Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study

Klamath National Forest, Siskiyou County, California

PWA Report No. 09082801
April 2010

U.S. Department of the Interior
Bureau of Reclamation
Assistance Agreement # 07FG200131

Prepared for:
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1 PROJECT SUMMARY

Hotelling Gulch is a tributary of the South Fork Salmon River in Siskiyou County, California. Its watershed covers an area of approximately 1.2 mi^2, and it drains into the South Fork from the left bank approximately 4 mi upstream from the South Fork/North Fork Salmon River confluence. The Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study area encompasses approximately 5 acres on lands managed by the United States Forest Service, extending ~600 ft upstream from the confluence of Hotelling Gulch with the South Fork Salmon River through the Cecilville Road stream crossing.

Two of the most important elements of long-term restoration and maintenance of both water quality and fish habitat are the removal of migratory barriers to fish passage and the reduction of future impacts from upland erosion and sediment delivery. Migratory barriers at road-stream crossings fragment native historic fish populations and can eliminate viable habitat for spawning and rearing. An inventory and fish passage evaluation of road crossings in Siskiyou County, completed in March 2002, identified the county road crossing of Hotelling Gulch as a high priority site due to the severity of the barrier for all species and life stages of fish, as well as the quantity and quality of upstream habitat excluded (Ross Taylor and Associates, 2002). At the request of the Salmon River Restoration Council (SRRC), and through funding from the Bureau of Reclamation, Pacific Watershed Associates Inc. (PWA) completed a feasibility study to assess reasonable alternatives to barrier remediation and sediment reduction at the Hotelling Gulch study area.

For the study, PWA conducted topographic and longitudinal profile surveys, subsurface stratigraphic investigations, aerial photographic analyses, and geomorphic mapping, and subcontracted to Mike Love and Associates (professional engineers) to complete a hydraulic and sediment transport analysis. After analyzing the data collected, PWA developed two reasonable alternatives to fish barrier removal and to the reduction of future sediment delivery to Hotelling Gulch. Alternative I recommends channel modification along the existing alignment, and upgrading the current culverted stream crossing to a bridge. It also includes reconfiguring the existing channel profile and cross section at the bridge crossing, and grading the channel downstream from the bridge to allow for more efficient conveyance of sediment. Alternatives IIa and IIb recommend excavating a new channel alignment for Hotelling Gulch above the Cecilville Road and connecting it with an existing western channel alignment below the road. Similar to Alternative I, it includes upgrading the existing stream crossing structure to a bridge, and grading the channel both upstream and downstream of the bridge.

The expected benefit of completing the stream channel habitat restoration outlined in this study lies in the return of salmonid populations and long-term sustainability of salmonid habitat in Hotelling Gulch. Each alternative presented here represents a reasonable solution to fish barrier modification and sediment reduction in Hotelling Gulch, and when implemented in combination with protective land-use practices, can be expected to significantly contribute to the long-term improvement of water quality and salmonid habitat in the watershed. With the findings of this feasibility study, entities interested in the sustainability of the watershed and preservation of salmonid habitat can advance efforts to obtain funding and implement a habitat restoration plan for the Hotelling Gulch study area.

2 CERTIFICATION AND LIMITATIONS

This report, entitled *Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study*, was prepared by or under the direction of a licensed professional geologist at Pacific Watershed Associates Inc. (PWA), and all information herein is based on data and information collected under the supervision of PWA staff. Subsurface investigations and analysis for the project, were similarly conducted by or under the responsible charge of a California licensed professional geologist at PWA.

The interpretations and conclusions presented in this report are based on a study of inherently limited scope. Observations are qualitative, or semi-quantitative, and confined to surface expressions of limited extent, artificial exposures of subsurface materials and shallow exposures of subsurface earth materials during test pit excavations. Interpretations of problematic geologic and geomorphic features (such as unstable hillslopes) and subsurface stratigraphy are based on the information available at the time of the study and on the nature and distribution of existing features.

The conclusions and recommendations contained in this report are professional opinions derived in accordance with current standards of professional practice, and are valid as of the submittal date. No other warranty, expressed or implied, is made. PWA is not responsible for changes in the conditions of the property with the passage of time, whether due to natural processes or to the works of man, or changing conditions on adjacent areas. Furthermore, to be consistent with existing conditions, information contained in the report should be re-evaluated after a period of no more than three years. It is the responsibility of the landowner and the SRRC to ensure that all recommendations in the report are reviewed and implemented according to the conditions existing at the time of construction. Also, PWA is not responsible for recommendations implemented outside of their professional oversight. Finally, PWA is not responsible for changes in applicable or appropriate standards beyond our control, such as those arising from changes in legislation or the broadening of knowledge, which may invalidate any of our findings.

Certified by:

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William R. Lew, California Professional Geologist #7872
Pacific Watershed Associates Inc.

3 INTRODUCTION

Two of the most important elements of long-term restoration and maintenance of both water quality and fish habitat are the removal of migratory barriers to fish passage and the reduction of future impacts from upland erosion and sediment delivery. Migratory barriers at road-stream crossings fragment native historic fish populations and can eliminate viable habitat for spawning and rearing. Also, sediment delivery to stream channels from roads and road networks has been extensively documented, and is recognized as a significant impediment to the health of salmonid habitat (Harr and Nichols, 1993; Flosi et al., 1998). Unlike many watershed improvement and restoration activities, migratory barrier removal and erosion prevention along forest road systems has an immediate benefit to the streams and aquatic habitat of a watershed (Pacific Watershed Associates, 1994; Weaver and Hagans, 1994; Weaver et al., 2006). Barrier removal enables native fish populations to re-colonize historic spawning and rearing habitat, while future road-related sediment reduction ensures that the biological productivity of the watershed's streams is minimally impacted by future road related erosion, and that future storm runoff can cleanse the streams of accumulated coarse and fine sediment, rather than continuing to deposit excess sediment from managed areas.

The Salmon River watershed is one of the most biologically intact subbasins of the Klamath River drainage basin. It provides habitat to salmonids and other at-risk species, and is recognized as one of the largest cold-water contributors to the Klamath River, where recent large-scale fish kills have been attributed to poorly oxygenated warm water. The Salmon River subbasin supports a coldwater resident and anadromous fishery which includes: spring and fall run Chinook salmon (*Oncorhynchus tshawytscha*), summer and winter run steelhead (*O. mykiss*), coho salmon (*O. kisutch*), sea run Pacific lamprey (*Lampreta tridentata*), and green sturgeon (*Acipenser medirostris*). Non-anadromous species include Klamath speckled dace (*Rhinichthys osculus Klamathensis*), Klamath small scale sucker (*Catostomus rimiculus*), and marbled sculpins (*Cottus klamathensis*). Threespine sticklebacks (*Gasterosteus aculeatus*) may be present, but their use of the habitat is unconfirmed. Resident trout are located throughout the subbasin. Introduced fish stocks include American shad (*Alosa sapidissima*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*). Anadromous salmonid habitat is extensive in the subbasin, distributed among tributaries of the Main Stem, Wooley Creek, North Fork and South Fork Salmon River. The Klamath National Forest (KNF) identifies the Salmon River as the watershed with the best anadromous fisheries habitat in the Klamath National Forest (de la Fuente and Haessig, 1994). The basin provides habitat for the largest wild run of spring Chinook salmon in the entire Klamath River system. It is possibly the largest remaining wild spring Chinook run left in California (West, 1991). Problems facing coho salmon and other fish include invasive exotic species, barriers to fish passage, depleted large woody debris (LWD), high sediment loads from the extensive road system, large wildfires, limited riparian function due to mine tailings, unscreened water diversions, unstable spawning gravels, and nutrient and temperature impairment (NCRWQCB, 2005).

The Hotelling Gulch watershed covers an area of approximately 1.2 mi^2, and is a tributary to the South Fork Salmon River in Siskiyou County, California. Hotelling Gulch drains into the South Fork from the left bank approximately 4 mi upstream from the South Fork/North Fork Salmon River confluence. An inventory and fish passage evaluation of road crossings in Siskiyou County identified the county road crossing of Hotelling Gulch as a high priority site because it effectively prevents all species and life stages of fish from moving upstream to access a large area of high quality habitat (Ross Taylor and Associates, 2002).

In 2008, the Salmon River Restoration Council (SRRC), a non-profit organization committed to restoring ecological function and aquatic habitat in the Salmon River, and educating and empowering local riverine communities, received a grant from the U.S. Department of Interior Bureau of Reclamation (Reclamation) to conduct a stream crossing and channel realignment feasibility study for Hotelling Gulch. Reclamation's Klamath Basin Area Office provided the SRRC with grant funding through its 2007 Klamath Basin Restoration Program. Subsequently, SRRC contracted Pacific Watershed Associates Inc. (PWA) to conduct the feasibility study and develop reasonable alternatives to restoration of aquatic habitat in Hotelling Gulch. This involved a variety of tasks that are described in this report.

The general purpose and scope of the study is to: (1) develop and evaluate alternatives to barrier removal that will guide future restoration projects in Hotelling Gulch, both to enhance fish passage and reduce sediment delivery to the South Fork Salmon River; (2) identify potential complications associated with each alternative; (3) estimate the volume of earth and number of trees to be removed at the site; (4) evaluate the likelihood of long-term success; and (5) develop preliminary cost estimates for each alternative.

This study represents a critical first step in reducing road related fisheries habitat degradation in Hotelling Gulch. It includes a preliminary list of alternative treatments that consider not only the need to remove the fish passage barrier and prevent future sediment delivery from the stream crossing to Hotelling Gulch, but also to maintain a suitable transportation route for landowners, residents and emergency personnel. Upon completion of a thorough review process involving representative stakeholders, we believe that the final design alternative chosen through this assessment, if implemented and employed in combination with protective land use practices, will improve and protect water quality and salmonid habitat in the Hotelling Gulch and Salmon River watersheds.

4 FIELD DESCRIPTION OF THE STUDY AREA

4.1 Location and Travel Directions to the Field Area

The Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study (HGFS) area is located in southwestern Siskiyou County, California, approximately 2.5 mi southeast of the town of Forks of Salmon, and approximately 10 mi northwest of the town of Cecilville (Figure 1). The HGFS area is accessed from State Highway 96 by exiting onto Salmon River Road near

Somes Bar, and following Salmon River Road southeast for approximately 17 mi to the town of Forks of Salmon. Proceed through Forks of Salmon and turn right, across the North Fork Salmon River Bridge, onto Cecilville Road. Continue southeast on Cecilville Road for approximately 4 mi to the project area, where Cecilville Road crosses Hotelling Gulch. Hotelling Gulch Campground is located approximately 1/8 mi to the east of the HGFS area.

4.2 Regional Climate, Terrain, and Geology

The climate of the central Klamath Mountain region in the Salmon River watershed is characterized by dry, warm summers and cool winters with periods of intense rainfall and snow accumulation during cold storms. Mean annual precipitation ranges from 35 to 85 in., with most of the rainfall occurring between November and April (NCRWQCB, 2005). Elevation ranges from approximately 450 ft to 8,920 ft in the Salmon River basin (USGS, 1979a, b).

The Salmon River watershed is located in steep, mountainous terrain, with hillslope gradients frequently exceeding 70% along inner gorges, headwalls, and upper ridge slopes. Vegetation types are highly variable throughout the watershed and include both conifer and hardwood forests, low level chaparral/brush lands, prairie/grassland, and barren, relatively vegetation free landscape in dominantly rocky areas (de la Fuente and Haessig, 1994).

The geology of the Salmon River watershed is composed of diverse rock groups including several distinct metamorphic belts, intrusive granitic batholiths, alluvial terrace deposits, colluvial deposits, and recent alluvial deposits. The Salmon River watershed is part of the greater regional physiographic Klamath Mountain province. Poorly consolidated and sheared metamorphic rocks as well as deeply weathered granitic rocks that are particularly susceptible to erosion and mass wasting during periods of sustained or heavy rainfall are exposed throughout the watershed. Large- and small-scale mass wasting is evident and pervasive within the watershed, including a significant historical record of landslides that have had major impacts on the main stem Salmon River (de la Fuente and Haessig, 1994). Hillslope debris slides, earthflows, slumps, cutbank landslides, and road fill landslides have all occurred within the watershed.

All 4 species of anadromous salmonids as well as the Pacific lamprey and green sturgeon are all present in the Salmon River watershed. Of significance for salmonid habitat, the combination of high rainfall and erodible, potentially unstable geologic substrate results in high rates of erosion and sediment delivery from road networks to stream channels. The lower tributaries and main channels alternately traverse gorges with steep and unstable slopes, and low-gradient reaches where sediment deposition and accumulation is amplified, especially as a result of historical mining and road building practices. Whereas salmonid populations have evolved and flourished with the natural processes of rainfall and erosion in the area, the impact of anthropogenically induced habitat fragmentation and erosion (e.g., mining, timber production and road construction) has resulted in a degradation of salmonid habitat and accelerated sediment delivery to streams in this important watershed.

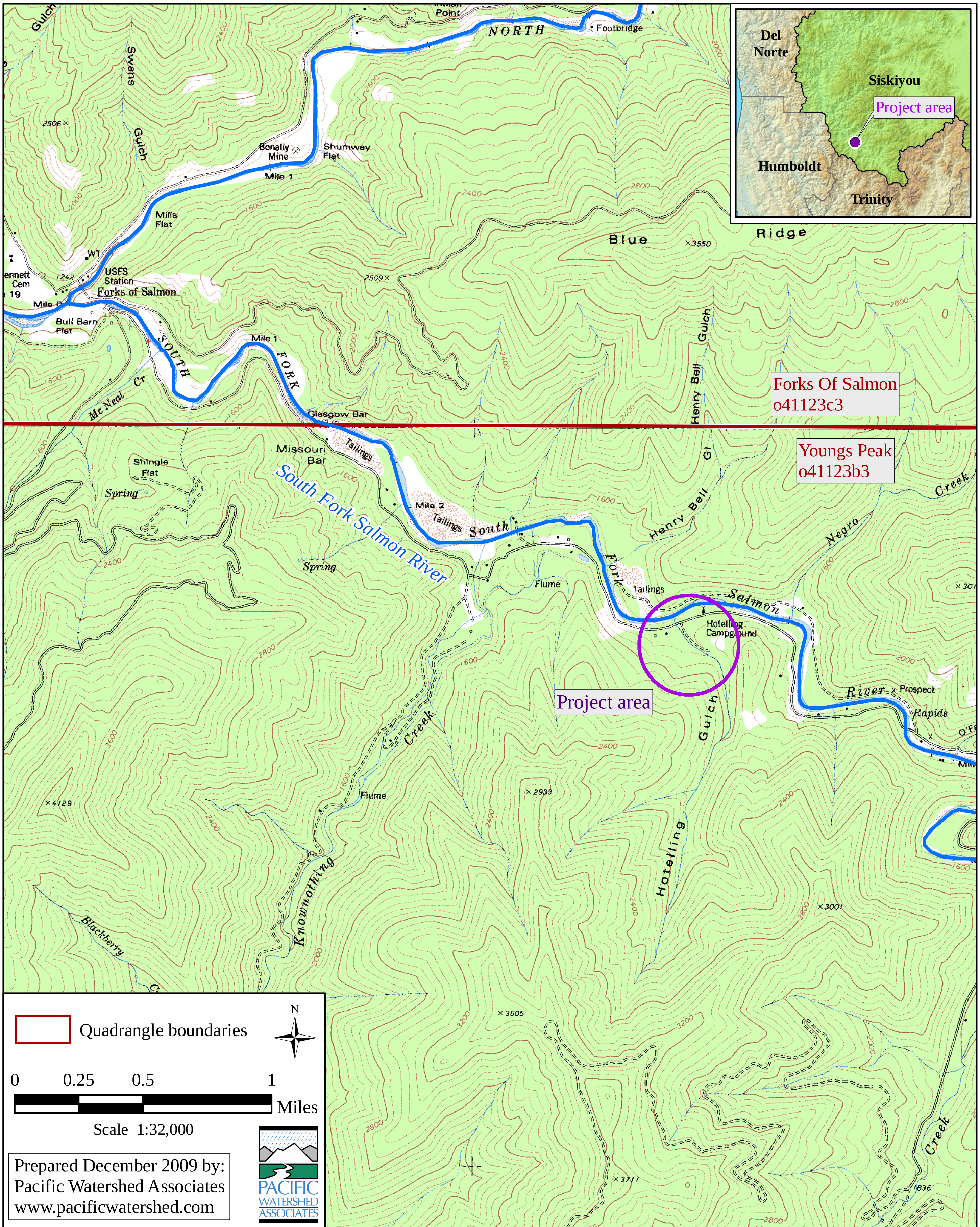

Figure 1. Location of the Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study, Klamath National Forest, Siskiyou County, California.

4.3 Overview of the HGFS area

Hotelling Gulch is a tributary of the South Fork Salmon River, draining into the South Fork from the left bank approximately 4 mi upstream from the South Fork/North Fork Salmon River confluence. The watershed for Hotelling Gulch is approximately 1.2 mi^2 in area, and located primarily on United States Forest Service (USFS) property.

Cecilville Road (a Siskiyou County maintained road) crosses over Hotelling Gulch with a double culverted fill crossing approximately 200 ft upstream from its confluence with the South Fork Salmon River. Currently, two 36 in. culverts are set near the base of fill (Map Sheet 1). With this current crossing design, however, stream flow begins to divert to the left down the inboard ditch during 2.33-year return interval storm flows (Mike Love and Associates, 2009; Appendix C). As a result, this county road crossing has been rebuilt multiple times over the years due to storm-based damage from capacity exceedance (Ross Taylor and Associates, 2002). Another drainage culvert conveys flow under the county road approximately 200 ft to the west of the current Hotelling Gulch culverted stream crossing. This culvert discharges flow from an intermittent swale above the road leading into a perennial stream channel below the road (Map Sheet 1). This location has been discussed as being the "original" Hotelling Gulch watercourse alignment. Both road crossings, as well as adjacent flat areas, lie within a large alluvial fan setting where channel deposits were strongly reworked during historical hydraulic and placer mining activities starting in the mid to late 1800s.

An analysis conducted by Ross Taylor and Associates (2002) identified Hotelling Gulch as being a high priority site for fish barrier remediation, based on evidence that the stream crossing was a complete barrier for all species at all life stages. A stream channel survey of Hotelling Gulch further showed that up to 1.4 mi of suitable spawning and rearing habitat exists above the current county road crossing. Over the course of more than 300 minutes of observation at the culvert outlet, although juvenile salmonids were observed below the outlet, no leap attempts were observed (Ross Taylor and Associates, 2002). Fishery surveys conducted in the Hotelling Gulch watershed by SRRC staff over the last 10 years have not recorded any salmonids above the culverts. However, juvenile salmonids (young of year) have been recorded above the crossing by Ross Taylor and Associates (2006).

Similar to many geomorphically comparable areas in the Salmon River watershed, much of the upper and middle Hotelling Gulch watershed is located in steep, mountainous terrain with hillslope gradients frequently exceeding 70% along inner gorges, headwalls and upper ridge slopes. In contrast, the area of the lower Hotelling Gulch watershed where the culvert structures are currently located, as well as extending several hundred feet upslope from the Cecilville Road, is a topographic low gradient strath terrace, where deposition or aggradation of upslope-derived alluvium and colluvium has resulted in a broad alluvial fan/river terrace complex. Subsurface and surface investigations indicate that the alluvial/colluvial deposits in this area are of varying thicknesses (~1-30 ft; Map Sheet 2), and are underlain by the Western Paleozoic/Triassic belt meta-sedimentary rocks (meta-sandstones, etc.; Wagner et al. 1987). Field evidence suggests most of the alluvial/colluvial cap has been reworked by historical mining activities (see results section). Within the steeper middle watershed above the project area, the Western Paleozoic/Triassic belt meta-sedimentary rocks and lenses of colluvium are exposed at the surface and in road cuts. Both aerial photo and field evidence suggest that hydraulic mining of hillslope materials above the project area has significantly disturbed natural hillslope and channel morphology, as well as alluvial stratigraphy, within the lower Hotelling Gulch watershed.

5 METHODS AND DATA COLLECTION

The HGFS involved a series of field and office related tasks that were completed in order to develop the analysis, findings and conceptual alternatives. The HGFS project consists of five distinct elements: (1) conducting background studies; (2) developing detailed topographic surveys of the field area, (3) conducting surface and subsurface geomorphic and hydrologic investigations, (4) conducting preliminary hydraulic modeling, and (5) compiling findings and developing preliminary conceptual design alternatives. All project elements were completed under the direction of a PWA licensed professional geologist.

During the first element of the HGFS project, PWA staff analyzed sequential historical aerial photographs and a set of digital imagery to document the history of channel and hillslope geomorphic changes within the HGFS area. Five sets of aerial photographs and one set of National Agricultural Imagery Program (NAIP) digital imagery were used in the analysis. The NAIP imagery was for 2005 (CaSIL, 2005), and the aerial photo years and approximate scales were 1944 (1:24,000), 1955 (1:24,000), 1964 (1:16,000), 1971 (1:18,000), and 1980 (1:12,000). A review of available documents related to the study area was also conducted, including: (1) Siskiyou County Culvert Inventory and Fish Passage Evaluation (Ross Taylor and Associates, 2002); (2) Catalog of Siskiyou County Culverts Located on Fish-Bearing Stream Reaches (Ross Taylor and Associates, 2002); (3) Hotelling Gulch preliminary habitat assessment field notes and comments (Ross Taylor and Associates, 2006); and (4) Geologic Map of the Weed Quadrangle (Wagner et al., 1987). A complete list of all documents reviewed for the HGFS is provided in Section 9 (References).

For the second element of the project, PWA used a total station to complete a detailed topographic landform survey and develop a detailed topographic base map of the project area and immediate surroundings. The resultant 2 ft contour interval base map (Map Sheet 1) accurately shows a series of features including stream channel locations, road alignments within the project area, stream crossing locations, and potential channel alignment alternatives. In addition, separate longitudinal profiles were surveyed along existing and potential channel alignment alternatives.

The third element of the HGFS included geomorphic mapping, collecting data for sediment transport analysis, and evaluating subsurface geology at a series of excavation pits. An important aspect of the geomorphic mapping and surveying was identifying surface exposures of bedrock, as near-surface bedrock constraints are of primary concern in determining whether or not a channel alignment could be constructed without drilling or blasting rock. Pebble counts were conducted using the Wolman (1954) technique along transects of the active channel in order to determine bedload particle size distribution for sediment transport analysis, and provide data for hydraulic modeling. For the subsurface testing, exploratory test pits were excavated with a hydraulic excavator in order to: (1) analyze stratigraphic correlations across the alluvial surfaces, (2) determine bedrock contact and water table elevations near existing and alternative channel alignment locations, and (3) support earth moving volume and cost estimates along alternative channel alignment locations.

The fourth project element, a preliminary hydraulic analysis, was completed by Mike Love and Associates (MLA, 2009). A copy of their report on the methods and result of the analysis, including stream channel and road crossing sizing for the current alignment of Hotelling Gulch, is provided in Appendix C.

The final phase of the project involved summarizing and synthesizing the background information, field data, and results of the hydraulic analysis to present a list of preliminary findings and alternative recommendations for guiding future planning efforts and engineering designs for the Hotelling Gulch fish barrier remediation.

6 RESULTS

6.1 Aerial Photographic Analysis

PWA staff analyzed sequential historical aerial photographs and a set of digital imagery to document the history of channel and hillslope geomorphic changes within the HGFS area. Five sets of aerial photographs and one set of National Agricultural Imagery Program (NAIP) digital imagery were used in the analysis.

Based on the stereoscopic analysis, the location of the Hotelling Gulch channel has shifted over time. In the 1944, 1955 and 1964 photo sets, the main Hotelling Gulch channel is located to the west of its current location (Figure 2). This is indicated by a riparian vegetation corridor that veers west of its current configuration upstream from the Cecilville Road crossing. The channel configuration visible in the photo sets from 1971 and later closely approximates the current configuration. However, the geomorphic channel expression along the alluvial fan of Hotelling Gulch is difficult to discern in the photos due to minimal relief and poor resolution of the available photo sets. Therefore, some uncertainty lies in the interpretation of the exact channel location. Some lateral channel migration from any known position has likely occurred historically due to the geomorphic nature of this alluvial fan setting and due to the past extensive mining disturbance of the alluvial deposits.

The first available photo set (1944) indicates a significant area (~2.5 acres) of ground disturbance several hundred feet above the Hotelling Gulch crossing (Figure 2). Both aerial photo analysis and on-the-ground geomorphic reconnaissance indicate that it was a hydraulically mined hillslope area. Large placer deposit piles appear just below the mined area and extend across the

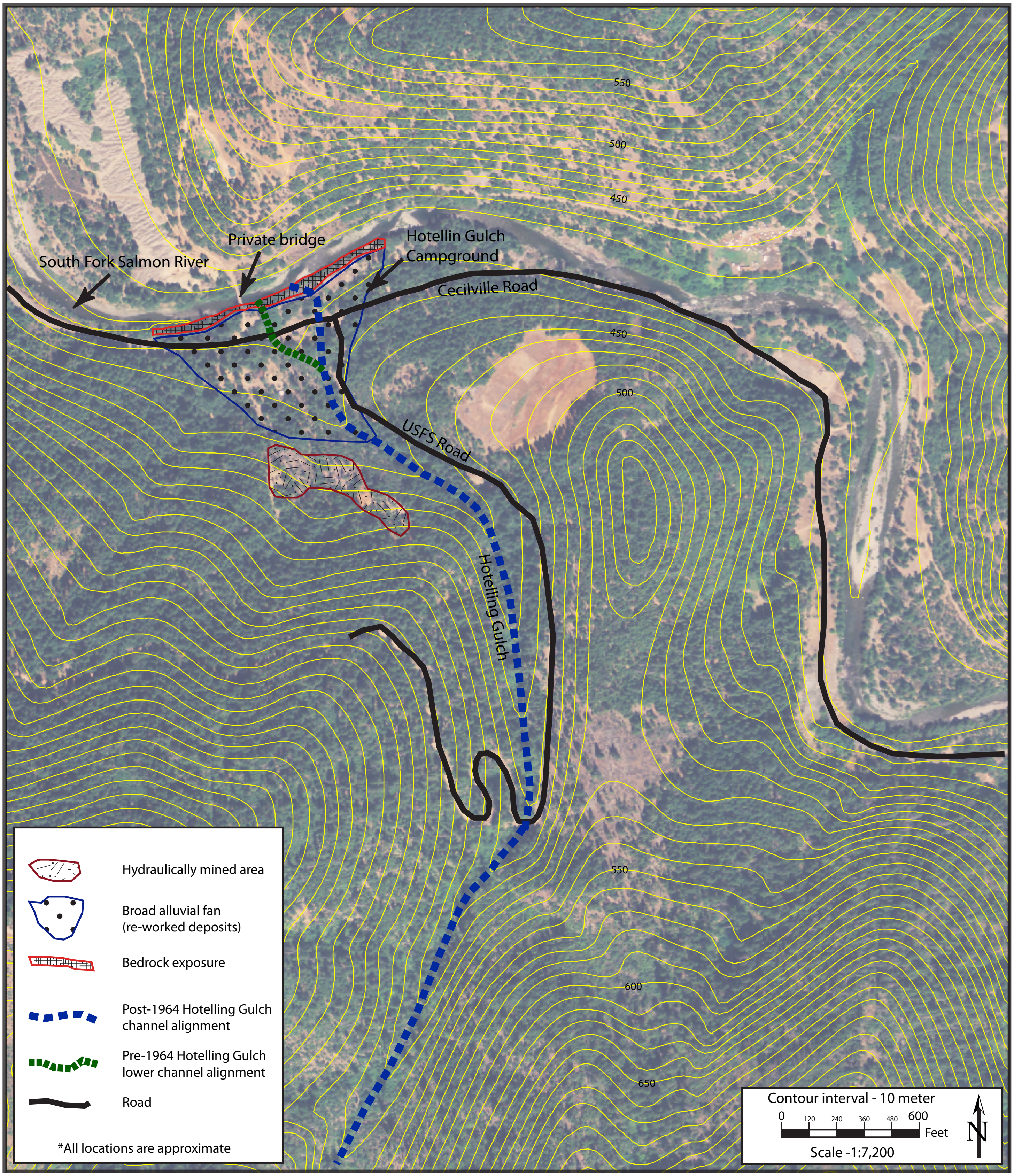

Figure 2. Geomorphic features of the Lower Hotelling Gulch project area. Mapping based on aerial photo anaysis and field reconaissance. Base mapping imagery from USDA 2005 NAIP. Contour layer generated from USDA 10 meter DEM.

alluvial fan surface below. Based on the extent of revegetation visible on the 1944 photos, major hydraulic placer mining activity appears to have ceased prior to the 1944 photo year.

6.2 Topographic Surveys

In order to evaluate channel modification, and design alternatives for stream crossing barrier remediation, a detailed topographic survey was required. The survey was used to develop a 2 ft contour interval topographical base map showing the location of roadways, drainage structures, stream channels, bedrock outcrops, etc., within the immediate project vicinity (Map Sheet 1). Next, longitudinal surveys were completed along the existing and proposed channel alignments to evaluate channel slopes, estimate the length of potential channel disturbance, and estimate the volume of earthen material to be excavated (Map Sheet 2).

Using a total station, a control network traverse loop was established around the project area. Wooden lath and rebar or galvanized nail spikes were set into the ground to be used and reoccupied as instrument stations or back sites for the topographic survey. From this control network, over 800 points were shot along strategic transects, to document slope breaks and other relevant topographic features, in order to develop the topographic base map. During the longitudinal profile survey, the total station was set up on control network stations with the best visibility to the stream, and points were shot at channel breaks within the thalwag. This thalwag profile was completed from upstream of the project area down to the confluence with the South Fork Salmon River.

Northing, easting, and elevation (NEZ) coordinates were developed for all points. These coordinates were imported into Autocad 2009 Civil 3D software in order to construct a digital terrain model (DTM) and, subsequently, a 2 ft contour interval base map. During the survey, no horizontal or vertical benchmarks were tied to, therefore, all coordinates generated for the survey are relative.

6.3 Geomorphic Mapping

To evaluate the surficial constraints of existing and alternative channel locations, a geomorphic field reconnaissance of the project area was completed. Surficially exposed bedrock, nearby hydraulically mined hillslopes, engineered structures (i.e., roads, crossings), stream channel locations, etc., were all identified in the field. These geomorphic features are illustrated on Figure 2 and Map Sheet 1).

6.4 Sediment Transport Analysis

MLA conducted a competence-based sediment transport assessment to estimate the size of sediment mobilized during specific flow events, as well as to identify locations likely to experience sediment deposition and channel aggradation through time (their complete report is in Appendix C).

PWA staff conducted 3 pebble counts along transects of the active channel to determine bedload particle size distribution for MLA's sediment transport and hydraulic modeling analysis. Results of the pebble counts are shown in Table 1 as well as in MLA's Hotelling Gulch Technical Memorandum (Appendix C).

Table 1. Pebble count results, Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study.

Pebble Count #1 Sample taken approximately 250 feet above culvert inlet		**Pebble Count # 2** Sample taken approximately 15-35 feet above culvert inlet		**Pebble Count # 3** Sample taken approximately 25-45 feet below culvert outlet	
Particle size (inches)	**Frequency**	**Particle size (inches)**	**Frequency**	**Particle size (inches)**	**Frequency**
20.2 - 28.5	0	20.2 - 28.5	0	20.2 - 28.5	0
14.3 - 20.2	2	14.3 - 20.2	0	14.3 - 20.2	0
10.1 - 14.3	2	10.1 - 14.3	3	10.1 - 14.3	0
7.1 – 10.1	2	7.1 – 10.1	5	7.1 – 10.1	1
5.0 – 7.1	6	5.0 – 7.1	5	5.0 – 7.1	3
3.6 – 5.0	10	3.6 – 5.0	11	3.6 – 5.0	4
2.5 – 3.6	9	2.5 – 3.6	9	2.5 – 3.6	9
1.8 – 2.5	7	1.8 – 2.5	8	1.8 – 2.5	7
1.3 – 1.8	7	1.3 – 1.8	8	1.3 – 1.8	10
0.9 – 1.3	6	0.9 – 1.3	12	0.9 – 1.3	13
0.6 – 0.9	5	0.6 – 0.9	10	0.6 – 0.9	12
0.4 – 0.6	9	0.4 – 0.6	9	0.4 – 0.6	14
0.3 – 0.4	8	0.3 – 0.4	6	0.3 – 0.4	8
0.2 – 0.3	5	0.2 – 0.3	6	0.2 – 0.3	10
< 0.2	22	< 0.2	9	< 0.2	13
D_{50} = 0.7 inches		D_{50} = 0.9 inches		D_{50} = 0.6 inches	
D_{84} = 3.1 inches		D_{84} = 3.2 inches		D_{84} = 1.8 inches	

Generally, the pebble count results show a larger particle size distribution upstream from the Hotelling Gulch stream crossing. MLA's sediment transport analysis results show that channel shear stresses required to transport the D_{84} particle size drop below threshold limits within 35 feet of the Hotelling Gulch stream crossing. Channel shear stress loss and associated aggradation is due to a backwater effect caused by undersized drainage structures at the stream crossing (see p. 8 of the MLA report, Appendix C). Due to these existing hydraulic conditions, aggradation and regular culvert plugging are likely to continue. Additionally, for 60 ft immediately below the Hotelling Gulch stream crossing, channel shear stresses required to transport the D_{84} particle size also drop below threshold limits. This is caused by a channel constriction below, again resulting in a backwater effect. Continued aggradation within this reach is a likely result. MLA's Technical

Memorandum provides a detailed discussion regarding the relationship between channel shear stress and sediment transport through the existing channel within the Hotelling Gulch project area.

6.5 Subsurface Testing

To understand stratigraphic correlations between bedrock and overlying alluvium, as well as lateral variations in seasonal water table depths, exploratory test pits were excavated using a hydraulic excavator. SRRC hired an equipment operator to excavate exploratory pits based at locations chosen by PWA's Professional Geologist. Test pits were selected at locations adjacent to potential and existing channel alignments in order to determine if there was underlying bedrock present, which could constrain whether channel reconstruction would be possible without blasting.

Nine test pits were excavated in November of 2008 (Map Sheet 1) to develop stratigraphic logs showing, where possible, depth to bedrock relative to the ground surface, as well as the relative water table surface elevations. In general, the alluvial stratigraphy is interpreted to be the result of extensive reworking by historical mining activities, road construction, etc. As shown on Map Sheet 2, subsurface units consisted primarily of unlaminated (massive), unsorted heterogeneous deposits, with rounded to subrounded particles ranging in size from sand to boulder. There are no definitive paleocurrent pattern indicators or other sedimentary structures indicative of fluvial environments.

In 7 of the 9 test pits, depth to bedrock was clearly identified and ranged from approximately 2 ft below ground surface elevation in Test Pit 1 to over 18 ft in Test Pit 7. In Test Pits 8 and 9, the excavator reached 18 ft (TP8) and 15 ft (TP9) below the ground surface elevation and either the bedrock was deeper than the excavator's workable reach, or groundwater inflow obscured visibility and it was not possible to determine if bedrock had been reached. In all test pits, the seasonal water table surface was identified and ranged from approximately 1 ft below ground surface elevation in Test Pit 1 to over 16 ft in Test Pit 8. Prior to backfilling the test pits, the bedrock/alluvium contact, the water table surface elevation, and the test pit aerial extent were surveyed (Map Sheets 1 and 2).

Based on this limited preliminary subsurface investigation within the project area, the seasonal water table appears to be sloping downgradient approximately 5 %, north 20 degrees west in direction towards Alternative lla alignment. Northward from Alternative lla, downgradient direction veers easterly toward a subsurface bedrock depression where the water table and bedrock surface appeared lowest in elevation (TP3; Map Sheet 1). The water table gradient and direction are unknown northward from Test Pits 1, 3 and 4.

6.6 Hydraulic Analysis

MLA conducted a hydraulic feasibility analysis that focused on the creation of a stable channel profile and crossing replacement within the existing alignment of Hotelling Gulch at Cecilville Road. The feasibility analysis included consideration of fish passage as well as more efficient conveyance of streamflow, sediment, and debris (Appendix C).

Hydraulic modeling results indicate that at flows less than the 2.33-year return period storm, stream flow diverts down the inboard ditch to the left. The volume of stream flow that diverts increases as stream flow increases up until the 50-year return period storm flow event. (MLA report, p. 6; Appendix C). MLA's hydraulic analysis provides estimated return period storm discharges, detailed cross-sectional and channel profile stage height/storm event relations, and channel cross-sectional design requirements based on hydraulic conditions (Appendix C). A final hydraulic analysis will be required during the final design when the most likely alternative is chosen for implementation.

7 DISCUSSION

This section describes 2 alternative approaches for improving fish passage at the crossing of Hotelling Gulch on Cecilville Road. Alternative I involves channel modification along the existing alignment, and upgrading the stream crossing culvert drainage structure to a bridge. It also includes reconfiguring the existing channel profile and cross section at the bridge crossing, and grading the channel downstream from the bridge to allow for more efficient conveyance of sediment. Alternative II involves excavating a new channel alignment for Hotelling Gulch above Cecilville Road and connecting it with an existing western channel alignment below the road. Similar to Alternative I, it includes upgrading the crossing to a bridge and grading the channel to more efficiently convey sediment. Each alternative exhibits benefits to fish passage. However, there are potential complications and constraints that must be considered to promote long-term success for fish passage and sediment reduction.

7.1 Alternative I - Eastern Channel Alignment (Existing Location)

7.1.1 Existing conditions

Currently, the existing conveyance of Hotelling Gulch streamflow occurs along the eastern channel and crosses Cecilville Road through two 36 in. diameter culverts (Map Sheet 1). During flows less than the 2.33-year return period storm flow, the crossing capacity is exceeded and stream flow diverts down the inboard ditch to the left (Appendix C). The existing undersized culverts create a fish passage barrier for salmonids of all age classes due to excessive water velocities at high fish passage flows, and insufficient water depths at low fish passage flows (MLA report, p 1; Appendix C). In addition, the lower eastern channel from the road crossing downstream tends to dry up during summer flow conditions.

7.1.2 Proposed modifications

Alternative I primarily involves channel modification along the existing alignment and upgrading the stream crossing structure to a bridge, as described in MLA's Technical Memorandum. MLA further proposes 2 different alternatives to channel grading (Alternatives A and B, MLA report p. 9; Appendix C). Alternative A includes reconfiguring the existing channel profile and cross section at the bridge crossing, while Alternative B includes additional channel grading downstream from the bridge to allow for more efficient conveyance of sediment. Additionally, to prevent roadway flooding, the existing low left bank upstream of the crossing should be raised to an elevation sufficient to contain the 100-year flow, but should be substantially lower than the bottom of the bridge deck (MLA report, p. 11; Appendix C). Through the channel regrade section downstream from the new bridge, it is proposed that the banks are sloped back to a 2:1 (H:V) grade with a 12.5 ft final channel width. For the channel reach through the new bridge section, it is proposed that the banks be sloped back to 1.5:1 (H:V) grade with a 12.5 ft final channel width, and rip-rap be placed along the sideslopes to prevent bridge abutment scour. The final channel, with an approximate 175 ft regrade length, will transition from ~ 2% slope in the lower section to over 4% slope in the upper section. For additional details regarding channel profile and cross section regrade configuration, bridge crossing design, and necessary roadway improvement, see Appendix B, Drawings 1 & 2, and Appendix C, MLA Technical Memorandum.

7.1.3 Fish passage and sediment reduction benefits

The proposed modifications to the existing channel and stream crossing are intended to promote fish passage for both adult and juvenile salmonids at flows which would normally be conducive to passage under natural conditions. The proposed design is intended to simulate geomorphic and hydraulic conditions that would occur in the channel if no crossing existed.

The existing stream crossing structure is severely undersized for the 100-year return period storm flow, and discussions with Siskiyou County Public Works staff indicate that the culvert structures have been reset and/or repaired from high water damage during the 1997 and 2006 storm flows. Culvert plugging and overtopping due to capacity exceedance has likely caused partial to complete washout of the stream crossing fill on multiple occasions, and subsequent downstream delivery of sediment to Hotelling Gulch. Upgrading the existing culverted fill to a bridge crossing capable of conveying the 100-year storm flow, sediment, and debris will result in a reduction of future sediment delivery to Hotelling Gulch and the South Fork Salmon River.

7.1.4 Project constraints and limitations

A constraint for adult salmonids success in migrating upstream is the ability of fish to travel up through the steep bedrock cascade at the mouth of Hotelling Gulch. During low/moderate level (~800 cfs) spring flow conditions there is approximately 8 ft of fall (vertical) over the last 40 ft of channel (horizontal). Under most conditions, that is an unsuitable grade for the upstream migration of salmonids. However, juvenile salmonids have been identified above the cascade. At this point, no hydrologic or hydraulic analysis has been completed to determine what river stage levels or return interval flows (on South Fork Salmon River) allow for upstream migration of salmonids into Hotelling Gulch. Likewise, implementing Alternative I will have little effect on the duration of surface water flow through the dry season.

Given that the availability of money will ultimately become a constraint to design and construction costs, it should be considered that modifications of the proposed design may be necessary to conform within these monetary constraints. Several additional alternatives discussed during the review of the draft report include: (1) re-aligning the road upstream where the channel remains better defined and exhibits sediment transport characteristics and less depositional characteristics; (2) lowering the level of the bridge base to less than 5 feet above the vertical adjustment profile; and (3) designing the engineered channel and bridge for a lower return period peak flow event in addition to incorporating a "weak link" overflow channel as a safety valve where exceedance flows may divert to the west and pass under the road at the lower location (Scott Sumner, Siskiyou County Public Works, personal communication, January 2010). These alternatives may be valid suggestions for lowering the cost of design and/or construction; however they have not been evaluated during this initial feasibility study.

7.1.5 Potential complications

The current channel lies within a broad alluvial fan that has likely been subject to multiple episodes of lateral channel migration, and periodically received large influxes of sediment through time. This is supported by evidence that, as recently as 1964, the channel was located to the left of its current configuration (Section 6.1). Therefore, there is some likelihood that future influxes of sediment could shift the upstream channel laterally and divert flows outside of its current alignment. Should this occur, there would likely be damage to the engineered channel, bridge, and/or roadway. Similarly, large influxes of upstream sediment could reduce capacity under the bridge, and reduce the effective conveyance of stream flow. It would be reasonable to expect that some level of maintenance would be required to sustain flow conveyance within its current configuration for the design life of the project.

7.1.6 Earthwork and vegetation disturbance

Based on MLA's design considerations for Alternative I, and survey data collected at the study area, physical alteration of earthen materials and removal of vegetation will be limited to: (1) removal of the existing stream crossing with 1.5:1 (H:V) sideslopes and 12.5 ft channel width; (2) excavation of footings for the new bridge; (3) grading of the channel profile and cross section through the bridge reach; (4) grading of the channel profile and cross section through the reach below the bridge (for MLA Alternative B) with 2:1 (H:V) sideslopes and 12.5 ft channel width; (5) construction of an earth berm to prevent diversion of stream flow to the left; and (6) addition of structural backfill and grading, for roadway improvements and transitions along both Cecilville Road and the USFS road. The road surface will have to be raised approximately 5 ft to accommodate the new bridge installation. Table 2 provides estimates for earthmoving and tree removal during construction.

Table 2. Estimates for earthmoving and tree removal during construction, Alternative I, Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study.

Construction element	Volume of earthen material moved (yd^3)	Trees removed (# > 4 in. DBH)
Stream crossing fill removal[1]	150	0
Excavation for bridge footings / foundation[2]	125	3
Regrade channel downstream (MLA Alternative B)[3]	140	8
Earth berm to prevent stream diversion	150	4
Roadway Improvements[4]	980	0
Totals	1,545	15

[1] Excavation and removal of the fill volume associated with the crossing, with a 12.5 ft channel width and 1.5:1 (H:V) sideslopes.
[2] Excavation and removal of fill for both the left and right footings.
[3] Excavation and removal of stored channel sediments, with a 12.5 ft channel width and 2:1 (H:V) stream bank slopes.
[4] Additional structural backfill necessary to meet AASHTO vertical and sag curve profile guidelines.

7.1.7 Preliminary cost estimates

The major costs associated with the implementation of Alternative I are outlined in Table 3. Specific work tasks include, but may not be limited to: (1) physical earthwork related to stream crossing removal, stream channel regrade, footing excavations, and roadway improvements; (2) final engineering design; and (3) final planning for permitting approval through State, federal, and local agencies. Contingency funds (estimated @ 25%) have been included to account for variations or increases in material and equipment costs, as well as unforeseen problems or additional project elements. The costs outlined are preliminary, subject to revision, and are to be used for planning purposes only. The estimated cost to implement Alternative I is approximately $294,000.

Table 3. Preliminary estimated costs for Alternative I, Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study.

Cost category	Work product / action	Estimated cost ($)
Stream crossing removal and stream channel regrade (MLA Alternatives A and B)[1]	Excavate crossing and grade channel to specified profile and cross section	7,000
Bridge materials and foundation[2]	Construct foundation and install bridge	120,000
Roadway improvements and earth berm construction[3]	Construct road approach / bridge transitions, USFS Road / Cecilville Road transition, repave alignment, etc.	48,000
Engineering and geotechnical	Civil and structural design and geotechnical analysis	45,000
Permitting	CEQA / NEPA compliance, Siskiyou County permits, etc.	15,000
	Subtotal	235,000
	Contingencies ~ 25% of Subtotal	59,000
	Totals	**294,000**

[1] Stream crossing removal and channel regrade/excavation costs are based on excavation production rates and prevailing wage equipment costs derived from several recently completed projects of a similar nature. Costs assume 45 yd^3/hr production rate using an excavator ($190/hr), 2 dump trucks ($105/hr each) a bulldozer ($160/hr) and a laborer ($80/hr) for dewatering activities.
[2] Costs assume $55,000 for bridge as quoted by manufacturer and 90% additional for installation. Also $15,000 has been included for guard rails, foundation materials, rip-rap, etc.
[3] Costs assume $30/$yd^3$ for structural backfill and $120/ton asphalt for repaving the roadway.

7.2 Alternative II (IIa and IIb) - Western Channel Alignment

7.2.1 Existing conditions

As previously discussed, currently the existing conveyance of Hotelling Gulch stream flow occurs along the eastern channel and crosses Cecilville Road through two 36 in. diameter culverts. Approximately 200 feet to the west, there is an additional drainage structure (a 36 in. diameter culvert) that conveys runoff from a man-made swale in direct alignment with the culvert, as well as flow from the approaching inboard ditch, and diverted flow from Hotelling Gulch when the Cecilville Road stream crossing capacity is exceeded. Below the western culvert outlet, a channel emerges and perennial stream flow is conveyed approximately 200 ft to the South Fork Salmon River (Map Sheet 1). This western channel location has been described as the "original" pre-1964 stream alignment; however, the long history of mining across the whole alluvial fan surface precludes knowing exactly where the natural channel was originally located.

7.2.2 Proposed modifications

Alternative II involves excavating a new channel alignment for Hotelling Gulch above Cecilville Road and connecting it with the existing western channel below the road. Two separate proposed alignments, the middle (IIa) and west (IIb) alignments, were considered to be feasible options (Map Sheet 1). The new, excavated channel above the stream crossing would tie into the existing Hotelling Gulch channel either at approximately 250 ft upstream (middle channel) or 400 ft upstream (west channel) (Map Sheet 1).

Alternative IIa alignment would require approximately 250 ft of new excavated channel above the road, with 2:1 (H:V) sideslopes, 12.5 ft final channel width and several broad channel bends that would require rip-rap to prevent bank scour and excessive lateral migration. The preliminary design grade for the constructed channel reach above the road is 5.8%, which is similar in grade to the approaching (6.1%) upstream channel. Similarly, Alternative IIb alignment would require approximately 400 ft of new excavated channel above the road, with 2:1 (H:V) sideslopes, 12.5 ft final channel width and several broad channel bends that would require rip-rap to prevent bank scour and excessive lateral migration. The preliminary design grade for the constructed channel reach above the road is 6.6%, which is steeper in grade to the approaching (6.1%) upstream channel. Based on initial surveys and preliminary design work, channel cross section and slope grade would be comparable to the east channel (Appendix B). However, the exact alignment, cross section, sinuosity, and slope grade may vary, based on the final hydraulic analysis and engineered channel design.

In addition to constructing up to 400 ft of new stream channel above the road, the culvert drainage structure would need to be upgraded with a bridge crossing and approximately 60 ft of downstream channel will require regrading to increase channel capacity, similar to that proposed in Alternative I. However, further hydraulic and site analysis are needed to determine the exact design parameters for the bridge and channel.

Preliminary subsurface investigations indicate that the excavation of a new channel along either the middle or west alternative alignment is feasible without blasting or drilling bedrock. Heterogeneous alluvium overlies metamorphic bedrock of the Hayfork terrain, which, based on subsurface investigation, appears to be deeper than would be necessary for the new channel excavation.

7.2.3 Fish passage and sediment reduction benefits

Preliminary topographic and longitudinal surveys indicate that a channel can be constructed with slope grades and morphology comparable to the existing (east channel) alignment. Just as in Alternative I, the proposed modifications to the channel and stream crossing are likely to promote fish passage for both adult and juvenile salmonids at flows which would normally be conducive to passage under natural conditions. Further hydraulic analysis is necessary to quantify and simulate proposed engineered channel conditions.

