Indian Creek Location Hydraulics Report

Revised December 15, 2006

1 Introduction

Trinity and Lewiston Dams were constructed on the Trinity River in Northern California as part of the Trinity River Division (TRD) of the Central Valley Project (CVP). Since dam operations began in 1963, the TRD has diverted up to 90 percent of the Trinity River's average annual yield at Lewiston, California. Forty years of limited flow releases from Lewiston Dam have greatly reduced the ability of the downstream river to transport coarse sediments. The change in downstream river morphology has degraded riverine habitats, resulting in a sharp decline in salmon and steelhead populations.

In an effort to rehabilitate downstream fish habitat and partially restore the ability of the Trinity River to transport coarse sediments, the Trinity River Restoration Program (TRRP) of the Bureau of Reclamation (Reclamation) has been implementing increased flow releases from Lewiston Dam into the Trinity River mainstem. Implementation of an increased flow release schedule, recommended in the *Trinity River Flow Evaluation Final Report* (US Fish and Wildlife Service and Hoopa Valley Tribe, 1999), required modification of four existing downstream bridges to accommodate higher flows, purchase and removal of a residential structure and outbuildings that were very low in the floodplain, and relocation or reconstruction of various wells, pumps, outbuildings and other structures that may be impacted by the increased flow releases. In addition to the higher fishery flow releases, mechanical channel rehabilitation is required at numerous locations between Lewiston Dam and the North Fork Trinity River to initiate the geomorphic response and habitat creation expected to result in significantly increased salmonid populations.

2 Hydrology

Flood flow estimates used in the hydraulic modeling analyses were taken from three sources:

1) the Flood Plain Information Report-Trinity River Lewiston Lake to Junction City, Trinity County, California (USACE, 1976);
2) the Estimation of 50-and 100-Year Tributary Accretion Floods document (McBain, 2002), and;
3) the Flood Plain Infrastructure Modifications Spring Flow Events draft report (Reclamation, 2005).

The 1976 USACE report provides the 100-year and 500-year annual flood events and hydraulic analyses used by FEMA to develop the current flood insurance rate maps (FIRMs) for the Trinity River. The 2002 McBain report provides flood flows as measured at mainstem Trinity River Gages during the January 1997 flood and estimates of tributary accretion between mainstem gages during this event. The 2005 Reclamation draft report provides an estimate of 10-year and 100-year spring tributary flows during the time period when maximum fishery flows (MFF) (11,000 cubic feet per second [cfs]) would be occurring from Lewiston Dam. Because the 1976 USACE report only provided flow rates at Lewiston and Douglas City, the 2002 McBain report was used to approximate how flows would have accumulated between these locations if the flood assumed in the 1976 study was similar to that which occurred in 1997. Design flows, including the 1997 flood flows, used in this analysis are provided in Table 1.

Table 1. Design flood flows

Location	Maximum Fishery Flow[a]	1997 Flood[b]	FEMA 100-Year Flood[c]
Trinity River at Lewiston	11,000	6,000	8,500
Trinity River Below Rush Creek	12,096	12,500	19,300
Trinity River Below Grass Valley Creek	13,692	15,050	23,600
Trinity River Above Indian Creek	14,549	15,200	23,800
Trinity River Below Indian Creek	15,771	19,000	30,200
Trinity River Below Weaver Creek	17,544	22,000	35,200
Trinity River Below Reading Creek	18,613	24,000	38,500

Notes:
[a] MFF=11,000 cfs Lewiston Dam Release plus 100-year spring tributary flows (2005 Reclamation draft report)
[b] 2002 McBain report
[c] 1976 USACE report (used in FIRM study)

3 Hydraulic Analyses

Hydraulic modeling for the reach between Reading Creek and Steel Bridge Road (river mile [RM] 92.89 to RM 97.52) was performed using HEC-RAS. Figure 1 illustrates the Douglas City/Indian Creek reach of the mainstem Trinity River.). HEC-RAS is a numerical modeling software package developed by the Hydrologic Engineering Center for the US Army Corps of Engineers for performing one-dimensional, steady and unsteady flow, hydraulic computations (Brunner, 2001). Results of the hydraulic modeling were used to determine baseline hydraulic conditions (i.e., existing conditions) and to assess the impact of the proposed action and alternatives on flood elevations and to aid in the design process.

