

Figure 4.9. Longitudinal profile and cross-section geometry for Reach RL.

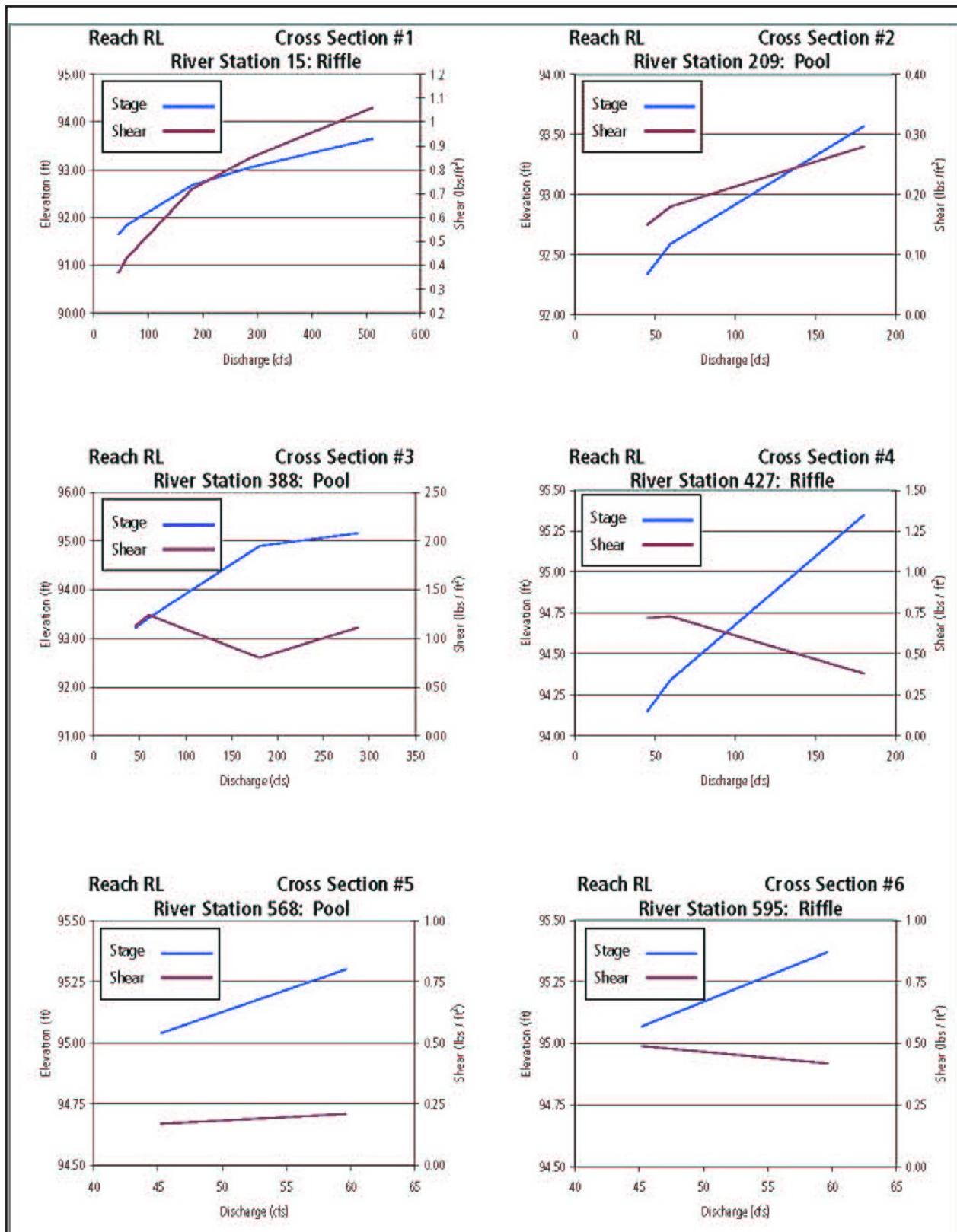


Figure 4.10. Discharge versus shear and stage for reference Reach RL.