Similar to Alternative I, upgrading the existing stream crossing to a bridge capable of conveying the 100-year return period storm flow, sediment, and debris would result in a reduction of future sediment delivery to Hotelling Gulch and the South Fork Salmon River.

7.2.4 Project constraints and limitations

Similar to the east channel mouth, a major constraint for adult salmonids success in migrating upstream is the ability of fish to travel up through the steep bedrock cascade at the mouth of the western channel. During low/moderate level (~800 cfs) spring flow conditions there is approximately 9 feet of fall (vertical) over the last 45 feet of channel (horizontal). Under most conditions, that is an unsuitable grade for the upstream migration of salmonids. However, a deep pool at the confluence of the west channel and the South Fork Salmon River provides a potential leap entrance into the channel. During this study, no analysis has been completed to determine what river stage levels or return interval flows (on South Fork Salmon River) allow for upstream migration of salmonids.

Constructing a new stream channel with suitable gradients, stable sideslopes and effective transport of sediment and water is constrained by local geologic material composition, valley confinement and baseline elevation controls at the upper and lower extent of the channel. During our preliminary investigations, it appears as though a new stream channel can be constructed with suitable gradients, stable sideslopes, and without blasting bedrock. However subsurface geologic conditions may differ from those inferred by our investigations. Further geotechnical investigations may be necessary to confirm channel construction suitability.

Alternative IIa and to a lesser extent Alternative IIb is constrained by the requirement to construct bends in the stream channel in order to make the transition from the existing to the constructed channel, to provide channel complexity, and to tie in with the newly constructed bridge crossing (Alternative IIa). Maintaining channel function may be problematic in this depositional alluvial fan setting.

7.2.5 Potential complications

Any attempt to design, construct and maintain an engineered channel several hundred feet in length is potentially subject to unforeseen complications. The entire project area including the proposed channel location(s) lies within a broad alluvial fan and has likely been subject to multiple episodes of lateral channel migration and large influxes of sediment through time. There is some likelihood that influxes of sediment could shift the channel laterally and divert flows outside of the reconstructed alignment. Engineered channel, bridge, and roadway damage would likely result. Similarly, large influxes of upstream sediment could reduce capacity under the bridge and reduce the effective conveyance of stream flow. It should be considered that some level of maintenance will be required to sustain flow conveyance within the new channel configuration for the design life of the project.

In general, complications may include but may not be limited to: downcutting, lateral migration, headcut development, and excessive aggradation, all of which have the potential to reduce or negate fish passage and erosion-prevention goals. These potential complications will need to be addressed during final engineering design.

7.2.6 Earthwork and vegetation disturbance

For Alternative II, based on survey data collected at the study area, physical alteration of earthen materials and removal of vegetation will be limited to: (1) existing stream crossing removal with 1.5:1 (H:V) sideslopes and 12.5 ft channel width; (2) excavation of footings for the new bridge; (3) grading of the channel profile and cross section through the bridge reach and below; (4) construction of a channel profile and cross section along the proposed new reach above the bridge with 2:1 (H:V) sideslopes and 12.5 ft channel width; and (5) addition of structural backfill and grading for roadway improvements and transitions along both Cecilville Road and the USFS road. Table 4 shows estimates for earthmoving and tree removal during construction. The estimate assumes the same cross sectional design channel from Alternative I has been applied to Alternative II.

Table 4. Estimates for earthmoving and tree removal during construction, Alternative II, Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study.

Construction element	Volume of earthen material moved (yd^3)	Trees removed (# > 4 in. DBH)
Stream crossing fill removal[1]	120	0
Excavation for bridge footing / foundation[2]	125	0
Grading of channel below bridge[3]	290	8
Construction of channel above road (Middle Alignment)[4]	1,700	47
Construction of channel above road (West Alignment)[4]	2,900	57
Roadway improvements[5]	980	0
Totals (Middle Alignment)	**3,215**	55
Totals (West Alignment)	**4,415**	65

[1] Excavation and removal of the fill volume associated with the crossing, with a 12.5 ft channel width and 1.5:1 (H:V) sideslopes.
[2] Excavation and removal of fill for both the left and right footings.
[3] Excavation and removal of stored channel sediments, with a 12.5 ft channel width and 2:1 (H:V) stream bank slopes.
[4] Excavation and removal of earthen material to construct a new channel alignment.
[5] Additional structural backfill necessary to meet AASHTO vertical and sag curve profile guidelines. Assumes the same volume as Alternative I, however no vertical or sag profiles were generated for this crossing alignment.

7.2.7 Preliminary cost estimates

The major costs associated with the implementation of Alternative II are outlined in Table 5. Specific work tasks include, but may not be limited to: (1) physical earthwork related to stream crossing removal, stream channel regrade, channel construction, footing excavations and roadway improvements; (2) final engineering design; and (3) final planning for permitting approval through State, federal, and local agencies. Contingency funds have been included to account for variations or increases in material and equipment costs, as well as unforeseen problems or additional project elements. The costs outlined are preliminary, subject to revision, and are to be used for planning purposes only. The estimated cost to implement **Alternative IIa** is approximately $367,000. The estimated cost to implement **Alternative IIb** is approximately $388,000.

Table 5. Preliminary estimated costs for Alternative II, Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study.

Cost category	Work product / action	Estimated cost ($)
Stream crossing removal and stream channel regrade[1]	Excavate crossing and grade channel to specified profile and cross section	8,000
Bridge materials and foundation[2]	Construct foundation and install bridge	120,000
Channel construction above road (**IIa - Middle Channel**)[1]	Construct channel to specified profile and cross section	47,000
Channel construction above road (**IIb - West Channel**)[1]	Construct channel to specified profile and cross section	64,000
Roadway improvements[3]	Construct road approach / bridge transitions, USFS Road / Cecilville Road transition, repave alignment, etc.	43,000
Engineering and geotechnical[4]	Civil and structural design and geotechnical analysis	55,000
Permitting[5]	CEQA / NEPA compliance, Siskiyou County permits, etc.	20,000
	Subtotal (Alternative IIa - Middle Alignment)	293,000
	Subtotal (Alternative IIb - West Alignment)	310,000
	Contingencies (Alternative IIa - Middle Alignment) ~ 25% of Subtotal	74,000
	Contingencies (Alternative IIb - West Alignment) ~ 25% of Subtotal	78,000
	Totals (Alternative IIa - Middle Alignment)	**367,000**
	Totals (Alternative IIb - West Alignment)	**388,000**

[1] Stream crossing removal and channel regrade/excavation costs are based on excavation production rates and prevailing wage equipment costs derived from several recently completed projects of a similar nature. Costs assume 45 yd^3/hr production rate using an excavator ($190/hr), 2 dump trucks ($105/hr each) a bulldozer ($160/hr) and a laborer ($80/hr) for dewatering activities.
[2] Costs assume $55,000 for bridge as quoted by manufacturer and 90% additional for installation. Also $15,000 has been included for guard rails, foundation materials, etc. Based on the stream channel and crossing configuration, it is assumed that the given specifications for the bridge will function at both the east and west alignments.
[3] Costs assume $30/$yd^3$ for structural backfill and $120/ton asphalt for repaving the roadway. Costs assume the same volume as Alternative I, however no vertical or sag profiles were generated for this crossing alignment.
[4] For alternative II, an additional $10,000 has been included for stream channel design work along the new channel alignment.
[5] For alternative II, an additional $5,000 has been included for permitting related to significantly increased physical disturbance within the project area.

8 SUMMARY AND RECOMMENDATIONS

The HGFS is intended to provide general guidance about which fish passage and sediment reduction implementation alternatives may be feasible at Hotelling Gulch. Based on this limited feasibility study, we believe that fish passage improvement and sediment reduction at Hotelling Gulch are reasonable goals, and that each alternative presented here represents a viable improvement project. Additionally, upgrading the existing stream crossing drainage structure to a bridge will result in reduced long-term maintenance costs for Siskiyou County along Cecilville Road.

8.1.1 Considerations for selecting Alternatives I or II (IIa, IIb)

The ultimate decision as to which design alternative will be selected lies with future project proponents (SRRC) and vested stakeholders such as the County of Siskiyou and potential funding entities. Both Alternatives I and II (IIa, IIb) represent reasonable projects, however certain criteria may help to favor one over the other.

Three first-cut considerations for selecting Alternatives I or IIa/b include the following:

1. Alternative I represents the least amount of physical disturbance to the project area and subsequently results in less damage to existing vegetation and mature trees (Tables 2 and 4).

2. Constructed post implementation channel gradients would be slightly gentler and more fish friendly with Alternative I compared to Alternatives IIa and IIb (Appendix B). Long term channel stability is likely to be similar for each alignment due to relatively homogenous geologic properties across all potential (proposed) and existing channel alignments (Map Sheet 2). However, Alternatives IIa and IIb will require constructing broad bends in the channel, which may be difficult to maintain during larger return interval storm events.

3. The cost of implementing Alternative I is significantly less than Alternatives IIa and IIb for comparable fish passage and sediment reduction benefits.

Several additional, more technical factors to consider include the following:

4. Test pit exploration and physical observation suggest that the lower west channel supports higher (relative to the channel bed elevation) base flow conditions throughout the year (Map Sheet 2). Aquatic organisms, including salmonids, could utilize perennial surface waters in the lower channel.

5. The east channel stream crossing is topographically higher than the west channel stream crossing. This, by nature of the existing configuration with the Cecilville Road, promotes diversion of streamflow towards the west. Upgrading the crossing to a bridge and constructing a lateral berm at the existing alignment will minimize this likelihood. However, there will always be some potential that streamflow could divert west and cause damage to road based infrastructure.

6. A deep pool at the mouth of the west channel appears to be a better configuration for helping adult salmonids leap into the channel above. However, it is unknown exactly how much of a benefit this is because it is likely that there would need to be concurrent high flow conditions on the South Fork Salmon River in order for fish to navigate past the steep bedrock cascade downstream from the crossing. Further hydraulic and hydrologic studies are recommended to determine what South Fork Salmon River flows are conducive for fish passage through the cascade at both the east and west channel mouths prior to completing the final design.

8.1.2 Other design and cost modifications suggested during the draft feasibility study review

As discussed in Section *7.1.4*, the availability of money will ultimately become a constraint to design and construction costs. Therefore it should be considered that modifications of the proposed design may be necessary to conform within monetary constraints. Several additional alternatives discussed during the review of the draft report include: (1) re-aligning the road upstream where the channel remains better defined and exhibits sediment transport characteristics and less depositional characteristics; (2) lowering the level of the bridge base to less than 5 feet above the vertical adjustment profile; and (3) designing the engineered channel and bridge for a lower return period peak flow event in addition to incorporating a “weak link” overflow channel as a safety valve where exceedance flows may divert to the west and pass under the road at the lower location (Scott Sumner, Siskiyou County Public Works, personal communication, January 2010). These alternatives may be valid suggestions for lowering the cost of design and/or construction; however they have not been evaluated during this initial feasibility study but should be considered prior to choosing a final design.

8.1.3 Recommendations

This study provides important information and guidance for decision making regarding implementation alternatives at Hotelling Gulch. It is not a substitute for detailed engineering and geotechnical studies that will be required prior to final design or before any on-the-ground improvement activities take place. As described above, Alternative I involves upgrading the existing culverted stream crossing drainage structure to a bridge and regrading the channel to allow for more efficient conveyance of stream flow and sediment in transport. If Alternative I is chosen it is recommended that a final hydraulic, geotechnical, structural and civil engineering design are completed for the project. The final design should include but may not be limited to items 1-6 in the ***Recommendations*** section of MLA’s Technical Memorandum (p. 17, Appendix C). Similarly, as described, Alternatives IIa and IIb involve upgrading the existing culverted stream crossing drainage structure to a bridge, regrading the channel to allow for more efficient conveyance of stream flow and sediment in transport, and construction of a new stream channel alignment above the road. If Alternatives IIa or IIb are chosen, it is recommended that a final hydraulic, geotechnical, structural and civil engineering design are completed for the project. Also, the final design should include but may not be limited to items 1-6 in the ***Recommendations*** section of MLA’s Technical Memorandum. Additionally, further analysis to characterize hydraulic and hydrologic conditions conducive for fish passage through the bedrock cascade adjacent to the South Fork Salmon River may provide additional useful information for final decision making. Finally, with either alternative, it is recommended that a long term maintenance permit from the appropriate agencies be developed and costs be determined so that the County of Siskiyou can effectively maintain the project throughout its design life.

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Appendix A

Hotelling Gulch Study Area Photographs

Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study,
Klamath National Forest, Siskiyou County, California.

Photo 1. The Hotelling Gulch stream crossing inlet basin after significant storm damage during the winter of 2006.

Photo 2. Current view of the inlet basin on the existing (east channel) Cecilville Road crossing.

Photo 3. The Hotelling Gulch stream crossing culvert outlets after significant storm damage during the same event as Photo 1 above. Note the recent erosion of the crossing fillslope and sediment deposition filling the channel below.

Photo 4. Current view of the culvert outlets on the existing (east channel) Cecilville Road crossing.

Photo 5. View looking upstream at the active stream channel taken approximately 50 ft above the Hotelling Gulch stream crossing.

Photo 6. The active stream channel looking downstream at the Hotelling Gulch stream crossing, approaching the culvert inlet basin. Note the recent terrace deposits to the right, likely caused by culvert plugging and backwatering of the stream crossing.

Photo 7. View east up the Cecilville Road; standing at the west channel crossing and looking towards the Hotelling Gulch stream crossing (hump in road).

Photo 8. View west down the Cecilville Road; standing at the Hotelling Gulch stream crossing and looking towards the west channel crossing (alder trees at low point in road).

Photo 9. View of culvert inlet basin on the west channel Cecilville Road crossing. Willows constrict view.

Photo 10. View down the west channel alignment swale towards the crossing on the Cecilville Road. The Cecilville Road culvert lines up just to the left of the Douglas Fir tree in the center of the photo.

Photo 11. View of culvert outlet area on the west channel Cecilville Road crossing. Willows and blackberry obscure outlet.

Photo 12. Getting ready to start a new excavation pit along the west alignment above the Cecilville Road.

Photo 13. An excavation test pit showing typical stratigraphy; unsorted, heterogeneous alluvial/colluvial deposits that have been reworked by hydraulic mining activities.

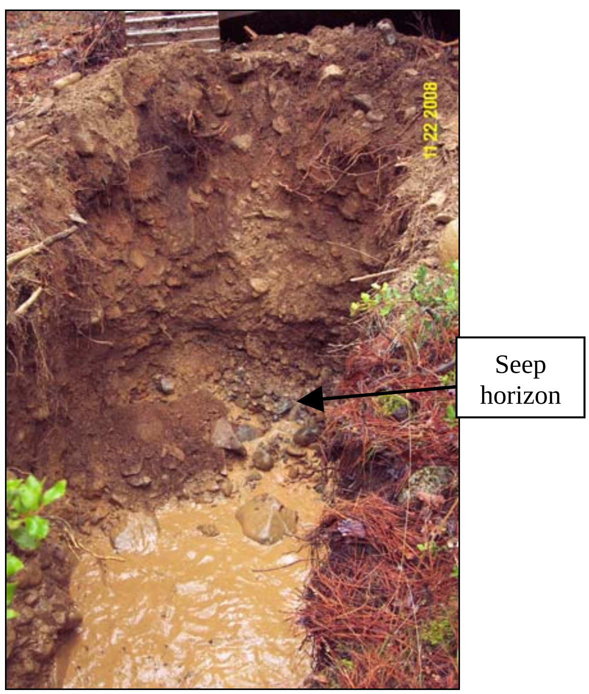

Photo 14. Another excavation test pit showing typical stratigraphy and ground water inflow.

Photo 15. Surveying depth to bedrock and the water table surface in an excavation pit.

Appendix B

Channel profile and cross section drawings showing existing and proposed conditions

Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study,
Klamath National Forest, Siskiyou County, California.

PACIFIC WATERSHED ASSOCIATES
P.O. Box 4433 Arcata, CA 95518
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Appendix B, Drawing 1 - East Alignment (Alternative I)

Channel profiles pre and post excavation specifications

Hotelling Gulch Stream Channel Modifcation Study, Siskiyou County
Project # 828 United States Forest Service property

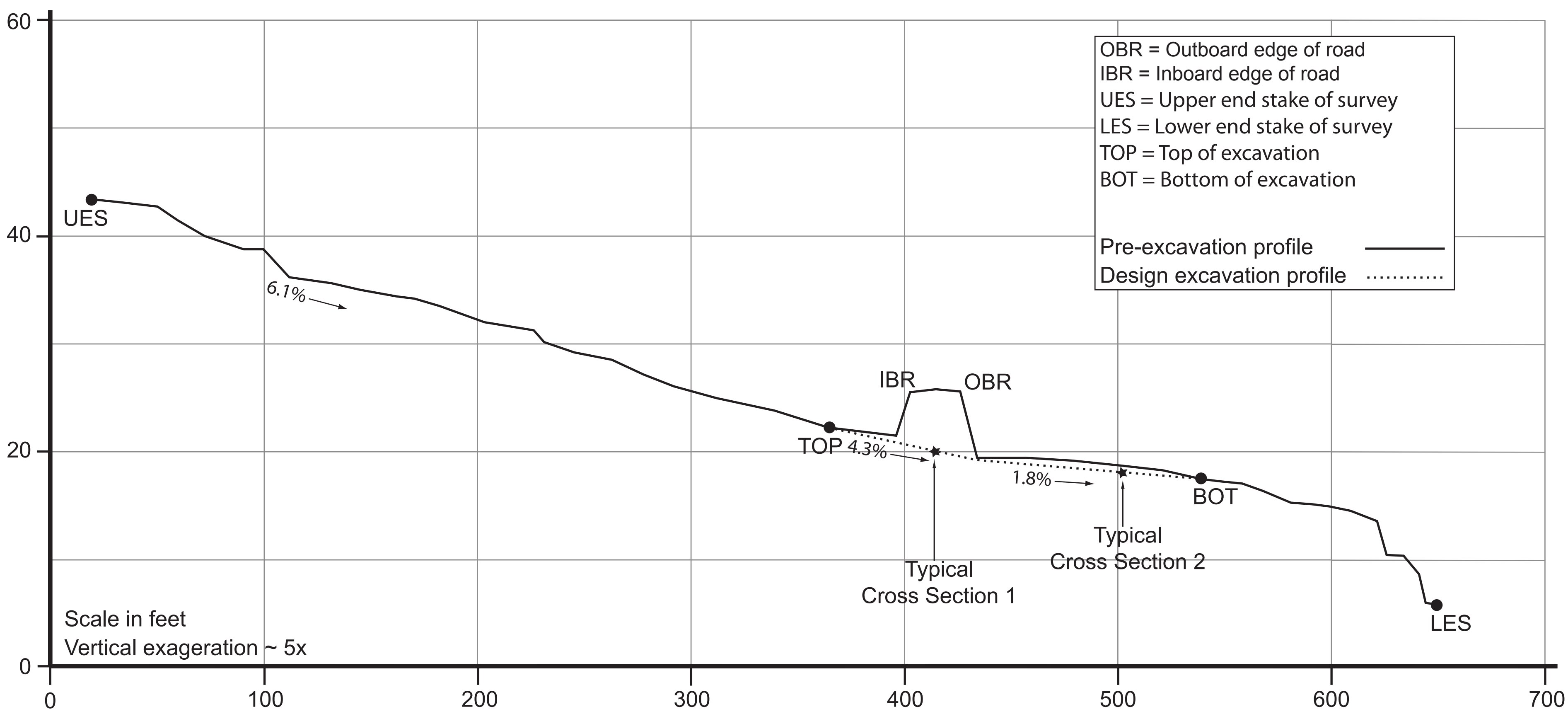
Developed for Salmon River Restoration Council, April 2010

Site - Hotelling
Road: Cecilville
Milepost: 3.5

Sheet 1 of 3
Phase: Final
Drawings: RL

Post-excavation specifications	
TOP to BOT slope distance (ft)	175
XS1 depth (ft)	4.8
XS2 depth (ft)	0.6
Estimated volume removed (yd^3)	290

Notes: (1) Drawings are preliminary and subject to revision



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Appendix B, Drawing 2 - East Alignment (Alternative I)

Channel cross sections pre and post excavation specifications

Hotelling Gulch Stream Channel Modifcation Study, Siskiyou County
Project # 828 United States Forest Service property

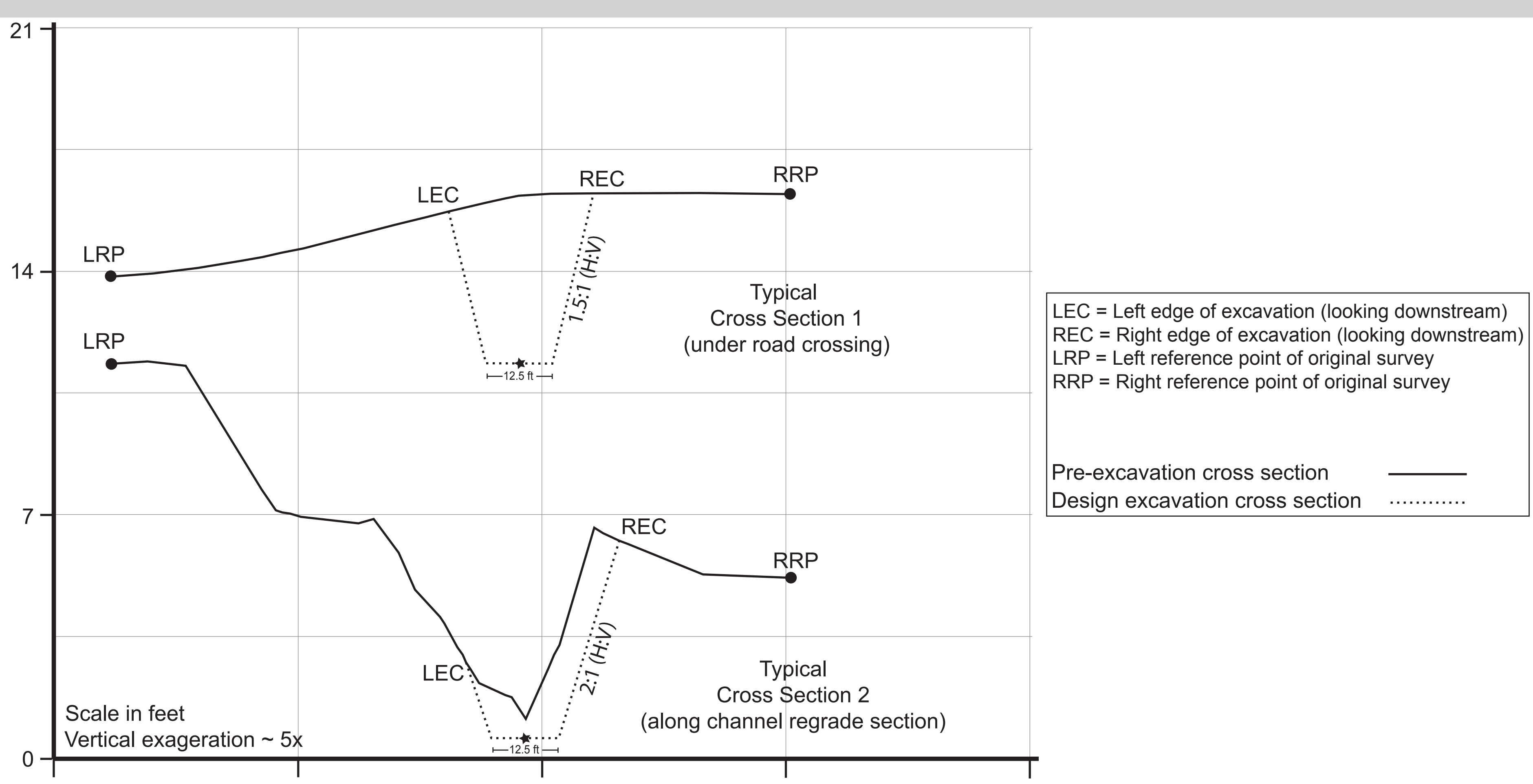
Developed for Salmon River Restoration Council, April 2010

Site - Hotelling
Road: Cecilville
Milepost: 3.5

Sheet 1 of 3
Phase: Final
Drawings: RL

Post-excavation specifications	
XS 1 LEC to REC distance (ft)	26.3
XS1 depth (ft)	4.8
XS 2 LEC to REC distance (ft)	28.4
XS2 depth (ft)	0.6

Notes: (1) Drawings are preliminary and subject to revision



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Appendix B, Drawing 3 - Middle Alignment (Alternative IIa)
Channel profiles pre and post excavation specifications

Hotelling Gulch Stream Channel Modifcation Study, Siskiyou County
Project # 828 United States Forest Service property

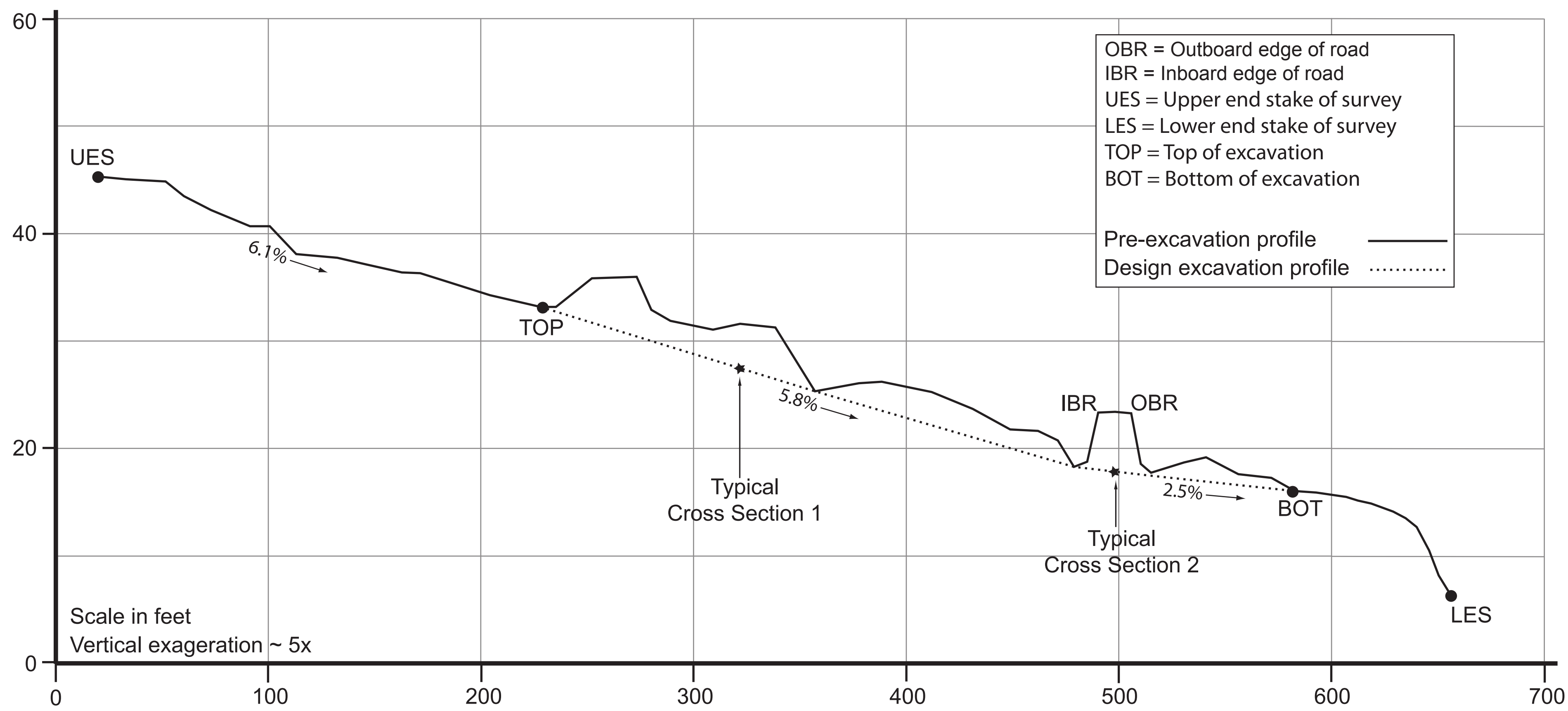
Developed for Salmon River Restoration Council, April 2010

Site - Hotelling
Road: Cecilville
Milepost: 3.5

Sheet 2 of 3
Phase: Final
Drawings: RL

Post-excavation specifications	
TOP to BOT slope distance (ft)	355
XS1 depth (ft)	4.3
XS2 depth (ft)	5.2
Estimated volume removed (yd^3)	2,110

Notes: (1) Drawings are preliminary and subject to revision



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Appendix B, Drawing 4 - Middle Alignment (Alternative IIa)
Channel cross sections pre and post excavation specifications

Hotelling Gulch Stream Channel Modifcation Study, Siskiyou County
Project # 828 United States Forest Service property

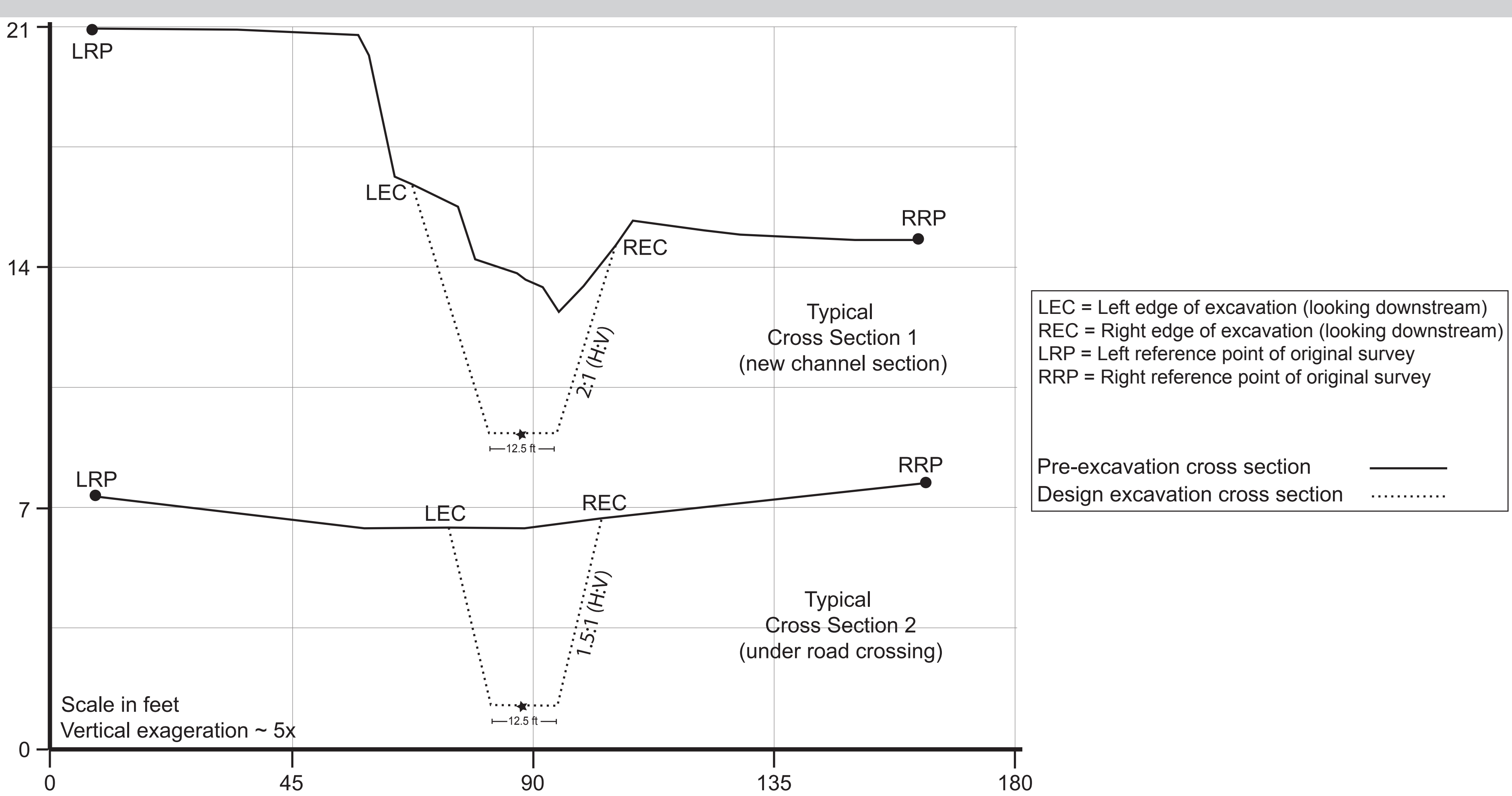
Developed for Salmon River Restoration Council, April 2009

Site - Hotelling
Road: Cecilville
Milepost: 3.5

Sheet 2 of 3
Phase: Final
Drawings: RL

Post-excavation specifications	
XS 1 LEC to REC distance (ft)	38.3
XS1 depth (ft)	4.3
XS 2 LEC to REC distance (ft)	28.6
XS2 depth (ft)	5.2

Notes: (1) Drawings are preliminary and subject to revision



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Appendix B, Drawing 5 - West Alignment (Alternative IIb)

Channel profiles pre and post excavation specifications

Hotelling Gulch Stream Channel Modifcation Study, Siskiyou County
Project # 828 United States Forest Service property

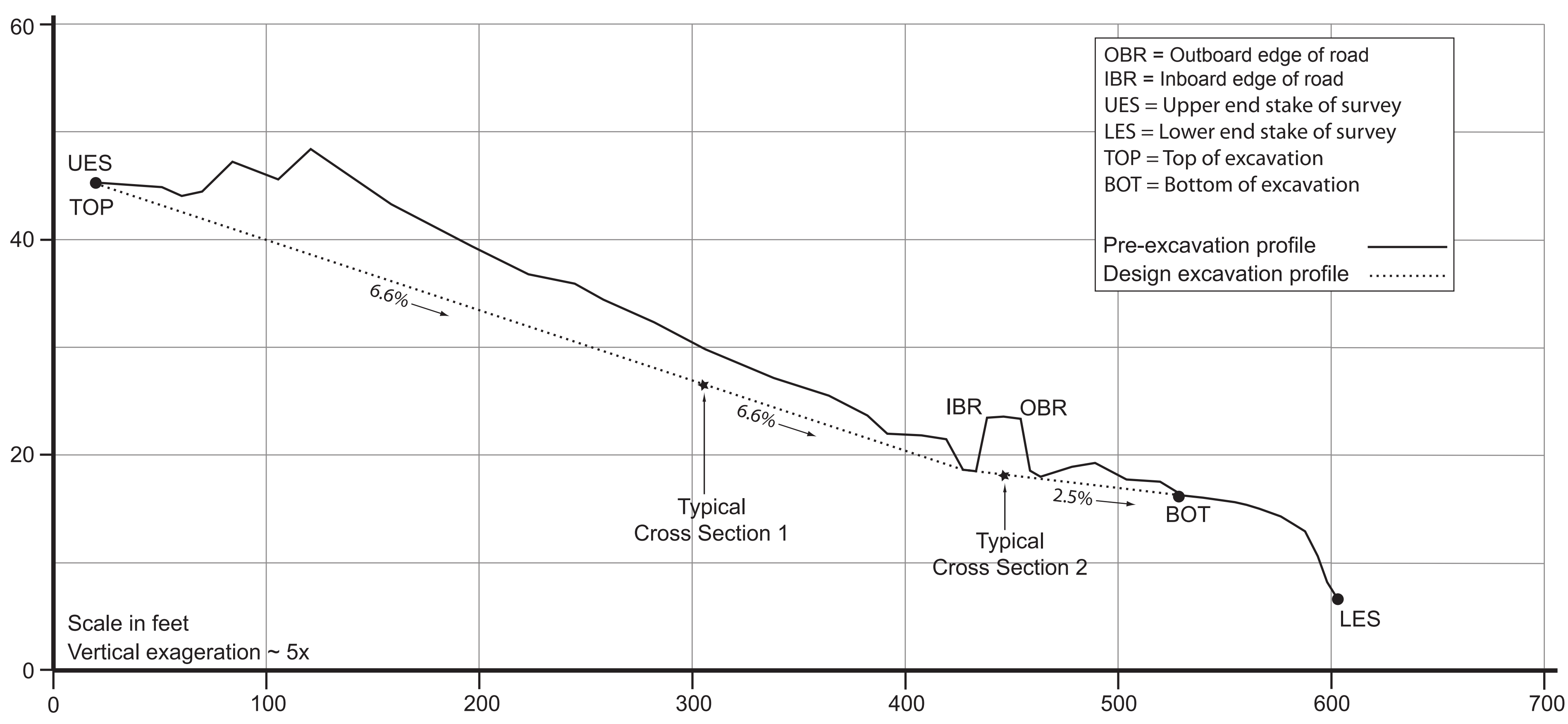
Developed for Salmon River Restoration Council, April 2010

Site - Hotelling
Road: Cecilville
Milepost: 3.5

Sheet 3 of 3
Phase: Final
Drawings: RL

Post-excavation specifications	
TOP to BOT slope distance (ft)	513
XS1 depth (ft)	2.7
XS2 depth (ft)	5.2
Estimated volume removed (yd^3)	3,310

Notes: (1) Drawings are preliminary and subject to revision



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Appendix B, Drawing 6 - West Alignment (Alternative IIb)

Channel cross sections pre and post excavation specifications

Hotelling Gulch Stream Channel Modifcation Study, Siskiyou County
Project # 828 United States Forest Service property

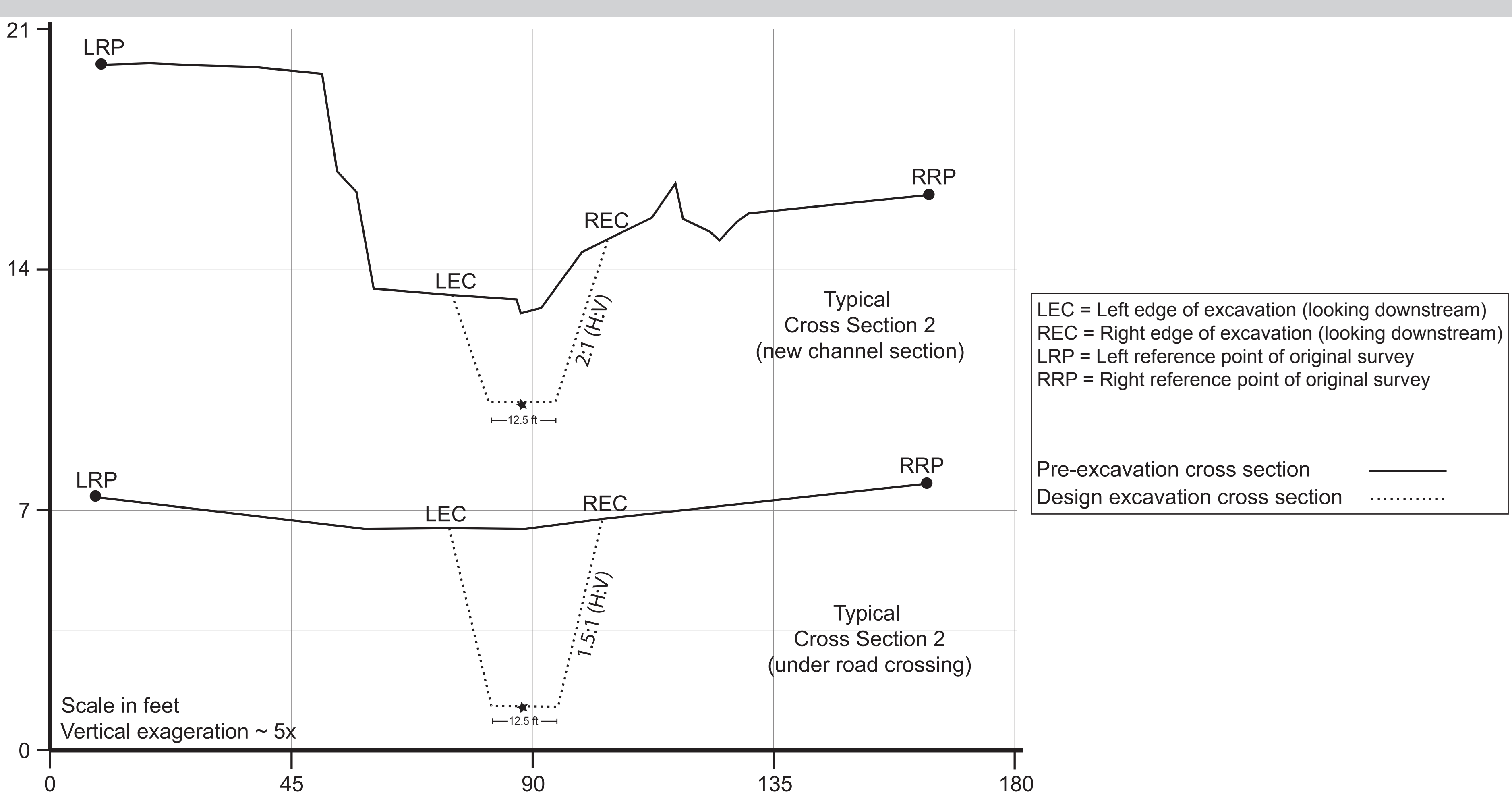
Developed for Salmon River Restoration Council, April 2010

Site - Hotelling
Road: Cecilville
Milepost: 3.5

Sheet 3 of 3
Phase: Final
Drawings: RL

Post-excavation specifications	
XS 1 LEC to REC distance (ft)	28.9
XS1 depth (ft)	2.7
XS 2 LEC to REC distance (ft)	28.6
XS2 depth (ft)	5.2

Notes: (1) Drawings are preliminary and subject to revision



Appendix C

Mike Love and Associates Technical Memorandum,
Preliminary Hydraulic Analysis of Existing and Proposed Conditions along the Present Hotelling Gulch Channel Alignment

Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study,
Klamath National Forest, Siskiyou County, California.

Technical Memorandum

DATE: August 7, 2009

To: Randy Lew, PG. Pacific Watershed Associates

From: Michael Love P.E., Principal Engineer, Michael Love & Associates
mlove@h2odesigns.com / ph: 707-476-8938 / fax: 707-476-8936

Subject: **Preliminary Hydraulic Analysis of Existing and Proposed Conditions along the Present Hotelling Gulch Channel Alignment**

Background

The Salmon River Restoration Council has requested that Pacific Watershed Associates (PWA) assess the feasibility of various alternatives to create a stable channel alignment and stream crossing for Hotelling Gulch at Cecilville Road (Figure 1). PWA has requested that Michael Love and Associates (MLA) prepare a hydraulic analysis of existing conditions and of a new stream crossing structure in the current alignment of the channel and road-stream crossing.

Hotelling Gulch is located in a historical alluvial fan that experienced extensive hydraulic mining in the 1800s. The road crosses the stream in a reach characterized as an alluvial fan, which creates challenges regarding maintaining a permanent channel alignment in an area that experiences intermittent high sediment loads and historically underwent frequent channel shifting.

The existing twin 36" CMP culvert crossing of Cecilville Road at Hotelling Gulch was listed as priority number four in the *Siskiyou County Culvert Inventory and Fish Passage Evaluation* (Ross Taylor & Associates, 2002). The undersized nature of the culverts creates a fish passage barrier for salmonids of all age classes due to excessive water velocities at high fish passage flows and insufficient water depths at low fish passage flows. Until 2007, when the existing culverts were reset at grade (2009, Scott Summer, Siskiyou County engineer, personal communication), the culvert outlets were perched above the downstream channel and a scour pool had formed.

Backwatering during frequent high flow events created by the undersized crossing has created a sizable amount of sediment deposition upstream of crossing, requiring the County to dredge the channel occasionally to maintain flow conveyance. The sediment deposition has reduced channel and crossing capacity, causing flows to overtop the left channel bank and Cecilville Road during larger flow events.

Ross Taylor & Associates (2002) recommended that the current road crossing be replaced with a bridge or large culvert that creates unimpeded fish passage and allows natural geomorphic processes to occur. The Taylor Report also indicates that the current stream alignment and the location of its confluence with the South Fork Salmon River may not be in its original location,

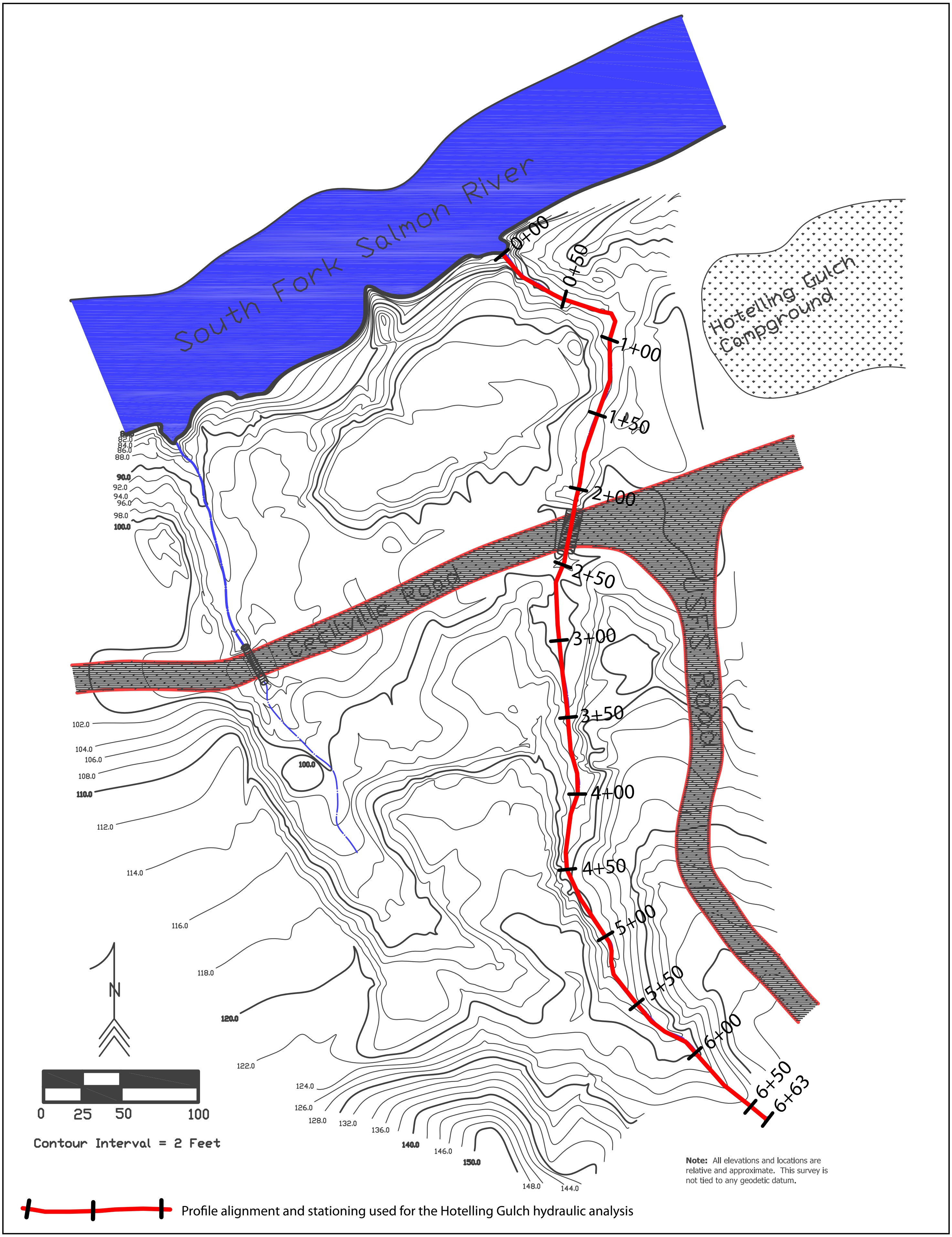


Figure 1. Plan view map of Hotelling Gulch in the vicinity of Cecilville Road. Figure modified from the Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study, Map Sheet 1 (PWA, 2009).

but was possibly moved towards the east during the extensive hydraulic mining that occurred in this area. Part of the feasibility assessment being conducted by PWA includes investigating the feasibility of realigning Hotelling Gulch into a channel alignment to the west of the current alignment. Currently, flows of Hotelling Gulch that overtop the roadway flow down the road/ditch and into an existing channel to the west, which is lower in elevation.

Scope of Memorandum

The purpose of this Technical Memorandum is to summarize the findings of a hydraulic feasibility investigation that focused on the creation of a stable channel profile and crossing replacement within the existing alignment of Hotelling Gulch at Cecilville Road. The feasibility assessment included consideration of fish passage as well as more efficient conveyance of flow, sediment and debris.

This memorandum presents the results of the hydraulic analysis, which included preparing a steady state HEC-RAS hydraulic model and conducting a competence-based sediment transport analysis for existing conditions and proposed alternatives. To conduct the hydraulic analysis, preliminary channel cross sections and profiles, sizing of a new Cecilville Road bridge crossing, and identifying necessary changes to the road profile were developed to a conceptual level.

