against these uncertainties, Service biologists and hydrologists recommended that a 33 percent buffer be added to the 93-cfs flow target (93 + 31 = 124 cfs) to meet the needs of the endangered fishes from November through February (Table 2). At Maybell, minimum flows of this magnitude or less occurred historically during the winter about 1 in 6 years. Modeling based on projections of future water development and a proposed base-flow augmentation protocol (Roehm 2003) indicates that instream flow augmentation would be needed, to some extent, to satisfy a 124-cfs winter flow target in an historical context an average of about 1 in 7 years, whereas some augmentation would be needed from July through August to satisfy the 93-cfs flow target an average of 1 in 2 years.

Table 2. Revised base-flow targets[1] (cfs) for the Yampa River at Maybell, Colorado

NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
124	124	124	124	No flow recommendation				93	93	93	93
Fall-winter base-flow period				Spring Runoff Period				Per Modde et al. 1999			

[1] Based on historical frequency, magnitude and duration. There are no specific numerical flow recommendations during spring peak-flow months (March-June).

Implementation Guidelines

The Service also recognizes that the proposed augmentation protocol and estimated volume of augmentation water supply (up to 7,000 acre-feet (AF) as needed according to the protocol) will not completely satisfy these flow recommendations in the driest 10 percent of years. In these years, 7,000 AF of augmentation will only partially satisfy base-flow needs. Based on the proposed augmentation rate of 50 cfs, a 7,000-AF augmentation pool would be exhausted in only 2 months. In such situations, it may be prudent to reduce the augmentation rate and extend the duration of augmentation. For example, reducing the rate to 25 cfs would allow augmentation to continue for 4 months. The Service's hydrologist will work cooperatively with the Upper Colorado River Endangered Fish Recovery Program (Program); reservoir operators; the Colorado Water Conservation Board; and Colorado State Engineer to make the best possible use of this limited resource. Other adjustments may be made in the augmentation protocol as deemed necessary and appropriate by the Service and the Program, in consultation with reservoir operators and the State of Colorado.

REFERENCES

Hydrosphere Resource Consultants, Inc. 1995. Yampa River Basin recommended alternative, detailed feasibility study: final report. Boulder.

Modde, T. and G. Smith . 1995. Flow recommendations for endangered fish in the Yampa River Final report of the U.S. Fish and Wildlife Service to the Upper Colorado River Endangered Fish Program. Denver.

Modde, T., W. J. Miller, and R. Anderson. 1999. Determination of habitat availability, habitat use, and flow needs of endangered fishes in the Yampa River between August and October. Final Report to Upper Colorado River Endangered Fish Recovery Program. Denver.

O'Brien, J. S. 1987. Analysis of minimum streamflow and sediment transport in the Yampa River, Dinosaur National Monument. (submitted to The Nature Conservancy, Boulder, Colorado). Colorado State University. Fort Collins.

Roehm, G. W. 2003. A management plan for endangered fishes in the Yampa River Basin and environmental assessment. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6). Denver.

Rose, K. L. and D. R. Hann. 1989. Summary of historic habitat modeling on the Yampa River using the physical habitat simulation system: final report. U.S. Fish and Wildlife Service. Grand Junction.

Stanford, J. A. 1993. Instream flows to assist the recovery of endangered fishes of the Upper Colorado River Basin: review and synthesis of ecological information, issues, methods and rationale. Report for the Instream Flow Subcommittee of the Recovery Implementation Program. Denver.

Tyus, H.M. and C.A. Karp. 1989. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. U.S. Fish and Wildlife Service. Vernal, Utah.

Tyus, H. M. and C. A. Karp. 1990. Spawning and movements of razorback sucker, *Xyrauchen texanus*, in the Green River Basin of Colorado and Utah. The Southwestern Naturalist 35(4):427-433.