USFS Ecology Team conducted plant community sampling within this reach (comparable plots 97783 and 97785). The Nebraska sedge/tufted hairgrass was assigned an ecological status of high, while the threadleaf sedge dominated plot was not rated. Data developed as part of the present study (Table 4.8) indicate that the area is dominated by mid successional status ratings. Vegetation in the area is adjusting to past disturbances and current fluvial processes.

Table 4.8. Red Lake Creek successional status data.

| Successional Status | Percent Occurrence |
|---------------------|--------------------|
| Early | 22.5 |
| Mid | 48.1 |
| High | 29.5 |

Red Lake Creek functions through the meadow despite a history of intense grazing and placement of a large dam upstream. Despite these potential impacts a threshold defining the line between channel stability and channel response to land use change appears never to have been crossed. Cumulative land use impacts on this small watershed may have been limited when compared to impacts that could occur over the much larger watershed area upstream of Hope and Faith Valley.

Analysis and Summary: This reach was chosen to help understand how lower gradient meadow streams, particularly in the West Fork drainage, may have functioned prior to disturbance by land uses, particularly grazing. However, it is important to note that there are two important limitations in this type of analysis. First, watersheds being compared should be as similar in natural geomorphic characteristics as possible, but is seldom possible to find identical watersheds. In this case, Red Lake Creek is similar to other portions of the West Fork in terms of climate and geology, but there is a dam on the creek that limits bedload transport from upper reaches of the watershed. This dam also probably reduces the size of small to moderate floods, although storage in the reservoir is not likely high enough to substantially reduce the size of larger rain-on-snow floods. Nonetheless, Red Lake Creek may be somewhat less inherently dynamic than the West Fork in Hope and Faith Valleys. Second, reference reaches should be as little disturbed as possible. Again, the Red Lake Creek site has limitations in this respect, as grazing has occurred in the past. However, given the land use history of the Upper Carson, it is not possible to find areas where land use has not occurred.

Even with these limitations, the geomorphic function of Red Lake Creek provides insight into the proper function of meadow streams in the upper Carson River watershed. Although a significant portion of the streambed is mobile during bankfull flows in Red Lake Creek, the streambanks are stable in comparison to those in Hope and Faith Valleys. Differences in land use patterns, with higher levels of grazing in Hope and Faith Valleys, may be partly responsible. It should also be noted that similar levels of land use may have different effects on different types of channels. Thus land use patterns may have been similar in both areas, but the higher inherent natural dynamism of the West Fork in Hope and Faith Valleys resulted in a greater response to land use impacts.

The smaller size of the Red Lake channel with respect to the surrounding meadow also suggests that land use had greater impacts on the West Fork in Hope and Faith Valleys. The West Fork in the lower portion of Hope Valley has a similar relationship to the floodplain, suggesting that this reach may be relatively close to historic conditions geomorphically. However, the West Fork in upper Hope Valley and the lower portion of Faith Valley is highly entrenched with respect to the surrounding meadow, which is probably at least partly due to past land use impacts.

4.2.6 Reach EF6 (Reference)

Rosgen Channel Type: B3/4c

Valley Form: Canyon

Bed Mobility: High

Restoration Objective: Not Applicable

Geomorphic Characteristics: The most significant factor defining reach breaks through the East Fork gorge is the location and influence of Highway 89 (see Figure 2.2 and maps contained in Section 3.2.2.3 of this report). Reach EF6 occurs within the East Fork Carson River gorge where the impact of the road is restricted to the adjacent hillslope. A longitudinal profile and cross sections of the reach are provided in Figure 4.11, while discharge and shear data are presented in Figure 4.12.

The presence of overflow or flood channels within this morphological stream type is conceptually different than what is observed in meadow channels. In meadow channels the floodplain is typically a low-relief surface that is inundated at a certain flood stage. Water movement over this surface occurs as sheet flow and is of low velocity, resulting in sediment deposition. In Rosgen-B channels with canyon morphology, the floodplain typically consists of overflow channels where flow is concentrated. Active and overflow channels are typically separated by a vegetated bar deposit with an elevation that is equal to or exceeds bankfull. These channels tend to be rougher since they often contain more vegetation but still may maintain riffle-pool sequences.