Peak Flows

Estimation of peak flood flows was necessary for use in the preparation of the hydraulic modeling. Local flood estimation charts presented in the *Siskiyou County Drainage Manual* (Siskiyou County, 1974) were used to estimate peak flows with recurrence intervals of 2.33, 5, 10, 25, 50 and 100-year (Table 1). Variables used to determine peak flows within each sub-region were drainage area and mean annual precipitation.

Table 1. Summary of peak discharges for various storm events on Hotelling Gulch.

Flow Return Period	2.33-Year	5-Year	10-Year	25-Year	50- Year	100-Year
Peak Discharge	38 cfs	66 cfs	104 cfs	169 cfs	230 cfs	282 cfs

Existing Conditions

Hydraulic Model Development

Hydraulic modeling of the existing channel was conducted using the Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS), a one-dimensional steady-state open channel flow model. Channel hydraulics of Hotelling Gulch were analyzed from the confluence with the South Fork of the Salmon River to approximately 600 feet upstream, where the stream valley becomes more confined. Model results were used to quantify existing channel and culvert capacity and to evaluate sediment transport competence of the existing channel.

Cross sections for the hydraulic model were obtained from a digital elevation model of the project area provided by PWA in AutoCAD format. Cross sections were spaced from 10 to 45 feet apart, and located at significant changes in channel slope and/or geometry. Cross sections were also located at the existing stream crossing in accordance with ACOE (2008) to properly simulate flow contraction and expansion into and out of the crossing. Cross section numbering was based on alignment stationing for the existing channel, with station zero located at the confluence of Hotelling Gulch and the South Fork of the Salmon River (Figure 1).

Manning's roughness coefficients were estimated for the channel (n = 0.110) and left and right overbanks (n = 0.145) using Jarrett's equation (Jarrett, 1984) and visual observations of the channel and floodplain. Levees and ineffective flow areas were incorporated into the model where appropriate to properly simulate in-channel and overbank flows.

The culvert crossing was modeled as two identical 3-foot diameter corrugated metal culverts projecting from the fill. The culvert's roughness was assumed to be n = 0.024 for a corrugated metal culvert. Culvert invert elevations were obtained from the thalweg profile provided by PWA. Entrance and exit loss coefficients were set to 0.9 and 1.0, respectively (ACOE, 2008). Contraction and expansion coefficients were set at 0.3 and 0.5, respectively, at the existing crossing (ACOE, 2008). For all other cross sections, the contraction and expansion coefficients were set at 0.1 and 0.3, respectively.

High flows currently overtop the left bank (looking downstream) before overtopping the road at the crossing. Overtopping flows are diverted down an inboard ditch upstream of Cecilville Road and into the channel to the west, rather than returning to the Hotelling Gulch channel. Water that leaves the system by overtopping the left bank was accounted for in the model using a lateral weir located upstream of the crossing. Flow that overtops Cecilville Road at the culvert crossing is conveyed to the downstream channel and was simulated using broad crested weir flow.

The upstream boundary condition of the model was set to normal depth, with a channel slope of 0.016. The downstream boundary condition was set at critical depth because a steeply sloping reach of bedrock drops abruptly to the Salmon River. It was assumed that the Salmon River water surface elevation did not affect the water surface elevations on Hotelling Gulch in the vicinity of the road-stream crossing.

The existing conditions model was prepared for the 2.33, 25, 50, and 100-year return flows. A low flow value of 2 cfs was also modeled.

Results and Analysis

Crossing and Channel Capacity

Table 2 and Figure 2 present the results from the existing conditions HEC-RAS modeling. More detailed results of the HEC-RAS modeling are included in Attachment 1.

Flows in the channel enter the inboard ditch at flows less than the 2.33-year return period flow, reducing flows into the downstream channel (Table 2). Also evident is the backwater created by the culverts at the 2.33-year return period flow and greater, which can cause localized sedimentation near the culvert inlets. As streamflow increases, a greater amount of flow leaves the channel over the left bank, until nearly half the flows leave the system during a 25-year storm event (Table 2). At approximately 190 cfs flows begin to overtop the roadway at the culvert crossing, which is slightly larger than the 25-year peak flow. Based on conversations with Scott Sumner of Siskiyou Country (2009 personal communication), the existing channel was dredged in the vicinity of the culvert in 2007 and the culvert appears to have been reset at a lower elevation to eliminate the drop to the outlet pool. Given the lack of large flow events since this work, the existing channel and culvert capacity is likely greater in its current condition than it is after several large flows that can cause sediment accumulation upstream of the culverts.

Table 2. Total flow and flow diverted out of Hotelling Gulch via a low left bank just upstream of the Cecilville Road crossing.

Flow Return Period (years)	2.33 Year	25 Year	50 Year	100 Year
Streamflow	38 cfs	169 cfs	230 cfs	282 cfs
Flow Leaving System via Left Bank	8 cfs	82 cfs	108 cfs	108 cfs
Flow in Downstream Channel	30 cfs	87 cfs	122 cfs	173 cfs
Percent of Flow Leaving System	22%	49%	47%	38%

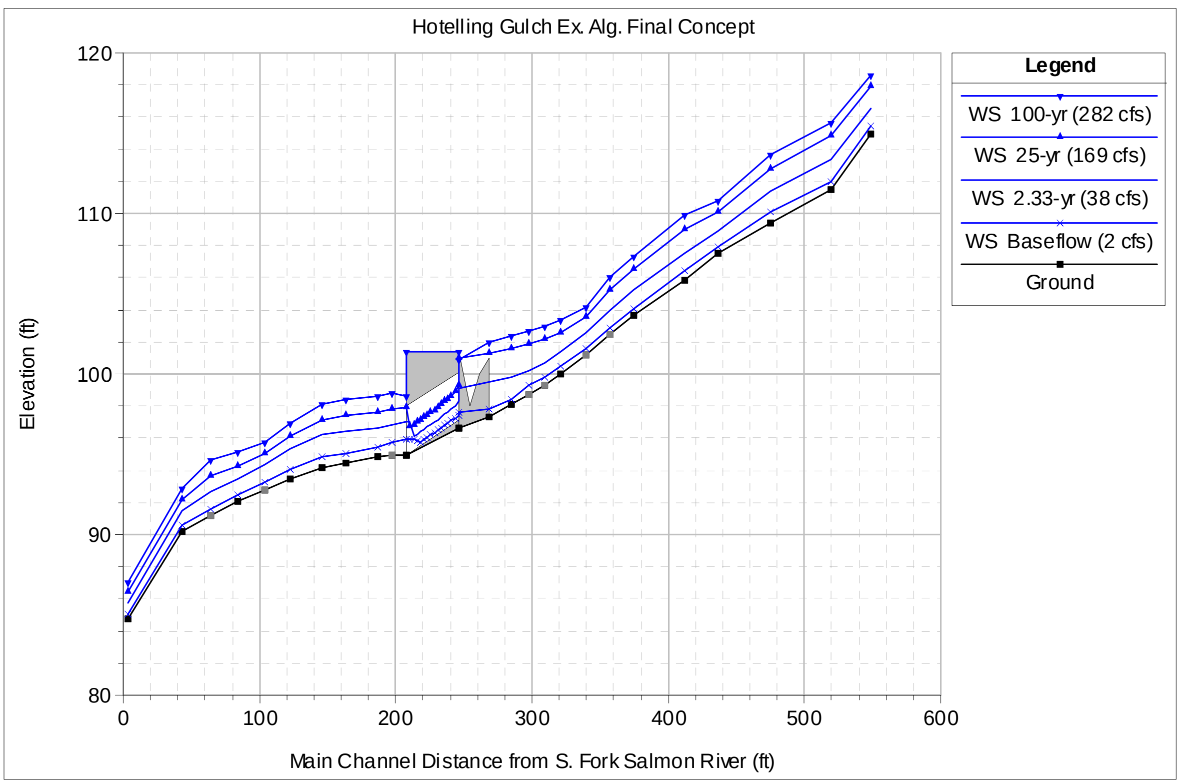


Figure 2. Existing condition water surface profiles at the Cecilville Road crossing of Hotelling Gulch. A lateral weir, shown as a vee upstream of the culvert, controls flow over the left channel bank and out of the system.

Sediment Transport Analysis

A competence-based sediment transport assessment was conducted to estimate the size of sediment mobilized during specific flow events, and to identify locations likely to experience sediment deposition and channel aggradation through time.

Particle Size

Three pebble counts, conducted by PWA on May 27, 2009, were used to determine the range of particle sizes common in the Hotelling Gulch stream channel (Table 3 and Figure 3). Data from Pebble Count 1, located upstream of the influence of the culvert, represent channel bed materials that are typical of what is transported into the project area from upstream. Data from Pebble Count 2, within the upstream influence of the culvert, indicate that channel particle sizes are larger in this location. Data from Pebble Count 3 located downstream of the culvert indicate that the channel material is characterized by smaller material than upstream of the culvert.

Table 3. Tabular results of three pebble counts conducted in Hotelling Gulch showing variations in particle size along the channel.

Pebble Count 1 250 Feet Upstream of Culvert Influence	Pebble Count 2 15-35 Feet Within Influence of Culvert	Pebble Count 3 25-45 Feet Downstream of Culvert
D_{50} = 0.7 inches	D_{50} = 0.9 inches	D_{50} = 0.6 inches
D_{84} = 3.1 inches	D_{84} = 3.2 inches	D_{84} = 1.8 inches

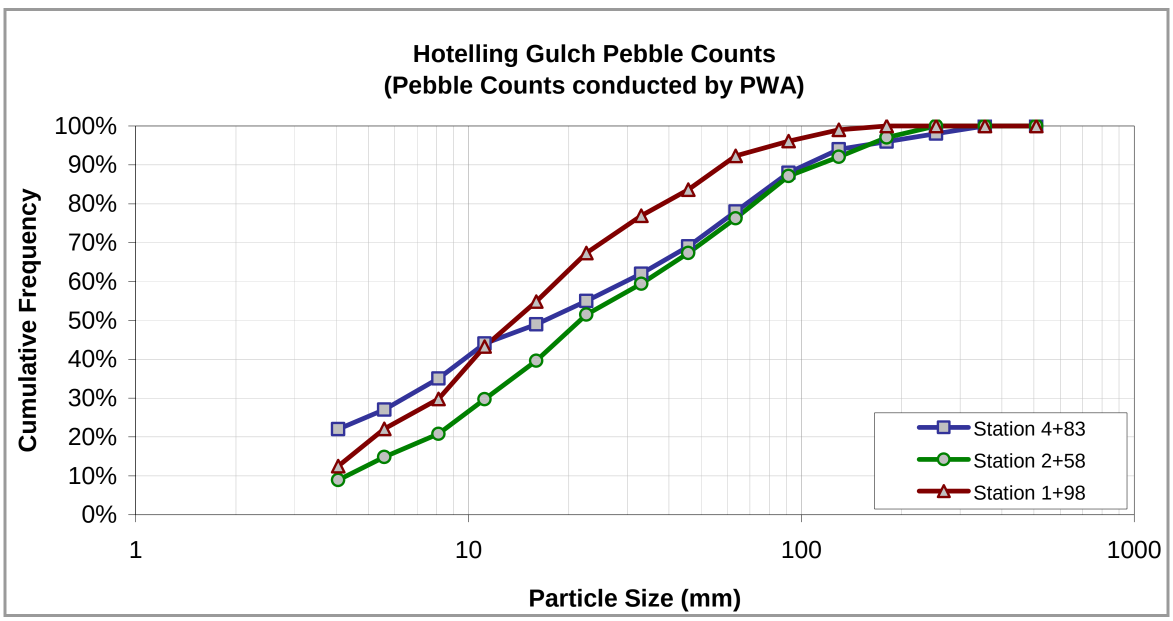


Figure 3. Gradation of channel bed material from pebble counts at three locations on Hotelling Gulch near Cecilville Road.

Sediment Deposition Zones

The sediment transport assessment and identification of potential sediment aggradation zones was performed using a competence-based shear stresses analysis. This method compares the channel shear stress within the modeled channel reach to the critical shear stress for a given particle size at a specific flow. Where channel shear stress exceeds the critical shear stress of a given particle size, transport of that particle size is expected to occur. Conversely, if the particle is transported to a channel reach with shear stresses less than the critical shear stress, it would be expected to deposit.

The critical shear stress is calculated as:

$$\tau_c = \tau^* \ (\gamma_s - \gamma_w) D_i$$

where:

τ_c	=	Critical shear stress to initiate movement of the particle size of interest, D_i (lb/ft^2)
τ^*	=	Critical dimensionless shear stress
γ_w	=	Specific weight of water (62.4 lb/ft^3)
γ_s	=	Specific weight of sediment (γ_w x 2.65) (lb/ft^3)
D_i	=	Particle diameter or size fraction of interest (ft)

The value of the critical dimensionless shear stress (τ^*) for mixed size stream sediments have been found to range from 0.04 to 0.086 (Buffington & Montgomery, 1997, Wilcock, 1998), with lower values when sand content in the sediment gradation exceeds approximately 30%. A critical dimensionless shear stress (τ^*) of 0.06 was selected for the sediment transport assessment, supported by visual observations of depositional areas. Lower values erroneously predicted transport at baseflow conditions within portions of the project reach.

The sediment transport assessment was conducted for the 2.33-year return period flow, slightly larger than a bankfull flow which typically has a return period between 1 and 2 years. It has been found that bankfull flows and flows with return periods of less than 5 year typically transport the greatest volume of sediment over time, and are the most significant in determining shape of an alluvial channel (Wolman and Miller, 1960).

A 3-inch particle size was selected for evaluation of the sediment transport competence of the existing channel based on the results of Pebble Count 1, which was assumed to reflect the size of material delivered to the project reach. This particles size, which reflects the D_{84} of Pebble Count 1, represents the size fraction where 84% of the material comprising the streambed is smaller. If during a commonly occurring flood event the channel reach does not have the competence to transport a 3-inch particle delivered from upstream, deposition of that size particle would be expected. Over time, this could lead to aggradation of the channel bed because of the relative frequency of that particle size.

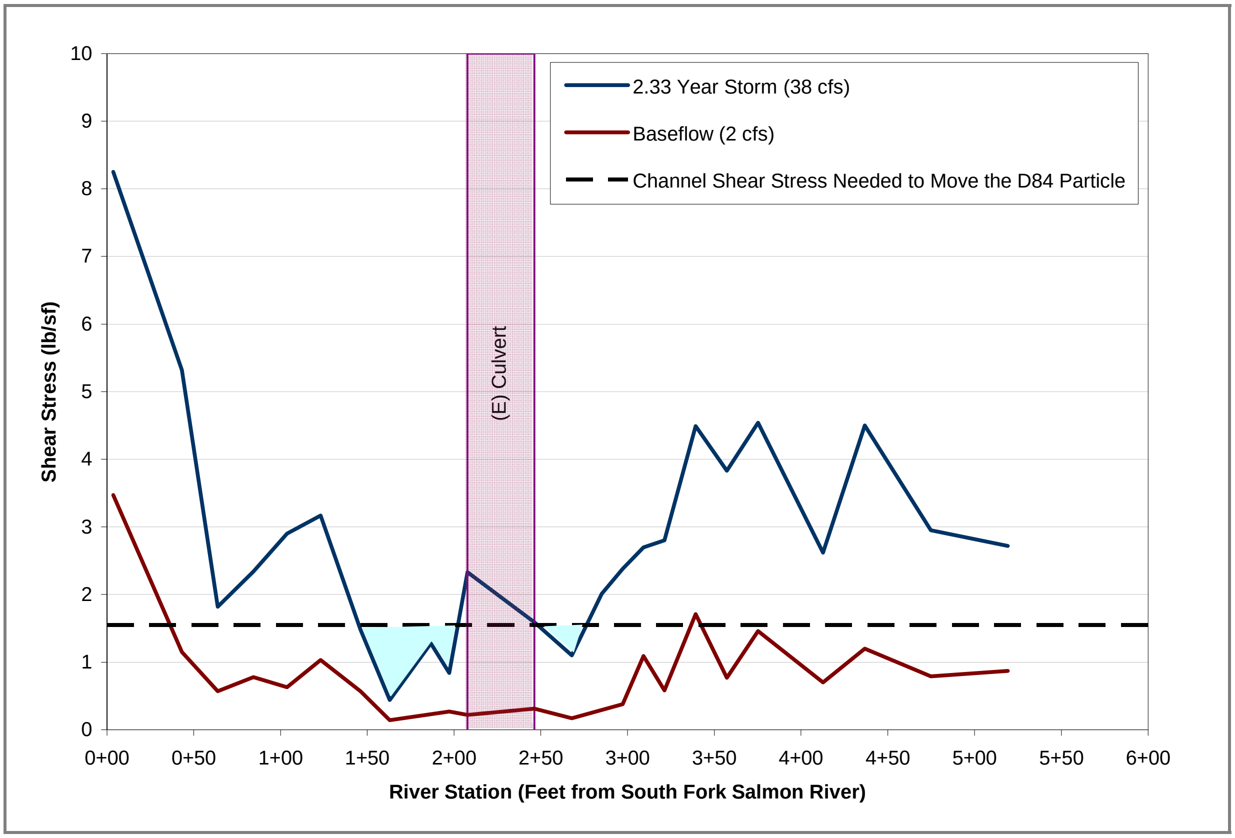


Figure 4. Shear stress at each HEC-RAS cross sections at baseflow and the 2.33-year return period flow. The dashed line represents the channel shear stress necessary to mobilize the D_{84} particle size using a dimensionless critical shear stress of 0.06. Light blue hatched areas indicate where channel shear stress is insufficient to maintain transport of the D_{84} particle and deposition is expected to occur at the 2.33-year return period flow. The high shear at the confluence with the South Fork Salmon River is in a steeply sloped bedrock chute.

Results of the sediment transport assessment indicate there are two reaches within Hotelling Gulch where the channel shear stress is insufficient to maintain transport of the D_{84} at the 2.33-year return period flow (Figure 4). These reaches are located immediately upstream and downstream of the culvert. Upstream of the culvert, in a 35-foot channel reach between stations 2+50 and 2+85, sediment deposition is predicted to occur because of the backwater from the culvert is causing a drop in water surface slope and channel shear stress. With recurring high flows, sediment will continue to deposit in this section of channel and the culvert and channel capacity will further decrease. This will increase the frequency of flows overtopping the left bank and leaving the channel. Observations in the field and discussions with Scott Sumner of Siskiyou County confirm that sediment deposition is occurring in this area, as well as farther upstream, requiring occasional dredging by the County.

The cause of the low channel shear stress in the 60-foot channel reach downstream of the culvert (Stations 1+50 to 2+10), is due to a widening of the channel followed by a channel constriction further downstream. Immediately downstream of the culvert, the channel flow area substantially increases to over 25 square feet from the approximately 11 to 14 square feet typical of the channel upstream of the culvert (Attachment 1). Downstream of the widened channel area, near Station

1+23, the channel is constricted and confined by alluvial deposits, causing a backwater that creates a sharp decrease in shear stress between stations 1+50 to 2+10 (Figure 4). The drop in shear stress suggests that deposition and aggradation of the channel bed may be occurring in this area. It is likely that the channel maintenance by the County caused the widening of the channel reach immediately downstream of the culvert.

Development and Analysis of Crossing Alternatives

Two proposed alternatives for modifications of Hotelling Gulch within its current alignment and replacement of the crossing were developed. Both alternatives include replacing the existing culverts with a bridge. Installing a bridge to replace the existing culvert crossing necessitates grading a stream channel where the existing culvert is now located.

Alternative A addresses the crossing capacity and sediment transport competence of the channel at the crossing. It consists of replacing the culvert crossing with a bridge and grading under the bride to the design profile and cross section.

Alternative B addresses the crossing capacity, but also addresses maintaining continuous sediment transport from the upstream reaches of Hotelling Gulch through the crossing, to the confluence with the South Fork of the Salmon River. It consists of replacing the culvert crossing with a bridge, grading a channel under the bride to the design profile and cross section, and grading the channel approximately 100 feet downstream of the crossing.

Estimation of Channel Aggradation

To design an adequately sized crossing in a channel that regularly experiences sediment aggradation requires predicting the likely maximum aggraded channel profile within the project area during the life of the crossing structure. Once the channel bottom aggrades to this profile, the channel is expected to have sufficient competence to maintain sediment transport continuity through the project area. This profile is referred to as the High Vertical Adjustment Profile (VAP) and is based on field observation, interpretation of model results, and professional judgment. The high VAP was predicted assuming no channel maintenance will occur. All hydraulic modeling for determination of crossing freeboard and sediment transport competence are based on the predicted aggraded channel profile (High VAP).

The results from the existing conditions sediment transport assessment and evaluation of the channel profile were used to estimate the high VAP. The downstream extents of aggradation are expected to extend to near station 1+23, approximately 100 feet downstream of the crossing, where the existing channel shear stresses increase (Figure 4 and Figure 5). Predicting the upstream extents of sediment aggradation was less obvious. As aggradation continues, the channel slope and capacity lessens and the area of sediment aggradation is expected to move upstream. Therefore, sediment aggradation was conservatively predicted to extend to the distinct break in channel slope near station 4+12, approximately 150 feet upstream of the crossing (Figure 5).

The predicted 4.3% slope of the aggraded channel forms a uniform channel profile from the upstream sediment delivery reaches, through the crossing, to downstream where the existing channel currently has sufficient sediment transport competence (Figure 5).

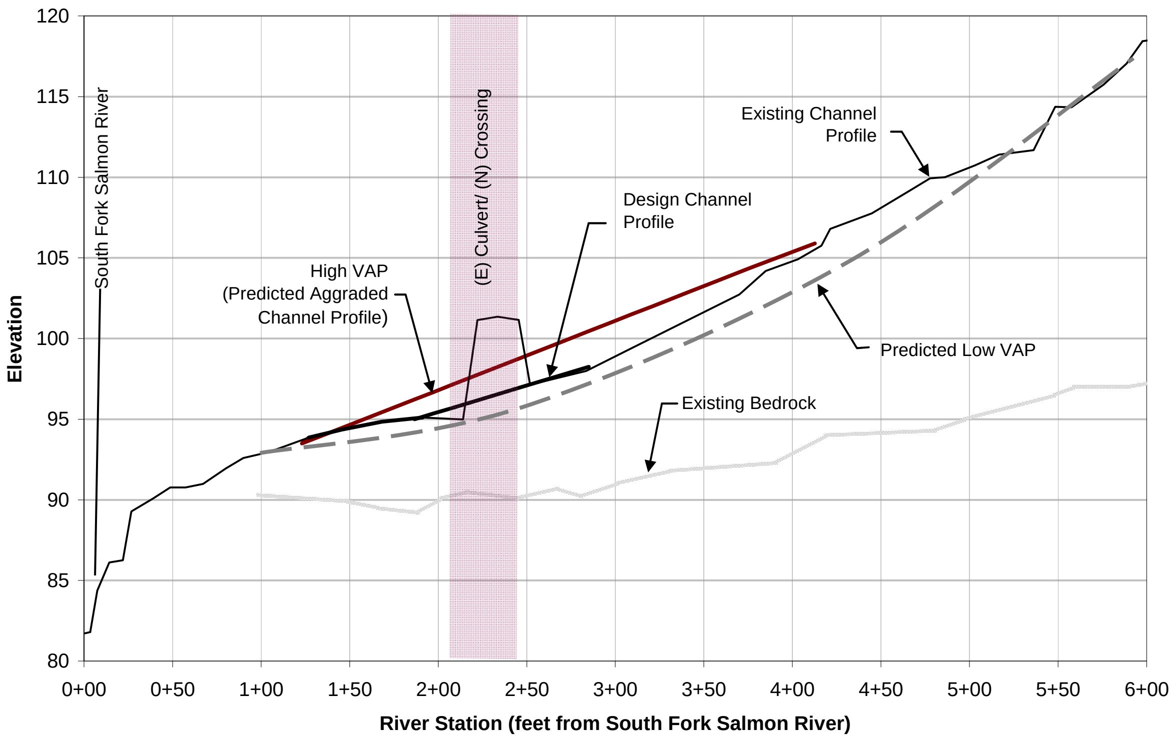


Figure 5. Existing channel profile with predicted low and high Vertical Adjustment Profiles (VAP's). The aggraded channel profile meets the existing channel upstream and downstream of the crossing to create a continuous 4.3% slope. An estimate of the bedrock elevations provided by PWA is also shown.

Estimation of Channel Degradation

A low vertical adjustment profile (VAP) was predicted that represents an estimate of the lowest elevation the channel could degrade, excluding bridge scour. The low VAP channel profile is not constructed; it is used to establish various design elevations, including the bottom elevation of revetment rock used to stabilize the channel banks and limit scour under a bridge crossing. The low VAP for this project is approximately 0.8 feet below the constructed channel bottom (Figure 5). Therefore, rock placed across the channel under the bridge to prevent excessive localized bridge scour should be placed a minimum of 0.8 feet below the constructed channel bottom.

Design Channel Profile

A stream profile and cross section will need to be constructed under the bridge crossing. The design channel profile under the bridge was estimated by projecting the slope of the downstream channel bottom upstream through the crossing to meet the existing channel bottom downstream of the crossing (Figure 5). The existing channel profile will serve as the design channel profile where grading is proposed downstream of the crossing for Alternative B (Figure 5).

Channel Cross Sections

Given the amount of channel aggradation anticipated at the crossing and the potential for large-scale, episodic sediment and debris loading (such as from upstream debris flows), a bridge was identified as the best-suited crossing structure for the site. A bridge can be designed to have a larger open area to pass sediment and debris than a culvert crossing. The channel grading and bridge sizing were prepared using stream simulation methodology (USFS, 2008), which uses characteristics of a nearby stable natural channel to design a channel within the project area. A crossing designed using the stream simulation methodology is assumed to provide the same level of fish passage as the existing stream channel, therefore, a fish passage analysis is not necessary.

The active channel width (bottom width) of the existing stable channel reach upstream of the project area is approximately 10 feet (Ross Taylor & Associates, 2002). Proposed channel grading was developed based on maintaining the active channel width at the low VAP (Figure 6). The constructed channel bottom width under the bridge at the design profile will be approximately 12.5 feet. For both Alternatives A and B, the proposed channel side slopes under the bridge are at 1.5:1 (H:V) and rip-rapped. For Alternative B the streambank grading extends approximately 100 feet downstream of the crossing with side slopes at 2:1 (H:V) and can be stabilized with vegetation. The cross section grading downstream of the crossing will meet the existing channel bed elevation.

To prevent roadway flooding, the existing low left bank upstream of the crossing should be raised to an elevation sufficient to contain the 100-year flow, but should substantially be lower than the bottom of the bridge deck. This will minimize the risk of flow and debris contacting the bottom of the bridge deck, causing pressure flow under the bridge that could cause substantial channel scour and threaten the structural integrity of the crossing.

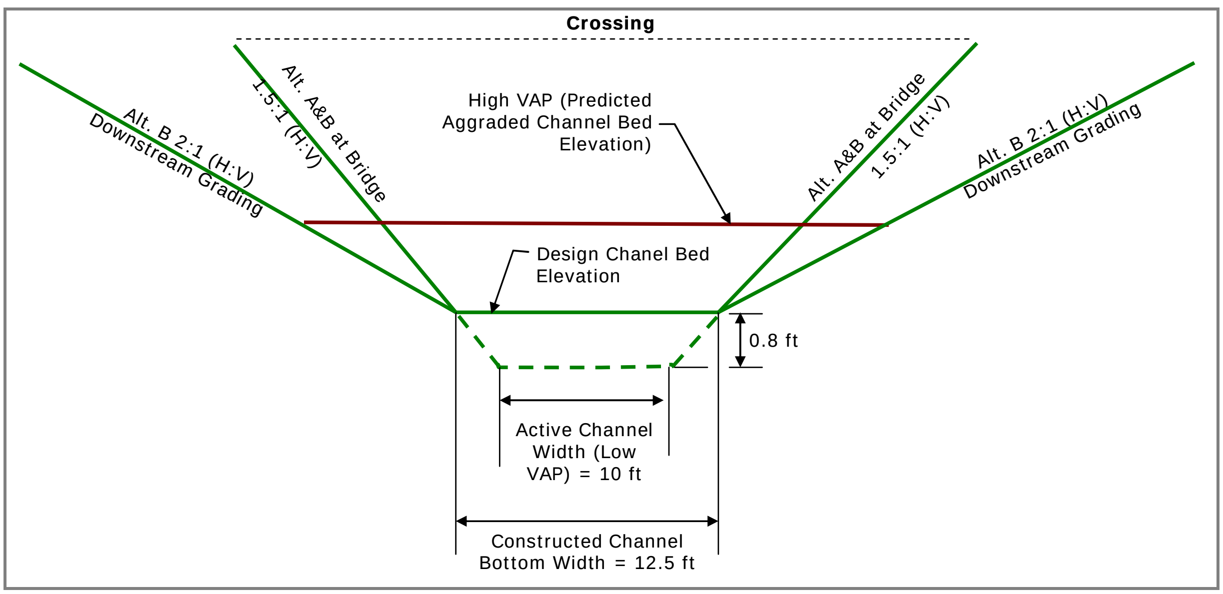


Figure 6. Proposed channel grading at the bridge and downstream for Alternatives A and B (vertically exaggerated). Under the bridge, the proposed channel side slopes are at 1.5:1 (H:V) and rip rapped. For Alternative B downstream of the bridge, channel side slopes are at 2:1 (H:V) and stabilized with vegetation. The toe of riprap and any scour control structures should be placed below the elevation of the low VAP.

Hydraulic Modeling

Hydraulic Model Development

Alternative A and B were both modeled using HEC-RAS. The modeling for both alternatives included the cross section grading shown in Figure 6 with the 12.5-foot channel bottom width graded at the design profile. All modeling was performed assuming fully aggraded sediment conditions (High VAP). Therefore, the modeling included use of the "Fixed Sediment Elevation" module in HEC-RAS, which computes channel cross section geometry and capacity given a sediment aggradation elevation at each cross section. At the upstream face of the bridge, this results in approximately 2 feet of sediment aggradation. Initially, the bottom of the bridge was established to maintain a minimum of 2 feet of freeboard at the 50-year return period flow per Siskiyou County design guidelines.

The results of the HEC-RAS modeling were then used to evaluate channel and bridge capacity and sediment transport competence within the project area. The results of the proposed condition HEC-RAS modeling are presented in the following sections and in Attachment 2.

Sediment Transport Assessment

A competence-based sediment transport assessment similar to existing conditions was performed for both Alternatives A and B for a 2.33-year event (Figure 7). For Alternative A at this flow, sediment transport competence for the D_{84} particle size is maintained through the proposed bridge crossing. However, downstream of the bridge, between stations 1+50 to 1+75, channel shear stresses drop below the shear stress value necessary to maintain transport of the D_{84} particle size. It is expected that sediment deposition may occur in this area, potentially aggrading the channel bed to an elevation higher than the high VAP. This could cause channel erosion and development of a higher VAP through the bridge crossing and upstream. If aggradation become high enough, the crossing may become blocked or the channel may avulse.

The downstream limits of grading were developed iteratively for Alternative B, extending the limits of grading downstream from the bridge to where channel sediment transport competence for D_{84} particle is maintained downstream to the confluence. Bottom widths of cross sections downstream of station 1+62 transition to 10 feet wide, which more closely matches the existing channel width. Modeling indicated that channel grading needs to extend downstream of the new bridge for approximately 100 feet to maintain sediment transport continuity (Figure 7).

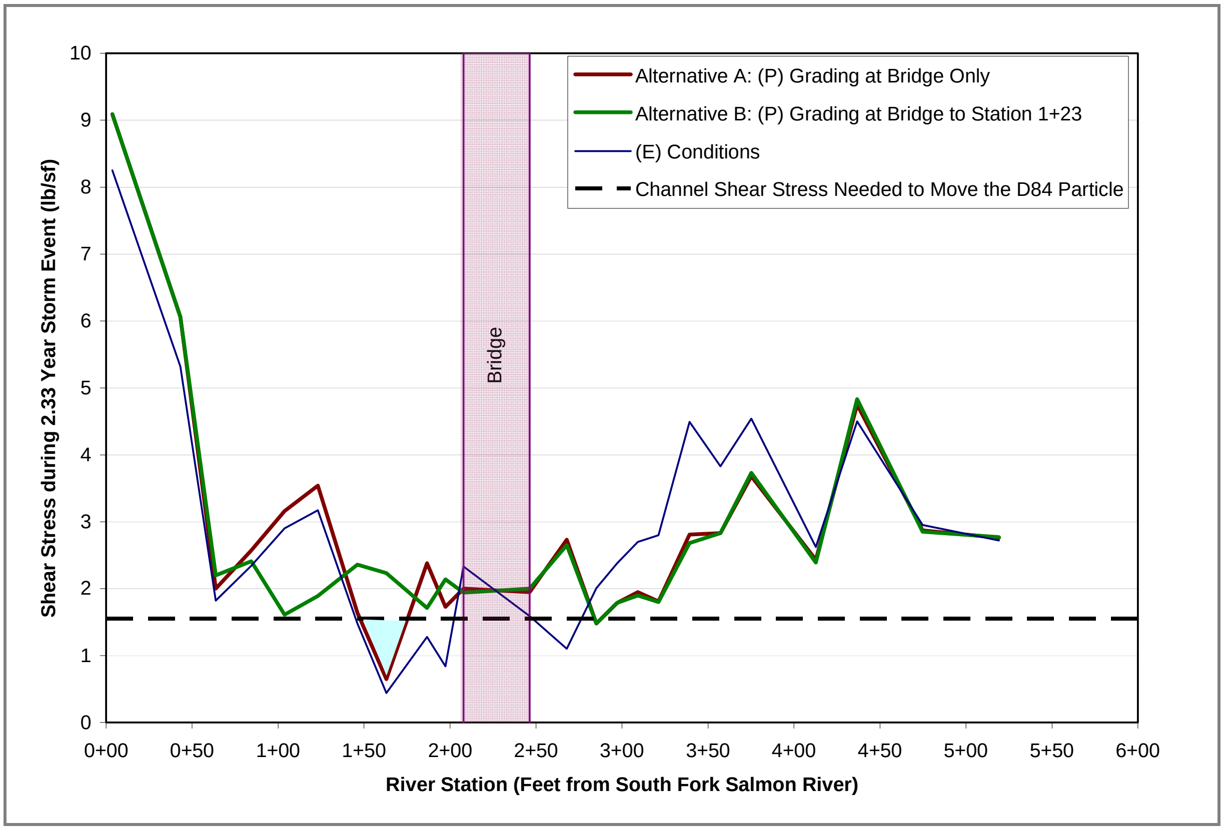


Figure 7. Existing condition and Alternatives A and B shear stress along Hotelling Gulch at a 2.33-year return period flow. The dashed line represents the channel shear stress necessary to mobilize the D_{84} particle size. The light blue hatched area indicates modeling results from Alternative A where channel shear stresses are insufficient to maintain transport of the D_{84} particle and aggradation may occur.

Bridge Crossing

Bridge Freeboard and Span

Siskiyou County desires a minimum of 2-feet of freeboard between the 50-year water surface elevation and the bottom of a bridge crossing (2009, Scott Sumner, Siskiyou County engineer, personal communication). The stream simulation design process recommends that a crossing maintain freeboard between the 100-year water surface elevation and the bottom of the crossing to minimize the potential of debris jamming at the upstream face of the crossing.

Figure 8 presents the channel profile and resulting water surface profiles for Alternatives A and B. Figure 9 shows the modeled cross section and water surface elevations at the upstream bridge face for each alternative. The water surface profiles for both alternatives are similar, except downstream of the bridge, where for Alternative A a backwater occurs between stations 1+23 and the bridge. This backwater is caused by a constriction in the channel near station 1+23 that abruptly decreases the channel area and increases depth. The resulting backwater causes a substantial drop in channel shear stress, as discussed in the existing conditions section. Under Alternative B, the downstream channel is graded to eliminate the channel constriction, thus eliminating the backwater.

If the bottom of the bridge is established based on maintaining 2-feet of freeboard for the 50-year water surface elevation, bottom of the bridge deck would be 4.1 feet above the aggraded channel bed at the high VAP. Using the same freeboard requirement for the 100-year water surface elevation raises the bottom of the bridge deck another 0.2 feet.

Hotelling Gulch has experienced extensive debris loading in the past, with quantities of large trees and boulders jamming the channel during high flows. Based on this, we recommend a minimum of 3 feet of freeboard be provided above the 100-year water surface elevation, placing the bottom of the bridge deck 5 feet above the aggraded channel bottom at the high VAP. This places the bottom of the bridge crossing at an elevation of 104 feet, necessitating a free-span of approximately 35 feet across the channel (Figure 8 and Figure 9).

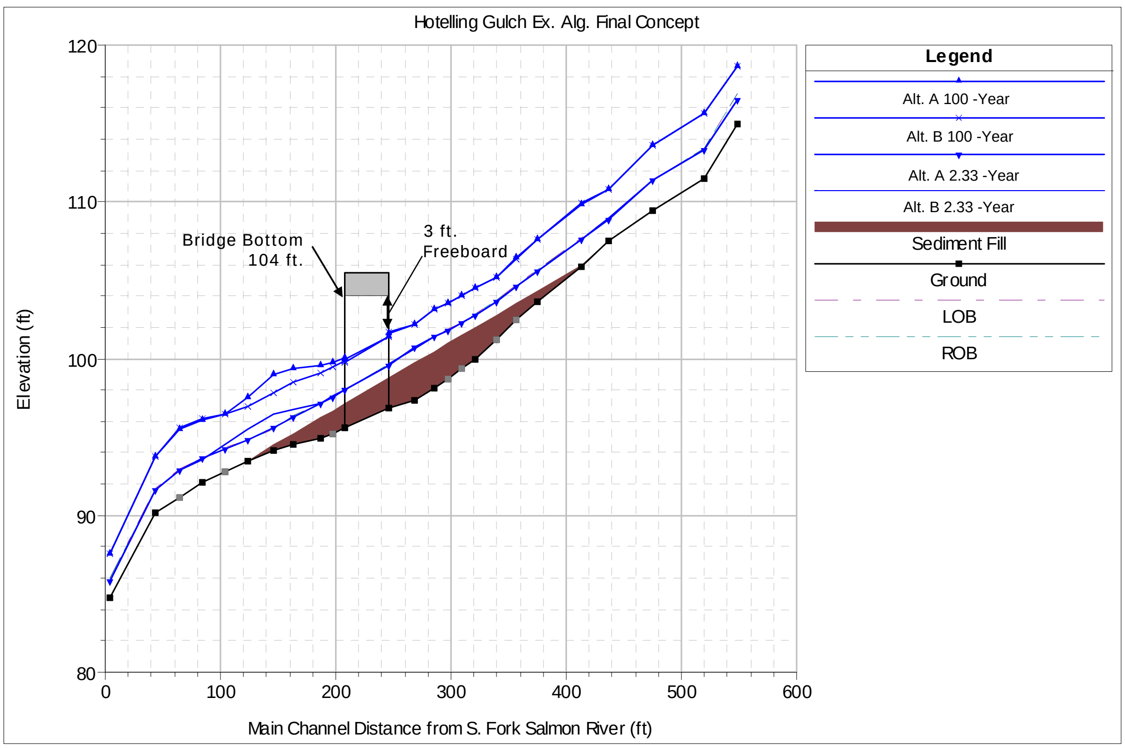


Figure 8. Profile of 2.33 and 100-year water surface profiles for Alternatives A and B. Note that the water surface profile for both alternatives are similar, except downstream of the bridge, where in Alternative A, a backwater occurs between station 1+23 and the bridge.

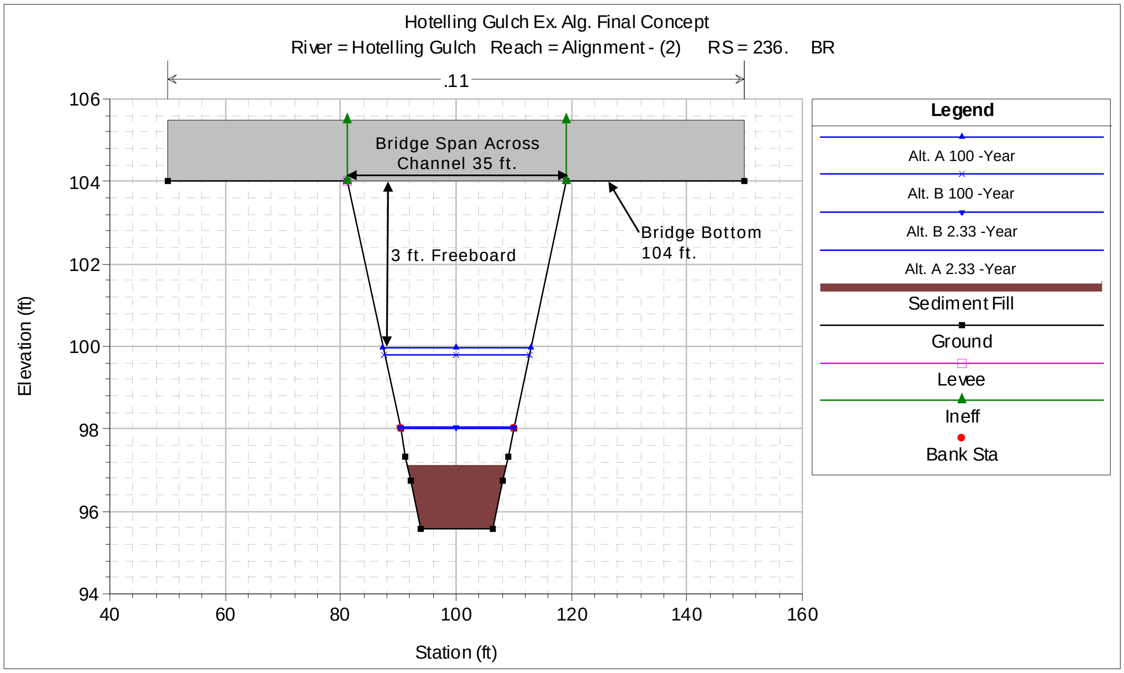


Figure 9. HEC-RAS representation of the proposed channel cross section and bridge crossing at the Cecilville Road crossing of Hotelling Gulch.

Foundation and Bridge Materials

Additional bridge length may be necessary to accommodate the bridge foundations. Based on information provided by PWA, the depth to bedrock in the vicinity of the bridge is at an approximate elevation of 90 feet, which is 6 feet below the existing channel bottom. Therefore, it is likely that spread footings on bedrock will be feasible for the site. However, a geotechnical analysis and structural design will be necessary to develop the foundation design.

Assuming a spread footing width of 4 feet on either side of the bridge, plus an additional 2 feet of width to place riprap, the total span of the proposed crossing will be approximately 47 feet. Scott Sumner indicated that pre-stressed concrete slab bridges are preferred by the County rather than steel bridges or culverts. Siskiyou County has found that Oregon Department of Transportation (ODOT) standard bridge details are sufficient for design (Attachment 3), though it is necessary for a structural engineer to ensure that the design meets California seismic standards. Assuming that California design standards are met, the ODOT 18-inch thick pre-stressed concrete slab bridge deck appears to be feasible for the replacement crossing at Hotelling Gulch. An 18-inch pre-cast concrete slab bridge can be constructed as a free-spanning bridge up to 49 feet long.

As with the foundation design, a structural analysis will be necessary to confirm the bridge design. Scott Sumner indicated that due to a high volume of heavy load traffic in the area, the bridge should be designed to sustain a minimum of HS-25 loading.

Roadway Improvements

To obtain the necessary flow conveyance and freeboard at the proposed Cecilville Road bridge crossing, the roadway will need to be raised. Setting the bottom of the bridge at elevation 104 feet, the roadway elevation at the crossing will be 105.5 feet, assuming an 18-inch thick bridge deck.

Road profiles for Cecilville Road that accommodate the proposed bridge were investigated using AASHTO vertical and sag curve guidelines and the existing roadway profile. Due to the steep roadway profiles along Cecilville Road, crest and sag vertical curves that meet AASHTO standards for 25 to 35 mph appear to be feasible to the west of the bridge crossing (Figure 10), but will necessitate approximately 500 feet of roadway modifications. An intersection with an unpaved Forest Service road is located to the east of the proposed bridge, but the topographic survey ends beyond the intersection. Based on the limited survey data, it appears that the intersection may need to be raised, also necessitating raising a portion of the Forest Service Road. Additional roadway topography is necessary to finalize roadway profiles for both Cecilville Road and the Forest Service Road to the east. Roadway profile modifications with steeper slopes and shorter vertical curves may be feasible if the assumed travel speed is reduced or AASHTO standards are not met, but this would require approval by the County.

Cecilville Road at Hotelling Gulch is a two-lane road. Standard land width is 12 feet, requiring a minimum road width of 24 feet with standard sections of guardrail on the bridge and bridge approaches.

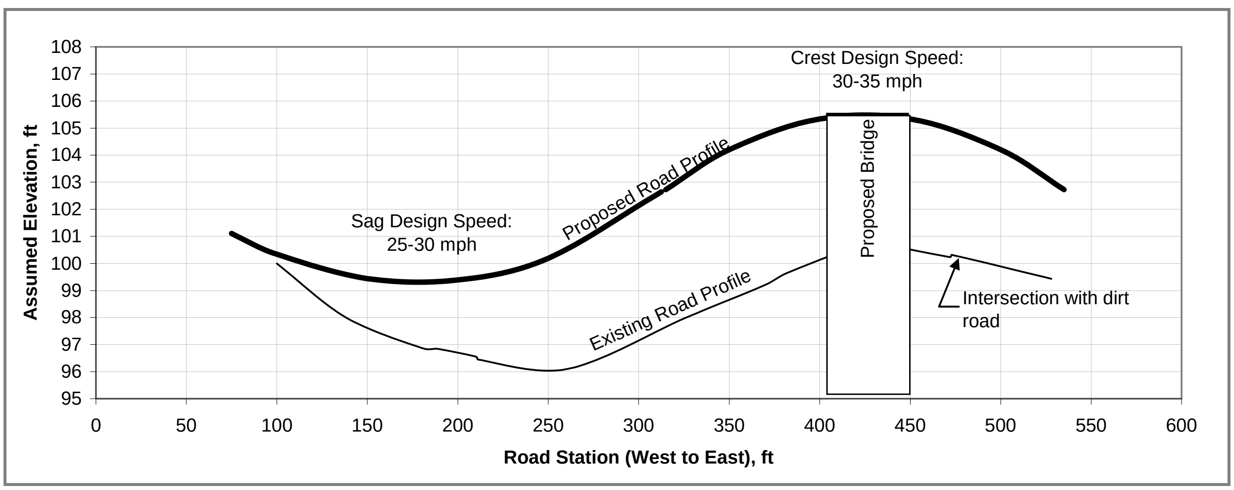


Figure 10. Proposed road profile and design speeds, as compared with the existing profile (vertically exaggerated).

