Preliminary Review of the Eagle River Drop Structures

Prepared For: Eagle County Engineering
Prepared By: Recreation, Engineering and Planning, Boulder, Colorado

Introduction:

An initial site visit, funded by Eagle County, was conducted by Recreation, Engineering and Planning (REP) to serve as a preliminary review of the Eagle River drop structures and Neilson Pipeline Ditch Diversion Structure. REP was contracted by Eagle County to evaluate the site and provide recommendations regarding the possibility of repairing and improving the existing drop structures and performance of the Neilson Pipeline head-gate, while concurrently improving safety and navigability through the reach for recreational river users. River users in the area have repeatedly expressed concern to the County regarding the safety of the existing drop structure and commercial river users currently avoid the reach all together. The County has noted significant structural instability of the drop structures over the past few years and has obtained a design plan for replacement of the drop structures from Resource Engineering, Inc. In addition to the site visit REP has conducted a preliminary review of these plans.

Existing Condition:

The initial site visit to the Eagle River was conducted on July 20th, 2005. This visit involved a visual inspection and cursory review of the river corridor and its current use. The river's flow was 380 cubic feet per second (cfs) in Avon and at 550 cfs just below Gypsum. The reach of the Eagle River through the project area is not the historic channel, its course having been altered during the construction of Interstate-70.

Our general observations of the river bank and surrounding riparian corridor, as well as the accounts of recreational river users and those of Mr. Peter Sulmeisters, Eagle County Engineering, lead us to believe that the streambed has an unstable subsurface. The undercut cave on river left just below the scour hole indicates general instability of the Eagle River within the project area.

The Eagle River Drop Structure

Conceptual: Not for construction purposes.

Large boulders have been set in a loose fashion across the stream to raise the water surface elevation and deliver water to the head-gate. The weir creates a steep hydraulic across the majority of the river and produces a drop between 3'-4'. The boulders along the crest of the weir are placed at approximately the same elevation and the downstream face of the drop is steep, approaching vertical on the river left side. The channel widens just downstream of the weir and the wide flood plain covered with cottonwoods and small footpaths created by fishermen and other users of the area. Further downstream, the river constricts to form a set of rapids.

Design Review:
We have reviewed the drawings that were submitted to Eagle County by Resource Engineering and dated December 30, 2004. The proposed drop structures appear sufficient in order to improve the diversion capabilities at the head gate. Drawings show three structures, vortex weirs, each dropping approximately two feet. The crest of the first drop is raised 18" in order to consistently deliver water to the head-gate.

The slope of the downstream face of each drop structure is designed at nearly a 1:1. Each structure is anchored at a minimum of 5' deep into the streambed. The three drops are placed 50' apart in the channel. The current design calls for material to placed in the scour hole below the first drop to create a scour pad.

Recommendations:
Based on available information, the design of these structures may not be a solution to the goals of long term stability, low maintenance, and navigability concerns stated by Eagle County. Our initial review and based on past projects in similar settings, lead us to believe that the downstream angle of the face of each drop structure is too steep and would continue to be a hazard for downstream mobility and structural stability. The proposed stepped boulder pattern for each vortex weir may dissipate the energy of the water flowing over the structure at lower flows on the Eagle River however potentially hazardous hydraulics will likely form at higher flows.

Our design team feels that the Eagle County's goals of increased performance of the Nielson Pipeline, improved safety and navigability, and long term stability would be better addressed by the replacement of the three proposed vortex weirs with three to four "U" drop structures. "U" Drops or grade control structures are placed across the width of the channel, anchored into the banks and stream-bed. "U" drops are designed to have a "low flow" area, "high flow" area and stepped wing for flood flows and anchoring. These types of structures are built with a slope between 8:1-10:1 that provide concentrated flow, the creation of a wave-form and a self-scouring plunge pool away from the base of the structure to prevent erosion at the base. These types of structures are intended to be navigable for a wide variety of river craft, including drift boats, at a wide range of flows, while simultaneously providing "play-boating" and surfing opportunities at their base. "U" drops are designed to passable by fish species and provide critical aquatic habitat through the creation and maintenance of the plunge pools.

Typical "U" Drop Structure in the Yampa River, Steamboat Springs, Colorado.

We recommend the construction of a drop with a "low flow" width of between twenty and thirty feet for Eagle County to maintain diversion capabilities at the Neilson Pipeline Ditch Diversion Structure.

We do not propose to modify the crest elevations as seen on the drawings, but rather to use a longer stretch of river to return the river to grade. We suggest that the structures be no closer than eighty feet apart, in order to control the tail water behind each structure and to create larger velocity shelters along the banks.