Along the East Fork of the Carson River, where large aggradation events and an actively mobile bed typifies channel conditions, an overflow channel can easily become the active channel, leaving the old active channel to vegetate and become the overflow channel. The dynamic nature of the valley bottom is a natural response to high sediment delivery and conservation of energy. The sinuous low-flow channel that results encourages variability in channel velocity and shear which forms the familiar pool and riffle sequence.

Aquatic Habitat Characteristics: Reach Ef6 has a well-developed pool-riffle sequence, providing variability in habitat characteristics. Deep pools provide cover habitat for fish populations and gravel and cobble dominated riffles provide coarse substrate for spawning and ideal conditions for production of macroinvertebrates. Many of the pools are formed at hard points such as bedrock outcrops or large boulders occurring in the bed. These roughness elements produce localized scour that builds habitat. Vegetated bars also provide overhanging vegetation.

Vegetation Characteristics: Twelve vegetation community types were identified within the reach, three of which were upland types. Riparian vegetation transitioned from banks and elevated stream terraces vegetated with more mature willows, cottonwoods, and wood's rose thickets, to point bars well vegetated with willow and cottonwood species and sparse to heavy herbaceous cover. Older point bars may provide the transition to uplands, with the higher elevations vegetated with upland shrub species. In other locations the transition to upland was abrupt, with a cliff face or steep slope providing the hydrologic boundary between upland and riparian areas.

A woody regeneration transect was established in this reach adjacent to the river on the left side, on a point bar. The age class distribution of willow and cottonwood species showed sprouts and saplings occurring nearer the water's edge. Older age classes became increasingly abundant as the elevation and distance from water increased. The proportion of sprouts and saplings to mature age classes for numerous species (coyote willow, black cottonwood, Lemmon's willow, Pacific tree willow and yellow willow) was approximately 20:3. Two dying and three dead willows were recorded. Wild rose was absent.