Recommendations

This memorandum identifies preliminary replacement bridge crossing and channel dimensions for the existing alignment of Hotelling Gulch at Cecilville Road. Alternative B, which includes channel grading extending 100 feet downstream of a new bridge crossing, appears most beneficial for conveying water, sediment, and debris. Before construction, a final hydraulic, geotechnical, structural and civil engineering design will be necessary for the crossing and stream. The final design should include the following:

1. Geotechnical analysis and structural design of the bridge foundation
2. Structural design of the bridge crossing to meet California requirements
3. Bridge scour analysis and design of the stream channel cross section and stabilization
4. Additional roadway profile survey and roadway design of Cecilville Road and the Forest Service road to the east of the project
5. Civil site design that includes a traffic control plan
6. Revegetation plans

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ATTACHMENT 1

Existing Condition HEC-RAS Model Output

HEC-RAS Plan: Existing River: Hotelling Gulch Reach: Alignment - (2)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	548.77	2.33-yr (38 cfs)	38.00	114.96	116.55	116.55	116.96	0.211465	5.12	7.42	9.36	1.01
Alignment - (2)	548.77	5-yr (66 cfs)	66.00	114.96	116.95	116.95	117.45	0.186256	5.68	11.63	11.78	0.99
Alignment - (2)	548.77	10-yr (104 cfs)	104.00	114.96	117.33	117.33	117.98	0.160387	6.49	16.47	14.09	0.97
Alignment - (2)	548.77	25-yr (169 cfs)	169.00	114.96	117.88	117.88	118.68	0.130726	7.32	25.17	17.50	0.93
Alignment - (2)	548.77	50-yr (230 cfs)	230.00	114.96	118.29	118.29	119.21	0.119441	7.95	32.90	20.05	0.91
Alignment - (2)	548.77	100-yr (282 cfs)	282.00	114.96	118.60	118.60	119.60	0.111716	8.36	39.51	21.91	0.90
Alignment - (2)	548.77	Baseflow (2 cfs)	2.00	114.96	115.42	115.42	115.54	0.296292	2.85	0.70	2.75	0.99
Alignment - (2)	519.2	2.33-yr (38 cfs)	38.00	111.51	113.33	112.78	113.46	0.040765	2.85	13.32	11.67	0.47
Alignment - (2)	519.2	5-yr (66 cfs)	66.00	111.51	113.77	113.17	113.96	0.042421	3.55	18.79	13.47	0.50
Alignment - (2)	519.2	10-yr (104 cfs)	104.00	111.51	114.22	113.55	114.50	0.043492	4.27	25.34	15.35	0.53
Alignment - (2)	519.2	25-yr (169 cfs)	169.00	111.51	114.83	114.09	115.23	0.044845	5.18	35.46	17.87	0.57
Alignment - (2)	519.2	50-yr (230 cfs)	230.00	111.51	115.29	114.52	115.79	0.045983	5.85	44.14	19.79	0.59
Alignment - (2)	519.2	100-yr (282 cfs)	282.00	111.51	115.64	114.84	116.21	0.046668	6.33	51.19	21.22	0.60
Alignment - (2)	519.2	Baseflow (2 cfs)	2.00	111.51	112.00	111.84	112.03	0.048849	1.30	1.54	5.24	0.42
Alignment - (2)	474.76	2.33-yr (38 cfs)	38.00	109.44	111.36	110.88	111.49	0.048044	2.93	12.96	12.40	0.51
Alignment - (2)	474.76	5-yr (66 cfs)	66.00	109.44	111.77	111.26	111.98	0.047609	3.63	18.52	14.56	0.53
Alignment - (2)	474.76	10-yr (104 cfs)	104.00	109.44	112.22	111.62	112.50	0.046759	4.30	25.54	16.90	0.55
Alignment - (2)	474.76	25-yr (169 cfs)	169.00	109.44	112.82	112.14	113.21	0.046119	5.13	36.62	20.04	0.57
Alignment - (2)	474.76	50-yr (230 cfs)	230.00	109.44	113.28	112.55	113.75	0.045937	5.72	46.30	22.43	0.59
Alignment - (2)	474.76	100-yr (282 cfs)	282.00	109.44	113.61	112.87	114.15	0.045814	6.15	54.22	24.22	0.60
Alignment - (2)	474.76	Baseflow (2 cfs)	2.00	109.44	110.07	109.86	110.09	0.039337	1.26	1.59	4.74	0.38
Alignment - (2)	436.82	2.33-yr (38 cfs)	38.00	107.51	108.93	108.68	109.13	0.083337	3.54	10.74	11.78	0.65
Alignment - (2)	436.82	5-yr (66 cfs)	66.00	107.51	109.28	109.02	109.58	0.087595	4.44	15.00	13.17	0.70
Alignment - (2)	436.82	10-yr (104 cfs)	104.00	107.51	109.64	109.38	110.08	0.091088	5.37	20.00	14.61	0.75
Alignment - (2)	436.82	25-yr (169 cfs)	169.00	107.51	110.13	109.90	110.77	0.093658	6.52	27.74	16.60	0.79
Alignment - (2)	436.82	50-yr (230 cfs)	230.00	107.51	110.53	110.32	111.32	0.093769	7.32	34.60	18.18	0.82
Alignment - (2)	436.82	100-yr (282 cfs)	282.00	107.51	110.83	110.64	111.73	0.093045	7.87	40.27	19.39	0.83
Alignment - (2)	436.82	Baseflow (2 cfs)	2.00	107.51	107.93	107.84	107.97	0.085706	1.46	1.37	5.92	0.54
Alignment - (2)	412.64	2.33-yr (38 cfs)	38.00	105.89	107.53	107.13	107.64	0.045936	2.73	13.94	14.62	0.49
Alignment - (2)	412.64	5-yr (66 cfs)	66.00	105.89	107.93	107.42	108.10	0.043159	3.29	20.18	16.10	0.50
Alignment - (2)	412.64	10-yr (104 cfs)	104.00	105.89	108.37	107.75	108.60	0.040508	3.86	27.65	17.73	0.51
Alignment - (2)	412.64	25-yr (169 cfs)	169.00	105.89	109.00	108.19	109.31	0.037607	4.55	39.45	20.03	0.52
Alignment - (2)	412.64	50-yr (230 cfs)	230.00	105.89	109.49	108.56	109.87	0.035930	5.04	49.78	21.85	0.52
Alignment - (2)	412.64	100-yr (282 cfs)	282.00	105.89	109.87	108.85	110.30	0.034706	5.38	58.34	23.25	0.52
Alignment - (2)	412.64	Baseflow (2 cfs)	2.00	105.89	106.49	106.33	106.51	0.044505	1.14	1.75	6.71	0.39
Alignment - (2)	375.19	2.33-yr (38 cfs)	38.00	103.68	105.25	104.92	105.45	0.076504	3.61	10.52	10.33	0.63
Alignment - (2)	375.19	5-yr (66 cfs)	66.00	103.68	105.64	105.32	105.95	0.078725	4.49	14.88	11.97	0.67
Alignment - (2)	375.19	10-yr (104 cfs)	104.00	103.68	106.04	105.72	106.49	0.082463	5.44	19.88	13.26	0.72
Alignment - (2)	375.19	25-yr (169 cfs)	169.00	103.68	106.57	106.28	107.24	0.086986	6.65	27.40	15.00	0.77
Alignment - (2)	375.19	50-yr (230 cfs)	230.00	103.68	106.98	106.72	107.82	0.090066	7.54	33.84	16.51	0.81
Alignment - (2)	375.19	100-yr (282 cfs)	282.00	103.68	107.29	107.06	108.26	0.091998	8.19	39.09	17.82	0.83
Alignment - (2)	375.19	Baseflow (2 cfs)	2.00	103.68	104.06	103.97	104.10	0.101054	1.62	1.24	5.22	0.58
Alignment - (2)	357.21*	2.33-yr (38 cfs)	38.00	102.44	103.98	103.65	104.15	0.067817	3.29	11.56	12.30	0.60
Alignment - (2)	357.21*	5-yr (66 cfs)	66.00	102.44	104.35	104.01	104.61	0.069551	4.05	16.39	13.76	0.64
Alignment - (2)	357.21*	10-yr (104 cfs)	104.00	102.44	104.74	104.36	105.10	0.070231	4.86	21.94	15.13	0.67
Alignment - (2)	357.21*	25-yr (169 cfs)	169.00	102.44	105.27	104.86	105.79	0.069862	5.85	30.63	17.16	0.70
Alignment - (2)	357.21*	50-yr (230 cfs)	230.00	102.44	105.69	105.27	106.34	0.070004	6.58	38.06	18.74	0.72
Alignment - (2)	357.21*	100-yr (282 cfs)	282.00	102.44	106.00	105.57	106.75	0.070681	7.12	44.08	20.59	0.74
Alignment - (2)	357.21*	Baseflow (2 cfs)	2.00	102.44	102.91	102.75	102.93	0.044550	1.21	1.66	5.90	0.40
Alignment - (2)	339.23*	2.33-yr (38 cfs)	38.00	101.20	102.56	102.35	102.75	0.091834	3.48	10.92	13.61	0.68
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Alignment - (2)	339.23*	10-yr (104 cfs)	104.00	101.20	103.19	102.99	103.61	0.098594	5.25	20.35	16.41	0.78
Alignment - (2)	339.23*	25-yr (169 cfs)	169.00	101.20	103.59	103.46	104.24	0.108610	6.52	27.38	18.18	0.85
Alignment - (2)	339.23*	50-yr (230 cfs)	230.00	101.20	103.91	103.83	104.74	0.113168	7.42	33.50	19.72	0.89
Alignment - (2)	339.23*	100-yr (282 cfs)	282.00	101.20	104.16	104.13	105.12	0.115797	8.06	38.45	20.89	0.92
Alignment - (2)	339.23*	Baseflow (2 cfs)	2.00	101.20	101.59	101.53	101.64	0.134565	1.71	1.17	5.68	0.67
Alignment - (2)	321.25	2.33-yr (38 cfs)	38.00	99.96	101.35	101.02	101.47	0.054919	2.77	13.74	16.48	0.53
Alignment - (2)	321.25	5-yr (66 cfs)	66.00	99.96	101.69	101.30	101.87	0.054103	3.41	19.59	18.67	0.56
Alignment - (2)	321.25	10-yr (104 cfs)	104.00	99.96	102.05	101.60	102.30	0.052003	4.02	26.94	21.12	0.57
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Alignment - (2)	321.25	50-yr (230 cfs)	230.00	99.96	103.05	102.37	103.43	0.042571	5.09	50.03	25.63	0.56
Alignment - (2)	321.25	100-yr (282 cfs)	282.00	99.96	103.39	102.61	103.81	0.040393	5.39	60.07	30.63	0.56
Alignment - (2)	321.25	Baseflow (2 cfs)	2.00	99.96	100.45	100.29	100.47	0.037937	1.03	1.94	7.82	0.37
Alignment - (2)	309.196*	2.33-yr (38 cfs)	38.00	99.35	100.72	100.37	100.84	0.050617	2.74	13.89	18.04	0.52
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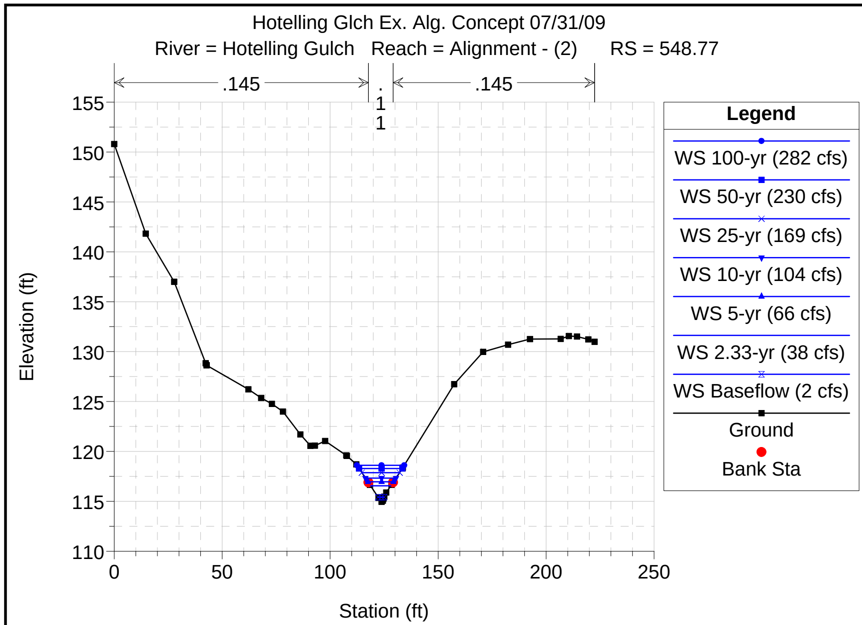
Alignment - (2)	309.196*	10-yr (104 cfs)	104.00	99.35	101.52	100.96	101.74	0.041157	3.81	28.37	23.10	0.52
Alignment - (2)	309.196*	25-yr (169 cfs)	169.00	99.35	102.16	101.38	102.44	0.034260	4.33	41.85	25.39	0.50
Alignment - (2)	309.196*	50-yr (230 cfs)	230.00	99.35	102.63	101.74	102.97	0.033109	4.81	51.96	27.01	0.51
Alignment - (2)	309.196*	100-yr (282 cfs)	282.00	99.35	102.97	101.99	103.36	0.032776	5.18	59.70	28.21	0.52
Alignment - (2)	309.196*	Baseflow (2 cfs)	2.00	99.35	99.77	99.68	99.80	0.087198	1.36	1.47	7.32	0.54

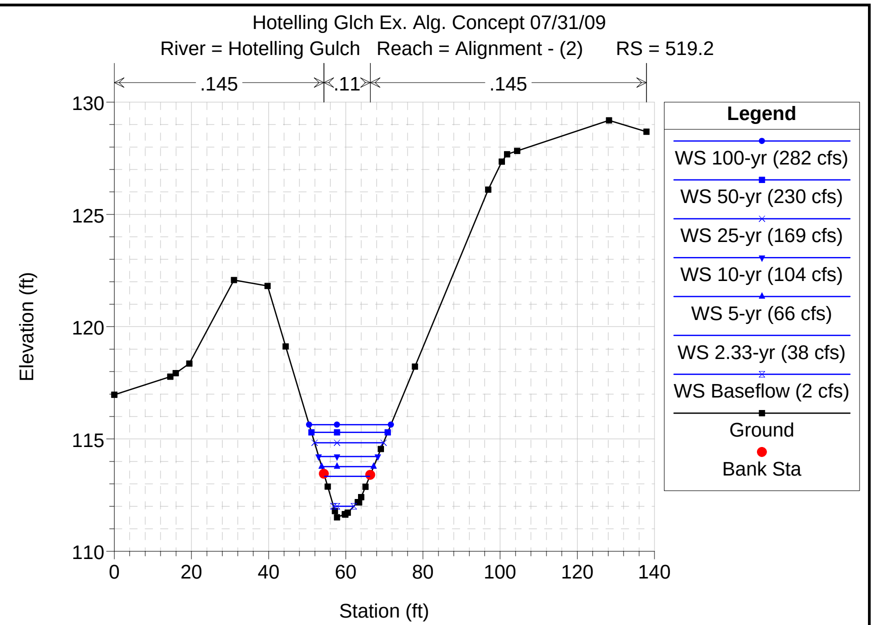
HEC-RAS Plan: Existing River: Hotelling Gulch Reach: Alignment - (2) (Continued)

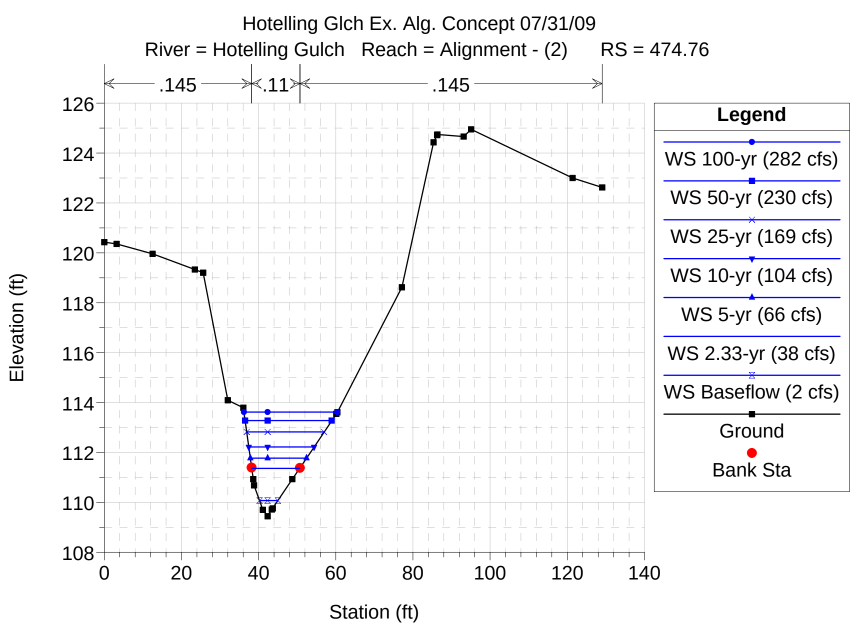
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	297.143*	2.33-yr (38 cfs)	38.00	98.73	100.18	99.76	100.28	0.041316	2.60	14.62	20.19	0.47
Alignment - (2)	297.143*	5-yr (66 cfs)	66.00	98.73	100.63	100.06	100.77	0.032949	3.01	22.25	23.00	0.45
Alignment - (2)	297.143*	10-yr (104 cfs)	104.00	98.73	101.16	100.36	101.33	0.026998	3.38	32.26	25.82	0.43
Alignment - (2)	297.143*	25-yr (169 cfs)	169.00	98.73	101.86	100.80	102.09	0.023374	3.88	46.98	28.22	0.42
Alignment - (2)	297.143*	50-yr (230 cfs)	230.00	98.73	102.33	101.16	102.61	0.024265	4.41	57.15	29.99	0.44
Alignment - (2)	297.143*	100-yr (282 cfs)	282.00	98.73	102.67	101.42	103.01	0.025034	4.81	64.96	31.52	0.46
Alignment - (2)	297.143*	Baseflow (2 cfs)	2.00	98.73	99.27	99.06	99.28	0.025089	0.83	2.40	9.83	0.30
Alignment - (2)	285.09	2.33-yr (38 cfs)	38.00	98.12	99.76	99.19	99.86	0.030205	2.45	15.52	23.09	0.41
Alignment - (2)	285.09	5-yr (66 cfs)	66.00	98.12	100.32	99.52	100.44	0.022600	2.79	24.22	26.40	0.38
Alignment - (2)	285.09	10-yr (104 cfs)	104.00	98.12	100.89	99.86	101.05	0.019757	3.18	34.72	29.80	0.38
Alignment - (2)	285.09	25-yr (169 cfs)	169.00	98.12	101.63	100.33	101.83	0.018613	3.74	50.43	34.25	0.38
Alignment - (2)	285.09	50-yr (230 cfs)	230.00	98.12	102.07	100.71	102.34	0.020503	4.31	61.19	37.04	0.41
Alignment - (2)	285.09	100-yr (282 cfs)	282.00	98.12	102.41	101.01	102.72	0.021704	4.72	69.85	39.34	0.43
Alignment - (2)	285.09	Baseflow (2 cfs)	2.00	98.12	98.44	98.44	98.53	0.334408	2.41	0.83	4.81	1.02
Alignment - (2)	267.9	2.33-yr (38 cfs)	38.00	97.36	99.48	98.30	99.54	0.011999	1.91	19.91	12.14	0.26
Alignment - (2)	267.9	5-yr (66 cfs)	66.00	97.36	100.04	98.68	100.13	0.013636	2.46	27.14	13.59	0.29
Alignment - (2)	267.9	10-yr (104 cfs)	104.00	97.36	100.60	99.11	100.74	0.015498	3.05	35.76	18.19	0.32
Alignment - (2)	267.9	25-yr (169 cfs)	169.00	97.36	101.32	99.66	101.52	0.017036	3.73	52.76	27.64	0.35
Alignment - (2)	267.9	50-yr (230 cfs)	230.00	97.36	101.72	100.09	101.99	0.020154	4.37	64.16	29.86	0.39
Alignment - (2)	267.9	100-yr (282 cfs)	282.00	97.36	102.02	100.45	102.34	0.021928	4.79	73.61	31.58	0.41
Alignment - (2)	267.9	Baseflow (2 cfs)	2.00	97.36	97.82	97.50	97.82	0.006695	0.61	3.30	7.84	0.16
Alignment - (2)	267		Lat Struct									
Alignment - (2)	246.32	2.33-yr (38 cfs)	29.60	96.62	99.16	98.16	99.24	0.016109	2.32	12.75	17.03	0.30
Alignment - (2)	246.32	5-yr (66 cfs)	45.36	96.62	99.70	98.43	99.82	0.015737	2.74	16.58	20.24	0.31
Alignment - (2)	246.32	10-yr (104 cfs)	62.75	96.62	100.27	98.69	100.41	0.014740	3.05	20.55	107.63	0.31
Alignment - (2)	246.32	25-yr (169 cfs)	86.50	96.62	101.00	99.01	101.18	0.013311	3.37	25.69	113.39	0.31
Alignment - (2)	246.32	50-yr (230 cfs)	120.55	96.62	101.25	99.43	101.55	0.020893	4.40	27.38	115.78	0.39
Alignment - (2)	246.32	100-yr (282 cfs)	172.65	96.62	100.93	99.99	101.66	0.056712	6.86	25.17	112.67	0.64
Alignment - (2)	246.32	Baseflow (2 cfs)	2.00	96.62	97.64	97.00	97.65	0.009806	0.85	2.36	3.77	0.19
Alignment - (2)	236.		Culvert									
Alignment - (2)	207.83	2.33-yr (38 cfs)	29.60	94.98	97.02	96.31	97.14	0.026594	2.76	10.71	18.82	0.39
Alignment - (2)	207.83	5-yr (66 cfs)	45.36	94.98	97.32	96.58	97.52	0.034287	3.54	12.82	20.11	0.46
Alignment - (2)	207.83	10-yr (104 cfs)	62.75	94.98	97.59	96.85	97.87	0.041591	4.27	14.69	21.22	0.52
Alignment - (2)	207.83	25-yr (169 cfs)	86.50	94.98	97.89	97.17	98.30	0.050521	5.15	16.81	22.71	0.59
Alignment - (2)	207.83	50-yr (230 cfs)	120.55	94.98	98.24	97.59	98.85	0.062374	6.26	19.25	24.57	0.67
Alignment - (2)	207.83	100-yr (282 cfs)	172.65	94.98	98.65	98.16	99.60	0.080856	7.81	22.09	26.73	0.78
Alignment - (2)	207.83	Baseflow (2 cfs)	2.00	94.98	95.90	95.44	95.91	0.008807	0.69	2.91	14.17	0.18
Alignment - (2)	197.24*	2.33-yr (38 cfs)	29.60	94.93	96.87	96.14	96.91	0.013241	1.57	18.90	17.99	0.27
Alignment - (2)	197.24*	5-yr (66 cfs)	45.36	94.93	97.18	96.32	97.23	0.013164	1.84	24.77	19.67	0.28
Alignment - (2)	197.24*	10-yr (104 cfs)	62.75	94.93	97.47	96.49	97.54	0.012997	2.09	30.70	21.09	0.29
Alignment - (2)	197.24*	25-yr (169 cfs)	86.50	94.93	97.81	96.69	97.90	0.012867	2.36	38.24	22.96	0.30
Alignment - (2)	197.24*	50-yr (230 cfs)	120.55	94.93	98.24	96.94	98.34	0.012718	2.66	48.42	25.37	0.30
Alignment - (2)	197.24*	100-yr (282 cfs)	172.65	94.93	98.78	97.25	98.91	0.012716	3.05	63.40	31.10	0.31
Alignment - (2)	197.24*	Baseflow (2 cfs)	2.00	94.93	95.79	95.38	95.80	0.014263	0.73	2.75	8.82	0.23
Alignment - (2)	186.65	2.33-yr (38 cfs)	29.60	94.87	96.67	96.10	96.73	0.022813	1.90	15.58	16.87	0.35
Alignment - (2)	186.65	5-yr (66 cfs)	45.36	94.87	96.99	96.30	97.06	0.019725	2.15	21.38	19.04	0.34
Alignment - (2)	186.65	10-yr (104 cfs)	62.75	94.87	97.29	96.47	97.38	0.018069	2.37	27.31	20.74	0.34
Alignment - (2)	186.65	25-yr (169 cfs)	86.50	94.87	97.64	96.68	97.74	0.016899	2.63	34.86	22.78	0.34
Alignment - (2)	186.65	50-yr (230 cfs)	120.55	94.87	98.06	96.92	98.19	0.015899	2.92	45.23	25.83	0.34
Alignment - (2)	186.65	100-yr (282 cfs)	172.65	94.87	98.61	97.25	98.76	0.015022	3.27	60.36	29.60	0.34
Alignment - (2)	186.65	Baseflow (2 cfs)	2.00	94.87	95.41	95.32	95.47	0.113399	1.86	1.08	3.97	0.63
Alignment - (2)	162.96	2.33-yr (38 cfs)	29.60	94.50	96.44	95.37	96.46	0.006065	1.15	25.65	21.90	0.19
Alignment - (2)	162.96	5-yr (66 cfs)	45.36	94.50	96.78	95.57	96.81	0.006146	1.37	33.54	24.80	0.20
Alignment - (2)	162.96	10-yr (104 cfs)	62.75	94.50	97.09	95.75	97.13	0.006187	1.55	41.63	27.48	0.20
Alignment - (2)	162.96	25-yr (169 cfs)	86.50	94.50	97.45	95.96	97.50	0.006244	1.76	51.94	70.56	0.21
Alignment - (2)	162.96	50-yr (230 cfs)	120.55	94.50	97.89	96.22	97.95	0.006267	2.00	65.48	77.71	0.22
Alignment - (2)	162.96	100-yr (282 cfs)	172.65	94.50	98.44	96.53	98.52	0.006366	2.29	83.92	86.86	0.23
Alignment - (2)	162.96	Baseflow (2 cfs)	2.00	94.50	95.07	94.72	95.08	0.005968	0.54	3.70	9.84	0.16
Alignment - (2)	146.16	2.33-yr (38 cfs)	29.60	94.13	96.21	95.51	96.28	0.023729	2.08	14.26	13.69	0.36
Alignment - (2)	146.16	5-yr (66 cfs)	45.36	94.13	96.53	95.77	96.62	0.022930	2.41	19.00	15.79	0.37
Alignment - (2)	146.16	10-yr (104 cfs)	62.75	94.13	96.83	96.00	96.94	0.022229	2.71	23.94	17.74	0.37
Alignment - (2)	146.16	25-yr (169 cfs)	86.50	94.13	97.17	96.26	97.31	0.021814	3.05	30.33	19.99	0.38
Alignment - (2)	146.16	50-yr (230 cfs)	120.55	94.13	97.59	96.53	97.76	0.021136	3.41	39.31	22.85	0.39
Alignment - (2)	146.16	100-yr (282 cfs)	172.65	94.13	98.12	96.91	98.33	0.020439	3.83	52.17	25.46	0.40
Alignment - (2)	146.16	Baseflow (2 cfs)	2.00	94.13	94.88	94.60	94.90	0.025746	1.09	1.83	4.91	0.31
Alignment - (2)	123.09	2.33-yr (38 cfs)	29.60	93.49	95.34	94.88	95.48	0.053732	3.02	9.81	9.60	0.53
Alignment - (2)	123.09	5-yr (66 cfs)	45.36	93.49	95.64	95.17	95.83	0.055322	3.55	12.85	10.99	0.55
Alignment - (2)	123.09	10-yr (104 cfs)	62.75	93.49	95.88	95.43	96.14	0.058000	4.10	15.71	12.11	0.58
Alignment - (2)	123.09	25-yr (169 cfs)	86.50	93.49	96.17	95.70	96.50	0.061170	4.71	19.31	13.42	0.62

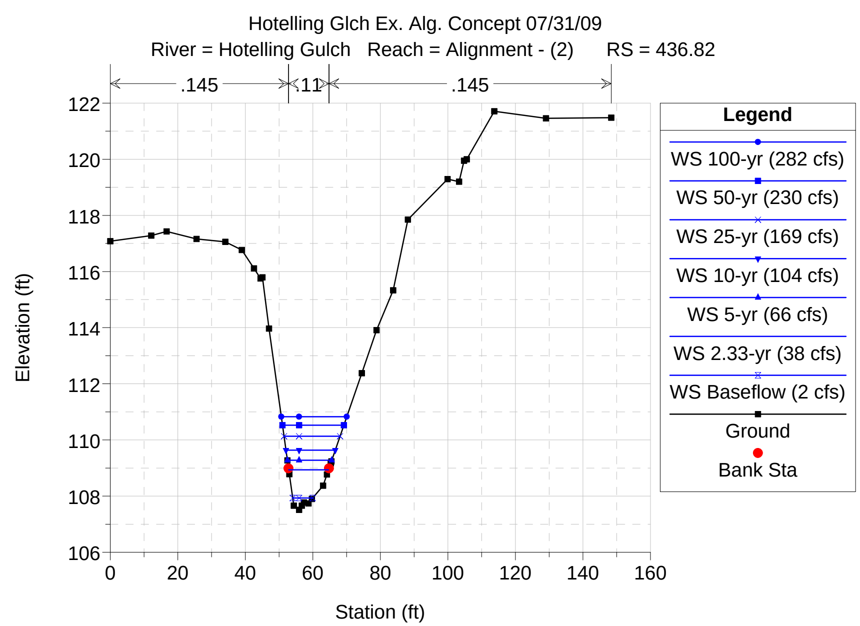
HEC-RAS Plan: Existing River: Hotelling Gulch Reach: Alignment - (2) (Continued)

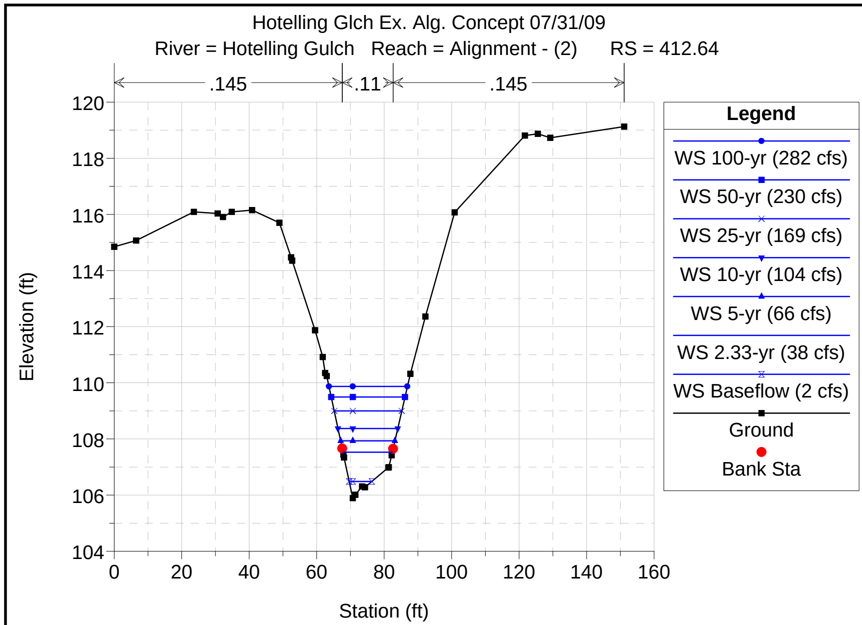
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	123.09	50-yr (230 cfs)	120.55	93.49	96.50	96.05	96.95	0.064511	5.42	24.12	14.99	0.65
Alignment - (2)	123.09	100-yr (282 cfs)	172.65	93.49	96.92	96.50	97.51	0.069324	6.33	30.76	16.92	0.70
Alignment - (2)	123.09	Baseflow (2 cfs)	2.00	93.49	94.07	93.87	94.11	0.047983	1.45	1.37	3.76	0.42
Alignment - (2)	103.735*	2.33-yr (38 cfs)	29.60	92.80	94.32	93.90	94.44	0.053556	2.84	10.41	11.53	0.53
Alignment - (2)	103.735*	5-yr (66 cfs)	45.36	92.80	94.60	94.16	94.76	0.054672	3.25	14.00	13.75	0.55
Alignment - (2)	103.735*	10-yr (104 cfs)	62.75	92.80	94.83	94.40	95.04	0.054802	3.70	17.35	15.50	0.57
Alignment - (2)	103.735*	25-yr (169 cfs)	86.50	92.80	95.10	94.64	95.36	0.054869	4.19	21.78	17.78	0.59
Alignment - (2)	103.735*	50-yr (230 cfs)	120.55	92.80	95.40	94.94	95.74	0.057422	4.81	27.50	20.55	0.62
Alignment - (2)	103.735*	100-yr (282 cfs)	172.65	92.80	95.76	95.34	96.21	0.061338	5.59	35.54	23.91	0.66
Alignment - (2)	103.735*	Baseflow (2 cfs)	2.00	92.80	93.31	93.12	93.33	0.033612	1.11	1.80	5.87	0.35
Alignment - (2)	84.38	2.33-yr (38 cfs)	29.60	92.11	93.42	92.99	93.52	0.042108	2.56	11.55	12.55	0.47
Alignment - (2)	84.38	5-yr (66 cfs)	45.36	92.11	93.70	93.21	93.84	0.041846	2.99	15.32	14.99	0.49
Alignment - (2)	84.38	10-yr (104 cfs)	62.75	92.11	93.95	93.41	94.12	0.040897	3.36	19.50	18.31	0.50
Alignment - (2)	84.38	25-yr (169 cfs)	86.50	92.11	94.25	93.64	94.46	0.038626	3.72	25.77	23.78	0.50
Alignment - (2)	84.38	50-yr (230 cfs)	120.55	92.11	94.64	93.97	94.86	0.033655	3.98	37.06	31.86	0.48
Alignment - (2)	84.38	100-yr (282 cfs)	172.65	92.11	95.15	94.38	95.38	0.027192	4.13	54.11	34.65	0.45
Alignment - (2)	84.38	Baseflow (2 cfs)	2.00	92.11	92.47	92.36	92.49	0.057297	1.17	1.71	7.84	0.44
Alignment - (2)	63.805*	2.33-yr (38 cfs)	29.60	91.16	92.69	92.14	92.77	0.031291	2.28	13.00	13.47	0.41
Alignment - (2)	63.805*	5-yr (66 cfs)	45.36	91.16	93.00	92.37	93.11	0.029750	2.62	17.43	15.10	0.41
Alignment - (2)	63.805*	10-yr (104 cfs)	62.75	91.16	93.29	92.58	93.42	0.027741	2.91	22.06	16.53	0.41
Alignment - (2)	63.805*	25-yr (169 cfs)	86.50	91.16	93.64	92.82	93.80	0.025855	3.23	28.17	18.33	0.41
Alignment - (2)	63.805*	50-yr (230 cfs)	120.55	91.16	94.08	93.09	94.27	0.023872	3.57	36.77	20.80	0.41
Alignment - (2)	63.805*	100-yr (282 cfs)	172.65	91.16	94.64	93.47	94.87	0.022508	3.99	49.18	24.12	0.42
Alignment - (2)	63.805*	Baseflow (2 cfs)	2.00	91.16	91.59	91.43	91.61	0.033557	1.04	1.92	6.94	0.35
Alignment - (2)	43.23	2.33-yr (38 cfs)	29.60	90.21	91.46	91.24	91.68	0.101865	3.83	7.73	8.58	0.71
Alignment - (2)	43.23	5-yr (66 cfs)	45.36	90.21	91.70	91.51	92.03	0.108085	4.57	9.97	9.38	0.76
Alignment - (2)	43.23	10-yr (104 cfs)	62.75	90.21	91.91	91.75	92.35	0.118453	5.34	11.94	10.04	0.82
Alignment - (2)	43.23	25-yr (169 cfs)	86.50	90.21	92.14	92.04	92.74	0.130406	6.24	14.34	10.79	0.88
Alignment - (2)	43.23	50-yr (230 cfs)	120.55	90.21	92.41	92.41	93.23	0.143815	7.30	17.45	11.70	0.95
Alignment - (2)	43.23	100-yr (282 cfs)	172.65	90.21	92.89	92.89	93.87	0.130343	8.11	23.39	13.26	0.94
Alignment - (2)	43.23	Baseflow (2 cfs)	2.00	90.21	90.57	90.47	90.60	0.076113	1.44	1.38	5.57	0.51
Alignment - (2)	3.58	2.33-yr (38 cfs)	29.60	84.73	85.72	85.72	86.04	0.211330	4.54	6.52	10.02	0.99
Alignment - (2)	3.58	5-yr (66 cfs)	45.36	84.73	85.94	85.94	86.36	0.197718	5.20	8.75	10.85	1.00
Alignment - (2)	3.58	10-yr (104 cfs)	62.75	84.73	86.15	86.15	86.66	0.177081	5.72	11.14	11.57	0.98
Alignment - (2)	3.58	25-yr (169 cfs)	86.50	84.73	86.40	86.40	87.01	0.160746	6.30	14.20	12.44	0.97
Alignment - (2)	3.58	50-yr (230 cfs)	120.55	84.73	86.73	86.73	87.46	0.145817	6.94	18.38	13.53	0.96
Alignment - (2)	3.58	100-yr (282 cfs)	172.65	84.73	87.03	87.15	88.05	0.165545	8.28	22.57	14.54	1.05
Alignment - (2)	3.58	Baseflow (2 cfs)	2.00	84.73	85.01	85.01	85.10	0.327063	2.37	0.84	4.90	1.01

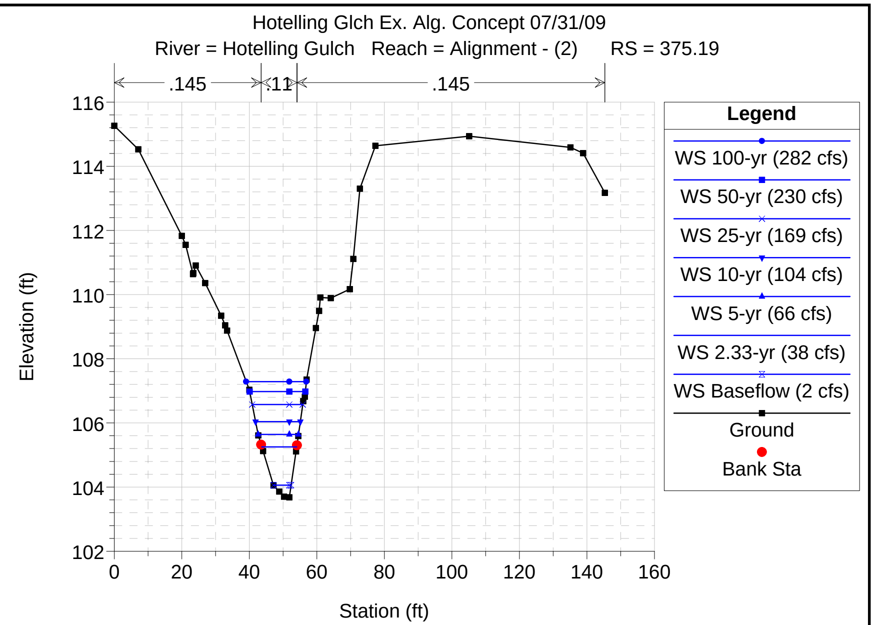

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 548.77
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

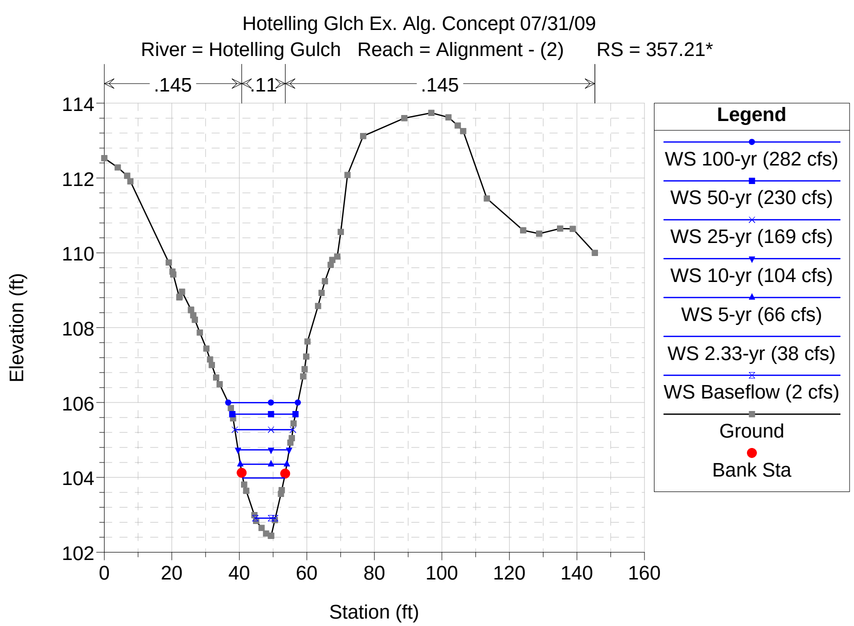

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 519.2
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

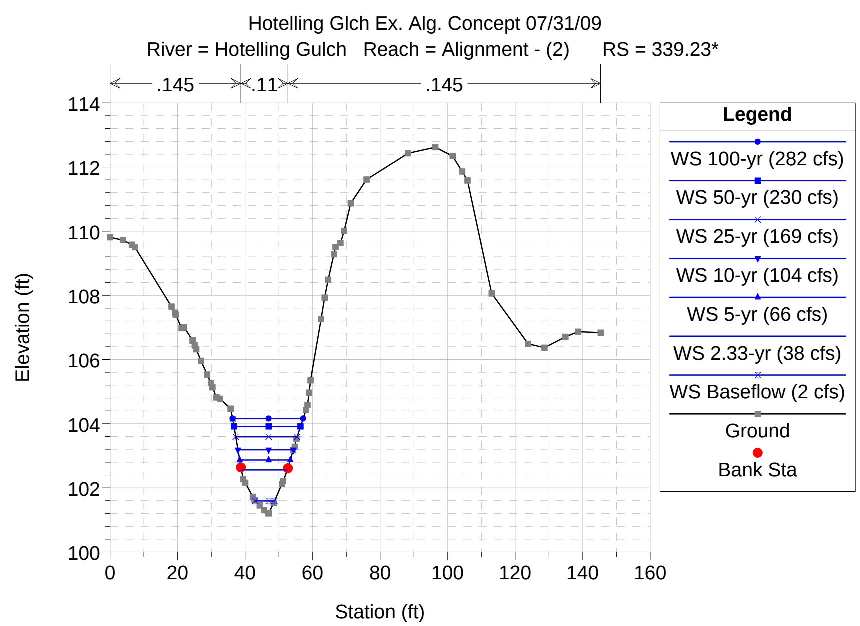

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 474.76
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

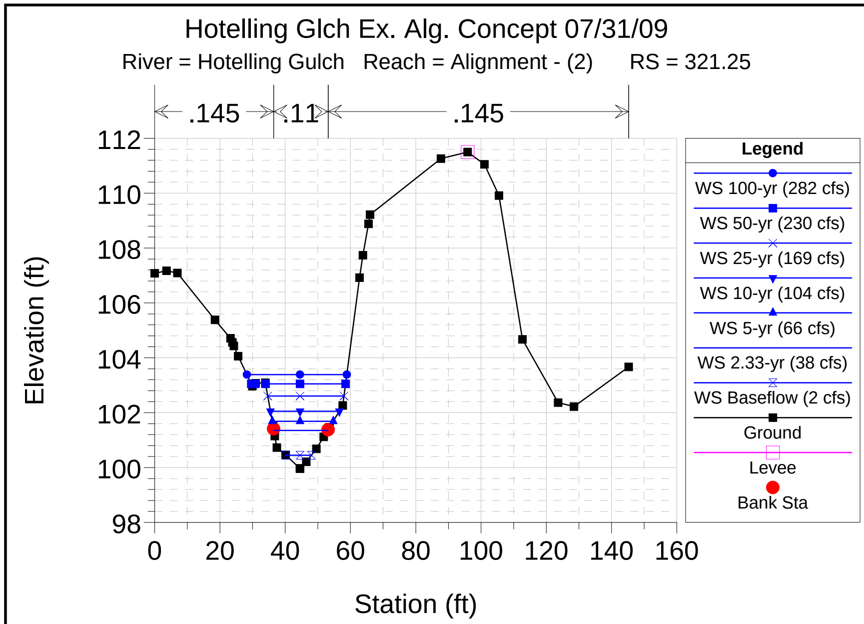

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 436.82
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

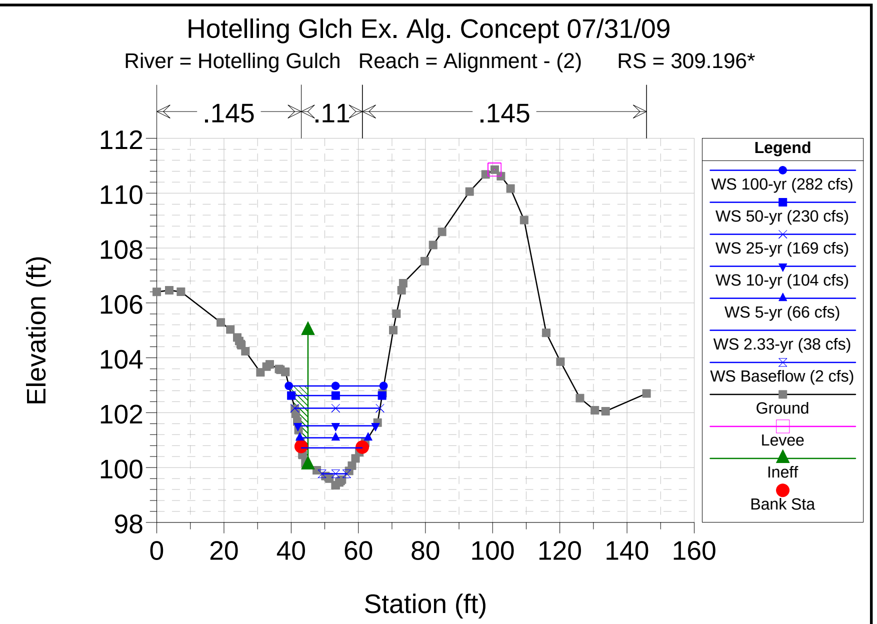

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 412.64
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

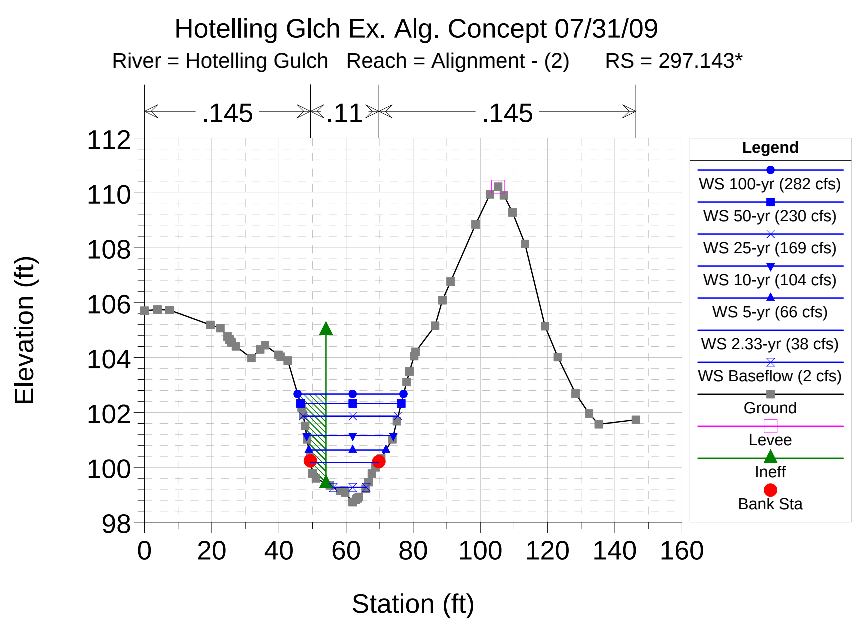

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 375.19
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

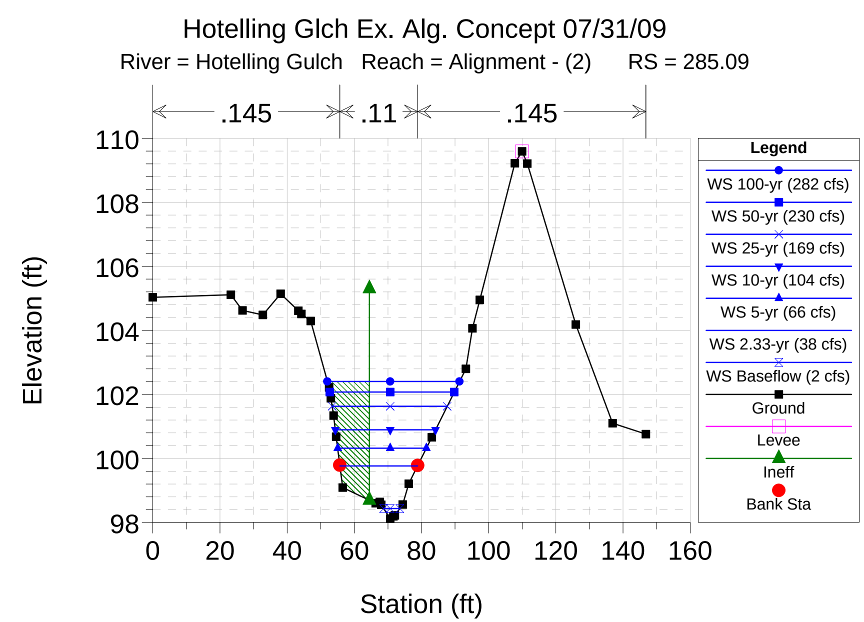

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 357.21*
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

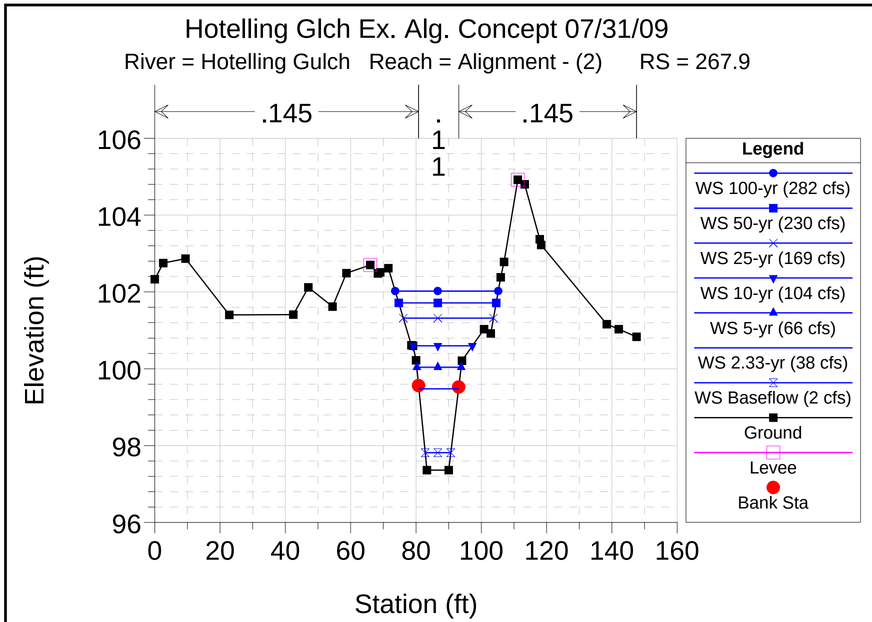

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 339.23*
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 321.25
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