3.1 Model Assumptions

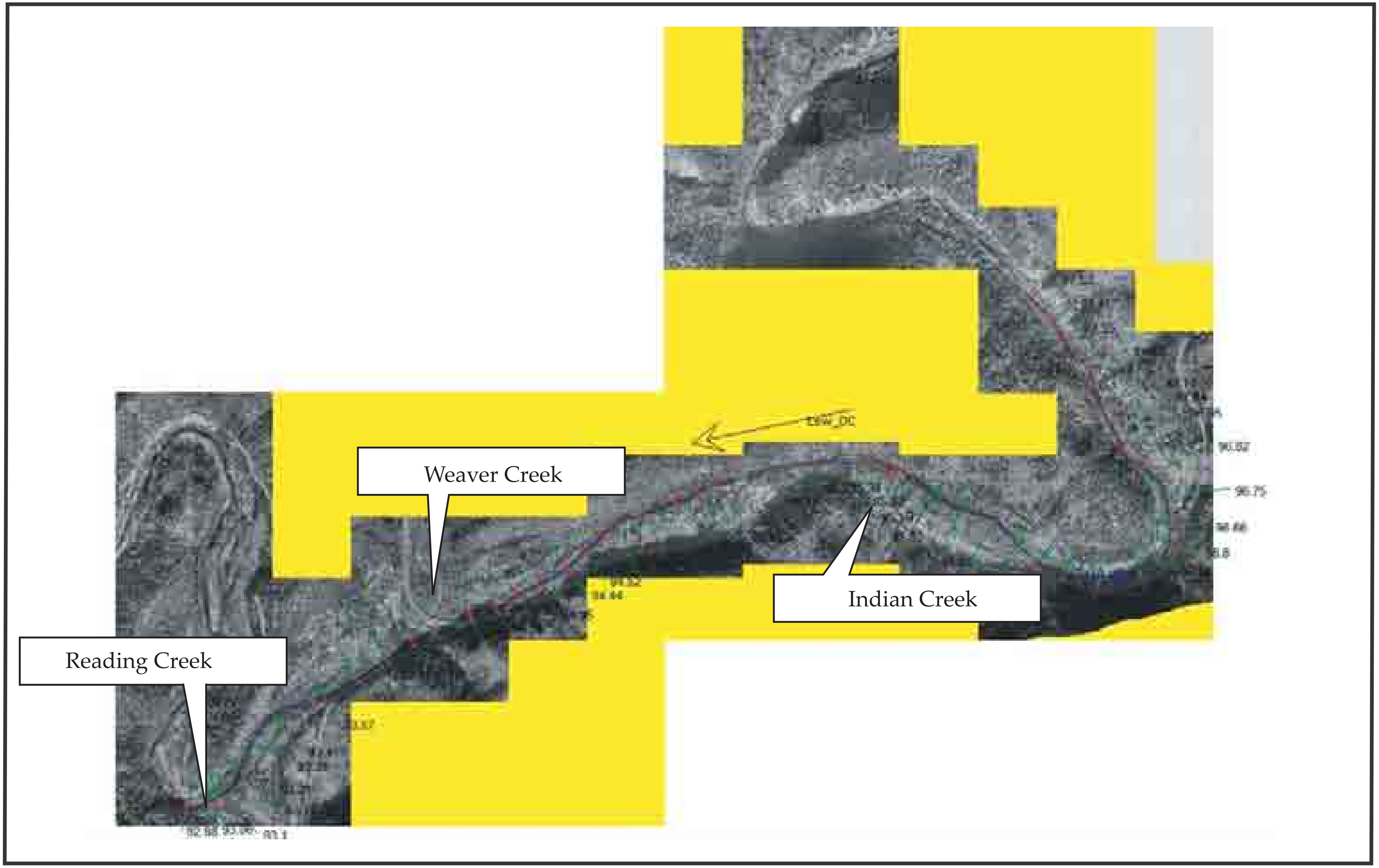
The hydraulic model of the No Action (existing conditions) alternative used for this analysis was developed by the Department of Water Resources (DWR) and made available to the TRRP in February of 2006. A detailed hydraulics report is expected to be issued by the DWR in July of 2006. The following is a general description of the model, and the assumptions made in the preparation and use of it.

To begin the hydraulic backwater computations, the flow at the downstream end of the HEC-RAS model was assumed to be at normal depth. The slope of the energy grade line at the downstream end of the model (used to compute normal depth) was estimated as equal to the slope of the longitudinal thalweg profile for approximately the first mile (approximated at 0.0023 ft/ft).

The geometric cross section data was based on 2 recent surveys:

1) November 2001 photogrammetry by Reclamation for topography above the low flow water line; and;

2) December 2004 LiDAR bathymetry for topography beneath the low flow water elevation.



Source: TRRP, 2006

Indian Creek Rehabilitation Site: Trinity River Mile 93.7-96.5

Figure 1

HEC-RAS Cross Sections

Douglas City/Indian Creek Reach, Mainstem Trinity River

These 2 survey datasets were merged into one digital terrain model, and cross sections were extracted at least every 500 feet using the USACE ArcGIS extension GeoRAS. These cross-sections are illustrated in Figure 1. AutoCAD was used to digitize the river centerline based on aerial photographs of the mainstem Trinity River when releases from Lewiston Dam were 5,000 cfs.

Roughness values were initially estimated based on typical channel roughness and on riparian mapping (based on 2001 aerial photos and field surveys) performed in 2002 which classified vegetation types and densities within the floodplain. Main channel and overbank areas were initially assigned Manning's n roughness values based on typical values from the literature. Using GeoRAS, these roughness values were then assigned to cross section stationing for import to HEC-RAS.