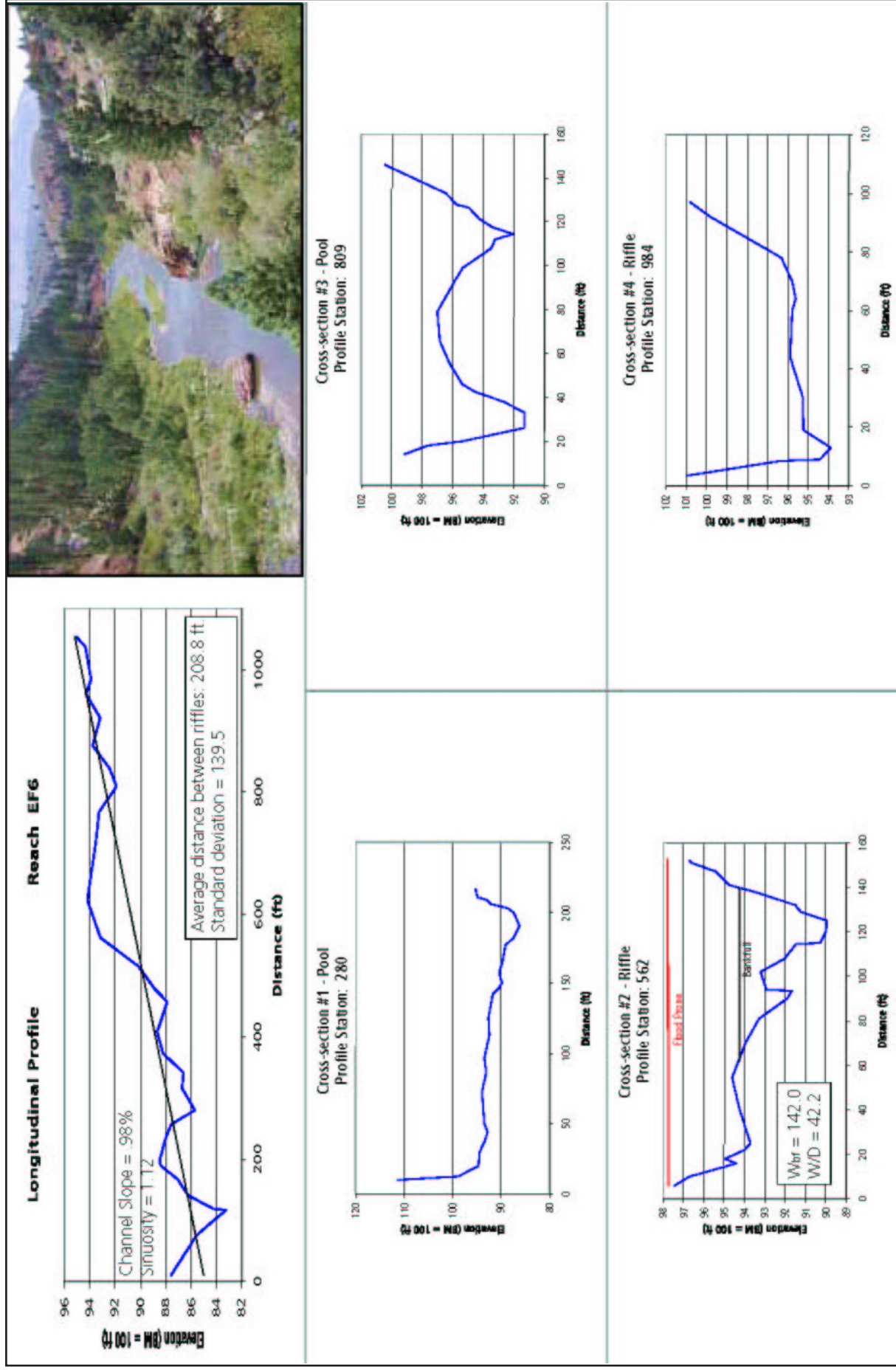


Figure 4.11. Longitudinal profile and cross-section geometry for Reach EF6.