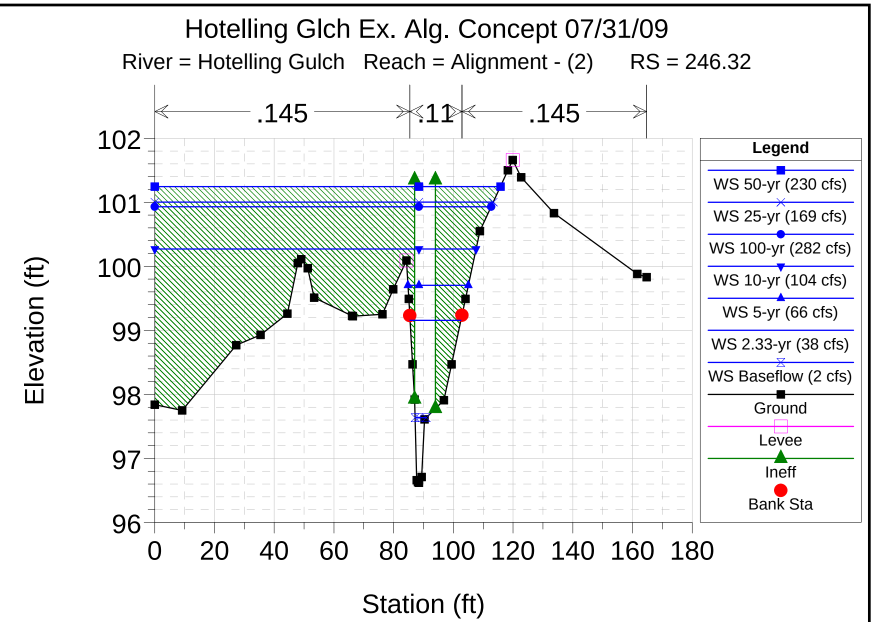

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 309.196*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 297.143*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta

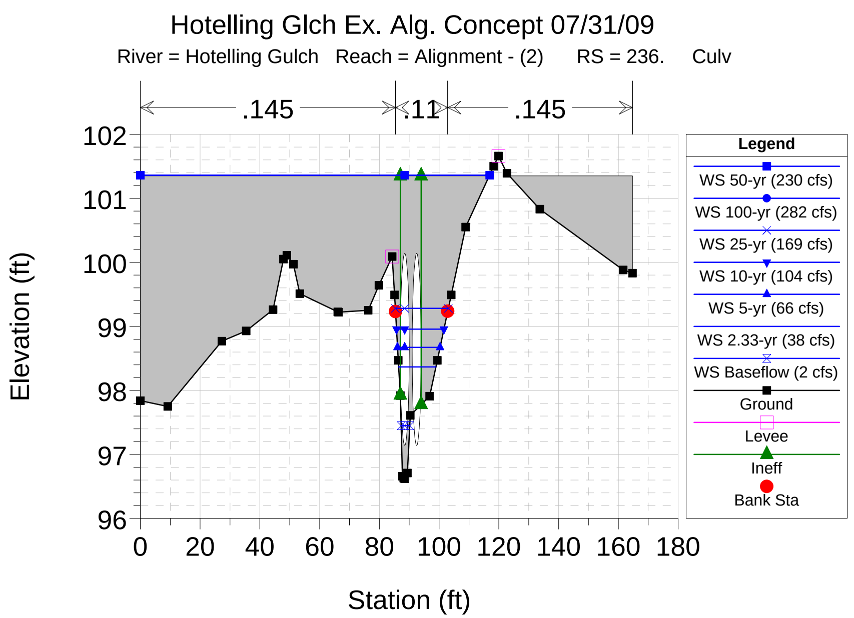

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 285.09
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta



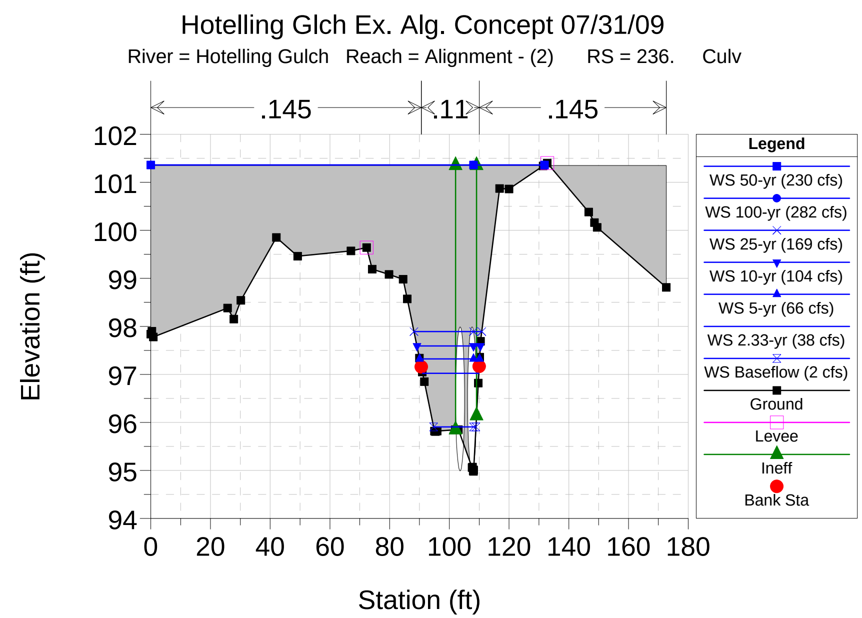
Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 267.9
.145
.11
.145
Elevation (ft)
96
98
100
102
104
106
Station (ft)
0
20
40
60
80
100
120
140
160
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta



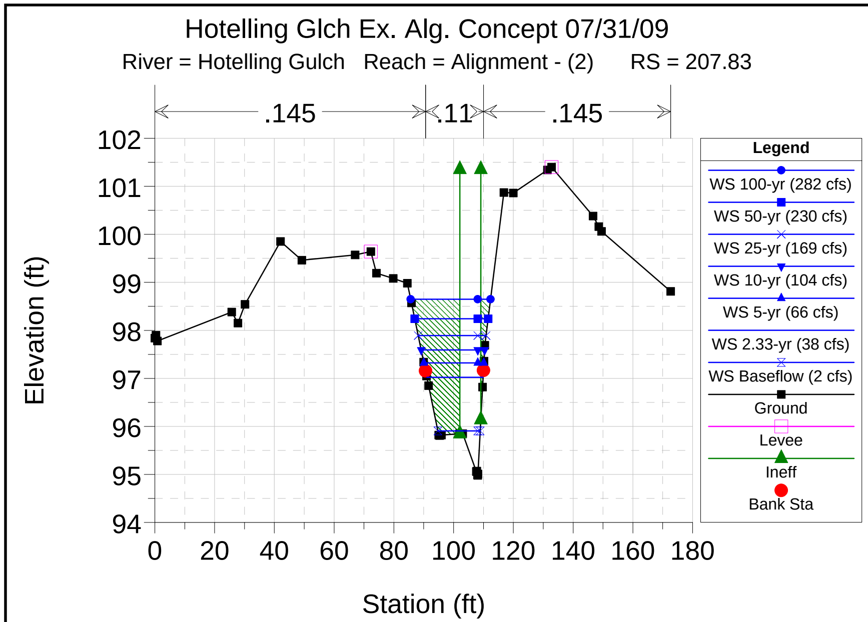
Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 246.32
.145
.11
.145
Elevation (ft)
96
97
98
99
100
101
102
Station (ft)
0
20
40
60
80
100
120
140
160
180
Legend
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 100-yr (282 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta

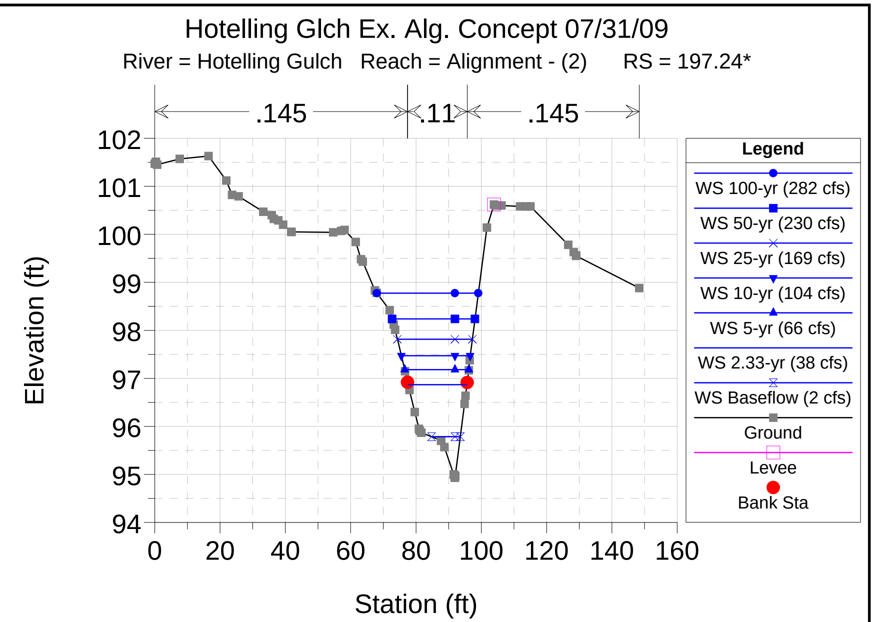


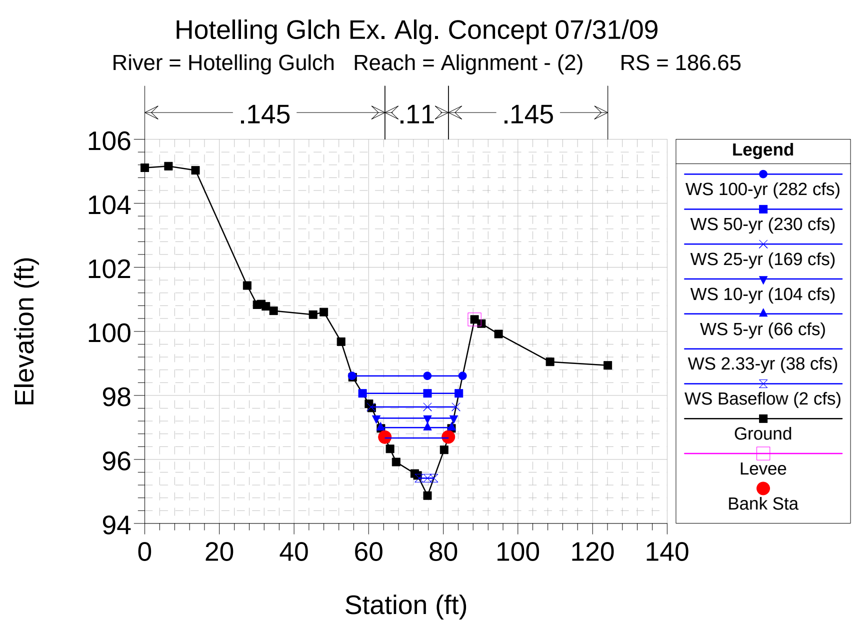
Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 236. Culv
.145
.11
.145
Elevation (ft)
96
97
98
99
100
101
102
Station (ft)
0
20
40
60
80
100
120
140
160
180
Legend
WS 50-yr (230 cfs)
WS 100-yr (282 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta

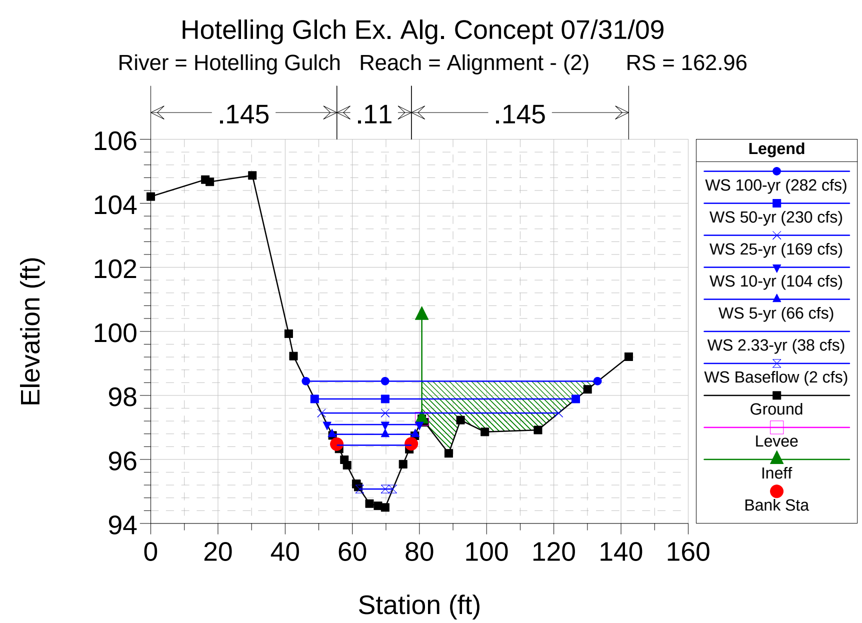


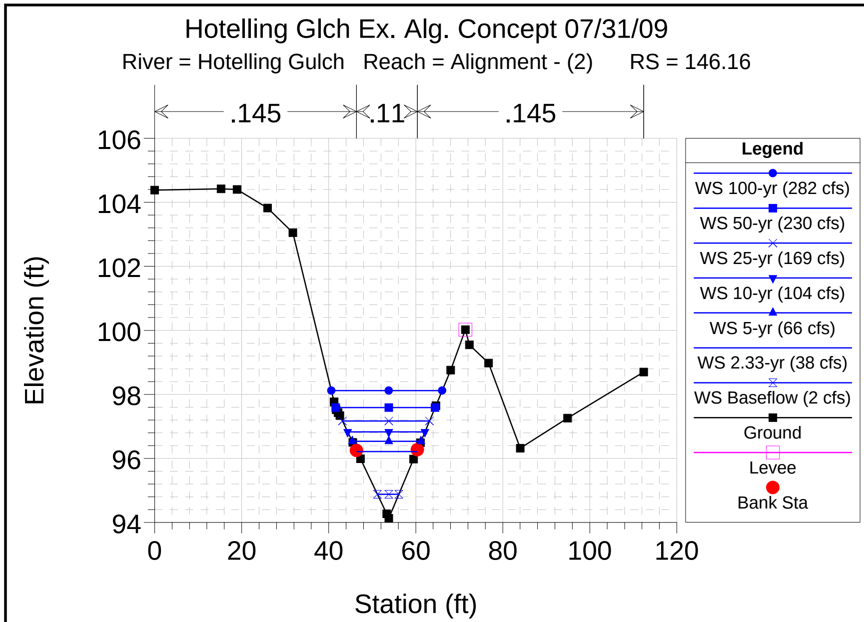
Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 236. Culv
.145
.11
.145
Elevation (ft)
94
95
96
97
98
99
100
101
102
Station (ft)
0
20
40
60
80
100
120
140
160
180
Legend
WS 50-yr (230 cfs)
WS 100-yr (282 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta

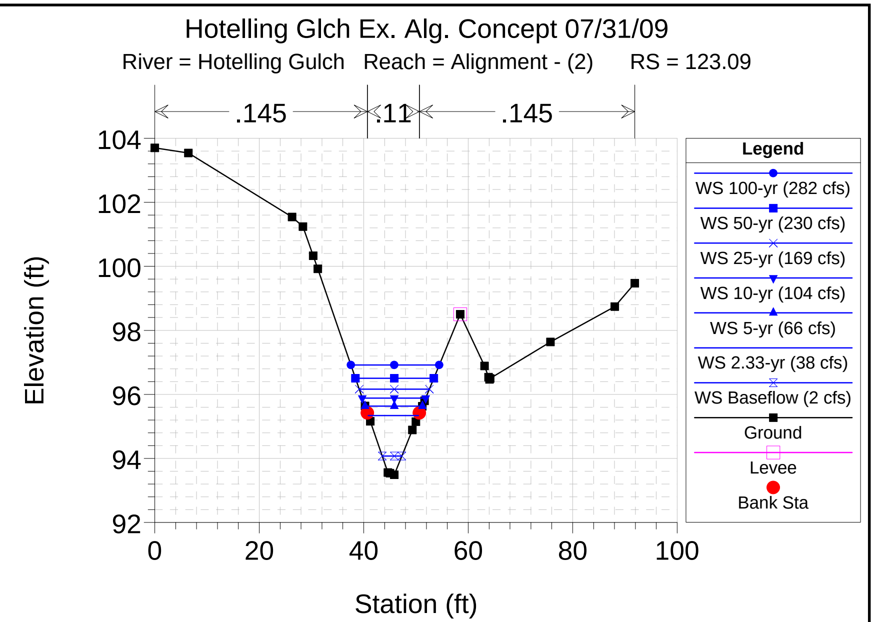

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 207.83
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta

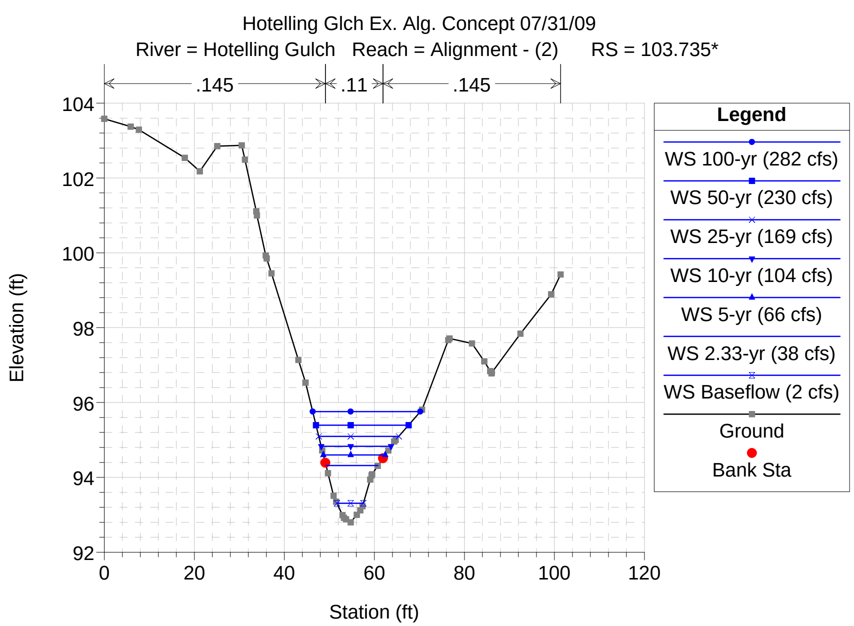

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 197.24*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

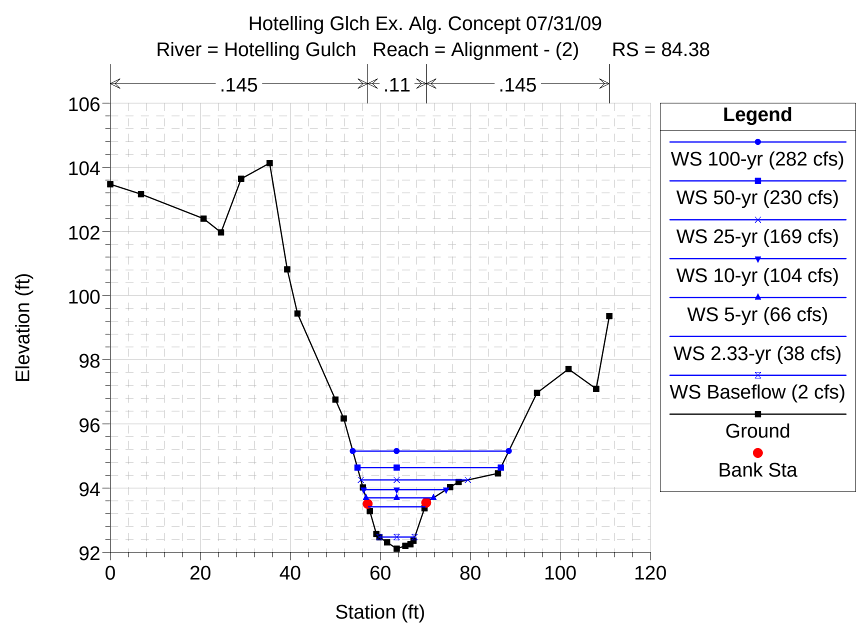

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 186.65
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

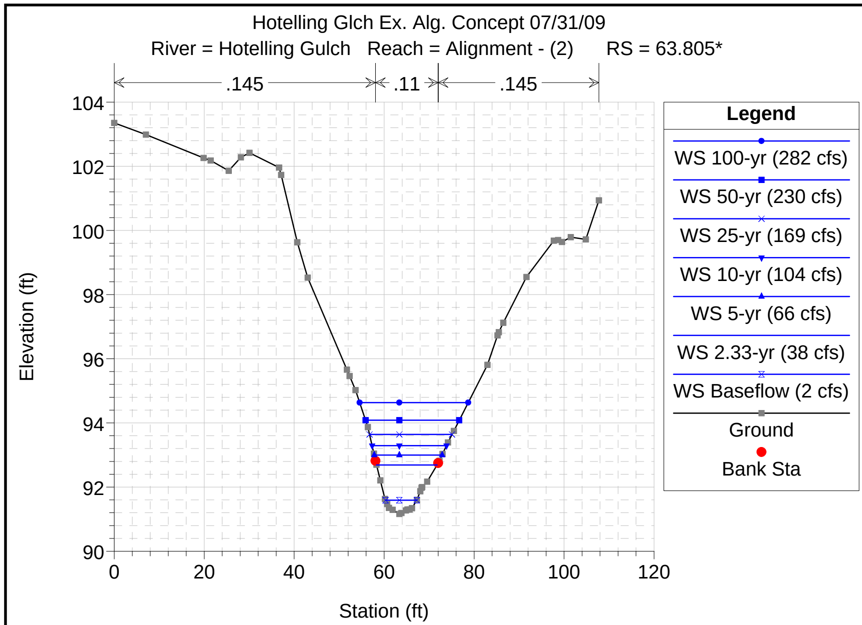

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 162.96
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Ineff
Bank Sta

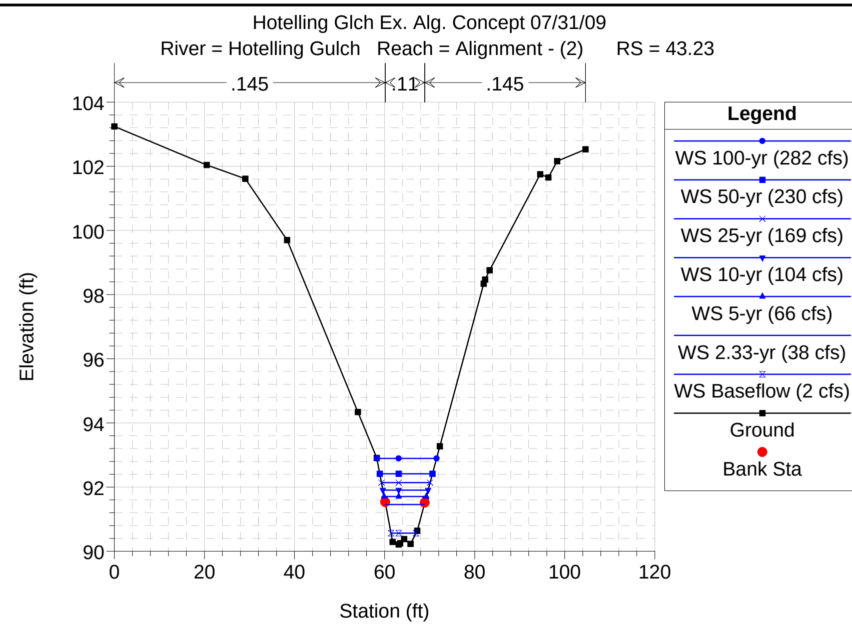

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 146.16
.145
.11
.145
Elevation (ft)
Station (ft)
106
104
102
100
98
96
94
0
20
40
60
80
100
120
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

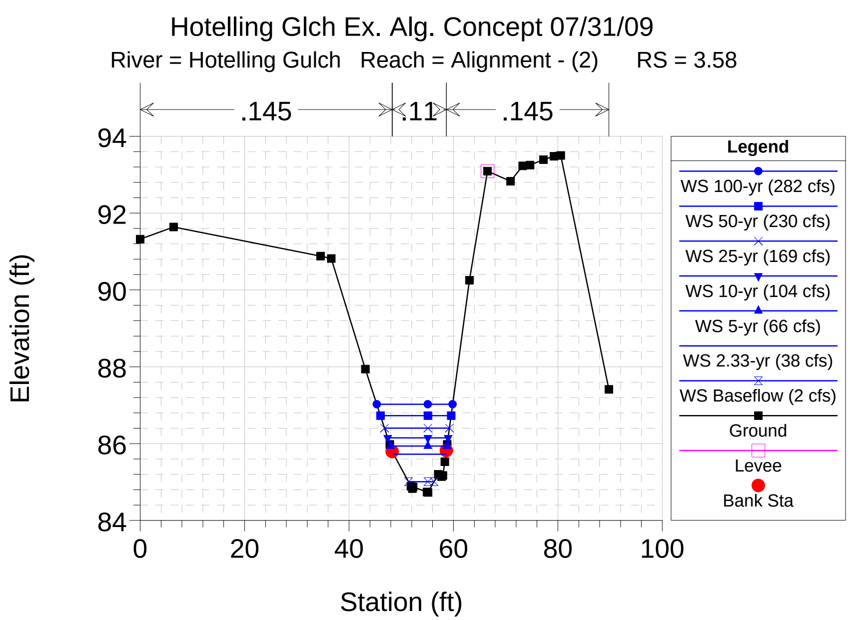

Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 123.09
.145
.11
.145
Elevation (ft)
Station (ft)
104
102
100
98
96
94
92
0
20
40
60
80
100
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 103.735*
.145
.11
.145
Elevation (ft)
Station (ft)
104
102
100
98
96
94
92
0
20
40
60
80
100
120
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 84.38
.145
.11
.145
Elevation (ft)
Station (ft)
106
104
102
100
98
96
94
92
0
20
40
60
80
100
120
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 63.805*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 43.23
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09
River = Hotelling Gulch Reach = Alignment - (2) RS = 3.58
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

ATTACHMENT 2

Proposed Condition HEC-RAS Model Output

HEC-RAS Plan: Alt A River: Hotelling Gulch Reach: Alignment - (2)

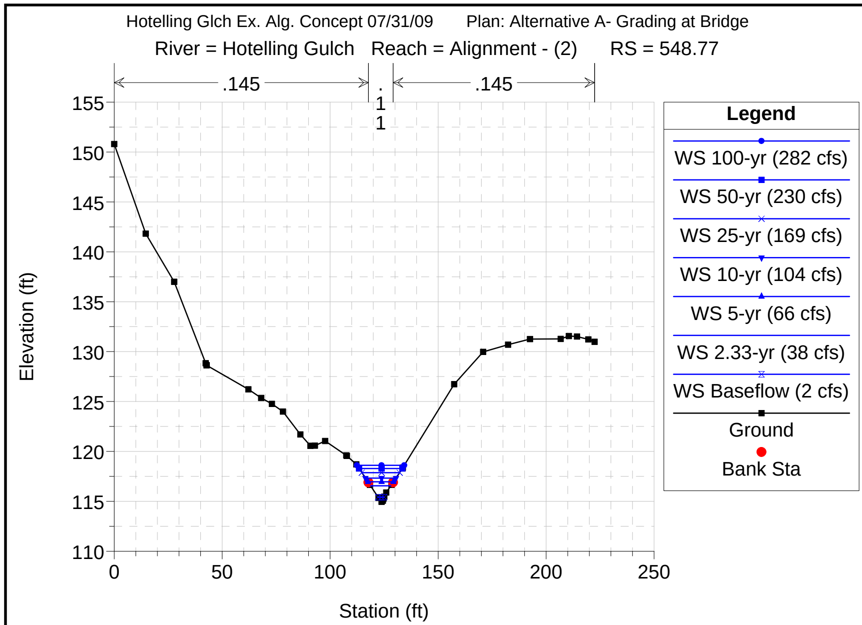
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	548.77	2.33-yr (38 cfs)	38.00	114.96	116.55	116.55	116.96	0.211465	5.12	7.42	9.36	1.01
Alignment - (2)	548.77	5-yr (66 cfs)	66.00	114.96	116.95	116.95	117.45	0.186256	5.68	11.63	11.78	0.99
Alignment - (2)	548.77	10-yr (104 cfs)	104.00	114.96	117.33	117.33	117.98	0.160387	6.49	16.47	14.09	0.97
Alignment - (2)	548.77	25-yr (169 cfs)	169.00	114.96	117.88	117.88	118.68	0.130726	7.32	25.17	17.50	0.93
Alignment - (2)	548.77	50-yr (230 cfs)	230.00	114.96	118.29	118.29	119.21	0.119441	7.95	32.90	20.05	0.91
Alignment - (2)	548.77	100-yr (282 cfs)	282.00	114.96	118.60	118.60	119.60	0.111716	8.36	39.51	21.91	0.90
Alignment - (2)	548.77	Baseflow (2 cfs)	2.00	114.96	115.42	115.42	115.54	0.296292	2.85	0.70	2.75	0.99
Alignment - (2)	519.2	2.33-yr (38 cfs)	38.00	111.51	113.32	112.78	113.45	0.041475	2.87	13.24	11.64	0.47
Alignment - (2)	519.2	5-yr (66 cfs)	66.00	111.51	113.76	113.16	113.96	0.042687	3.57	18.72	13.45	0.51
Alignment - (2)	519.2	10-yr (104 cfs)	104.00	111.51	114.22	113.55	114.50	0.043843	4.29	25.24	15.32	0.54
Alignment - (2)	519.2	25-yr (169 cfs)	169.00	111.51	114.83	114.09	115.23	0.044994	5.20	35.41	17.86	0.57
Alignment - (2)	519.2	50-yr (230 cfs)	230.00	111.51	115.29	114.52	115.79	0.046111	5.87	44.10	19.78	0.59
Alignment - (2)	519.2	100-yr (282 cfs)	282.00	111.51	115.63	114.85	116.21	0.046796	6.35	51.15	21.21	0.61
Alignment - (2)	519.2	Baseflow (2 cfs)	2.00	111.51	112.01	111.84	112.04	0.043306	1.24	1.61	5.33	0.40
Alignment - (2)	474.76	2.33-yr (38 cfs)	38.00	109.44	111.37	110.88	111.50	0.046404	2.89	13.13	12.47	0.50
Alignment - (2)	474.76	5-yr (66 cfs)	66.00	109.44	111.79	111.26	111.99	0.045810	3.57	18.82	14.67	0.52
Alignment - (2)	474.76	10-yr (104 cfs)	104.00	109.44	112.23	111.62	112.51	0.045652	4.25	25.79	16.98	0.54
Alignment - (2)	474.76	25-yr (169 cfs)	169.00	109.44	112.82	112.14	113.21	0.045825	5.10	36.71	20.07	0.57
Alignment - (2)	474.76	50-yr (230 cfs)	230.00	109.44	113.28	112.56	113.75	0.045852	5.70	46.32	22.44	0.59
Alignment - (2)	474.76	100-yr (282 cfs)	282.00	109.44	113.61	112.86	114.14	0.045830	6.12	54.18	24.21	0.60
Alignment - (2)	474.76	Baseflow (2 cfs)	2.00	109.44	110.05	109.86	110.08	0.044509	1.32	1.52	4.64	0.41
Alignment - (2)	436.82	2.33-yr (38 cfs)	38.00	107.51	108.91	108.68	109.12	0.089470	3.63	10.48	11.69	0.68
Alignment - (2)	436.82	5-yr (66 cfs)	66.00	107.51	109.25	109.02	109.57	0.092827	4.52	14.72	13.08	0.72
Alignment - (2)	436.82	10-yr (104 cfs)	104.00	107.51	109.62	109.38	110.07	0.094898	5.44	19.73	14.54	0.76
Alignment - (2)	436.82	25-yr (169 cfs)	169.00	107.51	110.13	109.90	110.77	0.094617	6.54	27.64	16.58	0.80
Alignment - (2)	436.82	50-yr (230 cfs)	230.00	107.51	110.53	110.32	111.32	0.093774	7.32	34.60	18.18	0.82
Alignment - (2)	436.82	100-yr (282 cfs)	282.00	107.51	110.83	110.64	111.73	0.092551	7.86	40.35	19.41	0.83
Alignment - (2)	436.82	Baseflow (2 cfs)	2.00	107.51	107.95	107.84	107.98	0.070346	1.37	1.46	6.05	0.49
Alignment - (2)	412.64	2.33-yr (38 cfs)	38.00	105.94	107.56	107.13	107.67	0.041454	2.64	14.42	14.74	0.47
Alignment - (2)	412.64	5-yr (66 cfs)	66.00	105.94	107.96	107.42	108.12	0.039659	3.23	20.62	16.21	0.49
Alignment - (2)	412.64	10-yr (104 cfs)	104.00	105.94	108.40	107.74	108.63	0.038226	3.82	28.13	17.83	0.50
Alignment - (2)	412.64	25-yr (169 cfs)	169.00	105.94	109.02	108.20	109.33	0.036303	4.53	39.91	20.12	0.51
Alignment - (2)	412.64	50-yr (230 cfs)	230.00	105.94	109.51	108.57	109.89	0.035208	5.04	50.16	21.92	0.52
Alignment - (2)	412.64	100-yr (282 cfs)	282.00	105.94	109.88	108.86	110.30	0.034633	5.41	58.43	23.27	0.53
Alignment - (2)	412.64	Baseflow (2 cfs)	2.00	105.94	106.47	106.33	106.49	0.054608	1.23	1.63	6.51	0.43
Alignment - (2)	375.19	2.33-yr (38 cfs)	38.00	104.33	105.61	105.26	105.78	0.062833	3.24	11.72	11.88	0.58
Alignment - (2)	375.19	5-yr (66 cfs)	66.00	104.33	105.99	105.62	106.24	0.064763	4.06	16.42	13.10	0.61
Alignment - (2)	375.19	10-yr (104 cfs)	104.00	104.33	106.38	105.97	106.75	0.067618	4.92	21.81	14.38	0.66
Alignment - (2)	375.19	25-yr (169 cfs)	169.00	104.33	106.91	106.49	107.46	0.071176	6.02	29.93	16.32	0.70
Alignment - (2)	375.19	50-yr (230 cfs)	230.00	104.33	107.31	106.92	108.01	0.074234	6.85	36.78	17.95	0.74
Alignment - (2)	375.19	100-yr (282 cfs)	282.00	104.33	107.61	107.24	108.43	0.076455	7.46	42.34	19.49	0.76
Alignment - (2)	375.19	Baseflow (2 cfs)	2.00	104.33	104.59	104.47	104.61	0.046122	1.11	1.80	7.50	0.40
Alignment - (2)	357.21*	2.33-yr (38 cfs)	38.00	103.56	104.62	104.27	104.75	0.051179	2.82	13.48	14.73	0.52
Alignment - (2)	357.21*	5-yr (66 cfs)	66.00	103.56	104.96	104.56	105.16	0.054867	3.57	18.62	15.98	0.56
Alignment - (2)	357.21*	10-yr (104 cfs)	104.00	103.56	105.32	104.88	105.61	0.057927	4.34	24.56	17.29	0.61
Alignment - (2)	357.21*	25-yr (169 cfs)	169.00	103.56	105.79	105.33	106.23	0.061996	5.34	33.26	19.23	0.65
Alignment - (2)	357.21*	50-yr (230 cfs)	230.00	103.56	106.15	105.69	106.71	0.066131	6.13	40.49	21.71	0.69
Alignment - (2)	357.21*	100-yr (282 cfs)	282.00	103.56	106.40	105.98	107.07	0.069717	6.73	46.22	23.59	0.72
Alignment - (2)	357.21*	Baseflow (2 cfs)	2.00	103.56	103.75	103.67	103.77	0.047743	0.96	2.08	11.15	0.39
Alignment - (2)	339.23*	2.33-yr (38 cfs)	38.00	102.78	103.63	103.36	103.74	0.060446	2.73	13.94	18.36	0.55
Alignment - (2)	339.23*	5-yr (66 cfs)	66.00	102.78	103.92	103.61	104.10	0.063116	3.41	19.45	19.73	0.59
Alignment - (2)	339.23*	10-yr (104 cfs)	104.00	102.78	104.21	103.88	104.48	0.067027	4.15	25.48	21.16	0.64
Alignment - (2)	339.23*	25-yr (169 cfs)	169.00	102.78	104.60	104.26	105.01	0.072863	5.15	34.25	24.20	0.69
Alignment - (2)	339.23*	50-yr (230 cfs)	230.00	102.78	104.91	104.58	105.43	0.075249	5.84	42.33	27.75	0.72
Alignment - (2)	339.23*	100-yr (282 cfs)	282.00	102.78	105.15	104.86	105.74	0.075380	6.30	49.12	28.92	0.74
Alignment - (2)	339.23*	Baseflow (2 cfs)	2.00	102.78	102.95	102.86	102.96	0.043494	0.82	2.43	15.35	0.36
Alignment - (2)	321.25	2.33-yr (38 cfs)	38.00	102.01	102.78	102.47	102.85	0.040494	2.18	17.44	23.84	0.45
Alignment - (2)	321.25	5-yr (66 cfs)	66.00	102.01	103.07	102.66	103.18	0.040311	2.70	24.53	25.96	0.47
Alignment - (2)	321.25	10-yr (104 cfs)	104.00	102.01	103.39	102.89	103.55	0.038513	3.18	34.16	30.65	0.48
Alignment - (2)	321.25	25-yr (169 cfs)	169.00	102.01	103.86	103.24	104.07	0.035116	3.71	49.14	33.05	0.49
Alignment - (2)	321.25	50-yr (230 cfs)	230.00	102.01	104.25	103.50	104.49	0.032687	4.07	62.21	34.93	0.48
Alignment - (2)	321.25	100-yr (282 cfs)	282.00	102.01	104.55	103.69	104.82	0.031093	4.32	72.82	36.31	0.48
Alignment - (2)	321.25	Baseflow (2 cfs)	2.00	102.01	102.14	102.08	102.15	0.045629	0.73	2.75	21.69	0.36
Alignment - (2)	309.196*	2.33-yr (38 cfs)	38.00	101.49	102.27	101.97	102.35	0.042470	2.27	16.77	27.05	0.46
Alignment - (2)	309.196*	5-yr (66 cfs)	66.00	101.49	102.57	102.17	102.69	0.041644	2.81	23.56	28.05	0.49
Alignment - (2)	309.196*	10-yr (104 cfs)	104.00	101.49	102.89	102.40	103.07	0.041381	3.36	31.15	29.16	0.51
Alignment - (2)	309.196*	25-yr (169 cfs)	169.00	101.49	103.36	102.73	103.61	0.040717	4.05	42.24	30.85	0.53
Alignment - (2)	309.196*	50-yr (230 cfs)	230.00	101.49	103.72	103.00	104.04	0.040907	4.58	51.10	38.55	0.55
Alignment - (2)	309.196*	100-yr (282 cfs)	282.00	101.49	103.99	103.22	104.37	0.041328	4.98	57.88	41.98	0.56
Alignment - (2)	309.196*	Baseflow (2 cfs)	2.00	101.49	101.63	101.56	101.64	0.040461	0.72	2.79	23.68	0.34

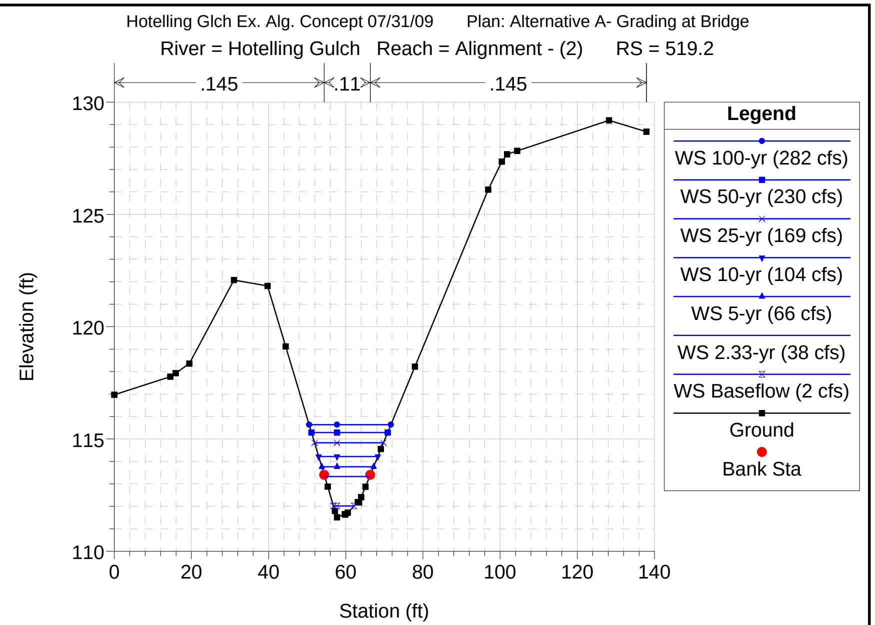
HEC-RAS Plan: Alt A River: Hotelling Gulch Reach: Alignment - (2) (Continued)

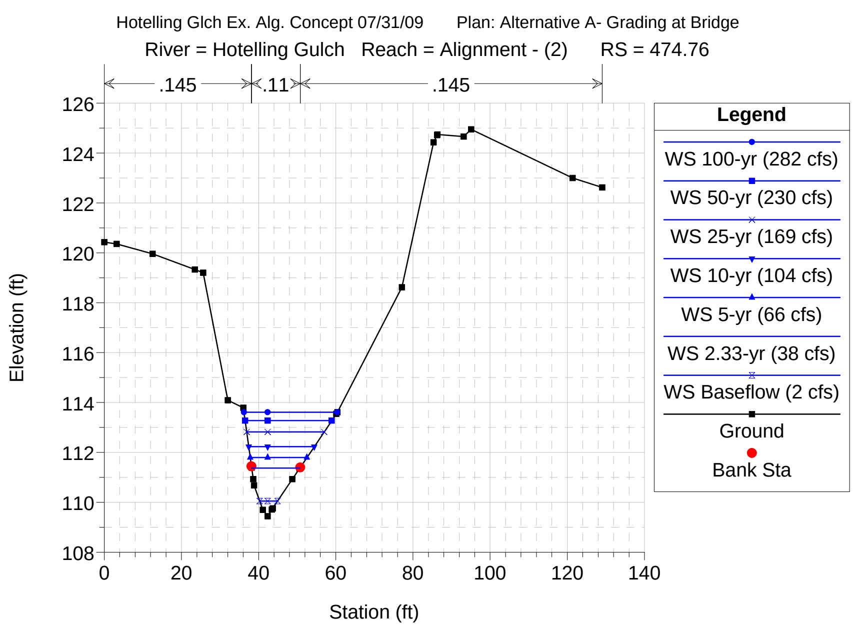
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	297.143*	2.33-yr (38 cfs)	38.00	100.97	101.79	101.45	101.86	0.038380	2.18	17.41	29.76	0.44
Alignment - (2)	297.143*	5-yr (66 cfs)	66.00	100.97	102.11	101.66	102.22	0.035601	2.65	24.92	30.94	0.45
Alignment - (2)	297.143*	10-yr (104 cfs)	104.00	100.97	102.45	101.89	102.61	0.034445	3.15	33.28	32.43	0.47
Alignment - (2)	297.143*	25-yr (169 cfs)	169.00	100.97	102.92	102.22	103.15	0.034604	3.82	44.97	34.45	0.49
Alignment - (2)	297.143*	50-yr (230 cfs)	230.00	100.97	103.28	102.48	103.58	0.035453	4.35	54.20	36.00	0.51
Alignment - (2)	297.143*	100-yr (282 cfs)	282.00	100.97	103.55	102.70	103.90	0.036355	4.74	61.22	37.15	0.53
Alignment - (2)	297.143*	Baseflow (2 cfs)	2.00	100.97	101.11	101.04	101.12	0.047769	0.76	2.63	25.75	0.37
Alignment - (2)	285.09	2.33-yr (38 cfs)	38.00	100.46	101.40	100.97	101.47	0.027912	2.02	18.80	32.85	0.39
Alignment - (2)	285.09	5-yr (66 cfs)	66.00	100.46	101.73	101.19	101.83	0.028322	2.52	26.32	34.91	0.41
Alignment - (2)	285.09	10-yr (104 cfs)	104.00	100.46	102.08	101.44	102.22	0.029546	3.06	34.72	37.07	0.44
Alignment - (2)	285.09	25-yr (169 cfs)	169.00	100.46	102.53	101.78	102.75	0.031852	3.78	46.66	40.26	0.47
Alignment - (2)	285.09	50-yr (230 cfs)	230.00	100.46	102.87	102.06	103.16	0.033617	4.32	56.39	42.57	0.50
Alignment - (2)	285.09	100-yr (282 cfs)	282.00	100.46	103.13	102.29	103.47	0.034844	4.72	63.85	43.65	0.52
Alignment - (2)	285.09	Baseflow (2 cfs)	2.00	100.46	100.61	100.53	100.62	0.035970	0.72	2.76	28.12	0.33
Alignment - (2)	267.9	2.33-yr (38 cfs)	38.00	99.72	100.67	100.37	100.78	0.061138	2.67	14.24	19.47	0.55
Alignment - (2)	267.9	5-yr (66 cfs)	66.00	99.72	100.94	100.65	101.11	0.066117	3.37	19.83	22.96	0.60
Alignment - (2)	267.9	10-yr (104 cfs)	104.00	99.72	101.21	100.91	101.46	0.070483	4.09	26.78	27.00	0.65
Alignment - (2)	267.9	25-yr (169 cfs)	169.00	99.72	101.60	101.30	101.95	0.069457	4.88	37.85	29.21	0.67
Alignment - (2)	267.9	50-yr (230 cfs)	230.00	99.72	101.93	101.57	102.35	0.066564	5.39	47.67	31.03	0.68
Alignment - (2)	267.9	100-yr (282 cfs)	282.00	99.72	102.19	101.78	102.65	0.063615	5.72	55.91	32.49	0.68
Alignment - (2)	267.9	Baseflow (2 cfs)	2.00	99.72	99.89	99.81	99.90	0.049753	0.91	2.20	13.19	0.39
Alignment - (2)	246.32	2.33-yr (38 cfs)	38.00	98.79	99.62	99.29	99.70	0.040828	2.29	17.25	24.95	0.45
Alignment - (2)	246.32	5-yr (66 cfs)	66.00	98.79	99.96	99.52	100.07	0.036416	2.71	26.30	29.88	0.45
Alignment - (2)	246.32	10-yr (104 cfs)	104.00	98.79	100.33	99.77	100.47	0.031115	3.05	38.17	32.35	0.44
Alignment - (2)	246.32	25-yr (169 cfs)	169.00	98.79	100.86	100.12	101.03	0.027350	3.49	55.94	36.36	0.43
Alignment - (2)	246.32	50-yr (230 cfs)	230.00	98.79	101.28	100.36	101.47	0.024851	3.78	71.86	40.53	0.43
Alignment - (2)	246.32	100-yr (282 cfs)	282.00	98.79	101.61	100.55	101.82	0.023283	3.98	84.30	43.77	0.42
Alignment - (2)	246.32	Baseflow (2 cfs)	2.00	98.79	98.94	98.86	98.94	0.039010	0.73	2.72	18.78	0.34
Alignment - (2)	236.		Bridge									
Alignment - (2)	207.83	2.33-yr (38 cfs)	38.00	97.13	98.00	97.64	98.07	0.042599	2.13	17.84	23.27	0.43
Alignment - (2)	207.83	5-yr (66 cfs)	66.00	97.13	98.31	97.85	98.42	0.041202	2.62	25.38	24.93	0.45
Alignment - (2)	207.83	10-yr (104 cfs)	104.00	97.13	98.67	98.09	98.82	0.038421	3.06	34.70	26.86	0.45
Alignment - (2)	207.83	25-yr (169 cfs)	169.00	97.13	99.21	98.42	99.40	0.033761	3.55	50.51	32.41	0.45
Alignment - (2)	207.83	50-yr (230 cfs)	230.00	97.13	99.66	98.69	99.88	0.029799	3.83	65.28	33.31	0.43
Alignment - (2)	207.83	100-yr (282 cfs)	282.00	97.13	100.01	98.90	100.25	0.027383	4.02	77.17	34.01	0.43
Alignment - (2)	207.83	Baseflow (2 cfs)	2.00	97.13	97.27	97.21	97.28	0.059949	0.86	2.33	17.59	0.41
Alignment - (2)	197.24*	2.33-yr (38 cfs)	38.00	96.68	97.58	97.20	97.66	0.034967	2.17	17.54	21.71	0.42
Alignment - (2)	197.24*	5-yr (66 cfs)	66.00	96.68	97.91	97.42	98.02	0.034011	2.67	24.93	23.49	0.44
Alignment - (2)	197.24*	10-yr (104 cfs)	104.00	96.68	98.31	97.67	98.45	0.030537	3.09	34.64	25.79	0.44
Alignment - (2)	197.24*	25-yr (169 cfs)	169.00	96.68	98.90	98.02	99.09	0.025750	3.53	51.74	32.33	0.43
Alignment - (2)	197.24*	50-yr (230 cfs)	230.00	96.68	99.39	98.31	99.60	0.022345	3.78	68.51	36.29	0.41
Alignment - (2)	197.24*	100-yr (282 cfs)	282.00	96.68	99.77	98.52	99.99	0.020204	3.93	82.88	39.13	0.40
Alignment - (2)	197.24*	Baseflow (2 cfs)	2.00	96.68	96.85	96.75	96.85	0.029320	0.69	2.91	17.86	0.30
Alignment - (2)	186.65	2.33-yr (38 cfs)	38.00	96.22	97.12	96.81	97.22	0.050522	2.52	15.11	19.76	0.51
Alignment - (2)	186.65	5-yr (66 cfs)	66.00	96.22	97.52	97.05	97.65	0.036999	2.84	23.55	22.07	0.46
Alignment - (2)	186.65	10-yr (104 cfs)	104.00	96.22	97.98	97.31	98.14	0.029225	3.15	34.44	25.26	0.44
Alignment - (2)	186.65	25-yr (169 cfs)	169.00	96.22	98.64	97.68	98.82	0.023234	3.53	52.52	29.74	0.41
Alignment - (2)	186.65	50-yr (230 cfs)	230.00	96.22	99.16	97.98	99.37	0.020324	3.78	68.60	32.12	0.40
Alignment - (2)	186.65	100-yr (282 cfs)	282.00	96.22	99.55	98.22	99.78	0.018836	3.98	81.58	33.92	0.39
Alignment - (2)	186.65	Baseflow (2 cfs)	2.00	96.22	96.37	96.31	96.38	0.072646	0.97	2.05	14.83	0.46
Alignment - (2)	162.96	2.33-yr (38 cfs)	38.00	95.20	96.73	95.85	96.76	0.009444	1.40	27.17	24.35	0.23
Alignment - (2)	162.96	5-yr (66 cfs)	66.00	95.20	97.21	96.11	97.25	0.008630	1.69	39.77	28.48	0.24
Alignment - (2)	162.96	10-yr (104 cfs)	104.00	95.20	97.72	96.39	97.78	0.008178	1.98	55.00	74.92	0.24
Alignment - (2)	162.96	25-yr (169 cfs)	169.00	95.20	98.41	96.76	98.50	0.007824	2.35	77.85	86.38	0.25
Alignment - (2)	162.96	50-yr (230 cfs)	230.00	95.20	98.95	97.03	99.05	0.007678	2.62	97.12	95.41	0.25
Alignment - (2)	162.96	100-yr (282 cfs)	282.00	95.20	99.36	97.25	99.47	0.007601	2.81	112.43	100.04	0.26
Alignment - (2)	162.96	Baseflow (2 cfs)	2.00	95.20	95.42	95.30	95.43	0.025583	0.75	2.68	13.14	0.29
Alignment - (2)	146.16	2.33-yr (38 cfs)	38.00	94.48	96.44	95.70	96.51	0.024183	2.22	17.11	15.16	0.37
Alignment - (2)	146.16	5-yr (66 cfs)	66.00	94.48	96.91	96.07	97.02	0.022908	2.69	24.96	18.27	0.38
Alignment - (2)	146.16	10-yr (104 cfs)	104.00	94.48	97.40	96.44	97.55	0.022074	3.17	34.77	21.59	0.39
Alignment - (2)	146.16	25-yr (169 cfs)	169.00	94.48	98.08	96.89	98.28	0.020899	3.73	50.71	25.26	0.40
Alignment - (2)	146.16	50-yr (230 cfs)	230.00	94.48	98.60	97.28	98.84	0.020215	4.12	64.59	27.79	0.40
Alignment - (2)	146.16	100-yr (282 cfs)	282.00	94.48	98.99	97.57	99.26	0.019807	4.40	75.84	29.61	0.41
Alignment - (2)	146.16	Baseflow (2 cfs)	2.00	94.48	94.95	94.73	94.97	0.030043	1.11	1.80	5.39	0.34
Alignment - (2)	123.09	2.33-yr (38 cfs)	38.00	93.49	95.53	95.04	95.70	0.054720	3.23	11.75	10.51	0.54
Alignment - (2)	123.09	5-yr (66 cfs)	66.00	93.49	95.95	95.48	96.20	0.058771	4.04	16.50	12.41	0.59
Alignment - (2)	123.09	10-yr (104 cfs)	104.00	93.49	96.36	95.88	96.73	0.062942	4.93	22.01	14.32	0.63
Alignment - (2)	123.09	25-yr (169 cfs)	169.00	93.49	96.90	96.45	97.45	0.068383	6.07	30.40	16.82	0.69
Alignment - (2)	123.09	50-yr (230 cfs)	230.00	93.49	97.27	96.91	97.99	0.074881	6.99	37.05	18.57	0.73
Alignment - (2)	123.09	100-yr (282 cfs)	282.00	93.49	97.54	97.24	98.39	0.080860	7.71	42.06	19.78	0.78