3.2 Model Calibration

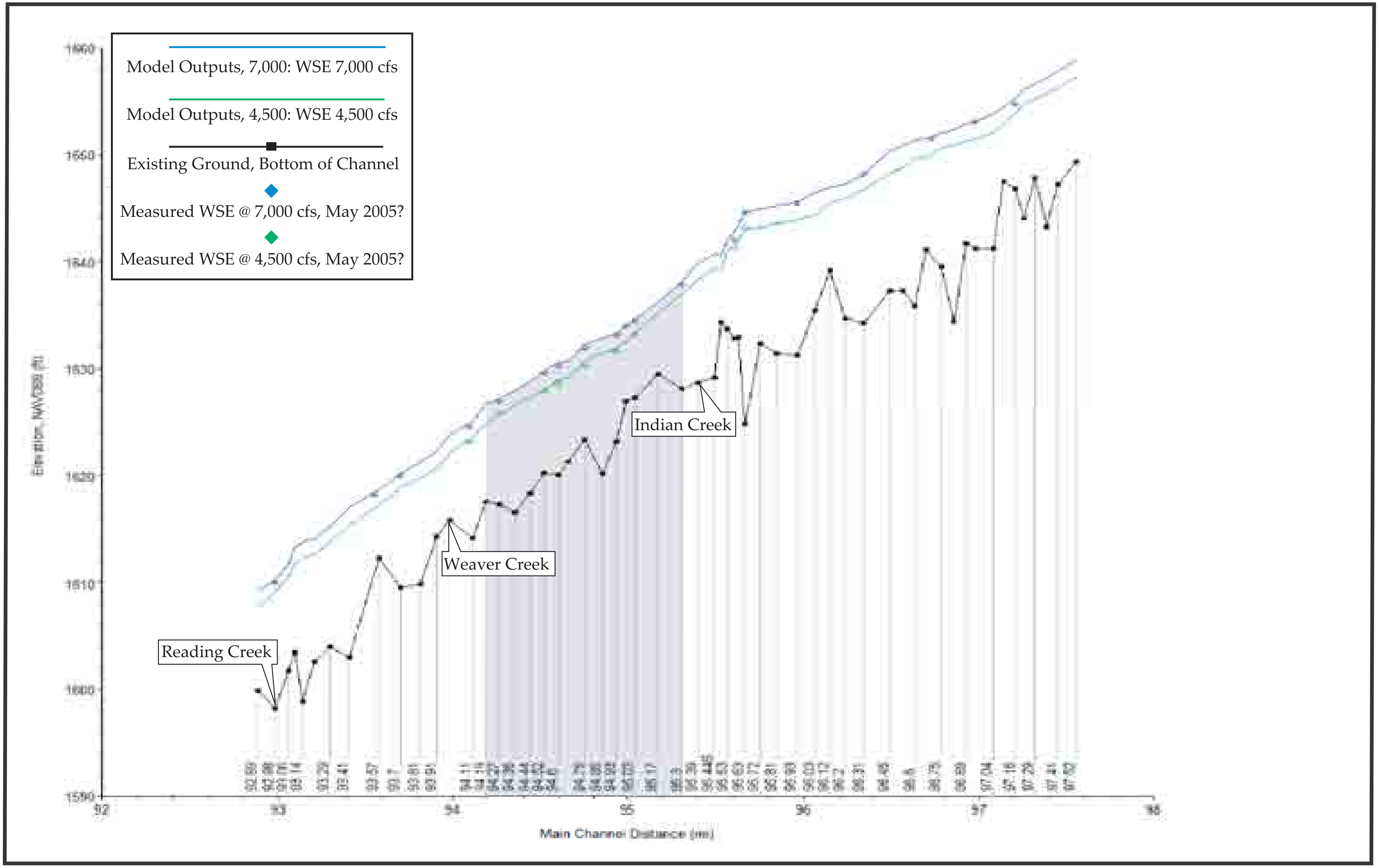
The DWR established high water benchmarks during the spring of 2005 during Lewiston Dam releases of 7,000 cfs and 4,500 cfs. Benchmarks were located at 102 locations between Lewiston Dam and the North Fork Trinity River over the course of approximately 40 miles. After flows receded, the DWR surveyed each benchmark to determine the actual water surface elevation observed during the high flow releases. Mainstem USGS gage data were analyzed to determine the flow at each benchmark at the time it was established.

Main channel Manning's roughness values in each model were adjusted over a range from 0.030 to 0.040, and overbank Manning's roughness values typically varied between 0.080 and 0.200, to match DWR surveyed water surface elevations within 0.5 feet for the 4,500 and 7,000 cfs discharge. Figure 2 shows the model calibration results with computed versus measured water surface elevations within the Douglas City/Indian Creek study reach. Figure 2 also identifies the location of tributaries that provide accretion flow to this reach (i.e., Indian Creek, Weaver Creek and Reading Creek).

In May of 2006, the DWR again established benchmarks during the TRRP fishery flow releases of 10,000 cfs. These benchmarks have yet to be surveyed. However, at the time of the 10,000 cfs release, the HEC-RAS model developed by DWR was run at the same flows as were actually occurring at the time, with very little deviation (less than 6 inches in observed locations) between predicted and actual water surface elevations. Therefore, the TRRP believes that the HEC-RAS model for the No Action alternative may be used to accurately predict water surface elevations at flows in the Douglas City to within 6 inches.

3.3 Proposed Action

The Proposed Action was modeled in HEC-RAS by modifying the cross section geometry to achieve desired inundation levels. For example, the cross sections for the sidechannel and floodplain features in Area R-8were iteratively adjusted and the model was run and re-run to achieve 1-foot of inundation at the design flows (1500 cfs for sidechannel and 4500 cfs for the floodplain). Chapter 2 of the EA/Draft EIR provides a sequence of typical cross sections that illustrate the rehabilitation activities incorporated into the Proposed Action. The overbank roughness values were also adjusted to range from 0.04 to 0.05 to account for the removal and subsequent partial regrowth of vegetation.



Source: TRRP, 2006

Figure 2
HEC-RAS Calibration at 4,500 cfs and 7,000 cfs
Douglas City/ Indian Creek Reach, Mainstem Trinity River

Figures 3 and 4 show the No Action (existing conditions) model versus the Proposed Action at the maximum fishery flow (11,000 cfs plus 100-year spring tributaries) and FEMA 100-year flood event, respectively. These figures also illustrate the thalweg elevation (deepest part) of the channel (existing ground line) as modeled at each cross section. As shown in Figure 3, the Proposed Action substantially reduces water surface elevations at the MFF flow between RM 94.19 and 95.3 (shaded area) with a maximum reduction of 1.3 feet near RM 94.6. Similarly shown in Figure 4, the Proposed Action substantially reduces water surface elevations at the FEMA 100-year flow as shown in the shaded area between RM 94.19 and 95.3, with a maximum reduction of 1.3 feet near RM 94.6. These figures also illustrate that no measurable change in water surface elevation is observed in the vicinity of the Douglas City Bridge (RM 93.91). The TRRP recognizes that this report does not adequately address risks to bridge structures. Additional consultation and coordination with CalTrans will occur throughout the planning process.

