Upper Carson River Watershed
Stream Corridor Condition Assessment

Executive Summary

In September of 2002, the Sierra Nevada Alliance, on behalf of the Alpine Watershed Group, entered into an agreement with the State Water Resources Control Board to prepare a Stream Corridor Condition Assessment for the Upper Carson River Watershed. MACTEC Engineering and Consulting was selected by the Alpine Watershed Group and retained by the Sierra Nevada Alliance to prepare the assessment. MACTEC's project team included Swanson Hydrology and Geomorphology, River Run Consulting, and C. G. Celio & Sons. The purpose of the assessment is to provide information about the Upper Carson River watershed so that future planning, restoration, and improvement in resource management can occur in a reasoned manner.

Channel and Floodplain Morphology

A stream ecosystem is the product of a complex and interconnected set of physical processes acting throughout the watershed**,** modulated by the hydraulic and structural influence of vegetation and wood. To add to the complexity of the aquatic ecosystem, these processes are highly dynamic over time, responding to climatic variability and circumstance. Chapter Two of the assessment provides a detailed summary of watershed geomorphic processes. Geologic and hydrologic influences on the watershed are discussed, followed by a consideration of factors that influence erosion and sediment supply. Natural geomorphic dynamism is characterized in terms of resistance to change and resilience following disturbance. These principals are then applied to a discussion of Upper Carson River channels. Channel and floodplain morphology are reviewed using three channel types (transport, confined response, and unconfined response channels) as a basis of description. The affect of woody debris and beaver on channel and floodplain morphology is also summarized.

Field Data Collection

The collection of field data occurred during two separate field sessions. A preliminary survey was conducted throughout the Upper Carson River Assessment Area. Goals were to familiarize the assessment team with existing physical and biological conditions, develop a general understanding of impacts and restoration opportunities, and to define areas that would be reviewed during the second, detailed field phase. Given the size of the assessment area and the focus on restoration of channel form and function, a reach approach was used to characterize the stream corridor. The preliminary survey resulted in the identification of 32 reaches (15 along the West Fork, 10 along the East Fork, 3 along Wolf Creek, and 4 along Markleeville Creek). Based on the consideration of data collected during the preliminary study, nine reaches were selected for more detailed characterization. Also, four bridges were selected for limited hydraulic analysis.

Detailed Reach Characterization

The purpose of the detailed reach characterization was to collect key geomorphic, hydraulic, and vegetation data. This information was used to develop restoration alternatives and can be used to guide future restoration actions. Watershed analyses conducted in the detailed assessment fall into four categories: broad-scale watershed characteristics; historic information; existing detailed studies; and data collected as part of this study. The goal was to assess changes in hydraulic conditions that ultimately manifest themselves in changes to sediment conditions, bank stability, and overall geomorphic function. Collected geomorphic data included longitudinal profiles, cross sections, and pebble counts. Estimated bank full discharge was calculated, and substrate stability under bank full conditions was analyzed. Aquatic

habitat analysis included pool frequency and quality, habitat complexity, and substrate characteristics. Vegetation characterization made use of the cross section composition sampling method. This method was employed coincident with cross sections sampled during the fluvial geomorphic assessment. Community typing provides information regarding vertical and horizontal structure, plant species composition and potentially successional status. Within each type, the presence of weedy or unique species was noted, whether dominant or not. Limited hydraulic modeling was conducted at selected bridges along the stream corridor. The purpose of the hydraulic analysis was to determine stage/discharge relationships, hydraulic forces on the streambed and banks, and other relevant flow characteristics. Output from the hydraulic analysis was incorporated into the stream geomorphic analysis, which included assessing natural versus artificial plan form changes to the stream, changes in bed load transport, and floodplain disruptions.

Human Impacts on the Watershed

Using all sources of collected data, the assessment team reviewed human development in the watershed and its effects on geomorphic and ecosystem processes. Human impacts on the Upper Carson Watershed have been significant and some may extend into prehistoric times. Where possible, photo pairs were developed that depict an area at different points in time. These photo pairs illustrate the type and magnitude of impacts that have occurred in the watershed since the onset of Euro-American occupation. Stark evidence of our impacts on the watershed remains. For example, in the 1860s as many as thirty thousand cattle passed through Hope Valley in any given year. In the last 20 years there have been none. The hills around Markleeville were once completely bare of timber, now forest stockings are at all time highs. There were 45 sawmills in Alpine County at one time, now there are none. Thirty-five hundred people lived in a single town in the East Fork watershed, now less than 1500 live in the entire County.