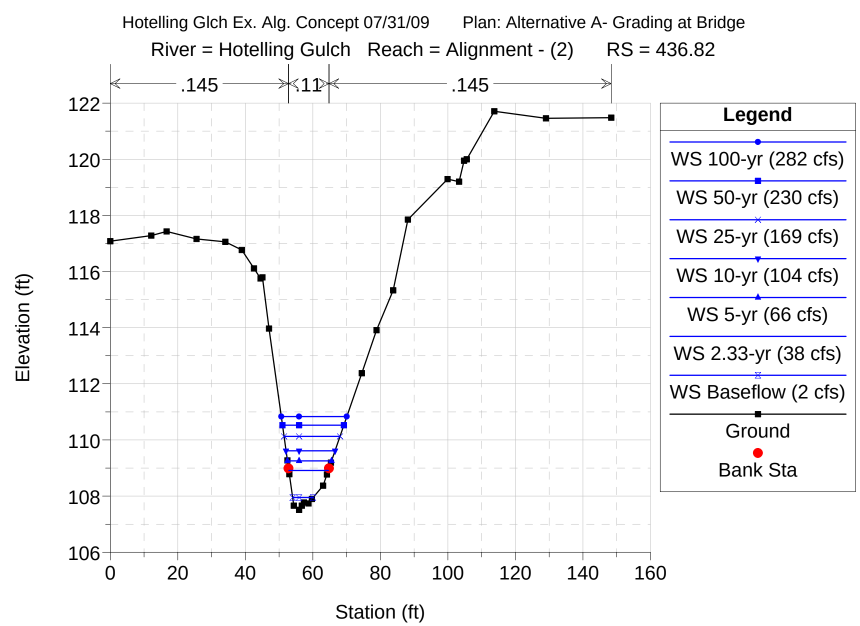
HEC-RAS Plan: Alt A River: Hotelling Gulch Reach: Alignment - (2) (Continued)

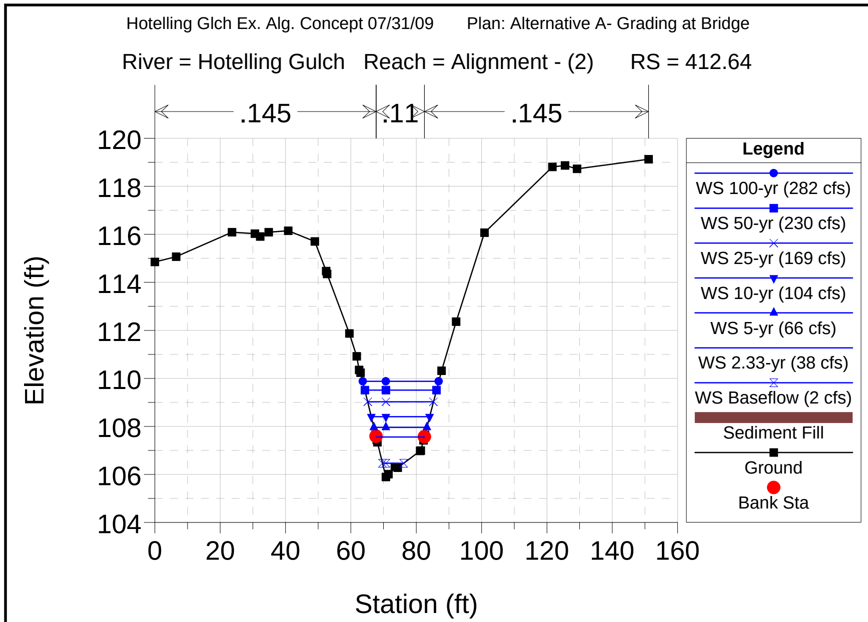
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	123.09	Baseflow (2 cfs)	2.00	93.49	94.07	93.87	94.11	0.048787	1.46	1.37	3.75	0.43
Alignment - (2)	103.735*	2.33-yr (38 cfs)	38.00	92.80	94.50	94.04	94.64	0.054003	3.00	12.65	12.97	0.54
Alignment - (2)	103.735*	5-yr (66 cfs)	66.00	92.80	94.90	94.44	95.10	0.054111	3.63	18.39	16.00	0.56
Alignment - (2)	103.735*	10-yr (104 cfs)	104.00	92.80	95.27	94.81	95.56	0.055787	4.37	25.03	19.41	0.60
Alignment - (2)	103.735*	25-yr (169 cfs)	169.00	92.80	95.73	95.30	96.16	0.061469	5.39	34.90	23.66	0.65
Alignment - (2)	103.735*	50-yr (230 cfs)	230.00	92.80	96.12	95.69	96.63	0.060583	5.98	44.52	25.99	0.66
Alignment - (2)	103.735*	100-yr (282 cfs)	282.00	92.80	96.43	95.99	96.99	0.057745	6.32	52.97	27.62	0.66
Alignment - (2)	103.735*	Baseflow (2 cfs)	2.00	92.80	93.31	93.12	93.33	0.033629	1.11	1.80	5.87	0.35
Alignment - (2)	84.38	2.33-yr (38 cfs)	38.00	92.11	93.60	93.11	93.71	0.042123	2.73	13.90	13.69	0.48
Alignment - (2)	84.38	5-yr (66 cfs)	66.00	92.11	94.02	93.45	94.19	0.040859	3.23	20.93	19.31	0.49
Alignment - (2)	84.38	10-yr (104 cfs)	104.00	92.11	94.47	93.83	94.67	0.036502	3.70	31.64	30.92	0.49
Alignment - (2)	84.38	25-yr (169 cfs)	169.00	92.11	95.12	94.32	95.33	0.027380	3.94	52.82	34.45	0.45
Alignment - (2)	84.38	50-yr (230 cfs)	230.00	92.11	95.64	94.72	95.86	0.022641	4.09	71.71	37.31	0.42
Alignment - (2)	84.38	100-yr (282 cfs)	282.00	92.11	96.04	94.95	96.26	0.020223	4.20	87.06	39.49	0.40
Alignment - (2)	84.38	Baseflow (2 cfs)	2.00	92.11	92.47	92.36	92.49	0.056881	1.17	1.72	7.84	0.44
Alignment - (2)	63.805*	2.33-yr (38 cfs)	38.00	91.16	92.88	92.28	92.97	0.030922	2.43	15.63	14.51	0.41
Alignment - (2)	63.805*	5-yr (66 cfs)	66.00	91.16	93.35	92.62	93.48	0.028032	2.90	23.03	16.81	0.42
Alignment - (2)	63.805*	10-yr (104 cfs)	104.00	91.16	93.87	92.98	94.04	0.025301	3.35	32.46	19.52	0.41
Alignment - (2)	63.805*	25-yr (169 cfs)	169.00	91.16	94.59	93.44	94.81	0.022651	3.89	48.12	23.86	0.41
Alignment - (2)	63.805*	50-yr (230 cfs)	230.00	91.16	95.13	93.81	95.40	0.021594	4.28	61.96	27.19	0.42
Alignment - (2)	63.805*	100-yr (282 cfs)	282.00	91.16	95.54	94.10	95.83	0.020926	4.55	73.55	29.87	0.42
Alignment - (2)	63.805*	Baseflow (2 cfs)	2.00	91.16	91.59	91.43	91.60	0.033978	1.05	1.91	6.94	0.35
Alignment - (2)	43.23	2.33-yr (38 cfs)	38.00	90.21	91.61	91.40	91.88	0.104631	4.16	9.14	9.08	0.73
Alignment - (2)	43.23	5-yr (66 cfs)	66.00	90.21	91.97	91.80	92.41	0.116094	5.29	12.59	10.25	0.81
Alignment - (2)	43.23	10-yr (104 cfs)	104.00	90.21	92.31	92.23	92.98	0.132739	6.58	16.29	11.37	0.89
Alignment - (2)	43.23	25-yr (169 cfs)	169.00	90.21	92.84	92.84	93.80	0.136018	7.99	22.70	13.08	0.95
Alignment - (2)	43.23	50-yr (230 cfs)	230.00	90.21	93.34	93.34	94.44	0.120339	8.62	29.87	15.42	0.92
Alignment - (2)	43.23	100-yr (282 cfs)	282.00	90.21	93.72	93.72	94.91	0.111350	9.05	36.07	17.26	0.91
Alignment - (2)	43.23	Baseflow (2 cfs)	2.00	90.21	90.57	90.47	90.60	0.073985	1.43	1.40	5.59	0.50
Alignment - (2)	3.58	2.33-yr (38 cfs)	38.00	84.73	85.85	85.85	86.22	0.205698	4.87	7.81	10.55	1.00
Alignment - (2)	3.58	5-yr (66 cfs)	66.00	84.73	86.18	86.18	86.70	0.182589	5.75	11.55	11.69	0.99
Alignment - (2)	3.58	10-yr (104 cfs)	104.00	84.73	86.56	86.56	87.23	0.158494	6.58	16.23	12.98	0.97
Alignment - (2)	3.58	25-yr (169 cfs)	169.00	84.73	87.03	87.11	87.98	0.158618	7.94	22.58	14.54	1.02
Alignment - (2)	3.58	50-yr (230 cfs)	230.00	84.73	87.30	87.53	88.60	0.182480	9.32	26.67	15.47	1.12
Alignment - (2)	3.58	100-yr (282 cfs)	282.00	84.73	87.51	87.86	89.09	0.197677	10.32	29.97	16.18	1.18
Alignment - (2)	3.58	Baseflow (2 cfs)	2.00	84.73	85.01	85.01	85.10	0.346233	2.42	0.83	4.87	1.03

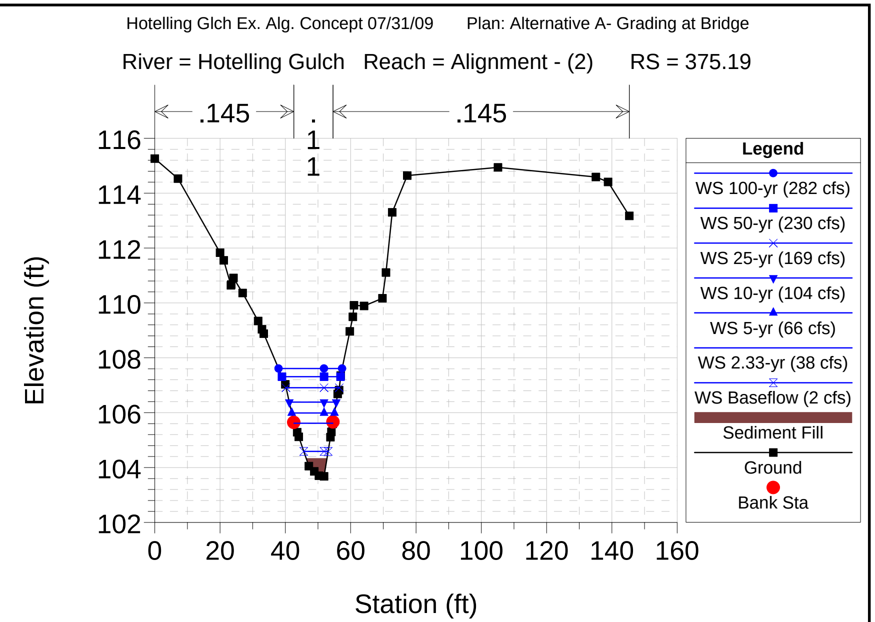

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 548.77
.145
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

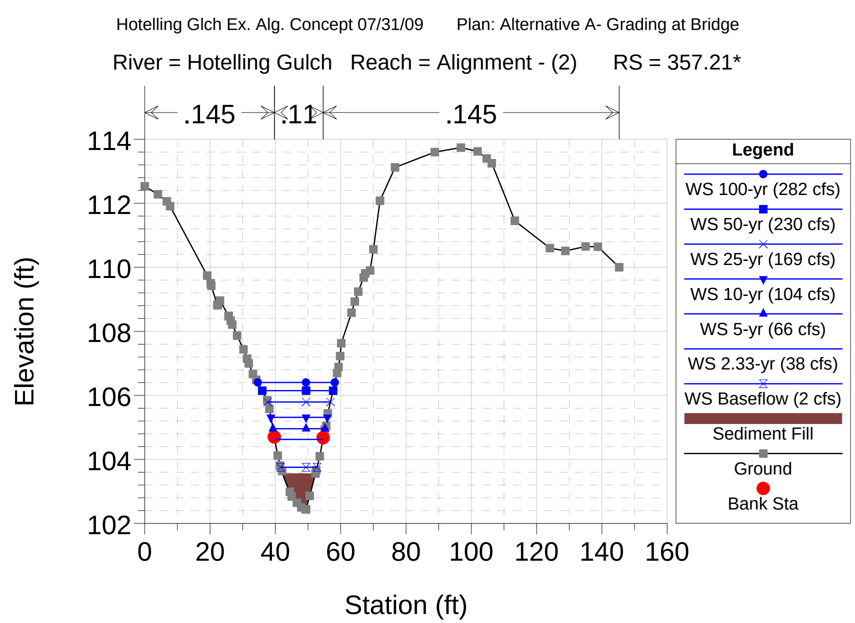

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 519.2
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

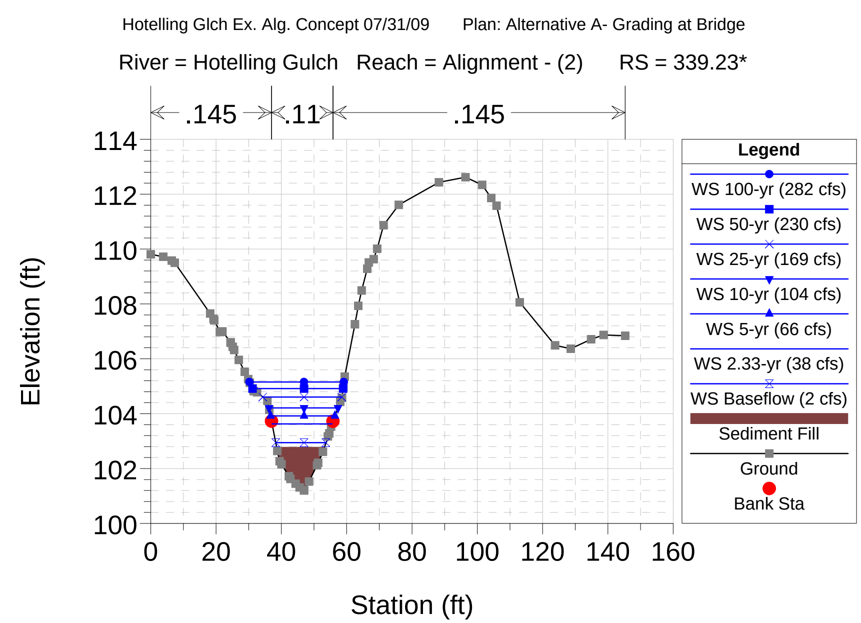

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 474.76
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

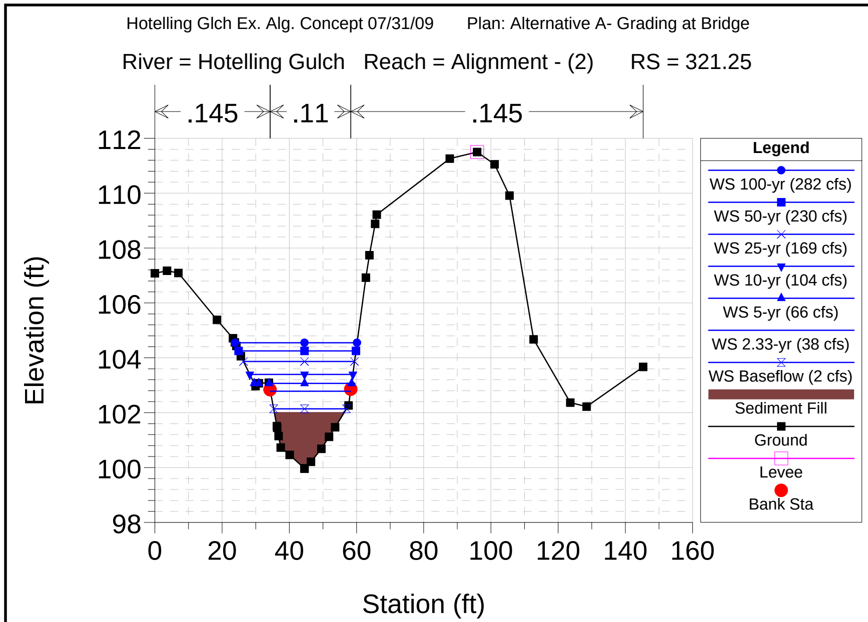

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 436.82
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta

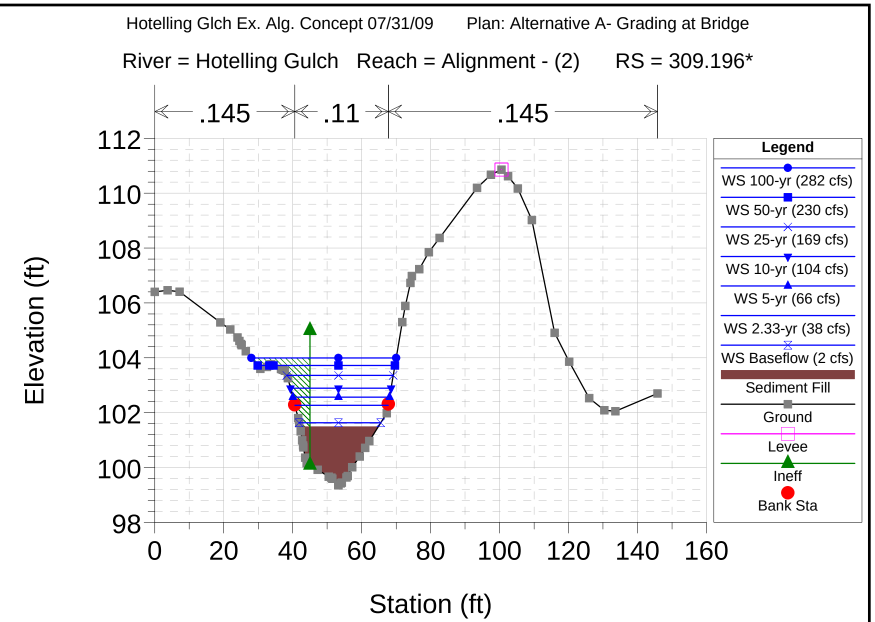

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 412.64
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta

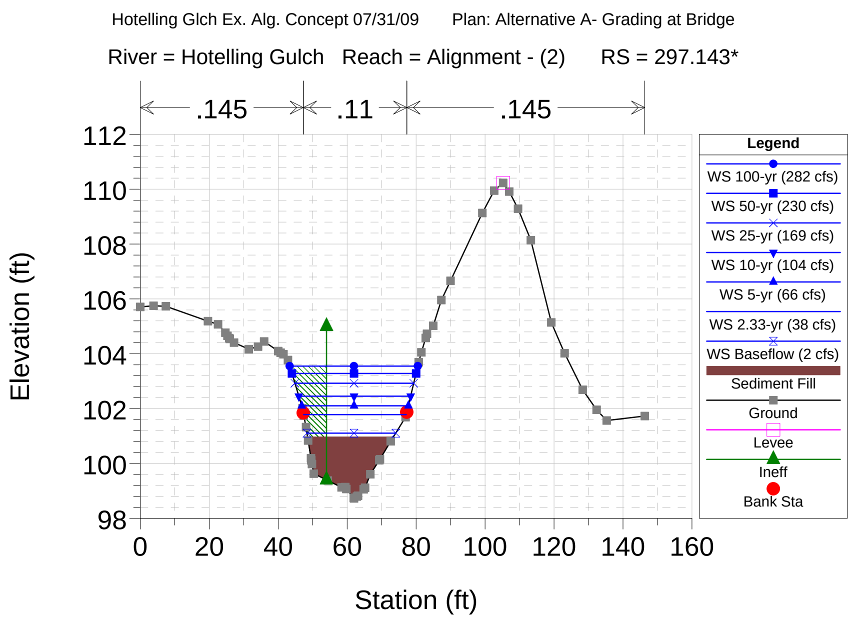

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 375.19
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta

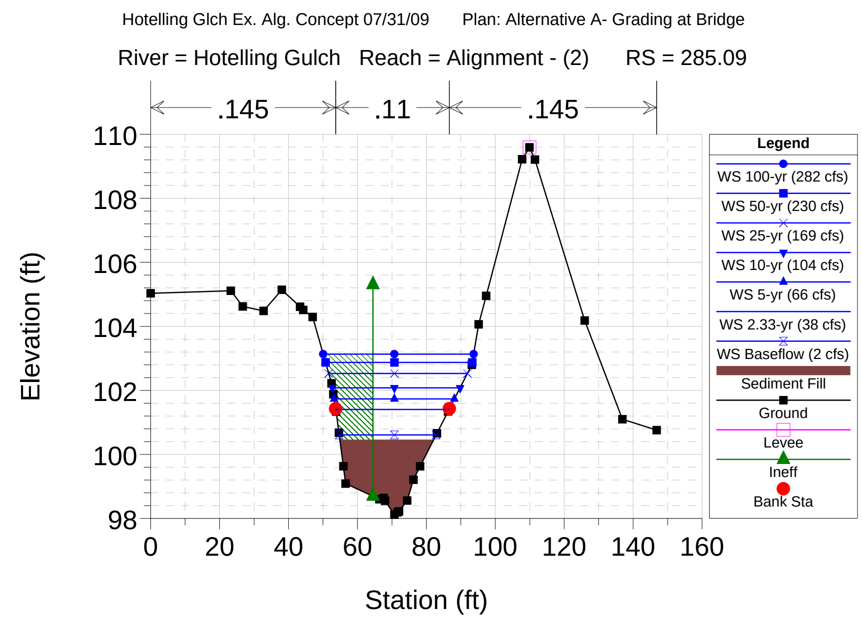

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 357.21*
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta

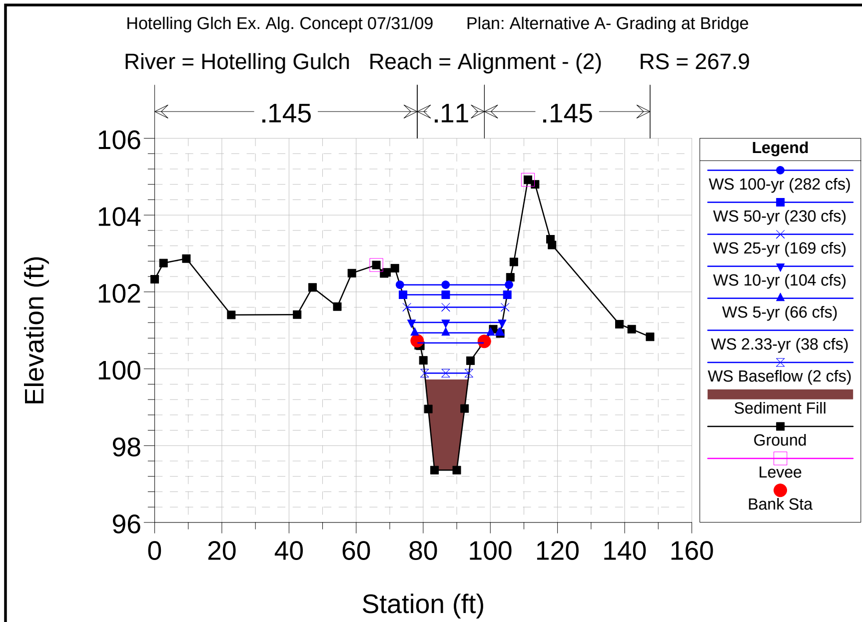

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 339.23*
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta

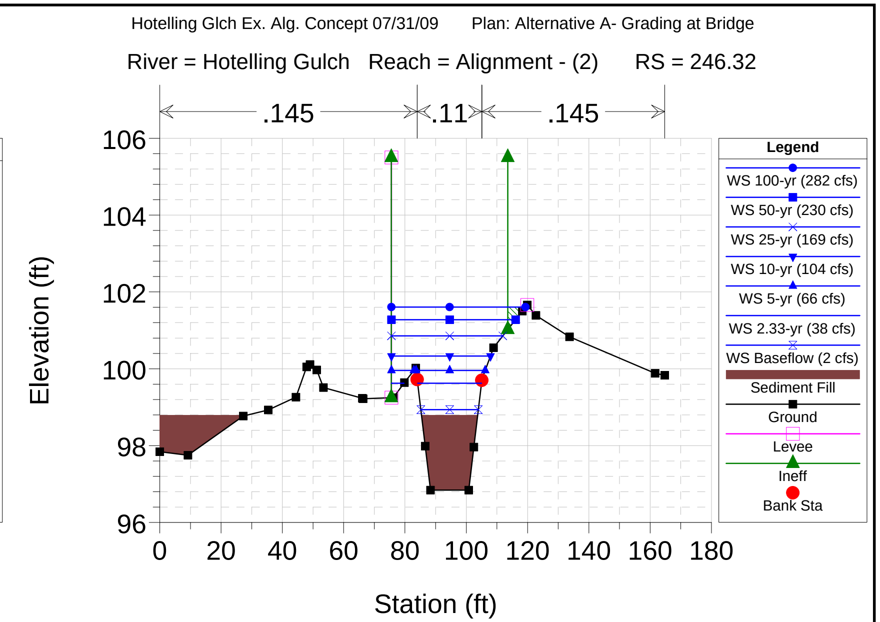

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 321.25
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

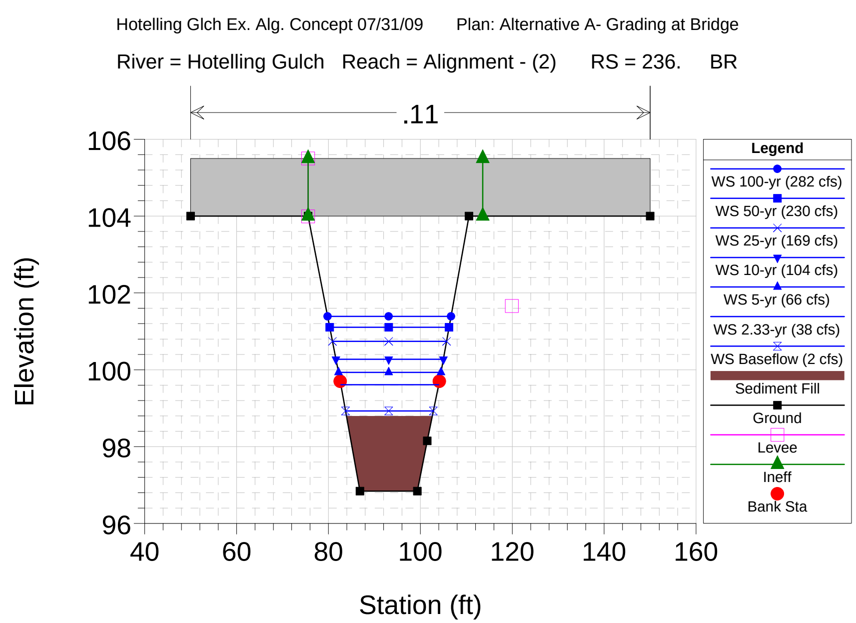

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 309.196*
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

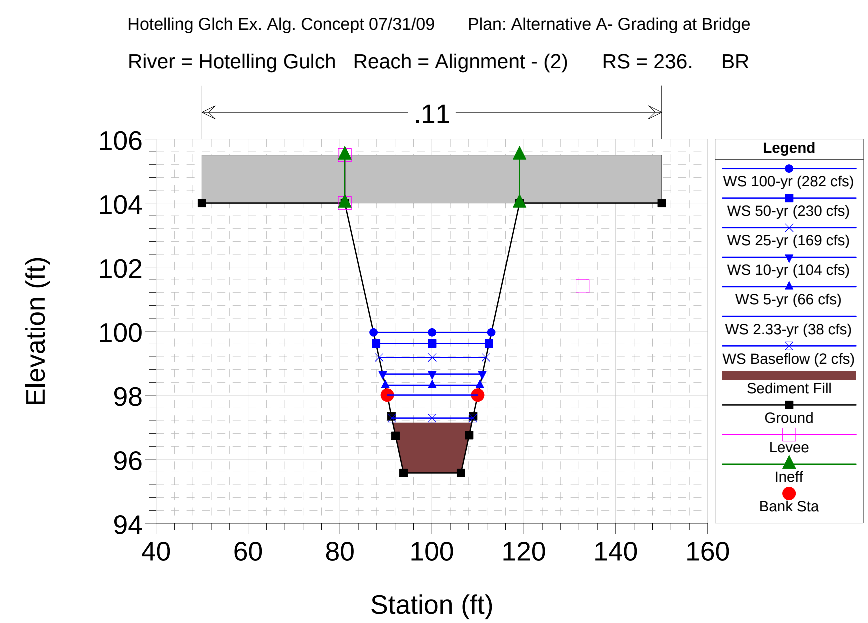

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 297.143*
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

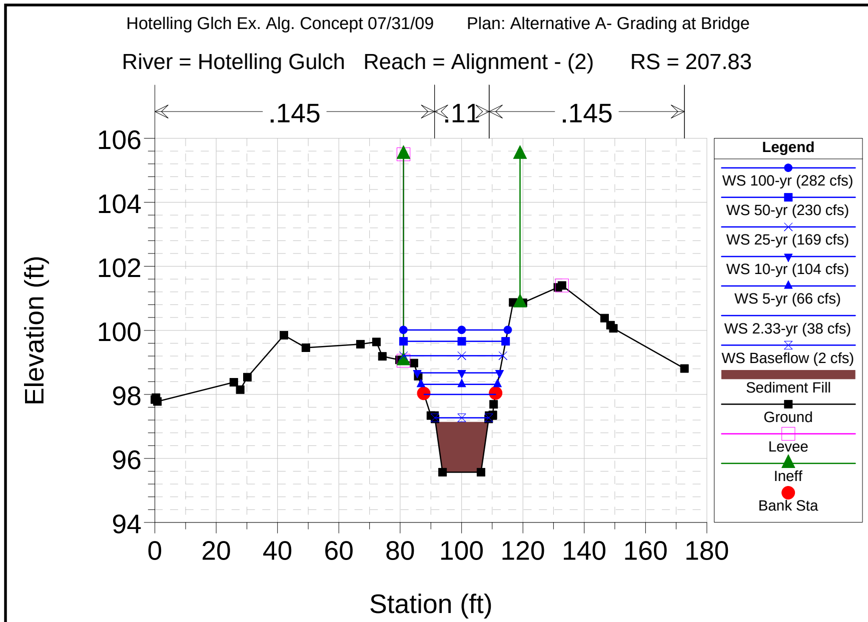

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 285.09
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

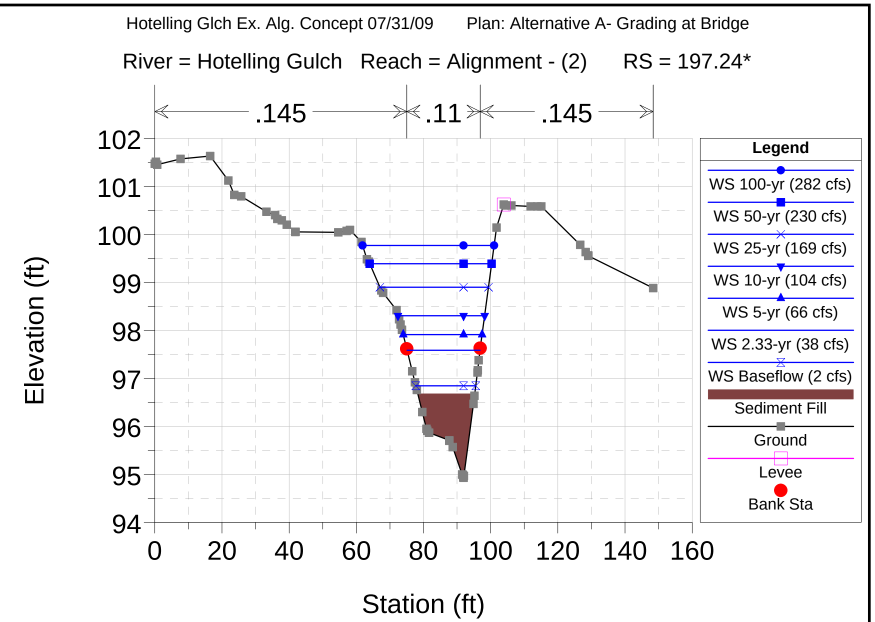

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 267.9
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta

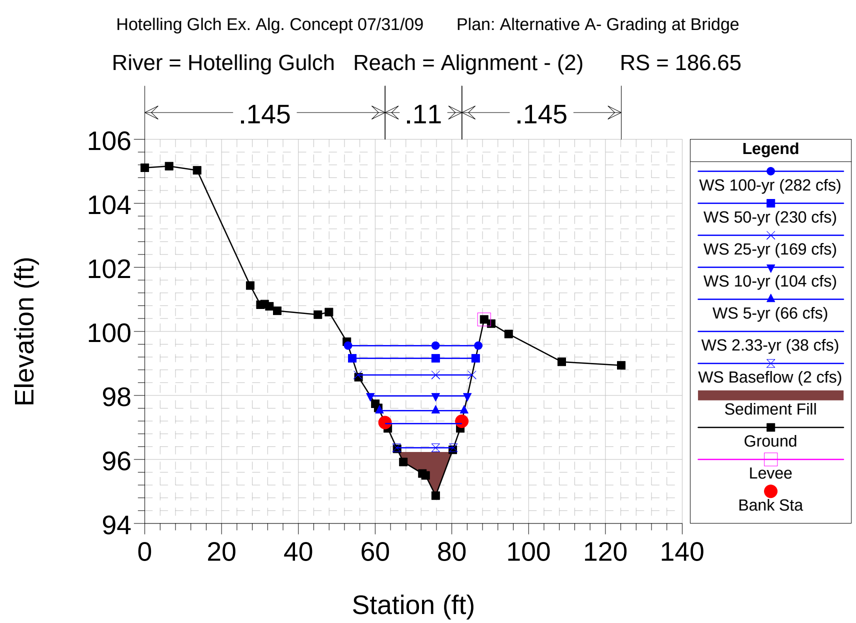

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 246.32
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

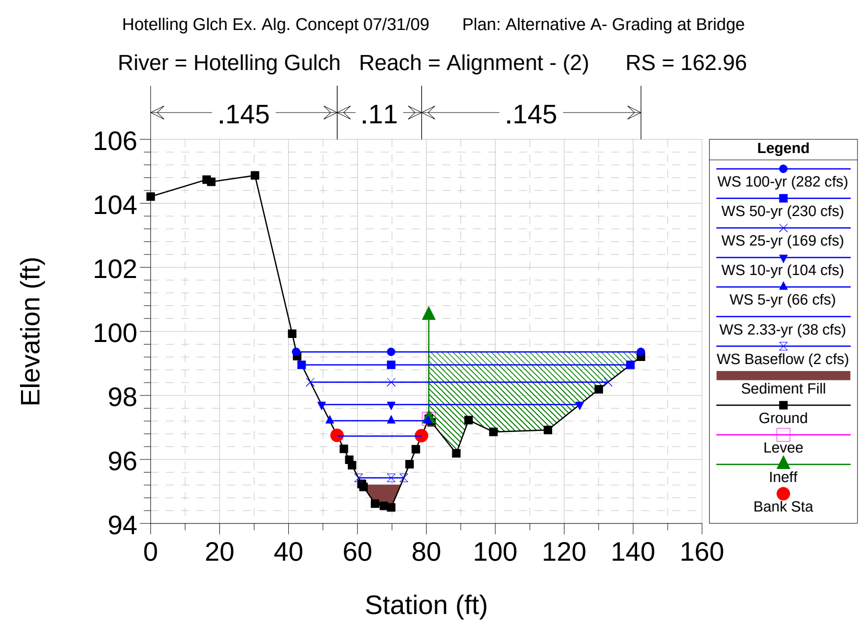

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 236. BR
.11
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

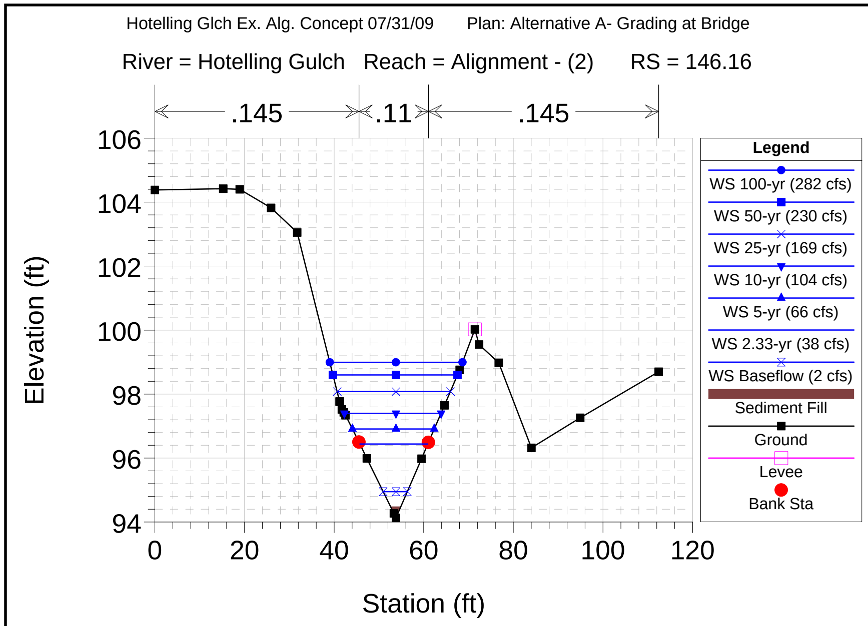

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 236. BR
.11
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

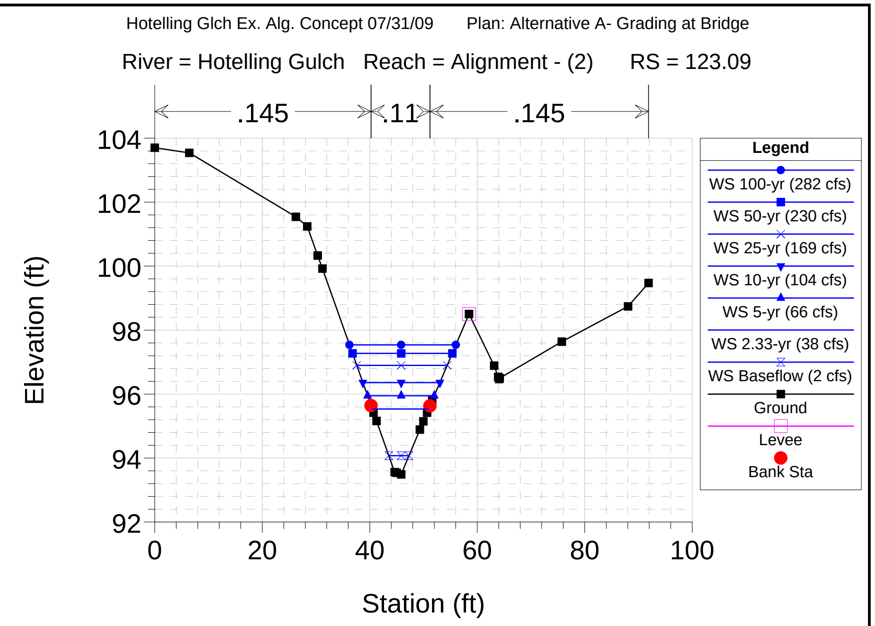

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 207.83
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

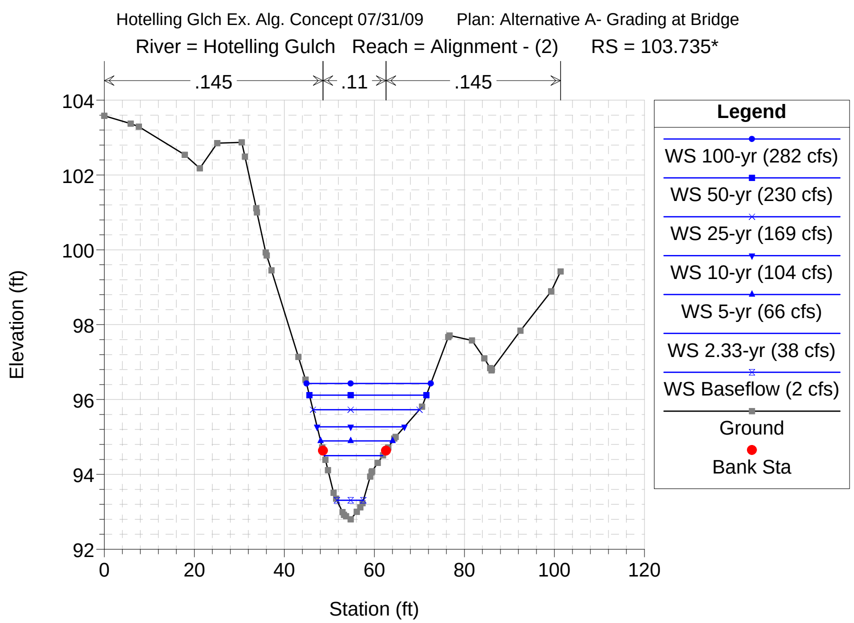

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 197.24*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta

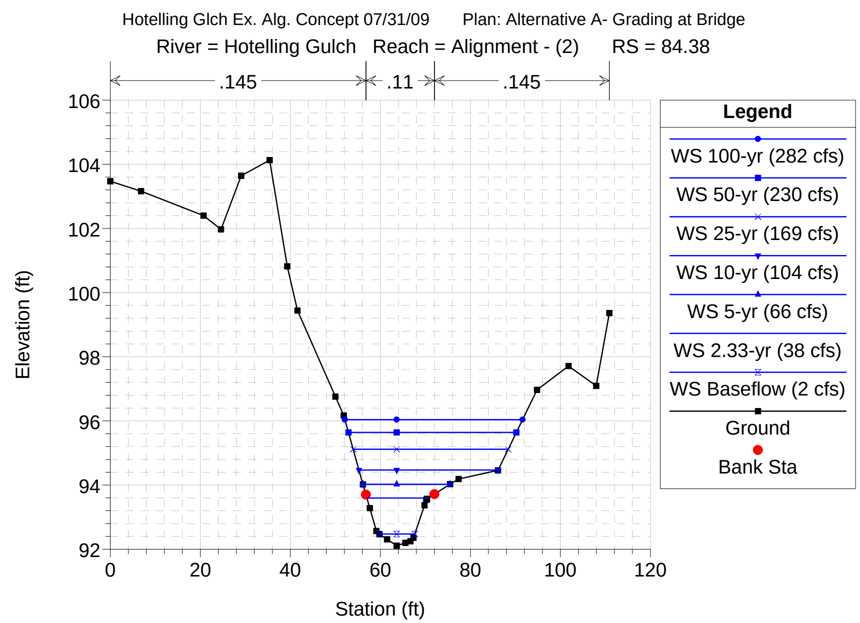

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 186.65
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta

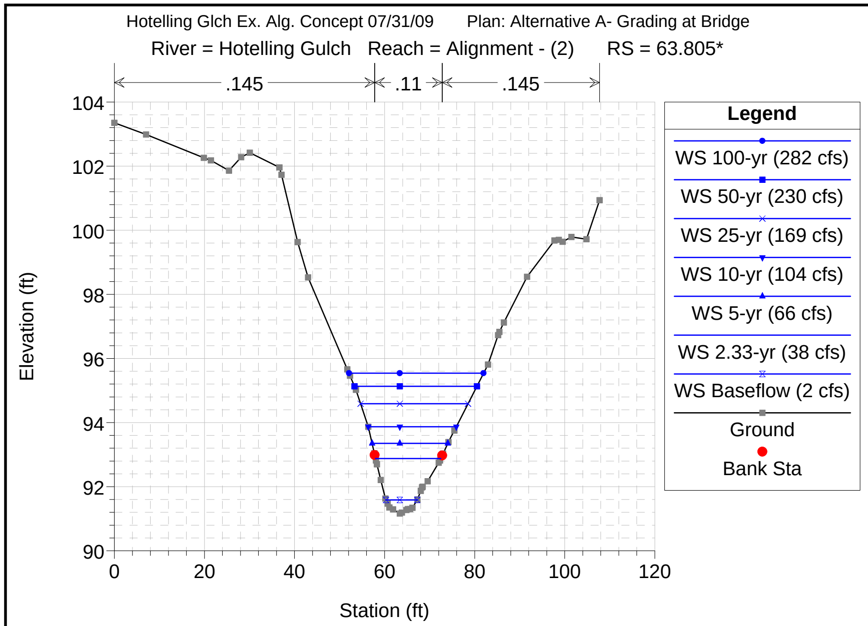

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 162.96
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