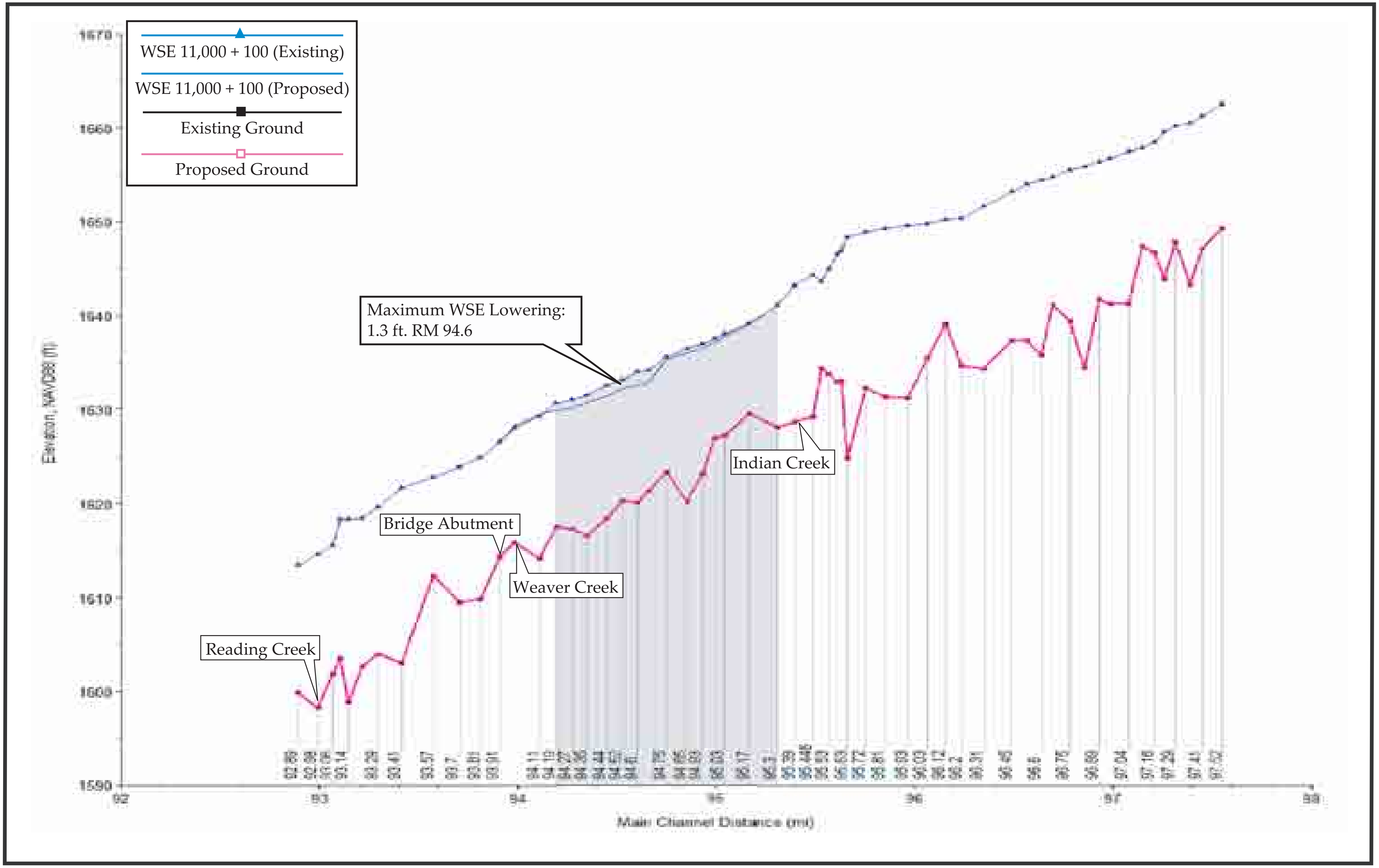
3.4 Alternatives 1 and 2

Alternatives 1 and 2 are hydraulically identical to the Proposed Action, and thus, were not modeled independently. Alternative 1 considers alternative access routes, and results in same river geometry as the Proposed Action. Similarly, Alternative 2 has the same river geometry as the Proposed Action but eliminates the berm notching at Area R-1, which would not influence hydraulic conveyance.

3.5 Alternative 3

Alternative 3 was modeled in HEC-RAS by modifying the cross section geometry to achieve desired inundation levels. For example, the cross sections for the sidechannel and floodplain features in Area R-8 were iteratively adjusted and the model was run and re-run to achieve 1-foot of inundation at the design flows (300 cfs for sidechannel and 6000 cfs for the floodplain). The supplement to Chapter 2 of the EA/Draft EIR provides a sequence of typical cross sections that illustrate the rehabilitation activities incorporated into Alternative 3. The overbank roughness values were also adjusted to range from 0.04 to 0.05 to account for the removal and subsequent partial regrowth of vegetation.