We recommend the use of concrete grout in each "U" drop. Concrete grout improves structural stability and prevents the creation of large voids in the structure which over time create the potential for entrapment by recreational river users. Grout should be placed in a de-watered environment with the use of temporary coffer dams. Additionally, the coffer dams will ensure that the boulders are placed at the proper overall slope, configuration and with sufficient vertical anchoring into the streambed.

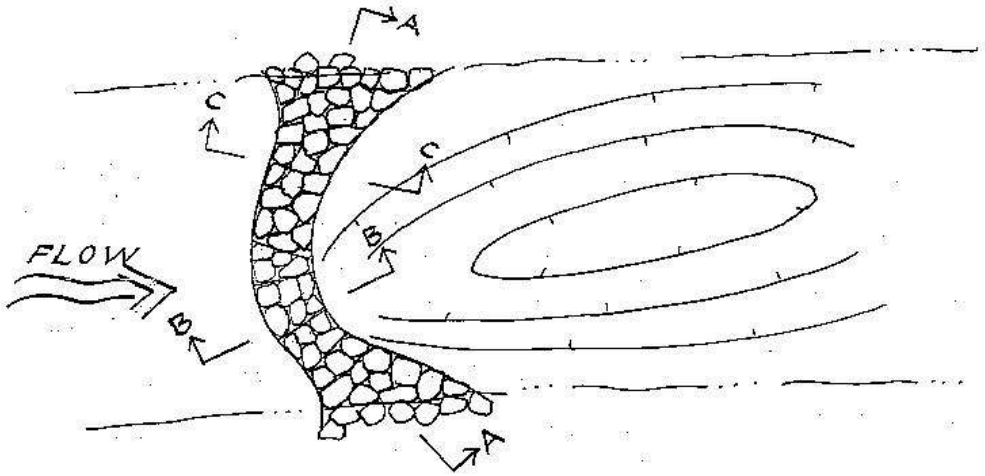
We concur with Resource Engineering that the scour hole must be filled. We recommend the placement of native material (2'-4' min. diatmeter) below each of the structures to act as a scour pad to prevent future undercutting and instability. Due to the likeliness of an unstable subsurface, we must anticipate erosion and address it in the initial in-stream construction period to improve long term stability and reduce the need for possible future heavy maintenance.

The recommendations noted above will potentially involve additional costs and quantities. The size and type of materials suggested for construction by the existing design would be suitable for our project, although the use of grout and additional dewatering measures may increase the overall costs of this alternative project. However,

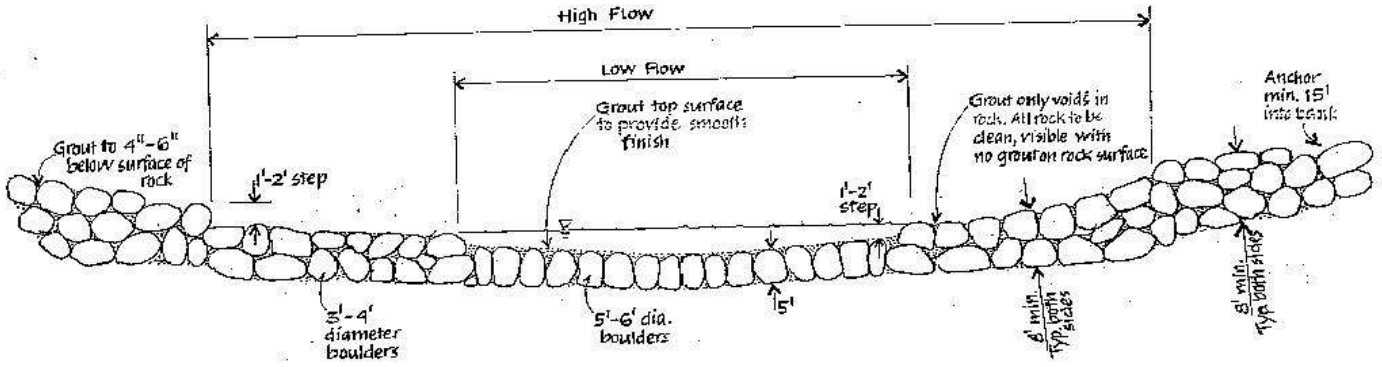
we feel that taking these precautions early in the project will lower the long term costs of addressing the instabilities mentioned above.

Attached are typical cross section and profile view of a “U” drop structure. The grout and temporary fills required to build coffer dams may require additional Army Corps of Engineering Section 404 permitting, and should be researched prior to construction of any in-stream enhancements.

A “U” Drop Structure was employed in order to raise the water surface elevation at this power plant on the Green River in Wyoming.