Management and Restoration Recommendations

The present assessment indicates that management actions and resource utilization of 150 years ago probably had a greater impact on the geomorphology of our streams than grazing or other land uses that have occurred over the last 20 years. This said, it is important to understand that even the effects of resource extraction of 150 years ago probably resulted in less sediment production than can occur due to landslides, thunderstorms, and other forces of nature. One must keep this interrelationship of natural and man made impacts in mind when considering management objective and restoration projects. Nonetheless, sediment produced by current land use activities, or other impacts to streams in the watershed can have negative geomorphic and ecological impacts on stream and watershed function. These include:

- Decrease in meadow stream bank stability.
- Increased watershed sediment delivery.
- Modifications to channels.
- Lowered in-stream flows.
- Impacted water quality and riparian habitat.

Based on results of all assessment activities, the assessment team developed management and restoration recommendations intended to address human disturbance. The team focused on the restoration of geomorphic and ecosystem processes. Components of such an approach should include recognition of the complexity and interconnectedness of ecological systems, recognition that ecosystems are constantly changing, and acknowledgement that ecosystem processes operate at multiple temporal and spatial scales. Dynamism is inherent in natural, functional streams. As a result, restoration projects must consider the role of change in both geomorphic and ecosystem process, and should be designed to allow dynamism to occur.

The assessment team does not recommend highly-engineered, "hard" solutions. Such structures do not allow for the regular adjustment of plan form and channel cross section common in alluvial channels. Also, given sediment availability in the system and its general dynamism, the use of a hard structure in a discrete location may simply shift erosional activities elsewhere. While hard structures may have limited application for limited objectives, their widespread use will not promote geomorphic or ecosystem function. Also, the assessment team does not recommend complete channel reconstruction in any given location. This would not only be very expensive, it also would be very risky given the dynamism inherent in these watersheds. Rain-on-snow floods would place enormous stress on newly constructed channels. Also, low summer flows make it difficult to re-vegetate newly constructed floodplains.

Restoration/Management Recommendation	**Unit**	**Estimated Cost**
Roads		
Detailed Road Assessment	Study	$10,000 to $20,000
Conduct a Demonstration Project	Mile	$20,000 to $40,000
Stream Restoration		
Conduct Bio-technical Stream Bank Restoration	Site	$13,000 to $17,000
Associated Monitoring	3-5 years	$15,000 to $20,000
Stabilize Faith Valley		
Stabilize Beaver Dam	Dam	$70,000 to $100,000
Reactivate Meanders	Site	$160,000 to $200,000
Associated Monitoring	3-5 years	$30,000 to $50,000
Reintroduce Beaver		$20,000 to $35,000
Selected Placement of Woody Debris	½ mile	$125,000 to $190,000
Associated Monitoring	3-5 years	$20,000 to $30,000
Floodplain Enhancement		
Limited Floodplain Reconstruction	One meander	$40,000 to $50,000
Associated Monitoring	3-5 years	$15,000 to $20,000
Support Markleeville Floodplain Restoration		-
Support East Fork Floodplain Restoration		-
Water Quality		
Support Efforts to Secure West Fork Flows		-
Support Mine Remediation Efforts	Study	$70,000
Support Indian Creek Restoration Efforts		-
Land Use Impacts		
Support Grazing Management Efforts		-
Support Recreation Management Efforts		-
Support Forest Structure Efforts		-
Monitoring and Adaptive Management		
Water Quality Monitoring	Year	$20,000 to $40,000
Photo Point Monitoring	Year	$2,000 to $5,000
Bank Retreat Staking	Year One	$10,000 to $15,000
	Subsequent Year	$2,000 to $5,000
Stream Flow Gaging	Year One	$30,000 to 35,000
	Subsequent Year	$10,000 to $15,000
Monitor Streambed Degradation at Bridges	3-5 years	$15,000 to $25,000

The assessment team does recommend active channel restoration measures in selected reaches. Recommended techniques are of a low intensity, allowing the channel to adjust to changing sediment supply or hydraulic conditions over time. Also, these treatments are designed to reinforce natural trends in channel recovery. Although removing the cause of channel disturbance should be the first priority of watershed programs, active restoration may be called for in some circumstances. All projects should have a strong adaptive management component with clearly defined objectives, a detailed monitoring plan, and a strategy for implementing monitoring results.

Based on the preceding considerations, the assessment team developed the following restoration and management recommendations. The Alpine Watershed Group has endorsed these restoration and management recommendations as priority activities over the next five years. Continued input from watershed stakeholders through the Alpine Watershed Group will be necessary as priority activities are carried out over time.