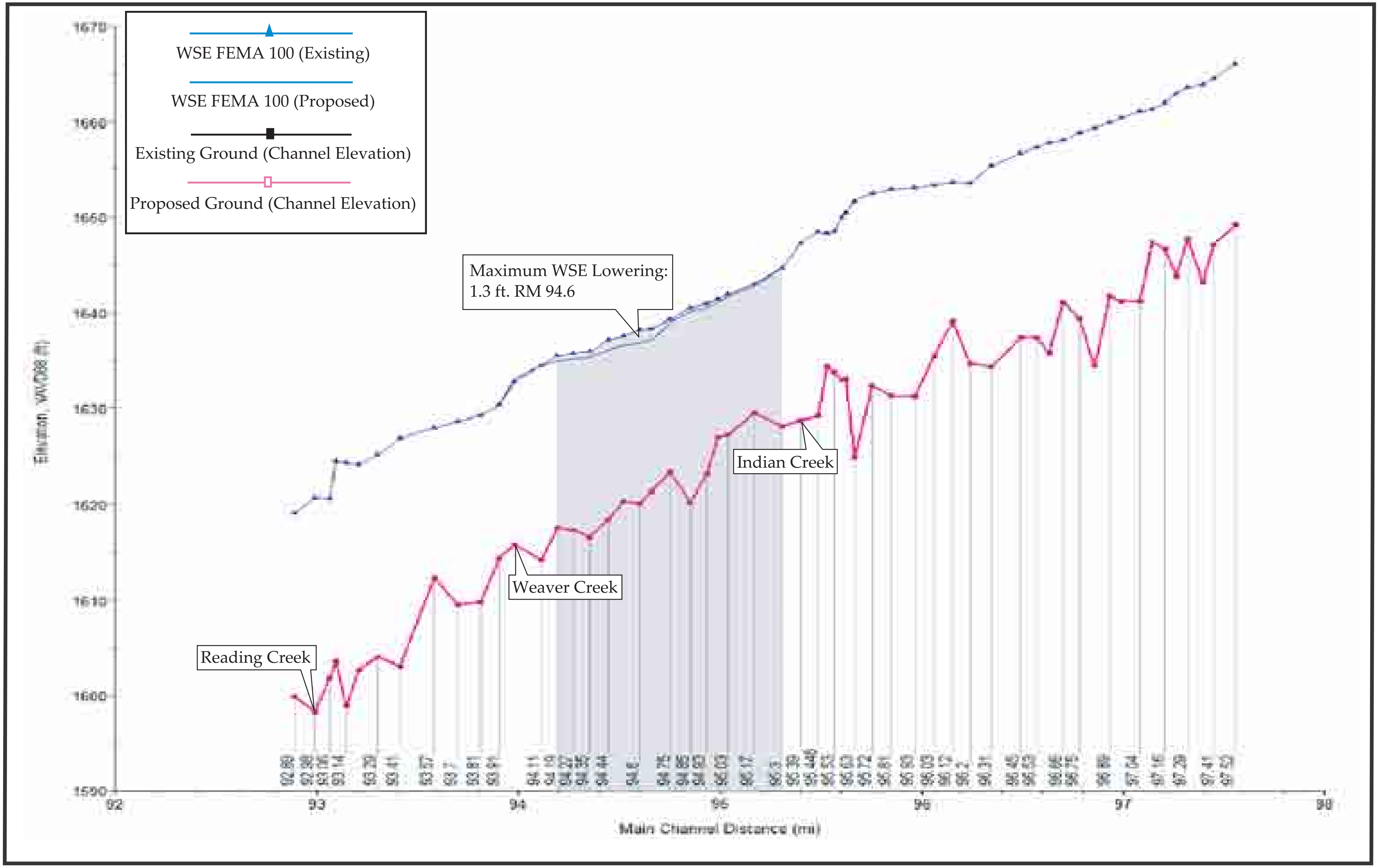
Figures 5 and 6 show the No Action (existing conditions) model versus Alternative 3 at the maximum fishery flow (11,000 cfs plus 100-year spring tributaries) and FEMA 100-year flood event, respectively. These figures also illustrate the thalweg elevation (deepest part) of the channel (existing ground line) as modeled at each cross section. As shown in Figure 5, Alternative 3 substantially reduces water surface elevations at the MFF flow between RM 94.19 and 95.3 (shaded area) with a maximum reduction of 1.3 feet near RM 94.6. Similarly shown in Figure 6, Alternative 3 substantially reduces water surface elevations at the FEMA 100-year flow as shown in the shaded area between RM 94.19 and 95.3, with a maximum reduction of 1.4 feet near RM 94.6. These figures also illustrate that no measurable change in water surface elevation is observed in the vicinity of the Douglas City Bridge (RM 93.91). The TRRP recognizes that this report does not adequately address risks to bridge structures. Additional consultation and coordination with CalTrans will occur throughout the planning process.



Source: TRRP, 2006

Figure 3

HEC-RAS Profile for Proposed Action at 11,000 cfs Lewiston Dam Release plus 100-year Spring Tributary Flows
Douglas City/Indian Creek Reach, Mainstem Trinity River