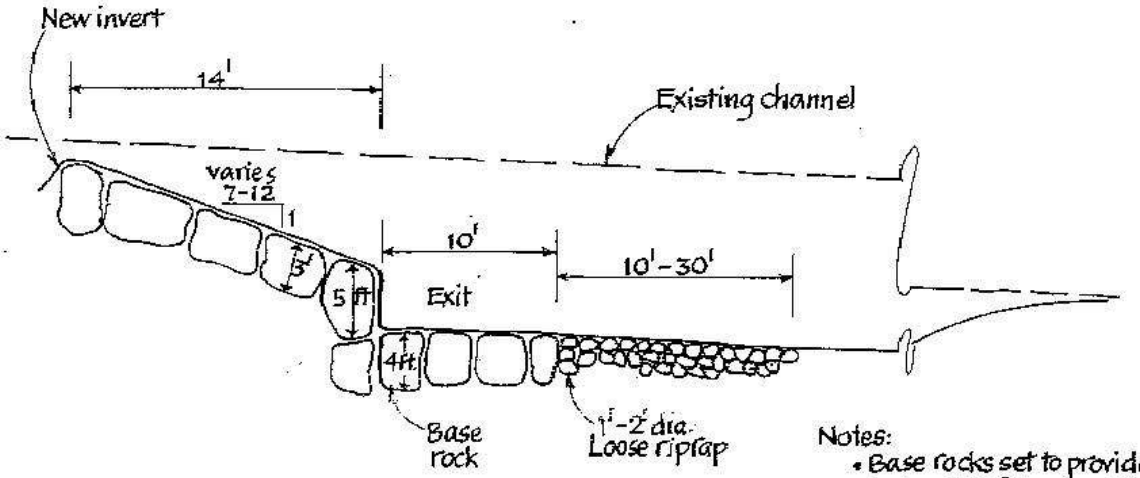


TYPICAL DROP STRUCTURE
NO SCALE



TYPICAL CROSS SECTION DROP STRUCTURE BANK TO BANK, A-A
Looking downstream - No scale

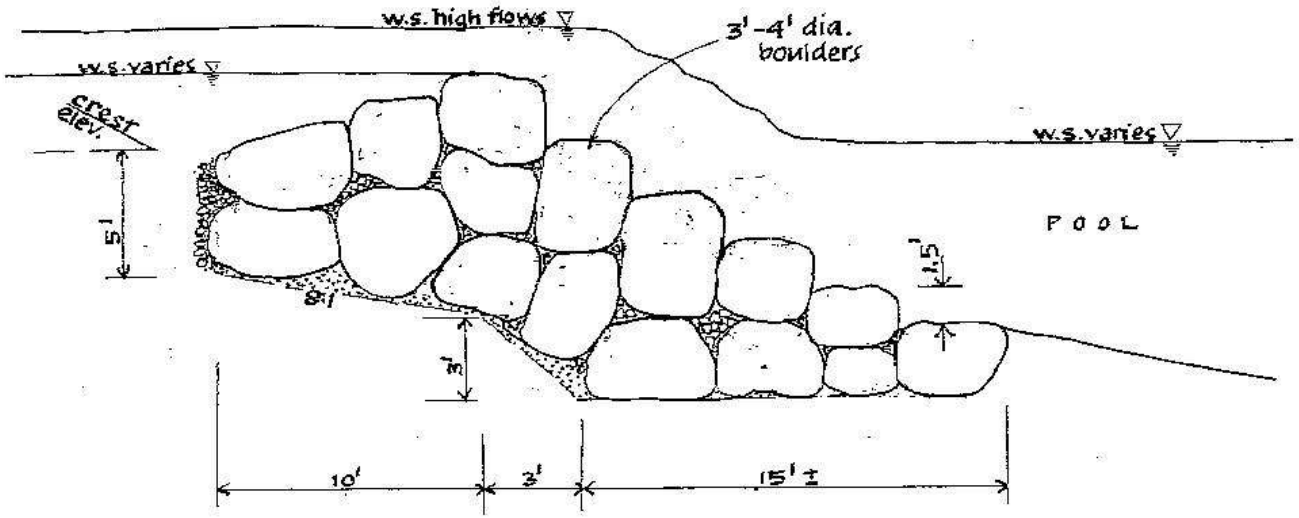
Conceptual: Not for construction purposes.



TYPICAL PROFILE VIEW OF DROP STRUCTURE FOR WHITEWATER WAVE, B-B

Notes:

- Base rocks set to provide scour reinforcement (i.e. scour depth = to depth of base rocks
- River is not impounded by drop structure. All drop is below existing channel invert.
- Total drop < 2 feet



TYPICAL SECTION OF ROCK BEYOND DROP STRUCTURE OPENING, C-C

NO SCALE