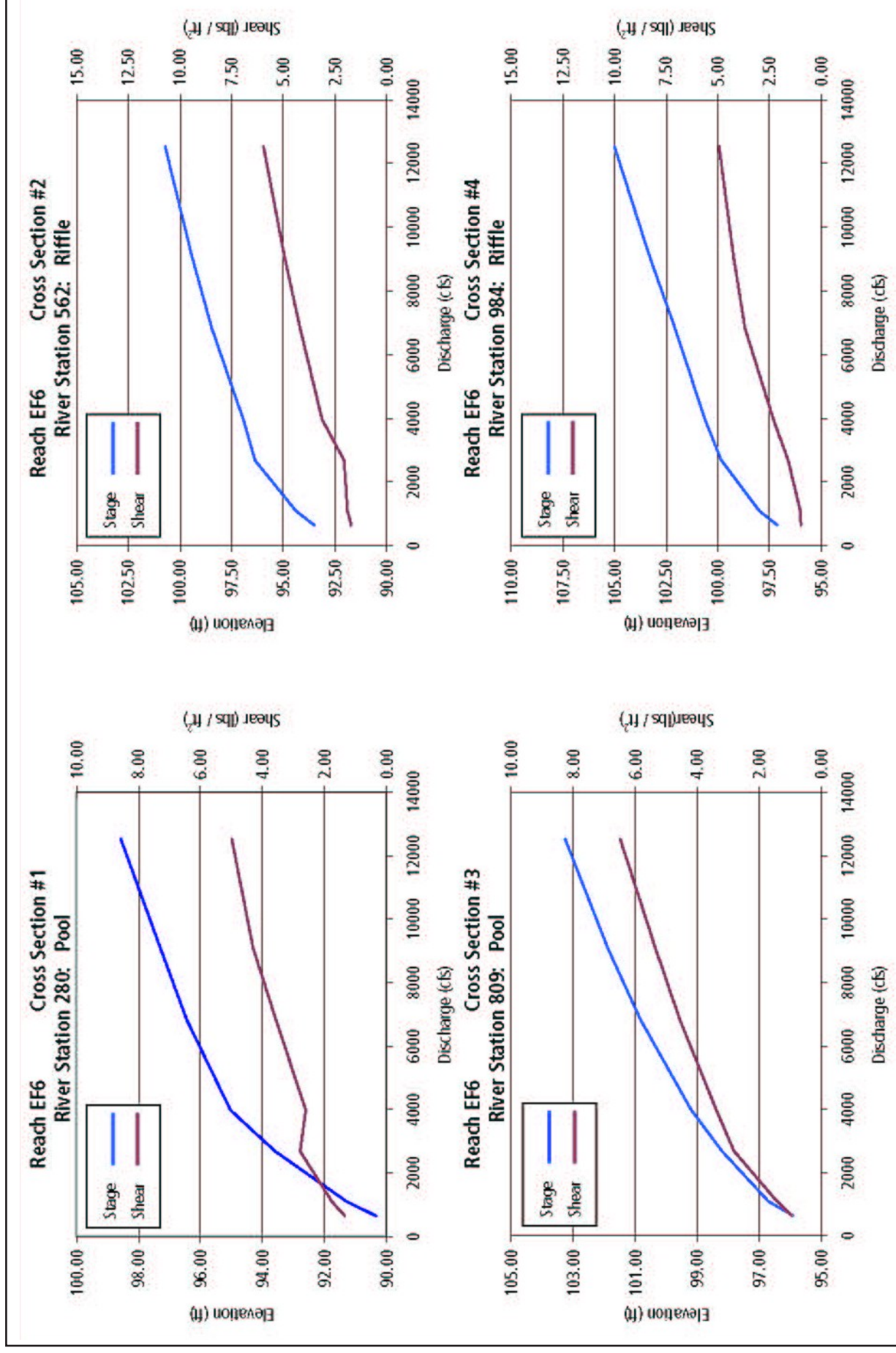


Figure 4.12. Longitudinal profile and cross-section geometry for Reach EF6

In contrast, at the top of bank on elevated stream terraces, wild rose thickets were common and dense, often intermingled with coyote willow. In some places wild rose had replaced older yellow willow clumps. Large, mature black cottonwood and Pacific tree willow were located at the base of the upland interface, either at the top of bank on the elevated stream terrace, or on the edge of the point bar adjacent to the slope separating the uplands from the riparian complex.

The proportion of young to older, dying, and dead wood vegetation indicates active recruitment for riparian willow and cottonwood species. The wild rose community type is considered marginally riparian and can indicate a response to past land use disturbance, but its roots and branches also provide soil stability in unconsolidated alluvium, thereby also providing water quality benefits. Some bull thistle (*Cirsium vulgare*), a noxious weed, were identified on one cross section. At this time, it does not appear to pose a threat to the establishment of more desirable species. Data developed as part of the present study (Table 4.9) indicate that the area is dominated by early and mid successional status ratings. Vegetation in the area is adjusting to past disturbances (recreation) and current fluvial processes. Management recommendations include removal of the few bull thistle plants present to prevent its establishment.

Table 4.9. Reach EF6 successional status data.

| Successional Status | Percent Occurrence |
|---------------------|--------------------|
| Early | 70.7 |
| Mid | 16.3 |
| High | 13.1 |

Analysis and Summary: Reach EF6 was selected as a reference reach, representing channel segments that occur on the East Fork that have not been directly impacted by the presence of the road on the floodplain surface. Where the road is perched on the hillslope away from the stream, channel and floodplain or overflow channel interactions take place and the natural pattern of disturbance and recovery of riparian vegetation is maintained. Where the road occurs on the valley floor, overflow channels are constricted and the potential for recovery of riparian vegetation following low frequency, high magnitude storm events is limited.