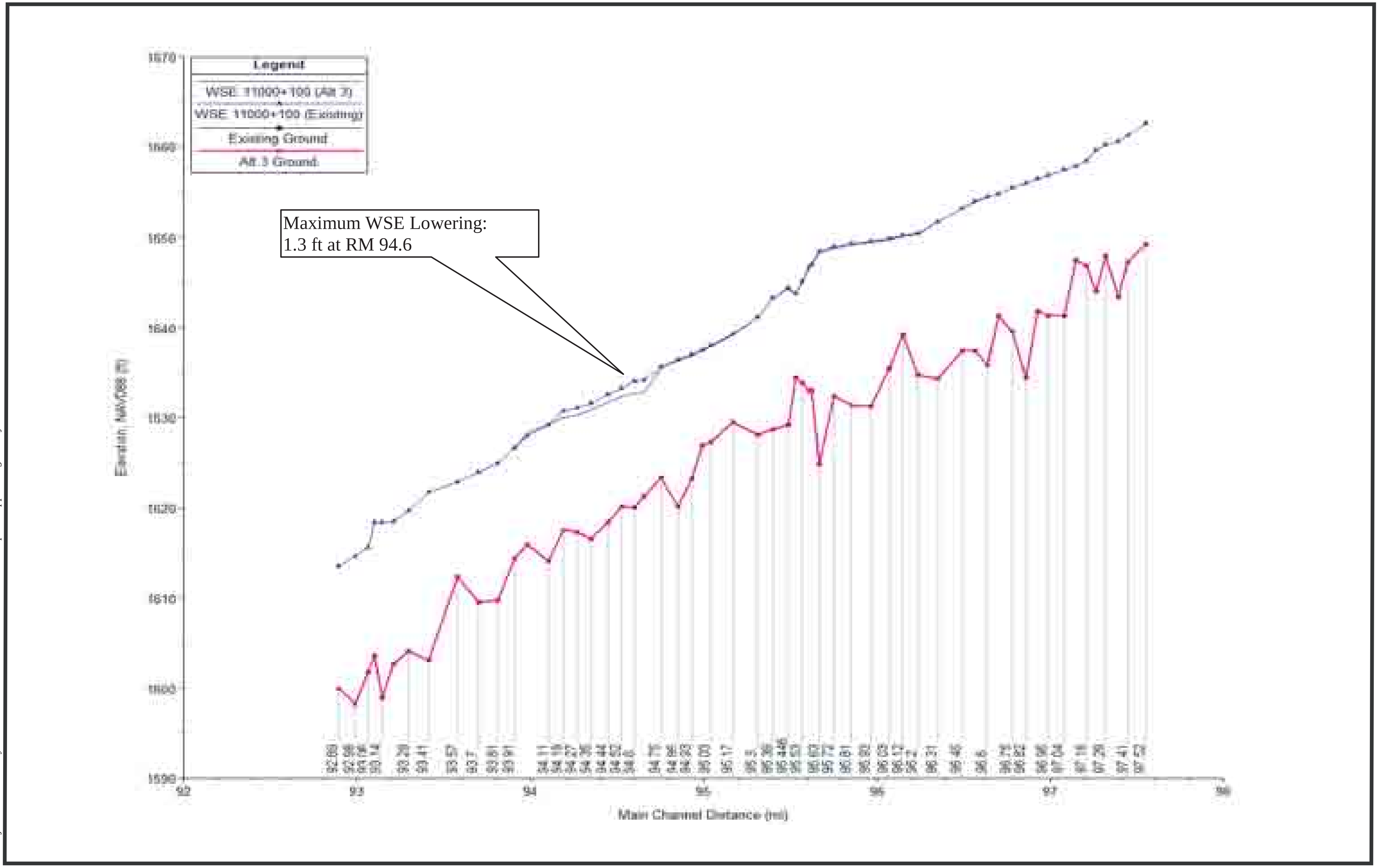


Source: TRRP, 2006

Indian Creek Rehabilitation Site: Trinity River Mile 93.7-96.5

Figure 4

HEC-RAS Profile for Proposed Action at FEMA 100-year Flood Flow
Douglas City/Indian Creek Reach, Mainstem Trinity River

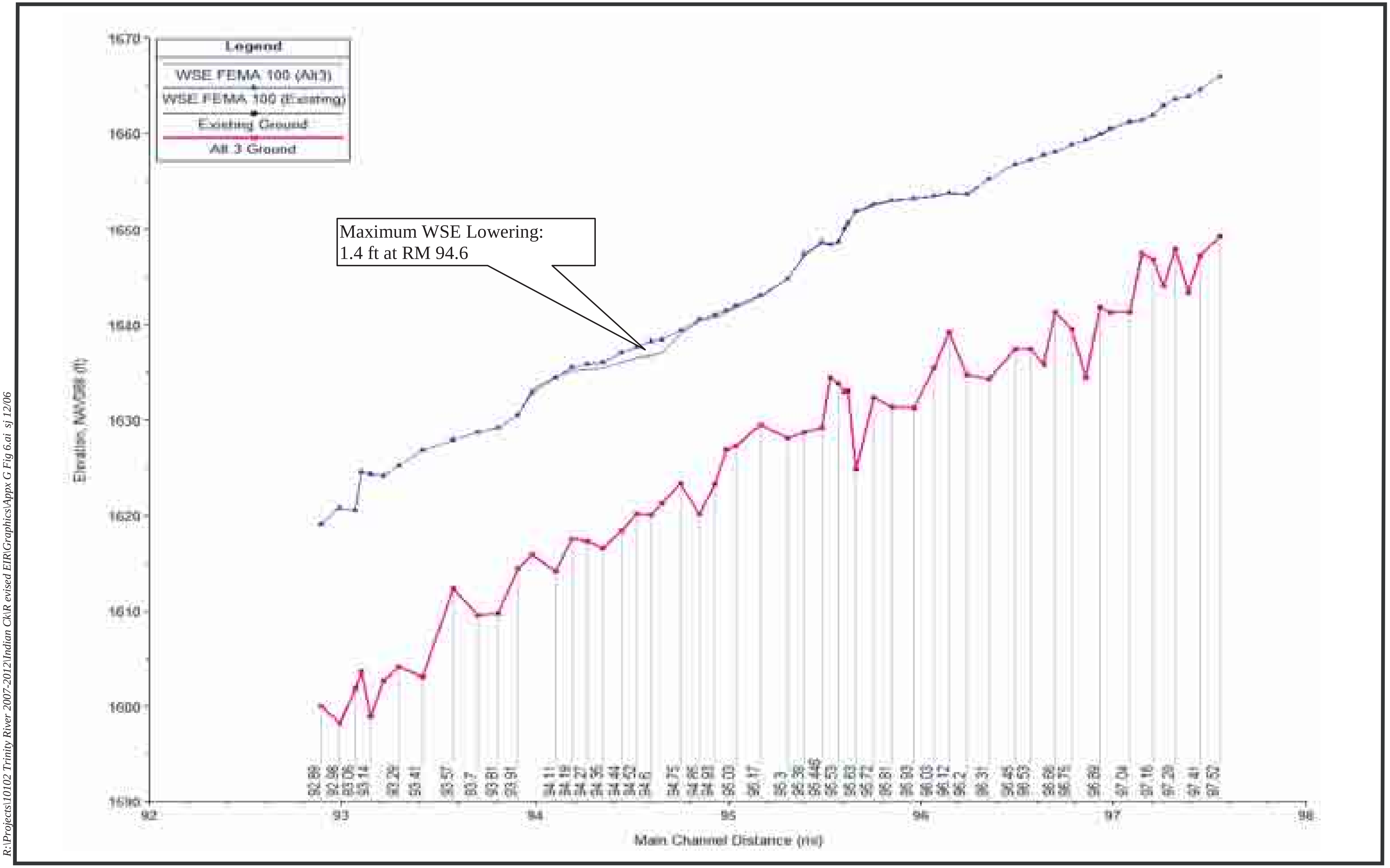


R:\Projects\10102 Trinity River 2007-2012\Indian Ck\R evised EIR\Graphics\Appx G Fig 5.ai sj 12/06

Source: TRRP, 2006

Figure 5

HEC-RAS Profile for Alternative 3 at 11,000 cfs Lewiston Dam Release plus 100-year Spring Tributary Flows
Douglas City/Indian Creek Reach, Mainstem Trinity River



Source: TRRP, 2006

R:\Projects\10102 Trinity River 2007-2012\Indian Ck\R evised EIR\Graphics\Appx G Fig 6.ai sj 12/06