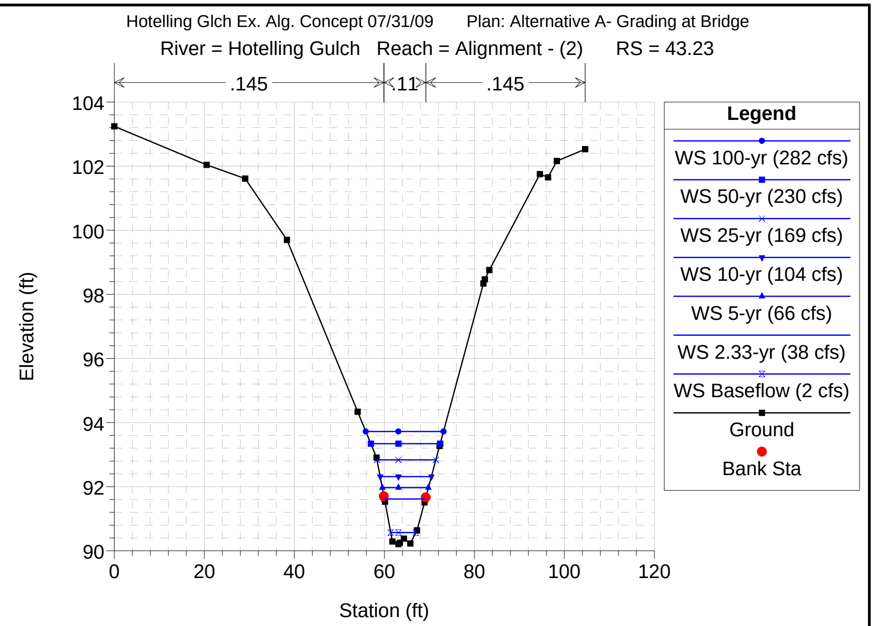

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 146.16
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta

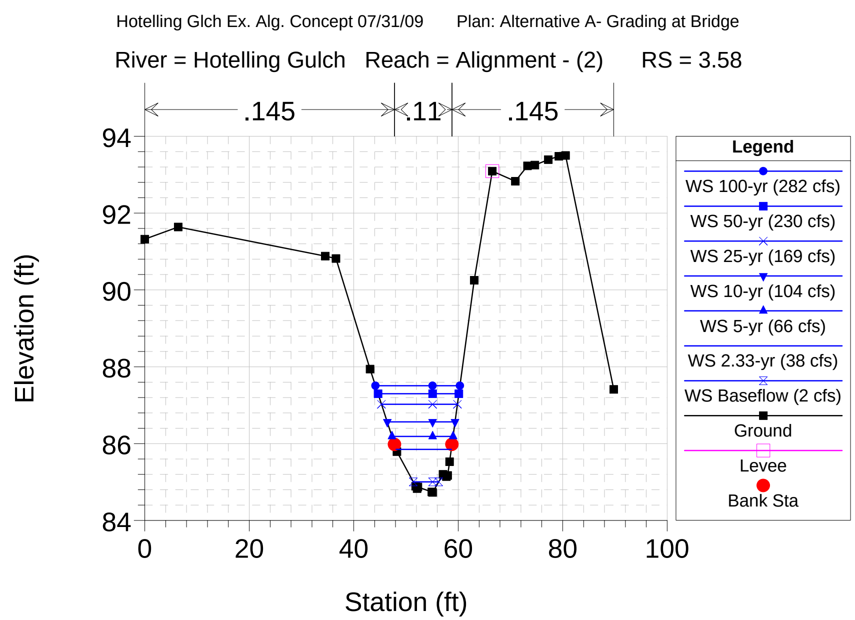

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 123.09
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 103.735*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 84.38
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 63.805*
.145
.11
.145
Elevation (ft)
Station (ft)
104
102
100
98
96
94
92
90
0
20
40
60
80
100
120
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 43.23
.145
.11
.145
Elevation (ft)
Station (ft)
104
102
100
98
96
94
92
90
0
20
40
60
80
100
120
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative A- Grading at Bridge
River = Hotelling Gulch Reach = Alignment - (2) RS = 3.58
.145
.11
.145
Elevation (ft)
Station (ft)
94
92
90
88
86
84
0
20
40
60
80
100
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

HEC-RAS Plan: Alt B River: Hotelling Gulch Reach: Alignment - (2)

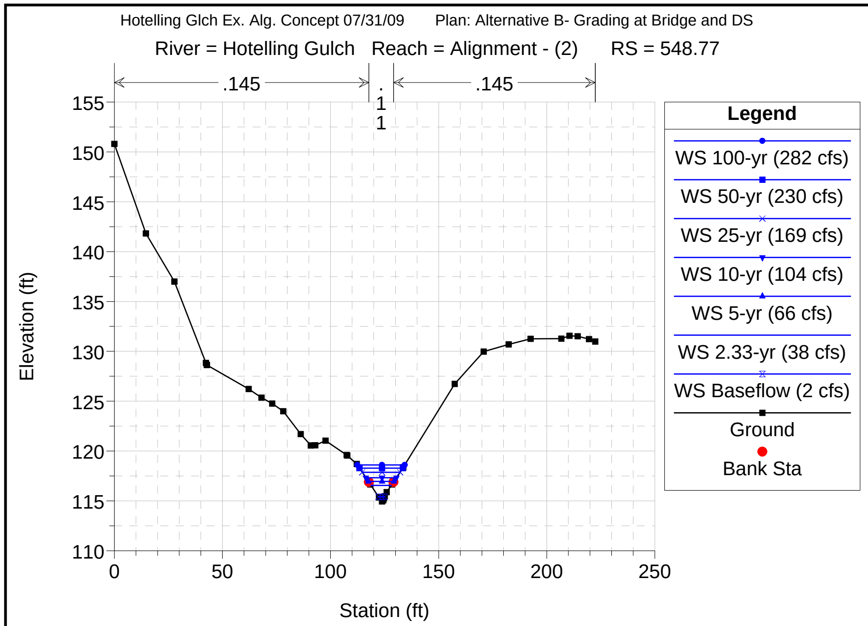
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	548.77	2.33-yr (38 cfs)	38.00	114.96	116.55	116.55	116.96	0.211465	5.12	7.42	9.36	1.01
Alignment - (2)	548.77	5-yr (66 cfs)	66.00	114.96	116.95	116.95	117.45	0.186256	5.68	11.63	11.78	0.99
Alignment - (2)	548.77	10-yr (104 cfs)	104.00	114.96	117.33	117.33	117.98	0.160387	6.49	16.47	14.09	0.97
Alignment - (2)	548.77	25-yr (169 cfs)	169.00	114.96	117.88	117.88	118.68	0.130726	7.32	25.17	17.50	0.93
Alignment - (2)	548.77	50-yr (230 cfs)	230.00	114.96	118.29	118.29	119.21	0.119441	7.95	32.90	20.05	0.91
Alignment - (2)	548.77	100-yr (282 cfs)	282.00	114.96	118.60	118.60	119.60	0.111716	8.36	39.51	21.91	0.90
Alignment - (2)	548.77	Baseflow (2 cfs)	2.00	114.96	115.42	115.42	115.54	0.296292	2.85	0.70	2.75	0.99
Alignment - (2)	519.2	2.33-yr (38 cfs)	38.00	111.51	113.32	112.78	113.45	0.041720	2.88	13.21	11.63	0.48
Alignment - (2)	519.2	5-yr (66 cfs)	66.00	111.51	113.76	113.17	113.96	0.042824	3.56	18.73	13.45	0.51
Alignment - (2)	519.2	10-yr (104 cfs)	104.00	111.51	114.22	113.55	114.50	0.043743	4.28	25.29	15.34	0.53
Alignment - (2)	519.2	25-yr (169 cfs)	169.00	111.51	114.83	114.09	115.23	0.045073	5.19	35.39	17.86	0.57
Alignment - (2)	519.2	50-yr (230 cfs)	230.00	111.51	115.29	114.52	115.79	0.046149	5.86	44.08	19.78	0.59
Alignment - (2)	519.2	100-yr (282 cfs)	282.00	111.51	115.63	114.84	116.21	0.046809	6.33	51.13	21.21	0.60
Alignment - (2)	519.2	Baseflow (2 cfs)	2.00	111.51	112.01	111.84	112.04	0.044291	1.25	1.60	5.31	0.40
Alignment - (2)	474.76	2.33-yr (38 cfs)	38.00	109.44	111.38	110.88	111.51	0.045867	2.88	13.19	12.49	0.49
Alignment - (2)	474.76	5-yr (66 cfs)	66.00	109.44	111.79	111.26	111.99	0.045744	3.57	18.80	14.66	0.52
Alignment - (2)	474.76	10-yr (104 cfs)	104.00	109.44	112.23	111.63	112.51	0.046101	4.27	25.68	16.94	0.55
Alignment - (2)	474.76	25-yr (169 cfs)	169.00	109.44	112.83	112.14	113.21	0.045600	5.10	36.76	20.08	0.57
Alignment - (2)	474.76	50-yr (230 cfs)	230.00	109.44	113.28	112.55	113.75	0.045559	5.70	46.42	22.46	0.58
Alignment - (2)	474.76	100-yr (282 cfs)	282.00	109.44	113.62	112.86	114.15	0.045532	6.12	54.30	24.23	0.60
Alignment - (2)	474.76	Baseflow (2 cfs)	2.00	109.44	110.06	109.86	110.08	0.043358	1.31	1.53	4.66	0.40
Alignment - (2)	436.82	2.33-yr (38 cfs)	38.00	107.51	108.91	108.67	109.11	0.091326	3.65	10.40	11.66	0.68
Alignment - (2)	436.82	5-yr (66 cfs)	66.00	107.51	109.25	109.01	109.57	0.093725	4.55	14.65	13.06	0.73
Alignment - (2)	436.82	10-yr (104 cfs)	104.00	107.51	109.62	109.38	110.07	0.094460	5.45	19.74	14.54	0.76
Alignment - (2)	436.82	25-yr (169 cfs)	169.00	107.51	110.12	109.90	110.77	0.095344	6.57	27.57	16.56	0.80
Alignment - (2)	436.82	50-yr (230 cfs)	230.00	107.51	110.52	110.32	111.32	0.094803	7.36	34.47	18.16	0.82
Alignment - (2)	436.82	100-yr (282 cfs)	282.00	107.51	110.82	110.64	111.74	0.093604	7.90	40.21	19.38	0.83
Alignment - (2)	436.82	Baseflow (2 cfs)	2.00	107.51	107.95	107.84	107.98	0.073526	1.39	1.44	6.02	0.50
Alignment - (2)	412.64	2.33-yr (38 cfs)	38.00	105.94	107.57	107.13	107.67	0.040613	2.62	14.52	14.77	0.47
Alignment - (2)	412.64	5-yr (66 cfs)	66.00	105.94	107.97	107.43	108.13	0.039254	3.20	20.78	16.24	0.48
Alignment - (2)	412.64	10-yr (104 cfs)	104.00	105.94	108.41	107.75	108.63	0.037795	3.78	28.29	17.87	0.50
Alignment - (2)	412.64	25-yr (169 cfs)	169.00	105.94	109.03	108.19	109.33	0.035963	4.49	40.05	20.15	0.51
Alignment - (2)	412.64	50-yr (230 cfs)	230.00	105.94	109.52	108.56	109.89	0.034618	4.98	50.43	21.96	0.51
Alignment - (2)	412.64	100-yr (282 cfs)	282.00	105.94	109.89	108.84	110.31	0.033962	5.34	58.77	23.32	0.52
Alignment - (2)	412.64	Baseflow (2 cfs)	2.00	105.94	106.47	106.33	106.49	0.052165	1.21	1.65	6.56	0.42
Alignment - (2)	375.19	2.33-yr (38 cfs)	38.00	104.33	105.61	105.26	105.77	0.064095	3.26	11.64	11.85	0.58
Alignment - (2)	375.19	5-yr (66 cfs)	66.00	104.33	105.98	105.62	106.24	0.066865	4.08	16.30	13.07	0.62
Alignment - (2)	375.19	10-yr (104 cfs)	104.00	104.33	106.37	105.97	106.75	0.069238	4.93	21.68	14.35	0.66
Alignment - (2)	375.19	25-yr (169 cfs)	169.00	104.33	106.89	106.49	107.45	0.073707	6.06	29.58	16.26	0.71
Alignment - (2)	375.19	50-yr (230 cfs)	230.00	104.33	107.29	106.92	108.00	0.077000	6.90	36.28	17.82	0.75
Alignment - (2)	375.19	100-yr (282 cfs)	282.00	104.33	107.58	107.23	108.42	0.079375	7.51	41.72	19.32	0.77
Alignment - (2)	375.19	Baseflow (2 cfs)	2.00	104.33	104.59	104.47	104.61	0.048372	1.13	1.78	7.48	0.41
Alignment - (2)	357.21*	2.33-yr (38 cfs)	38.00	103.56	104.61	104.26	104.73	0.052297	2.81	13.52	15.13	0.52
Alignment - (2)	357.21*	5-yr (66 cfs)	66.00	103.56	104.93	104.55	105.13	0.056395	3.57	18.63	16.39	0.57
Alignment - (2)	357.21*	10-yr (104 cfs)	104.00	103.56	105.27	104.86	105.57	0.060028	4.35	24.51	17.96	0.62
Alignment - (2)	357.21*	25-yr (169 cfs)	169.00	103.56	105.74	105.30	106.18	0.063815	5.34	33.27	19.44	0.66
Alignment - (2)	357.21*	50-yr (230 cfs)	230.00	103.56	106.09	105.66	106.66	0.067649	6.12	40.46	21.67	0.70
Alignment - (2)	357.21*	100-yr (282 cfs)	282.00	103.56	106.34	105.93	107.01	0.071117	6.71	46.10	23.28	0.73
Alignment - (2)	357.21*	Baseflow (2 cfs)	2.00	103.56	103.75	103.67	103.77	0.045424	0.94	2.13	11.38	0.38
Alignment - (2)	339.23*	2.33-yr (38 cfs)	38.00	102.78	103.62	103.34	103.73	0.058820	2.66	14.31	19.26	0.54
Alignment - (2)	339.23*	5-yr (66 cfs)	66.00	102.78	103.91	103.59	104.08	0.059910	3.28	20.16	20.64	0.58
Alignment - (2)	339.23*	10-yr (104 cfs)	104.00	102.78	104.21	103.85	104.45	0.062451	3.98	26.43	21.45	0.61
Alignment - (2)	339.23*	25-yr (169 cfs)	169.00	102.78	104.60	104.21	104.98	0.067367	4.94	35.29	24.15	0.67
Alignment - (2)	339.23*	50-yr (230 cfs)	230.00	102.78	104.91	104.51	105.39	0.069969	5.62	43.33	27.38	0.70
Alignment - (2)	339.23*	100-yr (282 cfs)	282.00	102.78	105.15	104.79	105.71	0.070452	6.08	50.03	28.58	0.71
Alignment - (2)	339.23*	Baseflow (2 cfs)	2.00	102.78	102.94	102.86	102.95	0.045898	0.82	2.43	15.90	0.37
Alignment - (2)	321.25	2.33-yr (38 cfs)	38.00	102.01	102.78	102.48	102.86	0.040054	2.17	17.50	23.85	0.45
Alignment - (2)	321.25	5-yr (66 cfs)	66.00	102.01	103.07	102.66	103.18	0.040978	2.72	24.34	24.59	0.48
Alignment - (2)	321.25	10-yr (104 cfs)	104.00	102.01	103.38	102.89	103.54	0.040074	3.22	33.70	30.57	0.49
Alignment - (2)	321.25	25-yr (169 cfs)	169.00	102.01	103.83	103.24	104.05	0.037354	3.78	48.12	32.89	0.50
Alignment - (2)	321.25	50-yr (230 cfs)	230.00	102.01	104.20	103.50	104.46	0.035146	4.16	60.68	34.72	0.50
Alignment - (2)	321.25	100-yr (282 cfs)	282.00	102.01	104.49	103.69	104.78	0.033612	4.43	70.89	36.07	0.50
Alignment - (2)	321.25	Baseflow (2 cfs)	2.00	102.01	102.14	102.08	102.15	0.042996	0.71	2.80	21.70	0.35
Alignment - (2)	309.196*	2.33-yr (38 cfs)	38.00	101.49	102.27	101.97	102.35	0.042603	2.23	17.03	27.86	0.46
Alignment - (2)	309.196*	5-yr (66 cfs)	66.00	101.49	102.57	102.17	102.68	0.041248	2.75	24.11	29.42	0.48
Alignment - (2)	309.196*	10-yr (104 cfs)	104.00	101.49	102.89	102.40	103.05	0.040519	3.28	32.07	30.46	0.50
Alignment - (2)	309.196*	25-yr (169 cfs)	169.00	101.49	103.34	102.72	103.58	0.039499	3.94	43.64	31.95	0.52
Alignment - (2)	309.196*	50-yr (230 cfs)	230.00	101.49	103.70	102.98	104.01	0.039425	4.45	52.88	39.81	0.54
Alignment - (2)	309.196*	100-yr (282 cfs)	282.00	101.49	103.97	103.19	104.33	0.039634	4.83	59.96	43.34	0.55
Alignment - (2)	309.196*	Baseflow (2 cfs)	2.00	101.49	101.63	101.56	101.64	0.043338	0.73	2.73	23.69	0.35

HEC-RAS Plan: Alt B River: Hotelling Gulch Reach: Alignment - (2) (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	297.143*	2.33-yr (38 cfs)	38.00	100.97	101.79	101.46	101.86	0.038493	2.18	17.46	29.98	0.44
Alignment - (2)	297.143*	5-yr (66 cfs)	66.00	100.97	102.11	101.66	102.22	0.035428	2.64	25.16	32.01	0.45
Alignment - (2)	297.143*	10-yr (104 cfs)	104.00	100.97	102.46	101.89	102.60	0.033814	3.11	34.10	34.45	0.46
Alignment - (2)	297.143*	25-yr (169 cfs)	169.00	100.97	102.93	102.23	103.14	0.033088	3.74	47.01	36.77	0.48
Alignment - (2)	297.143*	50-yr (230 cfs)	230.00	100.97	103.29	102.50	103.56	0.033210	4.21	57.23	38.12	0.50
Alignment - (2)	297.143*	100-yr (282 cfs)	282.00	100.97	103.56	102.71	103.88	0.033644	4.58	64.94	39.13	0.51
Alignment - (2)	297.143*	Baseflow (2 cfs)	2.00	100.97	101.11	101.04	101.12	0.042834	0.74	2.72	25.84	0.35
Alignment - (2)	285.09	2.33-yr (38 cfs)	38.00	100.46	101.40	100.97	101.47	0.027874	2.02	18.81	32.85	0.39
Alignment - (2)	285.09	5-yr (66 cfs)	66.00	100.46	101.73	101.19	101.83	0.028156	2.52	26.37	34.93	0.41
Alignment - (2)	285.09	10-yr (104 cfs)	104.00	100.46	102.08	101.44	102.22	0.029351	3.05	34.80	37.09	0.44
Alignment - (2)	285.09	25-yr (169 cfs)	169.00	100.46	102.53	101.78	102.75	0.031691	3.77	46.74	40.28	0.47
Alignment - (2)	285.09	50-yr (230 cfs)	230.00	100.46	102.88	102.07	103.16	0.033566	4.32	56.42	42.57	0.50
Alignment - (2)	285.09	100-yr (282 cfs)	282.00	100.46	103.13	102.28	103.47	0.034804	4.72	63.87	43.65	0.52
Alignment - (2)	285.09	Baseflow (2 cfs)	2.00	100.46	100.60	100.53	100.61	0.041182	0.76	2.65	28.08	0.35
Alignment - (2)	267.9	2.33-yr (38 cfs)	38.00	99.72	100.68	100.37	100.79	0.058913	2.63	14.43	19.59	0.54
Alignment - (2)	267.9	5-yr (66 cfs)	66.00	99.72	100.93	100.65	101.11	0.068453	3.40	19.61	22.63	0.61
Alignment - (2)	267.9	10-yr (104 cfs)	104.00	99.72	101.19	100.91	101.45	0.074330	4.16	26.28	26.90	0.66
Alignment - (2)	267.9	25-yr (169 cfs)	169.00	99.72	101.58	101.30	101.94	0.072256	4.94	37.33	29.11	0.68
Alignment - (2)	267.9	50-yr (230 cfs)	230.00	99.72	101.91	101.58	102.34	0.068408	5.43	47.22	30.95	0.69
Alignment - (2)	267.9	100-yr (282 cfs)	282.00	99.72	102.18	101.78	102.65	0.064468	5.74	55.65	32.44	0.68
Alignment - (2)	267.9	Baseflow (2 cfs)	2.00	99.72	99.90	99.81	99.91	0.042004	0.86	2.32	13.22	0.36
Alignment - (2)	246.32	2.33-yr (38 cfs)	38.00	98.79	99.61	99.29	99.69	0.043860	2.29	17.15	25.91	0.47
Alignment - (2)	246.32	5-yr (66 cfs)	66.00	98.79	99.96	99.52	100.06	0.035292	2.64	26.99	30.62	0.45
Alignment - (2)	246.32	10-yr (104 cfs)	104.00	98.79	100.34	99.76	100.47	0.029388	2.95	39.09	32.38	0.43
Alignment - (2)	246.32	25-yr (169 cfs)	169.00	98.79	100.88	100.09	101.04	0.025219	3.37	57.51	36.59	0.42
Alignment - (2)	246.32	50-yr (230 cfs)	230.00	98.79	101.31	100.34	101.50	0.022678	3.64	73.93	40.88	0.41
Alignment - (2)	246.32	100-yr (282 cfs)	282.00	98.79	101.65	100.52	101.85	0.021241	3.83	86.60	44.19	0.41
Alignment - (2)	246.32	Baseflow (2 cfs)	2.00	98.79	98.93	98.86	98.94	0.047772	0.78	2.57	18.83	0.37
Alignment - (2)	236.		Bridge									
Alignment - (2)	207.83	2.33-yr (38 cfs)	38.00	97.13	98.03	97.64	98.09	0.040079	2.05	18.50	23.42	0.41
Alignment - (2)	207.83	5-yr (66 cfs)	66.00	97.13	98.34	97.85	98.44	0.039837	2.55	26.08	25.08	0.43
Alignment - (2)	207.83	10-yr (104 cfs)	104.00	97.13	98.68	98.08	98.83	0.039182	3.03	35.05	26.93	0.44
Alignment - (2)	207.83	25-yr (169 cfs)	169.00	97.13	99.17	98.42	99.37	0.038069	3.63	49.24	32.33	0.46
Alignment - (2)	207.83	50-yr (230 cfs)	230.00	97.13	99.56	98.69	99.80	0.036293	4.00	62.00	33.11	0.46
Alignment - (2)	207.83	100-yr (282 cfs)	282.00	97.13	99.86	98.90	100.13	0.035270	4.28	71.93	33.70	0.47
Alignment - (2)	207.83	Baseflow (2 cfs)	2.00	97.13	97.29	97.21	97.30	0.040799	0.75	2.67	17.65	0.34
Alignment - (2)	197.24*	2.33-yr (38 cfs)	38.00	96.68	97.56	97.20	97.64	0.045182	2.20	17.25	22.25	0.44
Alignment - (2)	197.24*	5-yr (66 cfs)	66.00	96.68	97.89	97.42	98.00	0.043076	2.69	24.71	24.14	0.45
Alignment - (2)	197.24*	10-yr (104 cfs)	104.00	96.68	98.25	97.67	98.40	0.040491	3.16	33.80	26.28	0.46
Alignment - (2)	197.24*	25-yr (169 cfs)	169.00	96.68	98.75	98.01	98.96	0.038137	3.74	47.79	29.68	0.47
Alignment - (2)	197.24*	50-yr (230 cfs)	230.00	96.68	99.15	98.30	99.40	0.036438	4.14	60.39	33.13	0.48
Alignment - (2)	197.24*	100-yr (282 cfs)	282.00	96.68	99.46	98.51	99.74	0.035072	4.41	71.04	36.00	0.48
Alignment - (2)	197.24*	Baseflow (2 cfs)	2.00	96.68	96.82	96.75	96.83	0.048300	0.78	2.56	18.18	0.37
Alignment - (2)	186.65	2.33-yr (38 cfs)	38.00	96.22	97.17	96.73	97.23	0.032190	2.05	18.50	21.48	0.39
Alignment - (2)	186.65	5-yr (66 cfs)	66.00	96.22	97.50	96.96	97.60	0.032699	2.57	25.88	22.83	0.41
Alignment - (2)	186.65	10-yr (104 cfs)	104.00	96.22	97.87	97.21	98.01	0.032804	3.08	34.74	25.41	0.43
Alignment - (2)	186.65	25-yr (169 cfs)	169.00	96.22	98.38	97.56	98.59	0.032256	3.69	48.79	29.19	0.45
Alignment - (2)	186.65	50-yr (230 cfs)	230.00	96.22	98.80	97.85	99.04	0.031195	4.09	61.43	31.66	0.46
Alignment - (2)	186.65	100-yr (282 cfs)	282.00	96.22	99.12	98.08	99.39	0.030192	4.36	71.83	33.21	0.46
Alignment - (2)	186.65	Baseflow (2 cfs)	2.00	96.22	96.37	96.29	96.38	0.038186	0.73	2.73	18.39	0.33
Alignment - (2)	162.96	2.33-yr (38 cfs)	38.00	95.20	96.29	95.83	96.36	0.042254	2.15	17.70	20.60	0.41
Alignment - (2)	162.96	5-yr (66 cfs)	66.00	95.20	96.66	96.08	96.77	0.038392	2.58	25.97	23.79	0.41
Alignment - (2)	162.96	10-yr (104 cfs)	104.00	95.20	97.08	96.36	97.21	0.034843	2.98	36.49	27.35	0.41
Alignment - (2)	162.96	25-yr (169 cfs)	169.00	95.20	97.67	96.73	97.84	0.030216	3.41	53.80	74.09	0.40
Alignment - (2)	162.96	50-yr (230 cfs)	230.00	95.20	98.14	97.03	98.33	0.027380	3.69	68.95	81.81	0.40
Alignment - (2)	162.96	100-yr (282 cfs)	282.00	95.20	98.50	97.26	98.71	0.025742	3.90	81.19	87.82	0.39
Alignment - (2)	162.96	Baseflow (2 cfs)	2.00	95.20	95.39	95.29	95.40	0.045814	0.83	2.41	13.72	0.35
Alignment - (2)	146.16	2.33-yr (38 cfs)	38.00	94.48	95.56	95.16	95.67	0.041108	2.59	14.67	15.76	0.47
Alignment - (2)	146.16	5-yr (66 cfs)	66.00	94.48	95.95	95.44	96.11	0.038803	3.17	21.15	17.34	0.48
Alignment - (2)	146.16	10-yr (104 cfs)	104.00	94.48	96.39	95.73	96.60	0.037018	3.73	29.03	19.08	0.49
Alignment - (2)	146.16	25-yr (169 cfs)	169.00	94.48	96.98	96.18	97.27	0.035836	4.45	40.99	21.45	0.51
Alignment - (2)	146.16	50-yr (230 cfs)	230.00	94.48	97.43	96.54	97.80	0.035348	4.97	51.23	23.29	0.52
Alignment - (2)	146.16	100-yr (282 cfs)	282.00	94.48	97.77	96.81	98.19	0.035309	5.36	59.34	24.65	0.53
Alignment - (2)	146.16	Baseflow (2 cfs)	2.00	94.48	94.68	94.58	94.69	0.038782	0.87	2.30	12.19	0.35
Alignment - (2)	123.09	2.33-yr (38 cfs)	38.00	93.49	94.77	94.22	94.86	0.029506	2.36	16.07	15.02	0.40
Alignment - (2)	123.09	5-yr (66 cfs)	66.00	93.49	95.19	94.52	95.32	0.029898	2.93	22.69	16.67	0.43
Alignment - (2)	123.09	10-yr (104 cfs)	104.00	93.49	95.63	94.85	95.82	0.030387	3.52	30.44	18.45	0.45
Alignment - (2)	123.09	25-yr (169 cfs)	169.00	93.49	96.21	95.29	96.49	0.031955	4.31	41.79	20.79	0.48
Alignment - (2)	123.09	50-yr (230 cfs)	230.00	93.49	96.65	95.66	97.01	0.032965	4.89	51.46	22.59	0.50
Alignment - (2)	123.09	100-yr (282 cfs)	282.00	93.49	96.97	95.95	97.39	0.034145	5.33	58.90	23.88	0.52

HEC-RAS Plan: Alt B River: Hotelling Gulch Reach: Alignment - (2) (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - (2)	123.09	Baseflow (2 cfs)	2.00	93.49	93.69	93.60	93.70	0.047015	0.97	2.07	10.80	0.39
Alignment - (2)	103.735*	2.33-yr (38 cfs)	38.00	92.80	94.26	93.63	94.34	0.024427	2.19	17.37	16.00	0.37
Alignment - (2)	103.735*	5-yr (66 cfs)	66.00	92.80	94.68	93.94	94.80	0.024625	2.72	24.71	18.91	0.39
Alignment - (2)	103.735*	10-yr (104 cfs)	104.00	92.80	95.11	94.27	95.27	0.025636	3.28	33.41	21.68	0.42
Alignment - (2)	103.735*	25-yr (169 cfs)	169.00	92.80	95.67	94.71	95.91	0.027185	4.01	46.71	27.28	0.45
Alignment - (2)	103.735*	50-yr (230 cfs)	230.00	92.80	96.13	95.08	96.42	0.026875	4.46	61.31	35.40	0.46
Alignment - (2)	103.735*	100-yr (282 cfs)	282.00	92.80	96.49	95.35	96.79	0.025280	4.67	74.54	38.04	0.45
Alignment - (2)	103.735*	Baseflow (2 cfs)	2.00	92.80	93.12	92.94	93.13	0.020793	0.80	2.49	9.37	0.27
Alignment - (2)	84.38	2.33-yr (38 cfs)	38.00	92.11	93.63	93.12	93.74	0.039321	2.64	14.37	14.13	0.46
Alignment - (2)	84.38	5-yr (66 cfs)	66.00	92.11	94.06	93.45	94.21	0.036559	3.18	21.59	19.77	0.47
Alignment - (2)	84.38	10-yr (104 cfs)	104.00	92.11	94.53	93.82	94.72	0.031765	3.59	33.55	31.25	0.46
Alignment - (2)	84.38	25-yr (169 cfs)	169.00	92.11	95.21	94.32	95.40	0.023589	3.80	56.02	34.95	0.42
Alignment - (2)	84.38	50-yr (230 cfs)	230.00	92.11	95.74	94.73	95.94	0.019960	3.96	75.38	37.84	0.40
Alignment - (2)	84.38	100-yr (282 cfs)	282.00	92.11	96.14	94.96	96.35	0.018109	4.09	91.00	40.03	0.39
Alignment - (2)	84.38	Baseflow (2 cfs)	2.00	92.11	92.47	92.36	92.49	0.059514	1.18	1.69	7.81	0.45
Alignment - (2)	63.805*	2.33-yr (38 cfs)	38.00	91.16	92.90	92.27	93.00	0.032561	2.57	14.80	13.03	0.42
Alignment - (2)	63.805*	5-yr (66 cfs)	66.00	91.16	93.38	92.65	93.53	0.030179	3.11	21.67	15.58	0.43
Alignment - (2)	63.805*	10-yr (104 cfs)	104.00	91.16	93.91	93.03	94.11	0.027819	3.61	30.70	18.64	0.44
Alignment - (2)	63.805*	25-yr (169 cfs)	169.00	91.16	94.63	93.53	94.89	0.025382	4.19	45.77	23.02	0.44
Alignment - (2)	63.805*	50-yr (230 cfs)	230.00	91.16	95.17	93.94	95.47	0.024472	4.62	59.07	26.33	0.44
Alignment - (2)	63.805*	100-yr (282 cfs)	282.00	91.16	95.57	94.25	95.91	0.023874	4.91	70.16	28.98	0.44
Alignment - (2)	63.805*	Baseflow (2 cfs)	2.00	91.16	91.58	91.41	91.60	0.033425	1.07	1.88	6.51	0.35
Alignment - (2)	43.23	2.33-yr (38 cfs)	38.00	90.21	91.61	91.40	91.88	0.104631	4.16	9.14	9.08	0.73
Alignment - (2)	43.23	5-yr (66 cfs)	66.00	90.21	91.97	91.80	92.41	0.116078	5.29	12.59	10.25	0.81
Alignment - (2)	43.23	10-yr (104 cfs)	104.00	90.21	92.31	92.23	92.98	0.132762	6.59	16.29	11.37	0.89
Alignment - (2)	43.23	25-yr (169 cfs)	169.00	90.21	92.84	92.84	93.80	0.136018	7.99	22.70	13.08	0.95
Alignment - (2)	43.23	50-yr (230 cfs)	230.00	90.21	93.34	93.34	94.44	0.120339	8.62	29.87	15.42	0.92
Alignment - (2)	43.23	100-yr (282 cfs)	282.00	90.21	93.72	93.72	94.91	0.111350	9.05	36.07	17.26	0.91
Alignment - (2)	43.23	Baseflow (2 cfs)	2.00	90.21	90.57	90.47	90.60	0.073985	1.43	1.40	5.59	0.50
Alignment - (2)	3.58	2.33-yr (38 cfs)	38.00	84.73	85.85	85.85	86.22	0.205698	4.87	7.81	10.55	1.00
Alignment - (2)	3.58	5-yr (66 cfs)	66.00	84.73	86.18	86.18	86.70	0.182589	5.75	11.55	11.69	0.99
Alignment - (2)	3.58	10-yr (104 cfs)	104.00	84.73	86.56	86.56	87.23	0.158494	6.58	16.23	12.98	0.97
Alignment - (2)	3.58	25-yr (169 cfs)	169.00	84.73	87.03	87.11	87.98	0.158618	7.94	22.58	14.54	1.02
Alignment - (2)	3.58	50-yr (230 cfs)	230.00	84.73	87.30	87.53	88.60	0.182480	9.32	26.67	15.47	1.12
Alignment - (2)	3.58	100-yr (282 cfs)	282.00	84.73	87.51	87.86	89.09	0.197677	10.32	29.97	16.18	1.18
Alignment - (2)	3.58	Baseflow (2 cfs)	2.00	84.73	85.01	85.01	85.10	0.346233	2.42	0.83	4.87	1.03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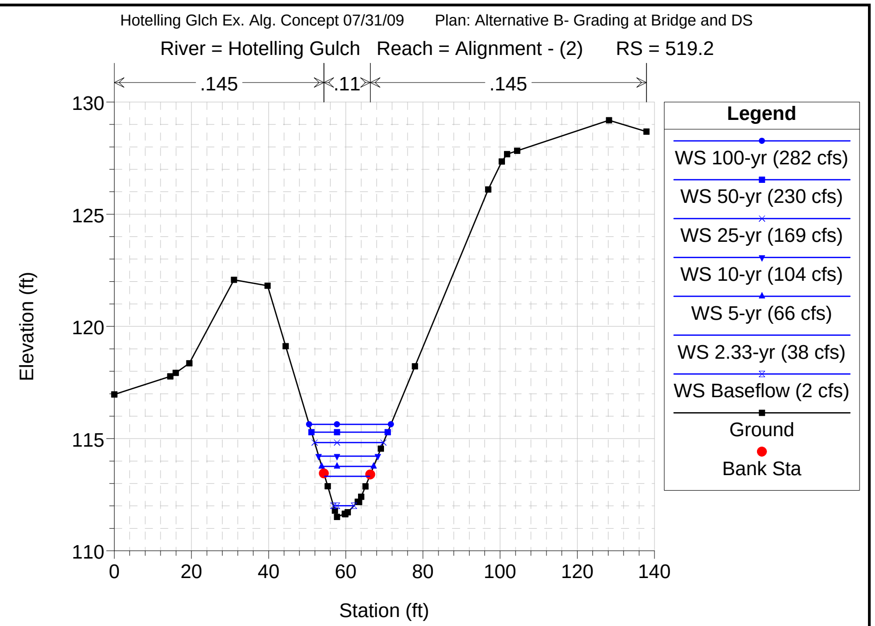
River = Hotelling Gulch Reach = Alignment - (2) RS = 548.77
.145
.145
.
1
1
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta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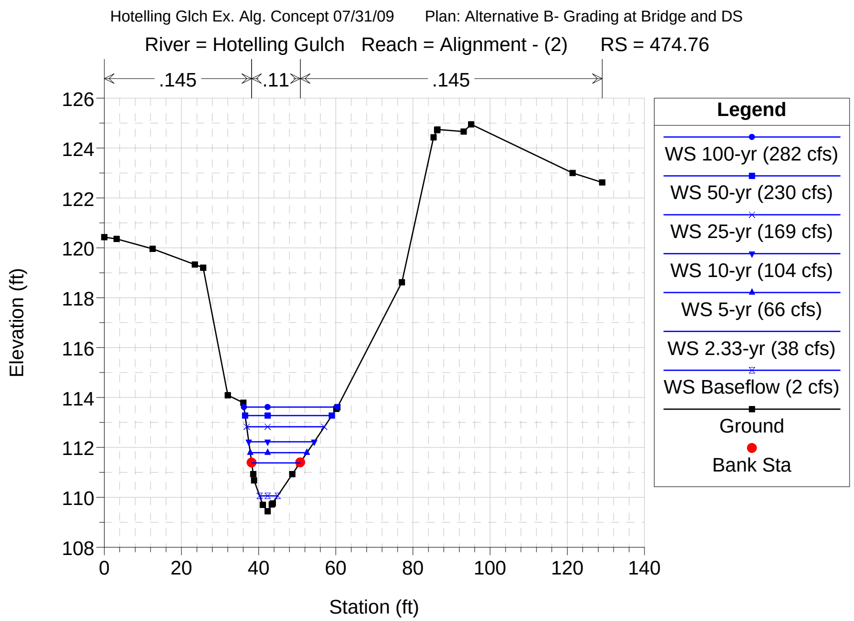
River = Hotelling Gulch Reach = Alignment - (2) RS = 519.2
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta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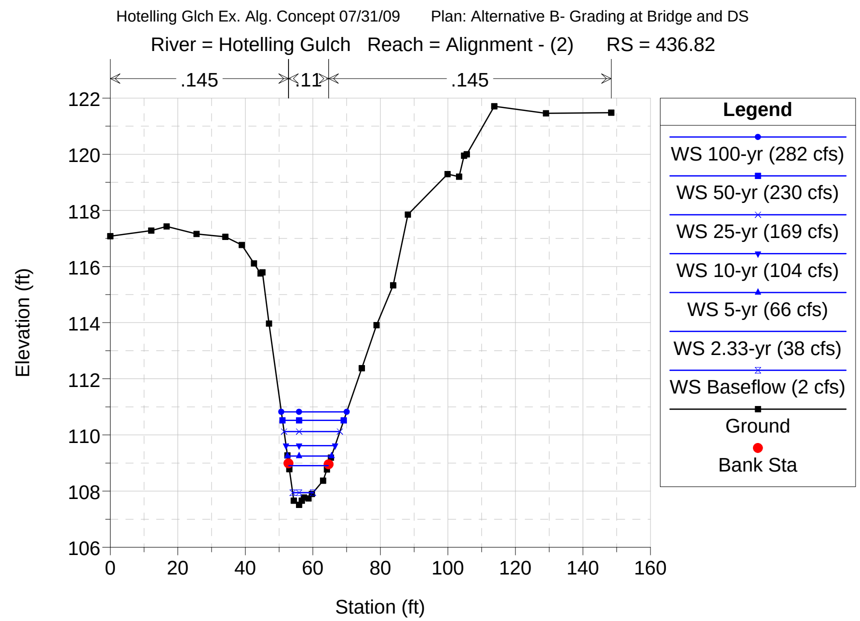
River = Hotelling Gulch Reach = Alignment - (2) RS = 474.76
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta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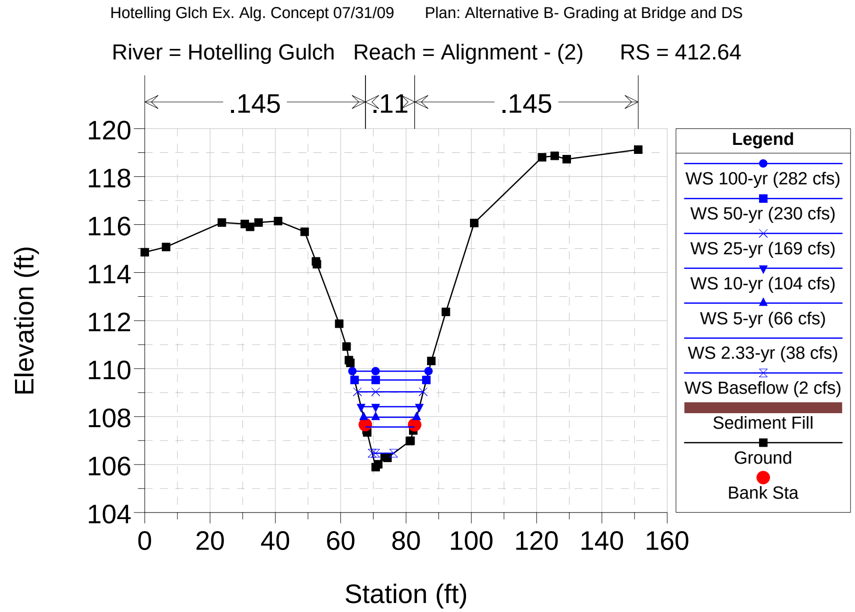
River = Hotelling Gulch Reach = Alignment - (2) RS = 436.82
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta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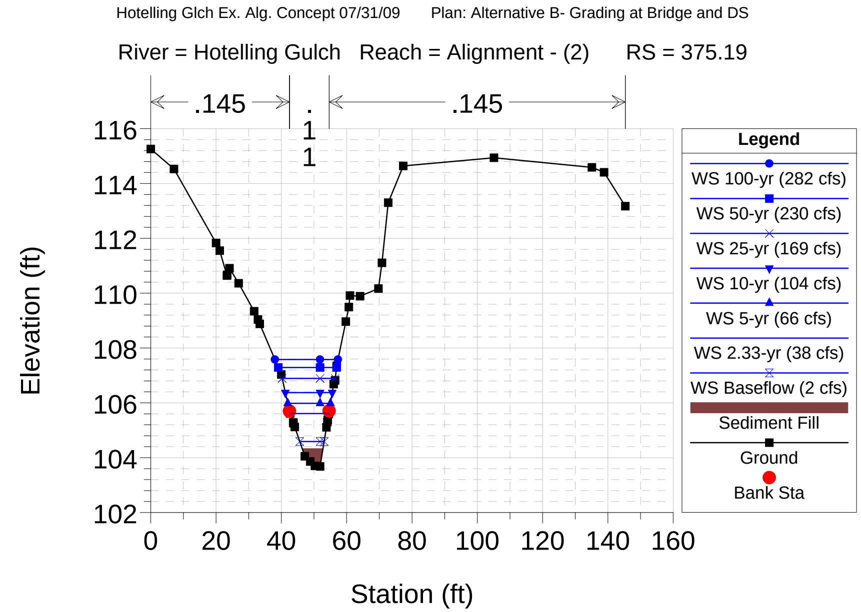
River = Hotelling Gulch Reach = Alignment - (2) RS = 412.64
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta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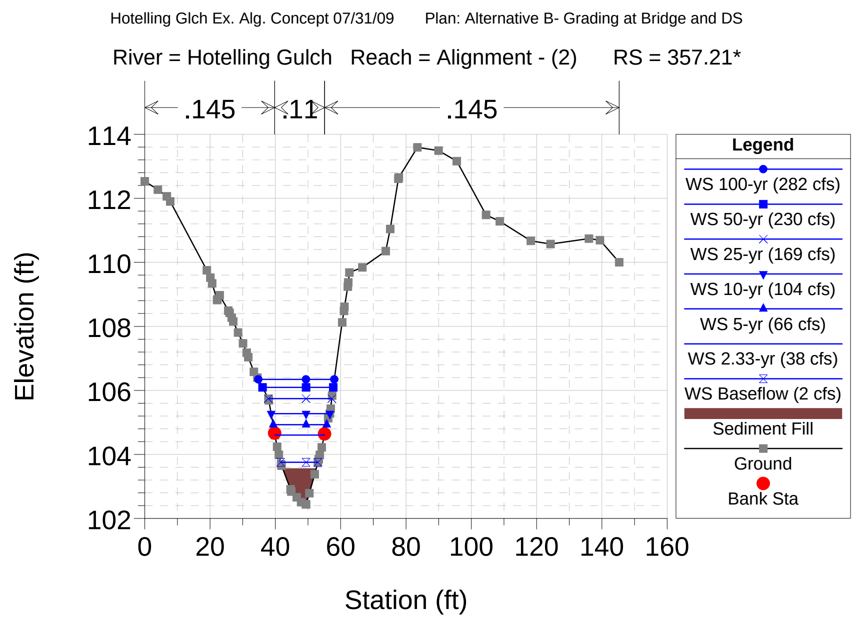
River = Hotelling Gulch Reach = Alignment - (2) RS = 375.19
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta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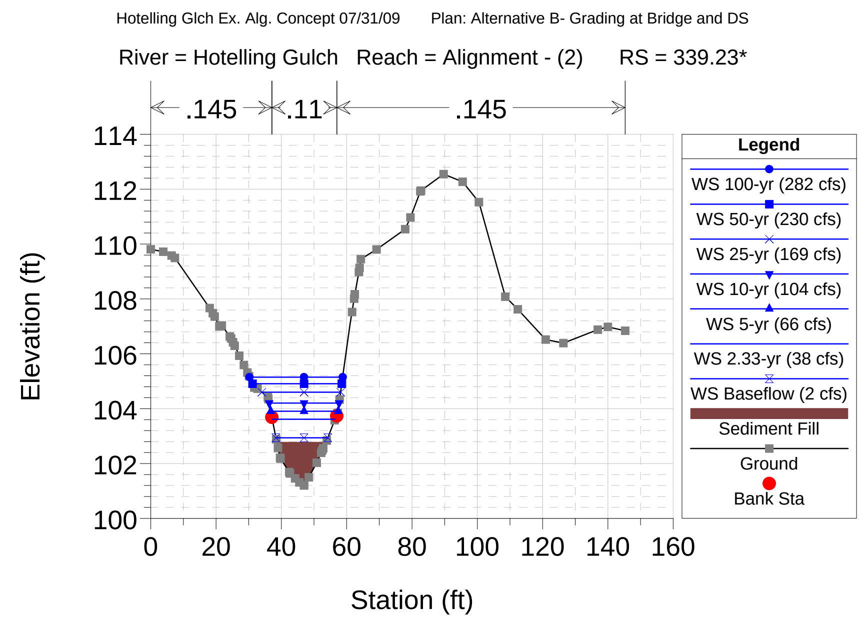
River = Hotelling Gulch Reach = Alignment - (2) RS = 357.21*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta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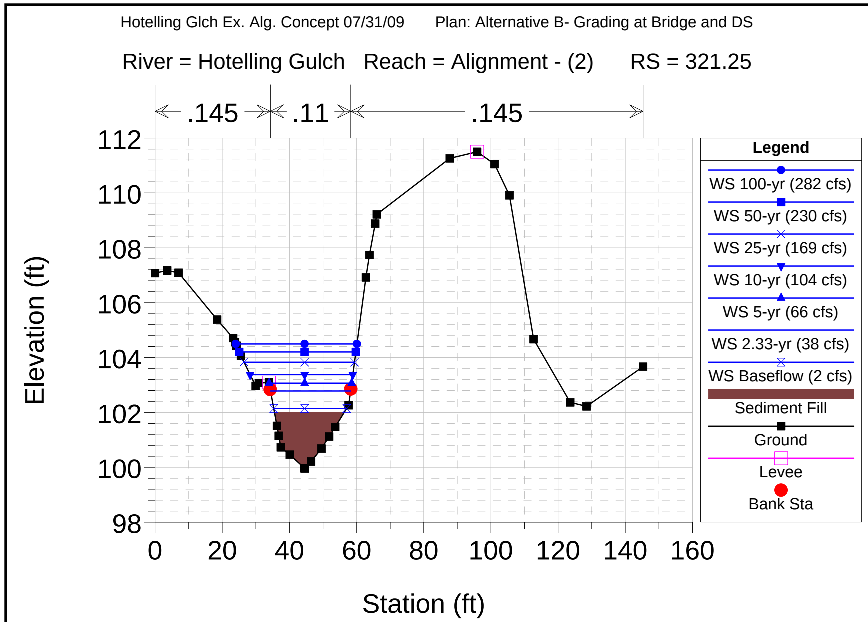
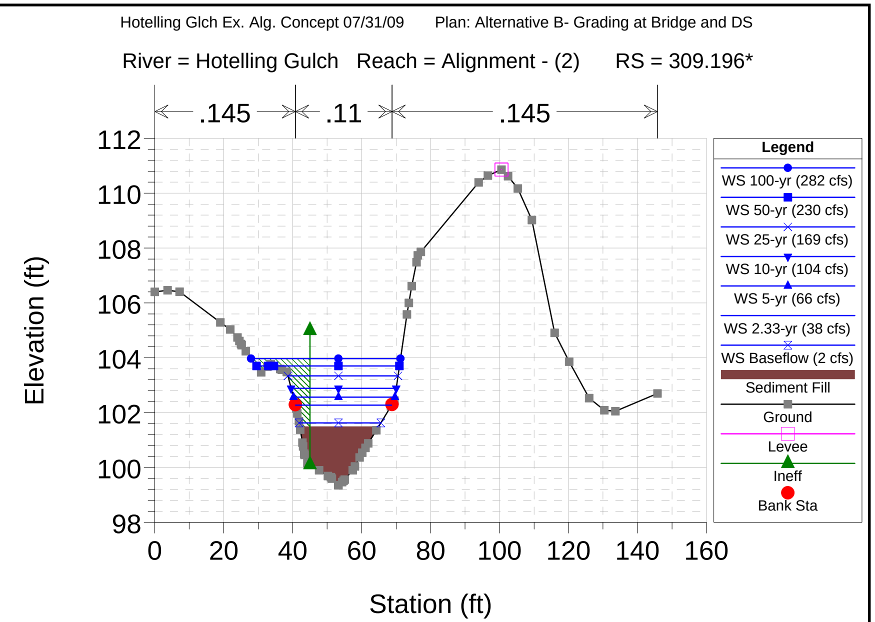
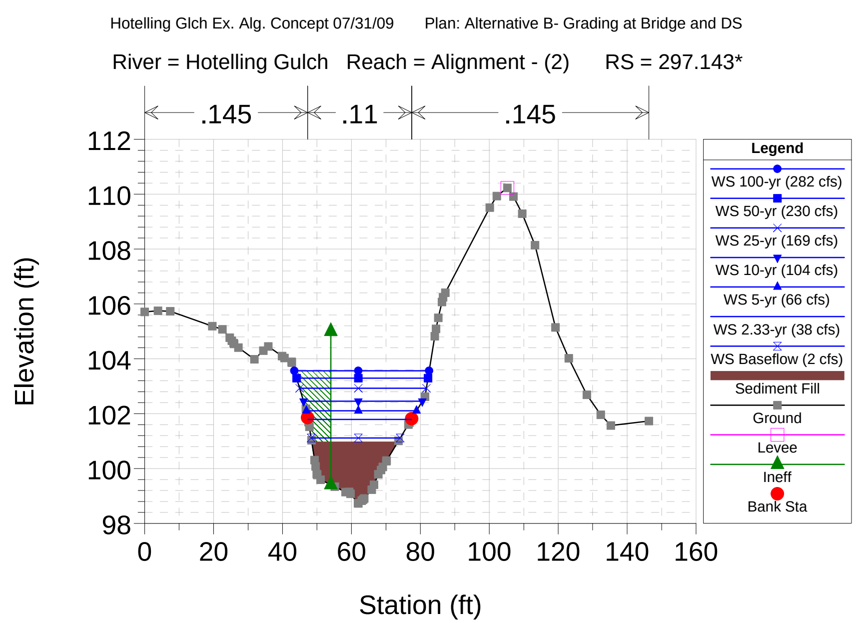
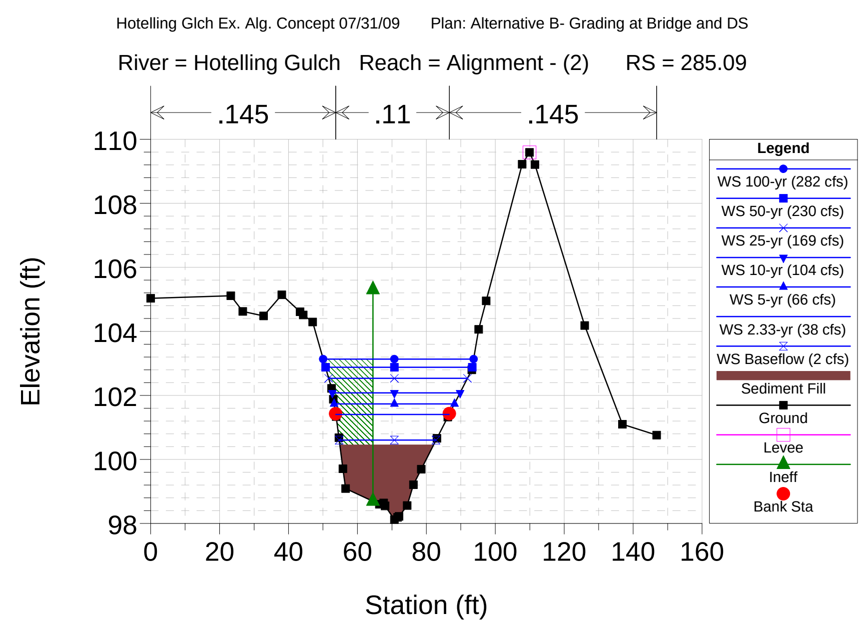
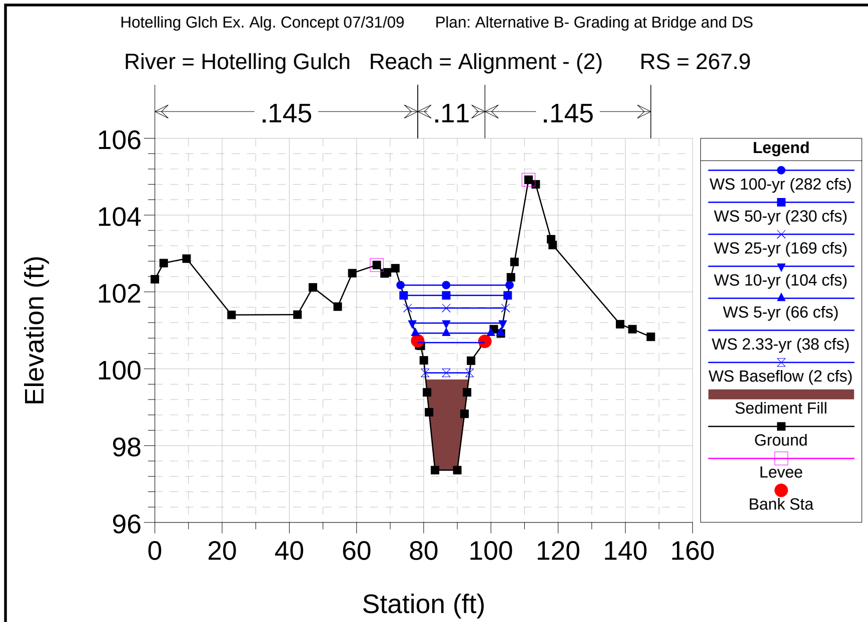
River = Hotelling Gulch Reach = Alignment - (2) RS = 339.23*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Bank Sta