An intact morphology consisting of active and secondary channels, depositional features, and well-developed pool-riffle sequence is critical to the functional integrity of the East Fork Carson River. Periods of high sediment delivery and transport are attenuated within the channel and floodplain through temporary storage of material. An active channel that is ephemeral and can migrate in response to aggradation is essential to maintaining aquatic habitat quality and complexity. Following high-magnitude, low frequency runoff events rapid recolonization of depositional features by native riparian vegetation provides a degree of stability.

Reach EF6 provides a good reference site for understanding functional channel morphology on the East Fork Carson River. Though there are additional impacts that may limit use of this reference area in understanding water quality or fish population conditions, it is adequate when attempting to understand channel and floodplain interactions and potential impacts associated with Highway 89.

4.2.7 Reach EF7

Rosgen Channel Type: B3c

Valley Form: Canyon

Bed Mobility: High

Restoration Objective: Remove in-channel levees and protect road toe, replace road out of floodplain

Reach EF7 is located along the East Fork of the Carson River just upstream of Reach EF6 (see Figure 2.2 and maps contained in Section 3.2.2.2 of this report). Reach EF7 was chosen to represent a segment of the East Fork Carson that is directly influenced by the presence of Highway 89 within the valley bottom and the presence of several gravel levees built to protect the road from storm damage that has historically occurred to large rain on snow events. A longitudinal profile and cross sections of the reach are provided in Figure 4.13, while discharge and shear data are presented in Figure 4.14.

Geomorphic Characteristics: Geomorphically, it is likely that Reach EF7 was similar in form and function to Reach EF6. Vegetated point bars, overflow channels, pool-riffle morphology, bedrock outcrops, and a gravel-cobble bed are features that are present in both channel reaches. The difference between the existing morphology on Reach EF7 and the morphology present in Reach EF6 relates to the position of Highway 89 and associated management practices used to protect it.

Within the detailed survey reach, a large levee was constructed to cut the main channel off from the overflow channel following the flood of 1997. The cut off channel is on the outer edge of a large bend in the river, suggesting that the cutoff channel may have become the active channel during the 1997 rain on snow event. The impact of cutting off the overflow channel is evident in the longitudinal, cross section and grain size data collected at the site. The slope of the active channel is steeper than what was observed in the reference reach (Reach EF6), reflecting the reduced channel length. It wasn't possible to lengthen the profile due to the constricting influence of the levee. The substrate is also much larger in Reach EF7, which is likely due to increases in shear (the depth-slope product).

The presence of the levee also produces homogeneity in the longitudinal profile with little to no pool and riffle development. The levee occurs through cross sections 2 and 3 of the study reach. Pools are only present at the upstream and downstream end of the study reach, outside the influence of the levee. It is interesting to note that some aggradation, evidenced by a high point in the cross section, occurs just downstream of where the levee ends and the cross section widens.

Aquatic Habitat Characteristics: Aquatic habitat conditions in Reach EF7 have been impacted by direct modifications to the channel and floodplain. Construction of the cutoff levee and loss of overflow channel has reduced habitat variability. Reach EF7 lacks deep pools, complex cover habitat, productive spawning areas, and streamside riparian shading. Additionally, backwater areas that typically provide refuge areas for fish and other aquatic organisms during high flow events has been lost through this reach due to construction of the levee.

Vegetation Characteristics: Eight vegetation community types were documented along the cross sections, two of them upland types. This reach was characterized by the presence of a levee, impounded water and grouted rock slope protection. The grouted rock slope protection exhibited one mature black cottonwood at the top of bank, with a few black cottonwood resprouting from buried stems at assorted elevations. The pattern of point bar colonization by willows and cottonwoods was present on the left side of the channel in a narrow band 6-10 feet wide. On the right side, this community type was present at the pond bank in a band approximately six feet wide. The left side point bar was bisected by a back bar channel, where an ecotone of upland shrubs and conifers was interspersed with coyote willow and black cottonwood. The back bar channel was on an elevated stream terrace and the presence of all age classes of upland and riparian woody vegetation may indicate transition to an upland environment.