Figure 6

HEC-RAS Pofile for Alternative 3 at FEMA 100-year Flood Flow
Douglas City/Indian Creek Reach, Mainstem Trinity River

3.6 Alternative Considered but Not Pursued

During formal and informal meetings with residents and stakeholders in the study reach, it became apparent that there is a strong desire/belief in the local community for the channel to be excavated in order to increase conveyance and reduce flood risk. To address these concerns, a modified geometry file was created that assumed the center of the river channel was excavated for purposes of alternative development. It was assumed that between RM 93.81 and RM 94.85, the center of the river would be excavated 25 ft wide at a longitudinal slope of 0.002 ft/ft, with 2:1 sideslopes (see Figure 7 for typical cross section). This alternative required the excavation of approximately 103,000 cubic yards, based on HEC-RAS calculations. As shown in Figure 8, this alternative did not significantly increase conveyance through the study reach, and only reduced upstream water surface elevations by no more than 8-inches (0.68 ft) at RM 94.85, substantially less than that of the Proposed Action which focused on floodplain reconstruction and vegetation removal. This alternative:

- would not provide additional juvenile salmonid habit;
- would be expected to have negative impacts to aquatic biota;
- would have much higher costs; and;
- would provide no assurance that the excavation would be maintained over time.

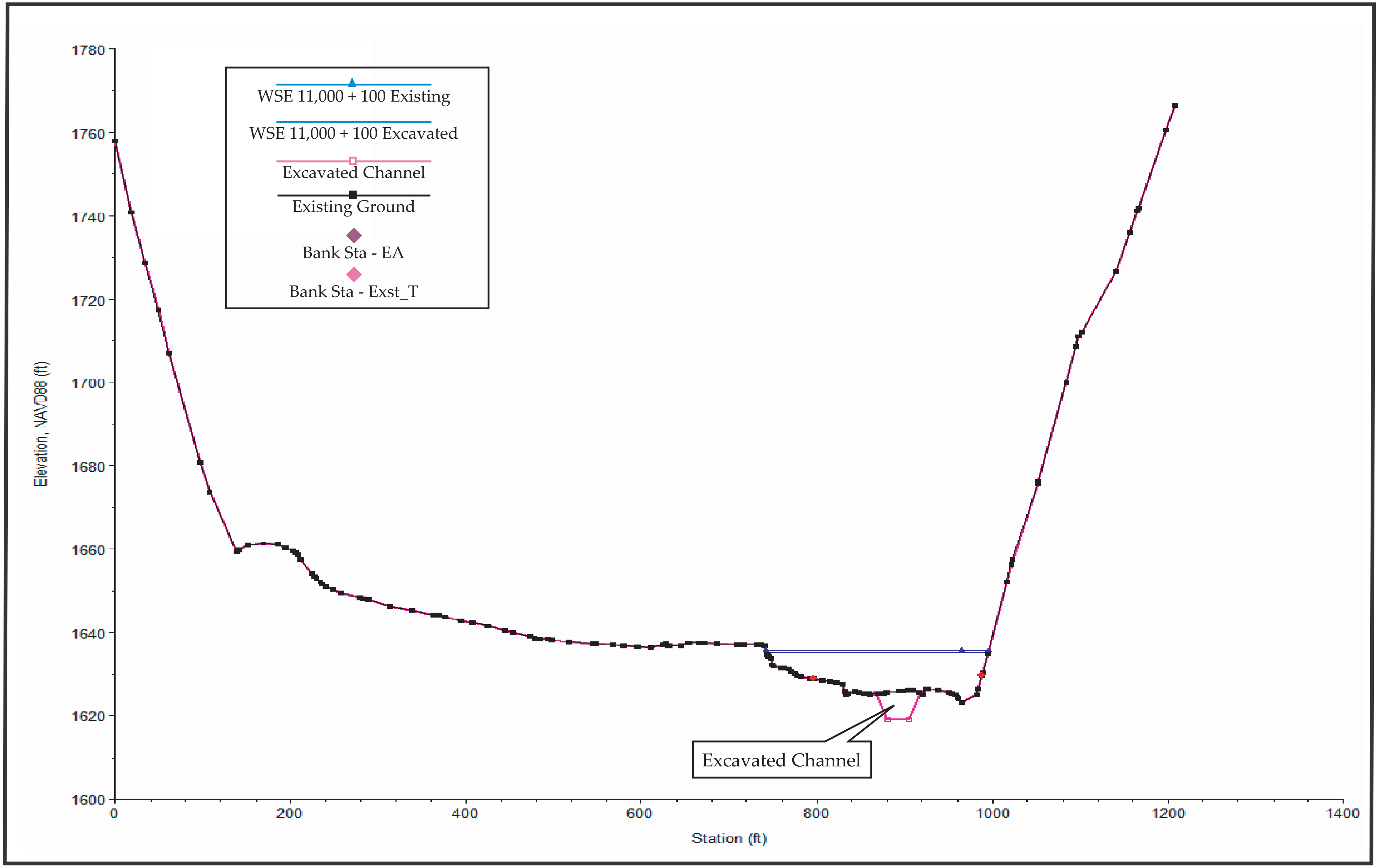
Therefore, the TRRP determined that it would not meet the standards of reasonableness required for environmental compliance.

4 Conclusions

Based on the modeling analyses described above and observations of similar floodplain hydraulics at the Hocker Flat rehabilitation site at flows in excess of 6,000 cfs, the Proposed Action and Alternatives 1 through 3 will significantly increase the hydraulic conveyance through the reach between RM 94.11 and RM 94.75. These analyses indicate that water surface elevations upstream of project area R-8 will decrease by 1.3 feet at the 11,000 cfs Lewiston Dam release plus 100-year spring tributary flow event. However, it should be noted that the model accuracy at these flows, which are rarely experienced and the hydraulic model has not yet been calibrated to, may be on the order of plus or minus 6-inches. At flows greater than the MFF, the model accuracy is likely on the order of plus or minus 1 foot.