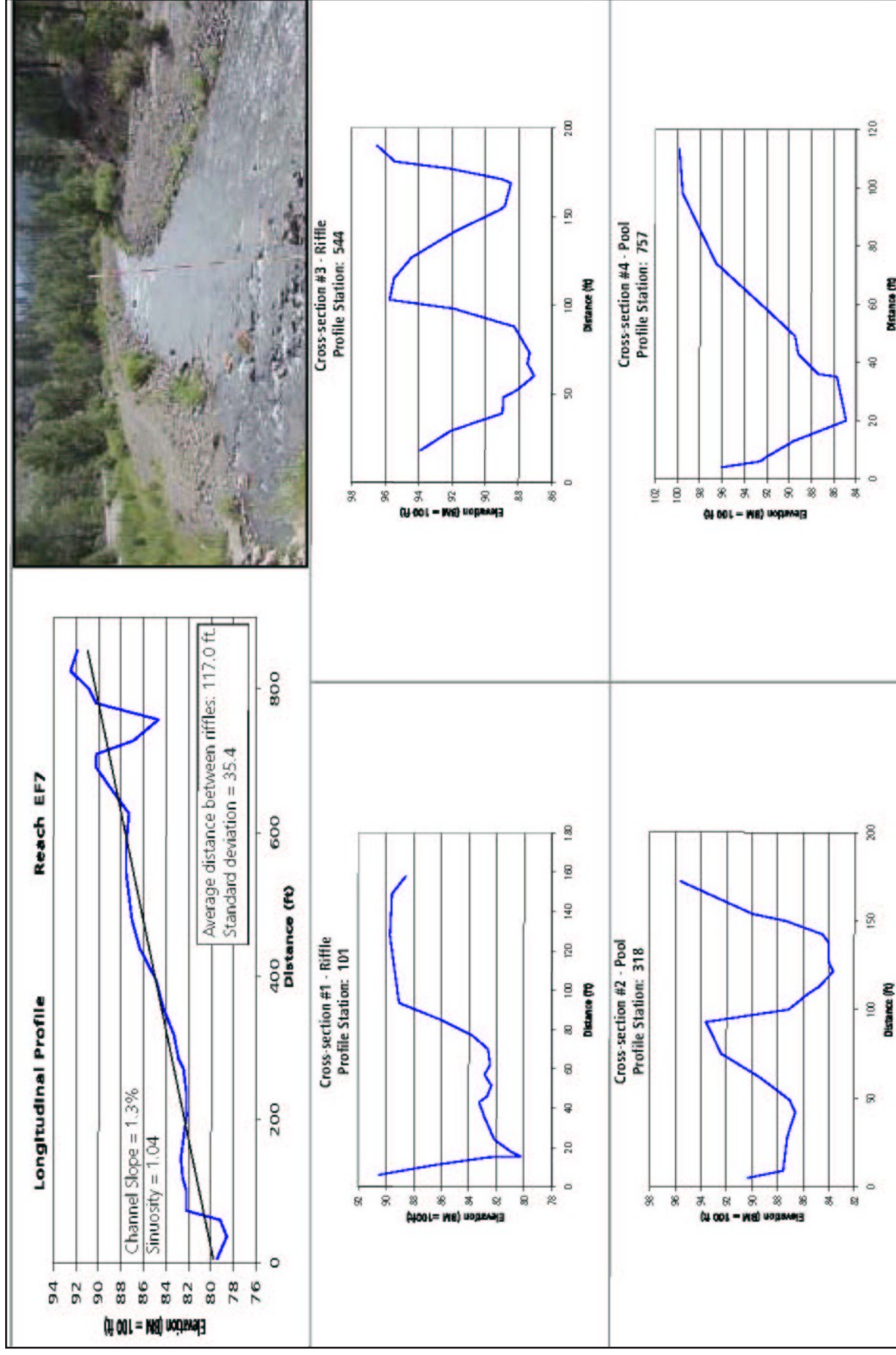


Figure 4.13. Longitudinal profile and cross-section geometry for Reach EF7.