When compared to the Proposed Action and Alternatives 1 through 3, the alternative of excavating the river channel would not meet the goals of this project of creating juvenile salmonid habitat and decreasing upstream water surface elevations. Furthermore, this alternative would likely cost double that of the Proposed Action or Alternatives 1 through 3, be difficult to construct, and over time the river would likely aggrade to the same levels as before this activity.

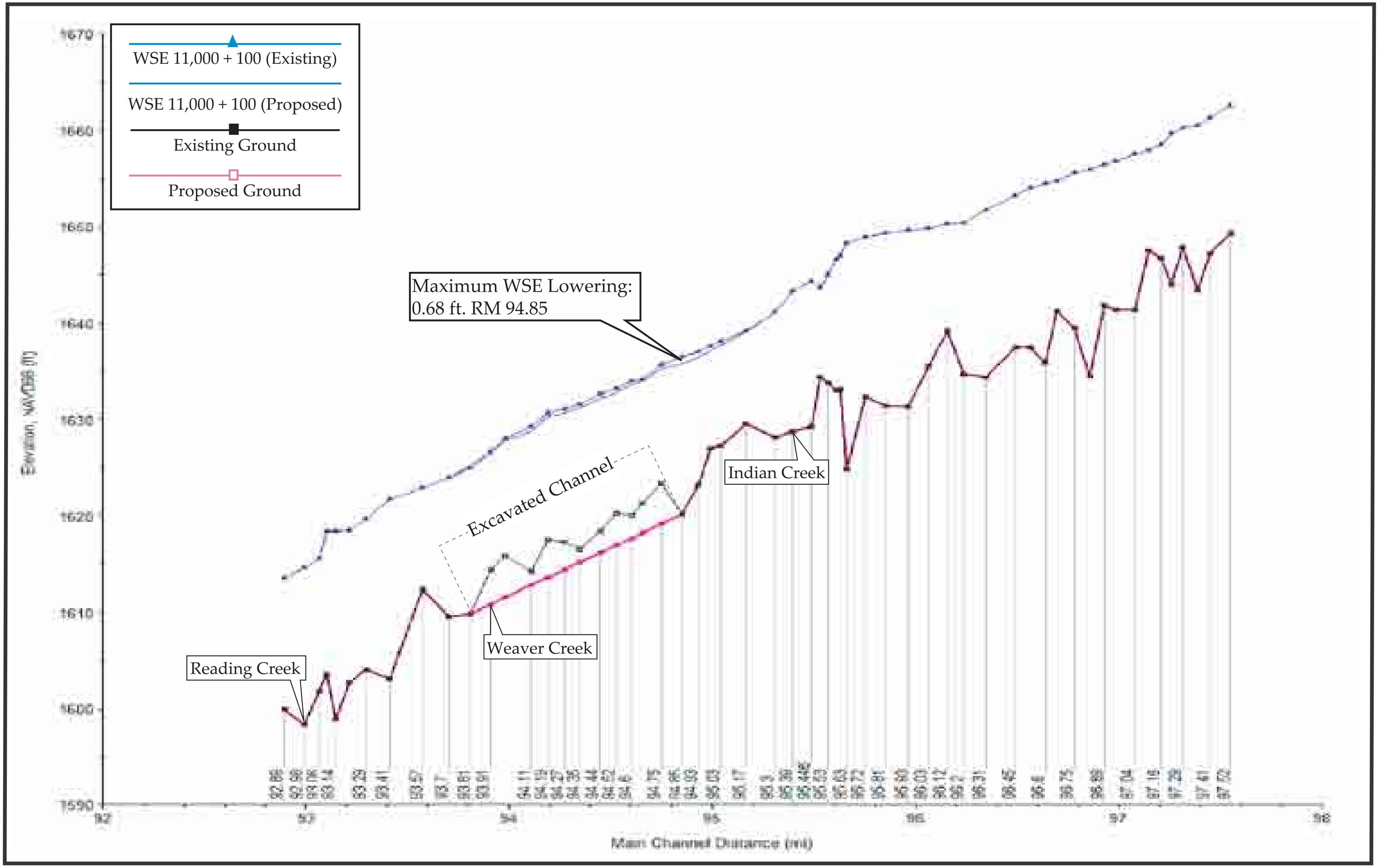
It is important to note that these analyses should not be compared with the 1976 USACE hydraulics study since the channel conditions have changed significantly due to morphological changes (e.g., riparian encroachment and channel aggradation and degradation) in the mainstem Trinity River and the named tributaries. Rather, this analysis adopts the FEMA hydrology and used best available topographic data to evaluate the relative impact to base flood elevations due to this project.



Source: TRRP, 2006

Figure 7

HEC-RAS Cross Section for Excavated Channel at RM 94.75
Douglas City/Indian Creek Reach, Mainstem Trinity River



Source: TRRP, 2006

Indian Creek Rehabilitation Site: Trinity River Mile 93.7-96.5

Figure 8

HEC-RAS Pofile for Excavated Channel Between RM93.81 and 94.85
Douglas City/Indian Creek Reach, Mainstem Trinity River

5 References

Brunner, Gary W. January 2001. HEC-RAS River Analysis System: User's Manual, Version 3.0; US Army Corps of Engineers (USACE), Hydraulic Engineering Center: CPD-68.

McBain, Scott. April 30, 2002. Estimation of 50-and 100-Year Tributary Accretion Floods, Lewiston Dam to Treadwell Bridge, Trinity River, California; McBain and Trush, Arcata, California.

US Army Corps of Engineers. April 1976. Flood Plain Information Report-Trinity River Lewiston Lake to Junction City, Trinity County, California.

US Bureau of Reclamation. November 2005. Trinity River, California Flood Plain Infrastructure Modifications Spring Flow Events DRAFT; Technical Service Center.

US Fish and Wildlife Service and Hoopa Valley Tribe. June 1999. Trinity River Flow Evaluation, Final Report; In consultation with the US Geological Survey, US Bureau of Reclamation, National Marine Fisheries Service, and the California Department of Fish and Game.