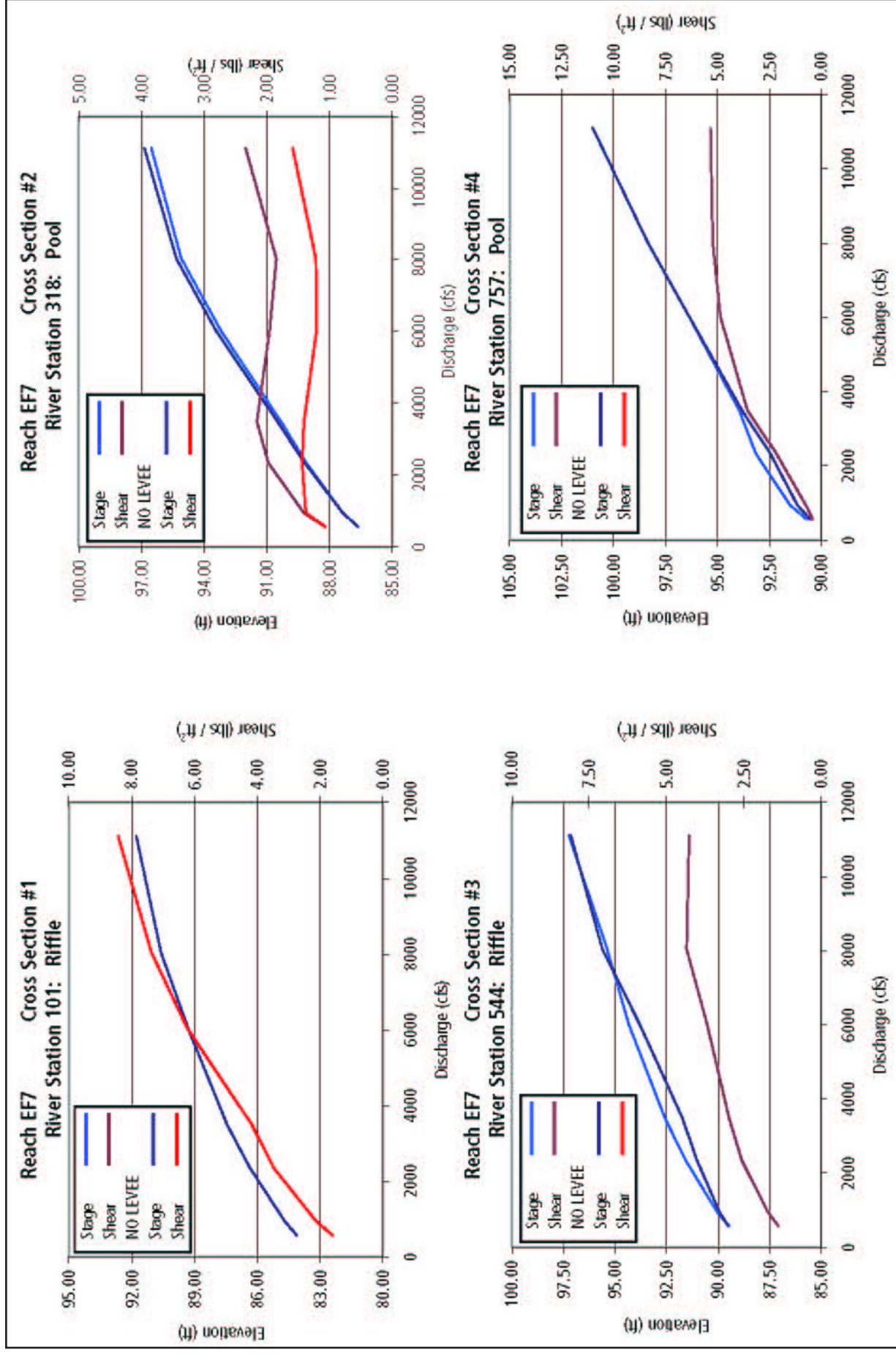


Figure 4.14. Discharge versus shear and stage for Reach EF7.