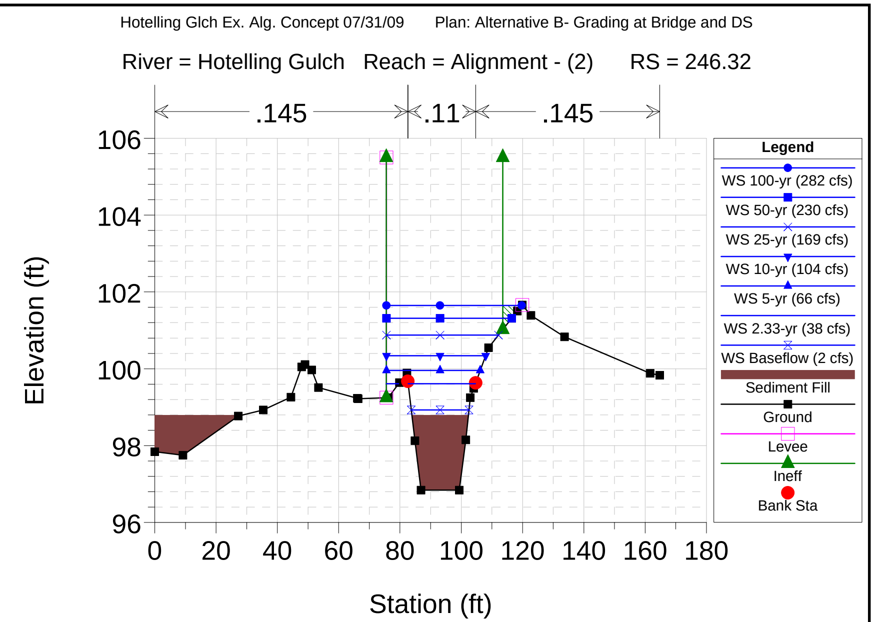

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 321.25
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
98
100
102
104
106
108
110
112
0
20
40
60
80
100
120
140
160

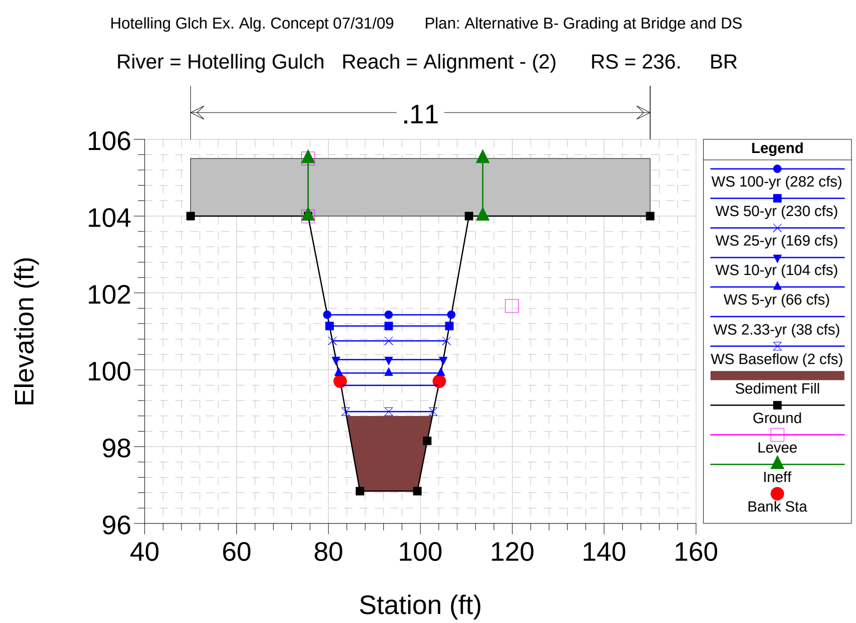

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 309.196*
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
98
100
102
104
106
108
110
112
0
20
40
60
80
100
120
140
160

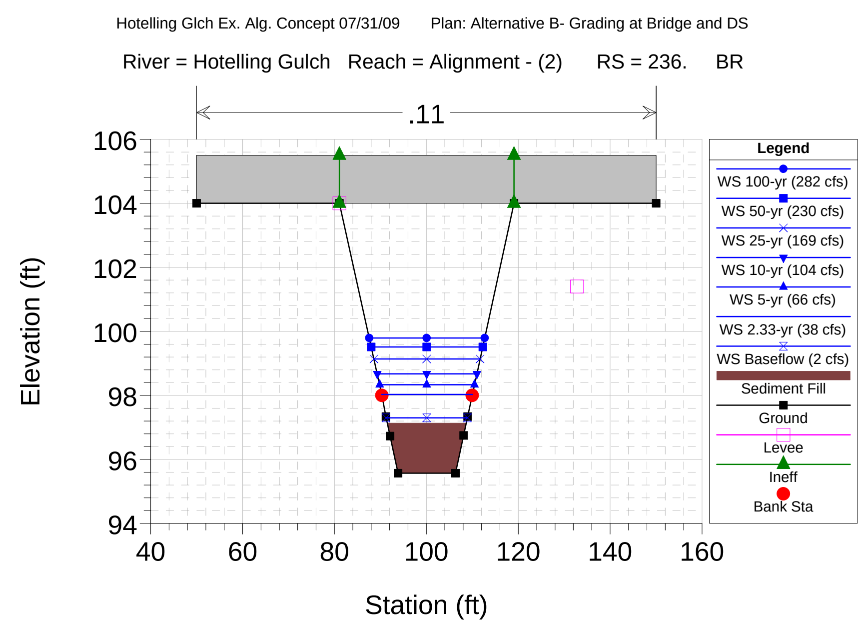

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 297.143*
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
98
100
102
104
106
108
110
112
0
20
40
60
80
100
120
140
160

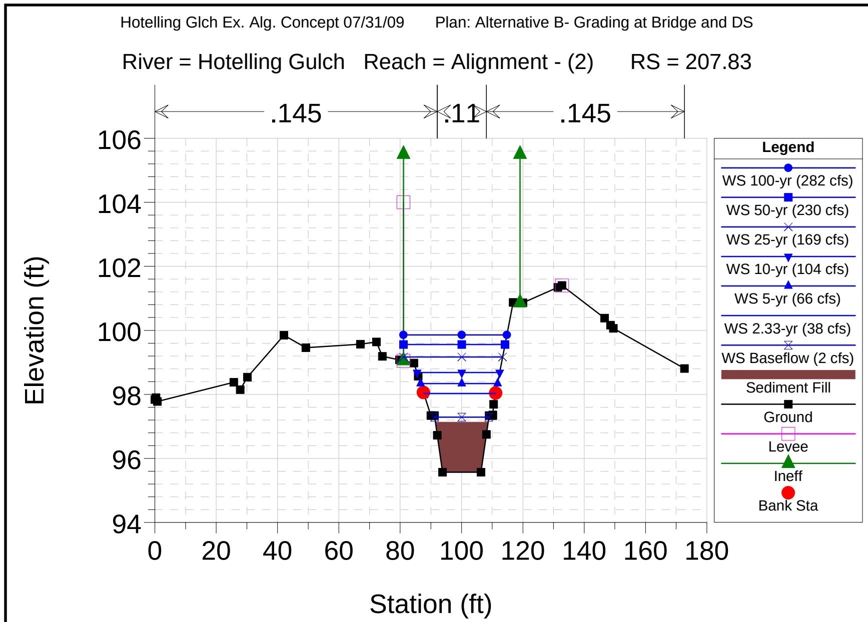

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 285.09
.145
.11
.145
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
98
100
102
104
106
108
110
0
20
40
60
80
100
120
140
160

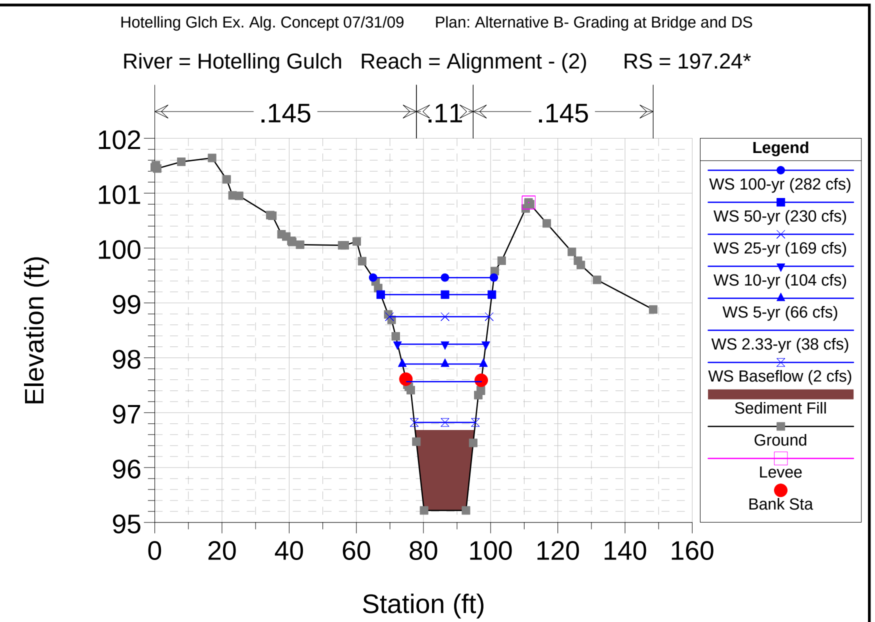

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 267.9
.145
.11
.145
Elevation (ft)
Station (ft)
106
104
102
100
98
96
0
20
40
60
80
100
120
140
160
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta

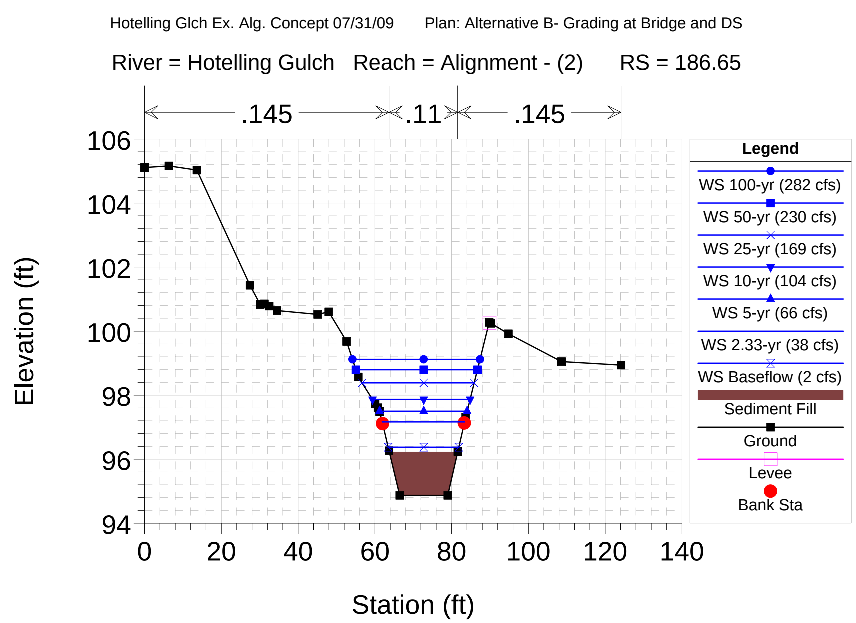

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 246.32
.145
.11
.145
Elevation (ft)
Station (ft)
106
104
102
100
98
96
0
20
40
60
80
100
120
140
160
180
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

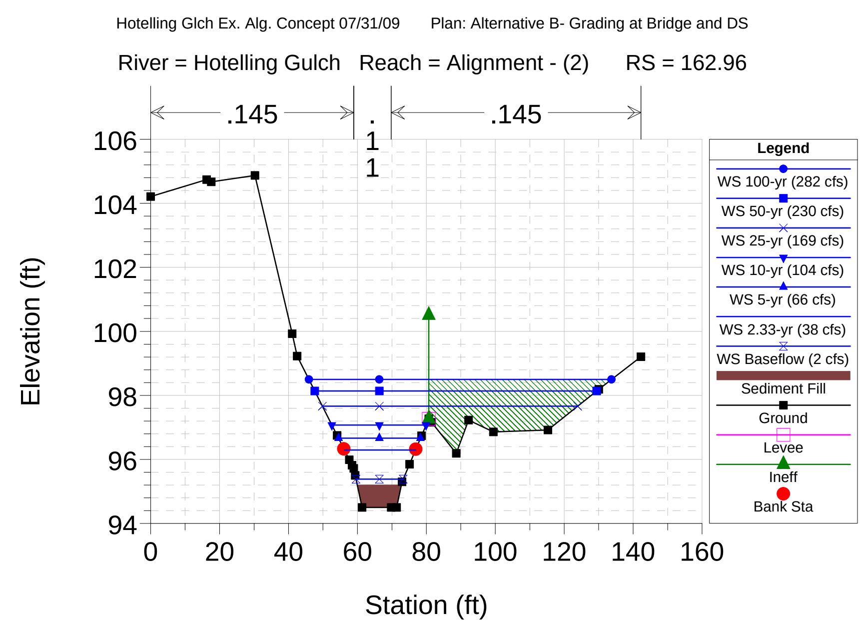

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 236. BR
.11
Elevation (ft)
Station (ft)
106
104
102
100
98
96
40
60
80
100
120
140
160
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

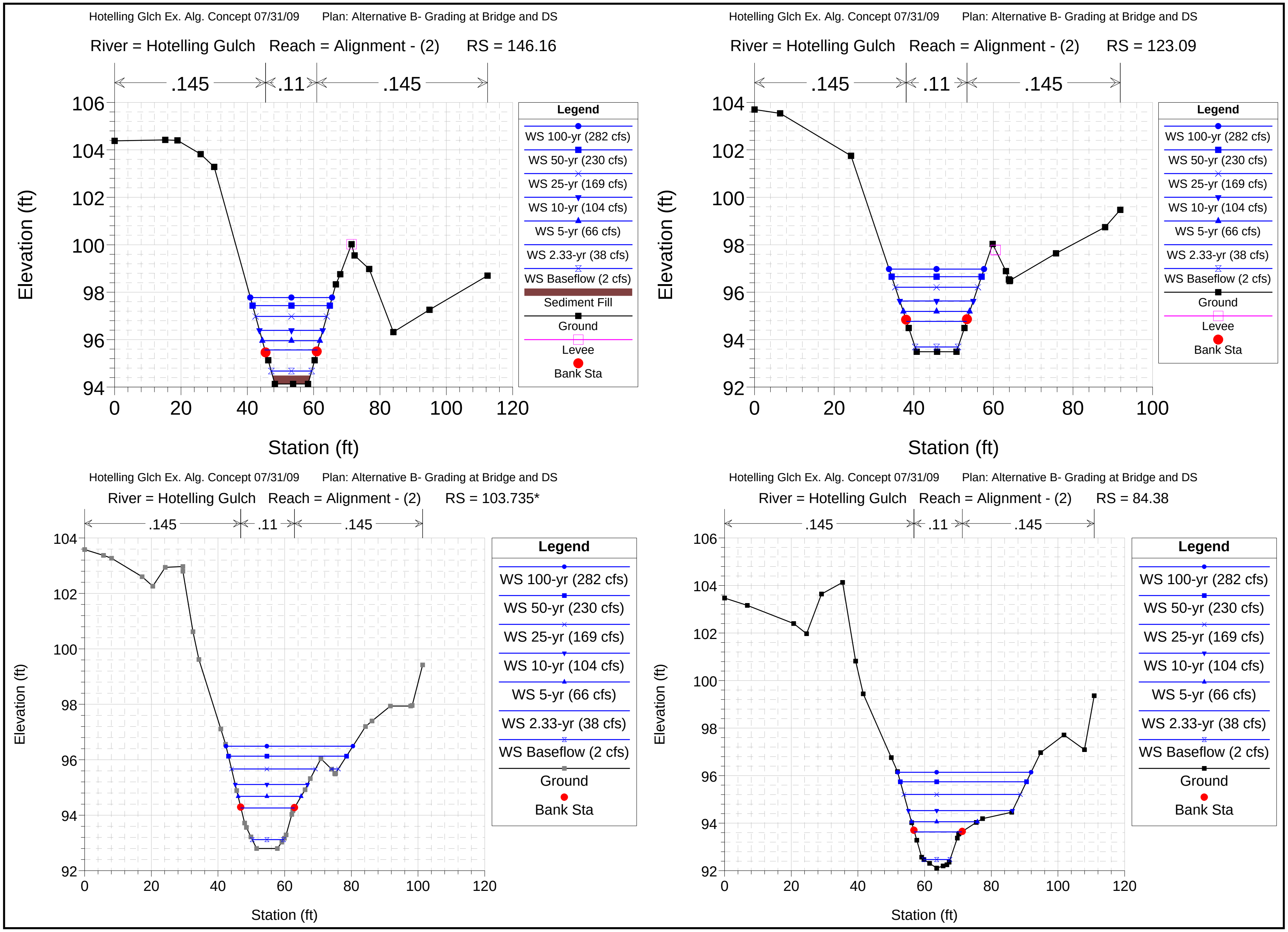

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 236. BR
.11
Elevation (ft)
Station (ft)
106
104
102
100
98
96
94
40
60
80
100
120
140
160
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

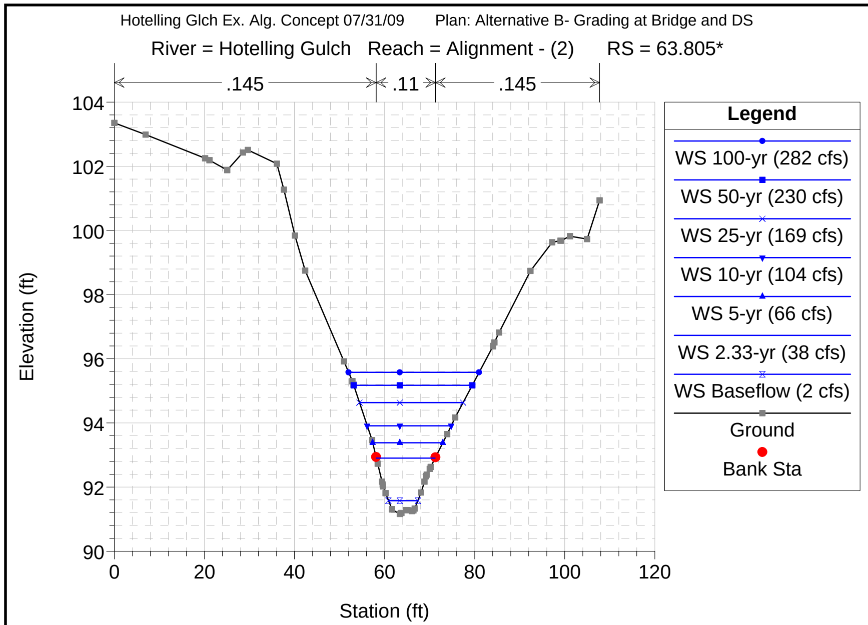

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 207.83
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta

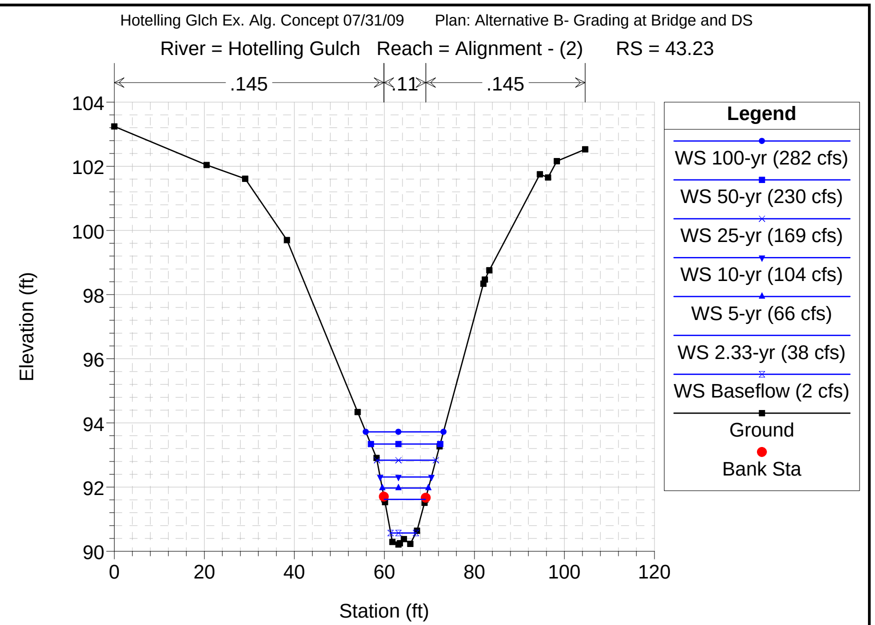

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 197.24*
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta

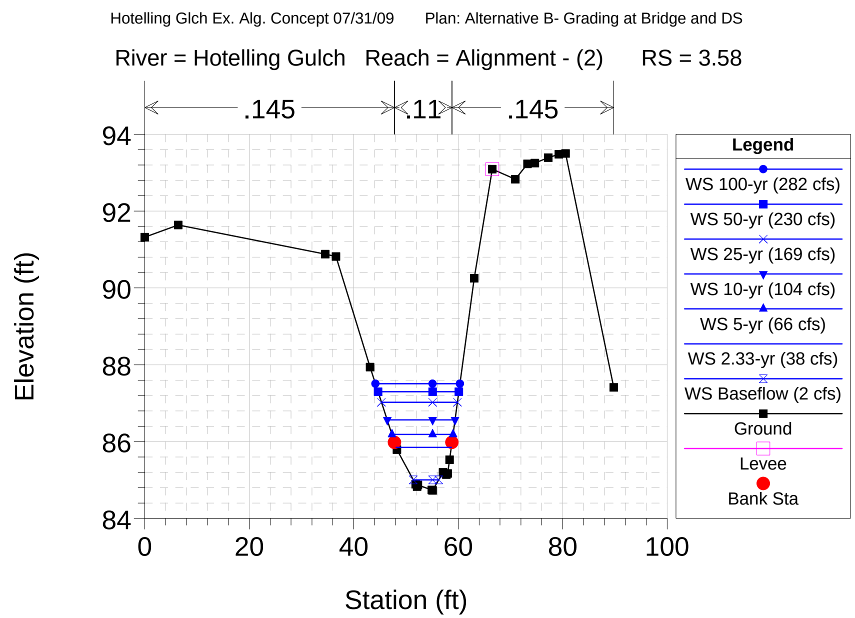

Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 186.65
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 162.96
.145
.11
.145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Ineff
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 146.16
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Sediment Fill
Ground
Levee
Bank Sta
Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 123.09
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta
Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 103.735*
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta
Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 84.38
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 63.805*
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 43.23
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Bank Sta


Hotelling Glch Ex. Alg. Concept 07/31/09 Plan: Alternative B- Grading at Bridge and DS
River = Hotelling Gulch Reach = Alignment - (2) RS = 3.58
.145 .11 .145
Elevation (ft)
Station (ft)
Legend
WS 100-yr (282 cfs)
WS 50-yr (230 cfs)
WS 25-yr (169 cfs)
WS 10-yr (104 cfs)
WS 5-yr (66 cfs)
WS 2.33-yr (38 cfs)
WS Baseflow (2 cfs)
Ground
Levee
Bank Sta

ATTACHMENT 3

ODOT Standard Precast Pre-stressed Concrete Slab Bridge Details

det3450.dgn 11-08

DET3450

SLAB 12"

Bottom Strand Pattern for Left half of slab. (Symm. ℄ Slab)	Slab No.	Total Strand	Debonded Strands	Distance "Yc" to c.g. strand at midspan, in.	Distance "Yu" to c.g.s. at midspan omitting top strand, in.	CONCRETE CLASS ksi	Concrete strength at release, ksi	Estimated Span, ft. (See Design Notes)	Estimated Initial Strand Stress Loss, ksi	Estimated Final Strand Stress Loss (27yrs.), ksi	Estimated Midspan Deflection: Upward at Transfer of Prestress	Estimated Midspan Deflection: Upward 3 months after transfer of Prestress (No SIDL)	Estimated Midspan Deflection: Instantaneous Downward Due to 100 psf SIDL	Estimated Shortening 2 weeks after Transfer of Prestress
	1	10	–	4.10	2.88	5.0	4.0	16	4.9	27.8	1/16"	1/8"	0"	1/16"
	2	12	–	4.06	3.08	5.0	4.0	18	5.8	29.9	1/8"	3/16"	0"	1/16"
	3	14	–	4.04	3.21	5.0	4.0	19.5	6.8	32.1	1/8"	1/4"	1/16"	1/16"
	4	16	–	3.77	3.02	5.0	4.0	22	8.1	34.6	1/4"	3/8"	1/16"	1/8"
	5	18	–	3.56	2.88	5.0	4.0	24	9.5	37.2	5/16"	7/16"	1/8"	1/8"
	6	20	–	3.39	2.76	5.5	4.0	26	10.8	39.8	1/2"	13/16"	1/8"	1/8"
	7	22	–	3.25	2.68	6.0	4.2	28	11.8	40.6	5/8"	1 1/16"	3/16"	1/8"
	8	24	2	3.14	2.60	6.0	4.3	30	12.9	41.9	3/4"	1 5/16"	1/4"	3/16"

6" | 12" | 6" ; 2'-0" (typ.)

Omit top 2 strands when computing ultimate moment capacity and stirrup spacing.

SLAB 15"

Bottom Strand Pattern for Left half of slab. (Symm. ℄ Slab)	Slab No.	Total Strand	Debonded Strands	Distance "Yc" to c.g. strand at midspan, in.	Distance "Yu" to c.g.s. at midspan omitting top strand, in.	CONCRETE CLASS ksi	Concrete strength at release, ksi	Estimated Span, ft. (See Design Notes)	Estimated Initial Strand Stress Loss, ksi	Estimated Final Strand Stress Loss (27yrs.), ksi	Estimated Midspan Deflection: Upward at Transfer of Prestress	Estimated Midspan Deflection: Upward 3 months after transfer of Prestress (No SIDL)	Estimated Midspan Deflection: Instantaneous Downward Due to 100 psf SIDL	Estimated Shortening 2 weeks after Transfer of Prestress
	1	12	-	4.56	3.08	5.0	4.0	23.5	5.9	29.7	1/8"	3/16"	1/16"	1/16"
	2	14	-	4.46	3.21	5.0	4.0	25.5	7.0	31.9	3/16"	5/16"	1/16"	1/8"
	3	16	-	4.14	3.02	5.0	4.0	28.5	8.2	34.4	1/4"	1/2"	1/8"	1/8"
	4	18	-	3.89	2.88	5.5	4.0	31	9.5	36.8	3/8"	11/16"	1/8"	1/8"
	5	20	-	3.69	2.76	5.5	4.0	33	10.9	39.2	1/2"	15/16"	3/16"	3/16"
	6	22	-	3.52	2.68	6.0	4.2	35.5	11.8	39.9	11/16"	1 3/16"	1/4"	3/16"
	7	24	2	3.39	2.60	6.0	4.2	37.5	13.1	42.0	13/16"	1 1/2"	5/16"	1/4"
	8	26	4	3.27	2.54	6.0	4.5	40	13.8	41.4	1"	1 3/4"	3/8"	1/4"
	9	28	6	3.17	2.49	6.5	4.7	42	14.6	41.9	1 3/16"	2 1/16"	7/16"	1/4"

6" | 1'-4" | 2"

Omit top 2 strands when computing ultimate moment capacity and stirrup spacing.

SLAB 18"

Bottom Strand Pattern for Left half of slab. (Symm. ℄ Slab)	Slab No.	Total Strand	Debonded Strands	Distance "Yc" to c.g. strand at midspan, in.	Distance "Yu" to c.g.s. at midspan omitting top strand, in.	CONCRETE CLASS ksi	Concrete strength at release, ksi	Estimated Span, ft. (See Design Notes)	Estimated Initial Strand Stress Loss, ksi	Estimated Final Strand Stress Loss (27yrs.), ksi	Estimated Midspan Deflection: Upward at Transfer of Prestress	Estimated Midspan Deflection: Upward 3 months after transfer of Prestress (No SIDL)	Estimated Midspan Deflection: Instantaneous Downward Due to 100 psf SIDL	Estimated Shortening 2 weeks after Transfer of Prestress
	1	14	-	5.18	3.54	5.0	4.0	30	6.1	29.8	1/8"	1/4"	1/16"	1/8"
	2	16	-	4.77	3.30	5.0	4.0	33	7.2	31.9	1/4"	3/8"	1/8"	1/8"
	3	18	-	4.44	3.13	5.0	4.0	35.5	8.4	34.1	5/16"	9/16"	3/16"	3/16"
	4	20	-	4.19	2.99	5.0	4.0	38.5	9.5	35.9	7/16"	13/16"	1/4"	3/16"
	5	22	-	3.98	2.88	5.5	4.0	41	10.7	38.0	5/8"	1 1/16"	1/4"	3/16"
	6	24	-	3.80	2.78	5.5	4.2	43	11.6	38.5	3/4"	1 5/16"	5/16"	1/4"
	7	26	2	3.65	2.71	5.5	4.2	45	13.0	40.8	7/8"	1 9/16"	3/8"	1/4"
	8	28	4	3.53	2.64	6.0	4.4	47	13.5	40.9	1 1/16"	1 13/16"	7/16"	1/4"
	9	30	6	3.42	2.59	6.0	4.5	49	14.4	41.8	1 3/16"	2 1/8"	1/2"	5/16"

6" | 1'-4" | 2"

Omit top 2 strands when computing ultimate moment capacity and stirrup spacing.

SLAB 21"

Bottom Strand Pattern for Left half of slab. (Symm. ℄ Slab)	Slab No.	Total Strand	Debonded Strands	Distance "Yc" to c.g. strand at midspan, in.	Distance "Yu" to c.g.s. at midspan omitting top strand, in.	CONCRETE CLASS ksi	Concrete strength at release, ksi	Estimated Span, ft. (See Design Notes)	Estimated Initial Strand Stress Loss, ksi	Estimated Final Strand Stress Loss (27yrs.), ksi	Estimated Midspan Deflection: Upward at Transfer of Prestress	Estimated Midspan Deflection: Upward 3 months after transfer of Prestress	Estimated Midspan Deflection: Instantaneous Downward Due to 100 psf SIDL	Estimated Shortening 2 weeks after Transfer of Prestress
	1	14	–	5.89	3.88	5.0	4.0	33.5	5.3	27.9	1/8"	3/16"	1/16"	1/8"
	2	16	–	5.64	3.88	5.0	4.0	36.5	6.1	29.5	3/16"	1/4"	1/8"	1/8"
	3	18	–	5.44	3.88	5.0	4.0	39	7.0	31.1	1/4"	3/8"	1/8"	3/16"
	4	20	–	5.29	3.88	5.0	4.0	41.5	7.8	32.7	5/16"	1/2"	3/16"	3/16"
	5	22	–	4.98	3.68	5.0	4.0	44	8.8	34.4	7/16"	11/16"	1/4"	3/16"
	6	24	–	4.72	3.51	5.0	4.0	46	9.9	36.3	9/16"	15/16"	1/4"	1/4"
	7	26	–	4.50	3.38	5.0	4.0	48.5	10.9	37.9	11/16"	1 3/16"	5/16"	1/4"
	8	28	2	4.31	3.26	6.0	4.2	51	11.6	38.3	13/16"	1 3/8"	3/8"	5/16"
	9	30	4	4.15	3.16	6.0	4.2	53	12.5	39.9	1"	1 11/16"	7/16"	5/16"
	10	32	6	4.01	3.08	6.0	4.2	55	13.5	41.5	1 1/8"	1 15/16"	1/2"	3/8"
	11	34	8	3.88	3.00	6.0	4.5	57.5	13.9	40.4	1 1/4"	2 1/8"	5/8"	3/8"

6" | 1'-4" | 2"

Omit top 2 strands when computing ultimate moment capacity and stirrup spacing.

SLAB 26"

Bottom Strand Pattern for Left half of slab. (Symm. ℄ Slab)	Slab No.	Total Strand	Debonded Strands	Distance "Yc" to c.g. strand at midspan, in.	Distance "Yu" to c.g.s. at midspan omitting top strand, in.	CONCRETE CLASS ksi	Concrete strength at release, ksi	Estimated Span, ft. (See Design Notes)	Estimated Initial Strand Stress Loss, ksi	Estimated Final Strand Stress Loss (27yrs.), ksi	Estimated Midspan Deflection: Upward at Transfer of Prestress	Estimated Midspan Deflection: Upward 3 months after transfer of Prestress (No SIDL)	Estimated Midspan Deflection: Instantaneous Downward Due to 100 psf SIDL	Estimated Shortening 2 weeks after Transfer of Prestress
	1	20	–	7.30	3.38	5.0	4.0	44	5.9	28.9	1/8"	3/16"	1/8"	3/16"
	2	22	–	6.99	3.43	5.0	4.0	46.5	6.6	30.2	3/16"	5/16"	1/8"	3/16"
	3	24	–	6.73	3.48	5.0	4.0	49	7.2	31.5	1/4"	3/8"	3/16"	3/16"
	4	26	–	6.51	3.51	5.0	4.0	51.5	7.9	32.7	5/16"	1/2"	1/4"	1/4"
	5	28	–	6.32	3.54	5.0	4.0	54	8.6	33.8	3/8"	5/8"	1/4"	1/4"
	6	30	–	6.16	3.57	5.0	4.0	56	9.4	35.2	7/16"	3/4"	5/16"	5/16"
	7	32	–	6.02	3.59	5.0	4.0	58	10.0	36.2	9/16"	15/16"	3/8"	5/16"
	8	34	–	5.77	3.48	5.5	4.2	60.5	10.7	36.5	5/8"	1 1/16"	3/8"	5/16"
	9	36	2	5.56	3.38	5.5	4.2	62.5	11.3	37.4	3/4"	1 5/16"	7/16"	3/8"
	10	38	4	5.36	3.29	5.5	4.2	65	12.0	38.3	7/8"	1 1/2"	9/16"	3/8"
	11	40	6	5.19	3.29	5.5	4.2	67	12.7	39.4	1"	1 9/16"	5/8"	7/16"
	12	42	8	5.12	3.24	6.0	4.4	69	13.0	39.1	1 1/16"	1 7/8"	11/16"	7/16"
	13	44	10	4.98	3.18	6.0	4.5	71	13.6	39.4	1 3/16"	2 1/16"	3/4"	7/16"

4" | 1'-6" | 2"

Omit top 4 strands when computing ultimate moment capacity and stirrup spacing.

SLAB 30"

(Symm. ℄ Slab)	Slab No.	Total Strand	Debonded Strands	Distance "Yc" to c.g. strand at midspan, in.	Distance "Yu" to c.g.s. at midspan omitting top strand, in.	CONCRETE CLASS ksi	Concrete strength at release, ksi	Estimated Span, ft. (See Design Notes)	Estimated Initial Strand Stress Loss, ksi	Estimated Final Strand Stress Loss (27yrs.), ksi	Estimated Midspan Deflection: Upward at Transfer of Prestress	Estimated Midspan Deflection: Upward 3 months after transfer of Prestress (No SIDL)	Estimated Midspan Deflection: Instantaneous Downward Due to 100 psf SIDL	Estimated Shortening 2 weeks after Transfer of Prestress
	1	28	-	6.46	3.04	5.0	4.0	59.5	7.8	31.7	3/8"	9/16"	1/4"	1/4"
	2	30	-	6.29	3.11	5.0	4.0	62	8.4	32.7	7/16"	11/16"	5/16"	5/16"
	3	32	-	6.14	3.16	5.0	4.0	64	9.0	33.9	1/2"	7/8"	3/8"	5/16"
	4	34	-	6.13	3.34	5.0	4.0	66	9.6	34.8	9/16"	15/16"	3/8"	3/8"
	5	36	-	6.11	3.50	5.0	4.0	68	10.1	35.7	5/8"	1 1/16"	7/16"	3/8"
	6	38	-	6.10	3.64	5.5	4.3	70	10.3	34.8	11/16"	1 3/16"	1/2"	3/8"
	7	40	-	6.09	3.76	6.0	4.5	72.5	10.4	34.3	3/4"	1 1/4"	9/16"	3/8"
	8	42	2	5.89	3.66	6.0	4.5	74.5	11.1	35.2	7/8"	1 7/16"	5/8"	7/16"
	9	44	4	5.70	3.58	6.0	4.5	76.5	11.7	36.2	1"	1 5/8"	11/16"	7/16"
	10	46	6	5.54	3.49	6.0	4.5	78.5	12.3	37.1	1 1/16"	1 13/16"	3/4"	1/2"
	11	48	8	5.39	3.42	6.5	4.8	81	12.5	36.1	1 3/16"	2"	13/16"	1/2"
	12	50	10	5.25	3.35	6.5	4.8	83	13.1	36.8	1 5/16"	2 3/16"	7/8"	1/2"
	13	52	12	5.19	3.38	6.5	5.0	85	13.3	36.3	1 3/8"	2 3/8"	1"	9/16"

4" | 1'-6" | 2"

Omit top 4 strands when computing ultimate moment capacity and stirrup spacing.

DESIGN ASSUMPTIONS:

HL-93 Live Loading (for Interior Beams) using distribution from LRFD Tables 4.6.2.2b-1 for moment and 4.6.2.3a-1 for shear.
The calculated distribution factor assumes girders are sufficiently connected to act as a unit (Cross Section "g" from Table 4.6.2.2.1-1).
24 ft wide bridge with 2 travel lanes.
50 psf present wearing surface plus 173 lb/ft rail load per slab.
40 psf future wearing surface.
30 degree skew angle
Allowable tension at release (in top of slab near supports)= 0.0948*sqrt(f'c).
Allowable final tension (in bottom of slab at midspan)= 0.0948* sqrt(f'c).
Allowable final compression (in top of slab at midspan)= 0.45* f"c.
"Yc" used for service load calculations (all strands included).
"Yu" used for ultimate load calculations (top of slab strands excluded).

Slab Size (inches)	15	18	21	26	30
Diaphragm weight, lb.(skew= 30 degrees)	470	740	960	1230	1560
Form weight, lb./ft.(tubes for voids)	10	14	16	20	27

DESIGN NOTES:

Estimated span lengths in the design tables are determined by using the DESIGN ASSUMPTIONS.
Determine the project allowable span lengths using the appropriate design loads. Slabs on each project will require a unique design. Determine the wheel load distribution for interior slabs using Table 4.6.2.2.2b-1 of the AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS.
Determine the wheel load distribution for exterior slabs using Table 4.6.2.2.2d-1. Ensure exterior slabs do not have less capacity than interior slabs.
The HL-93 tandem axle plus lane loading moments control for spans less than 38'.
Check torsional stress when computing stirrup spacing requirements.

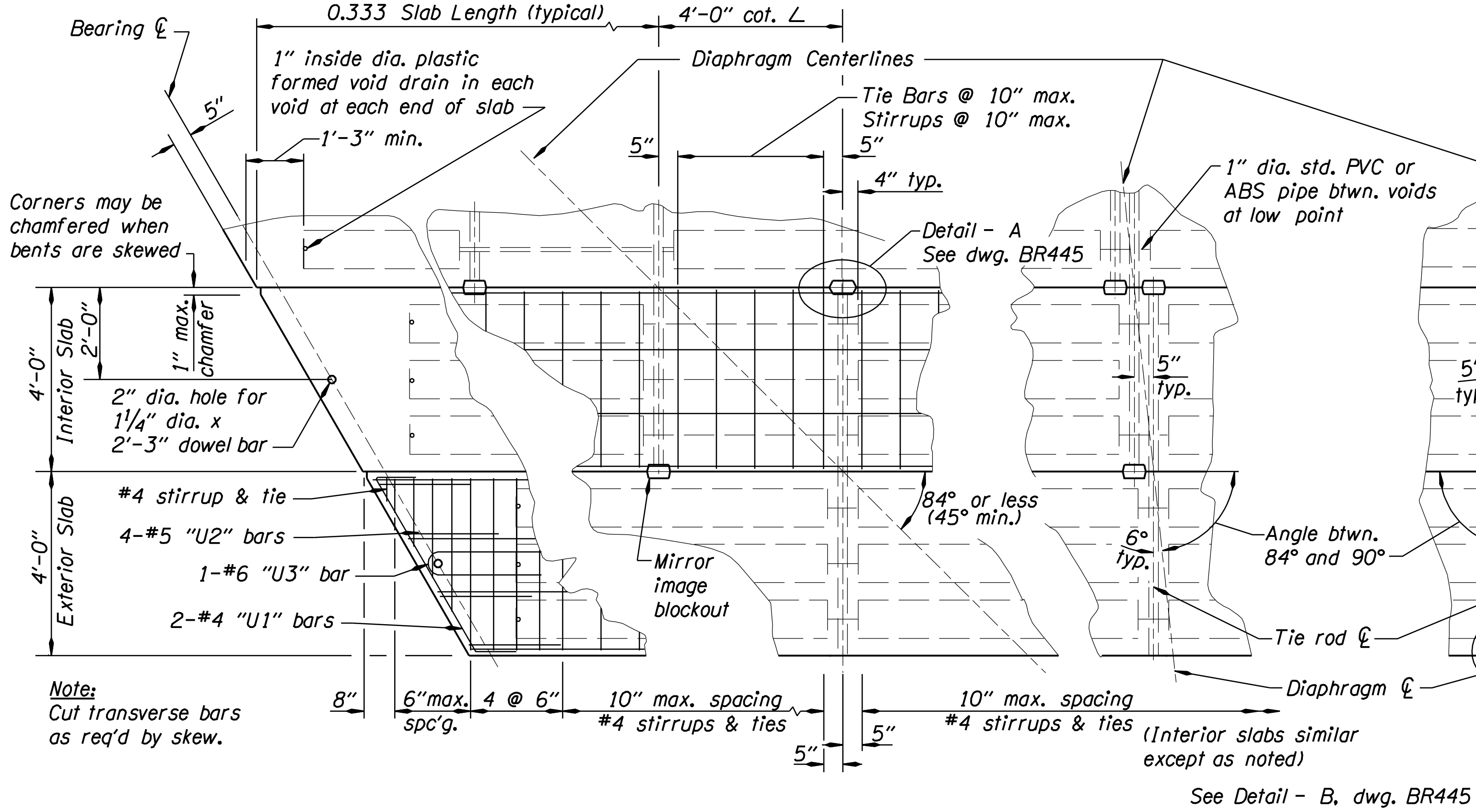
NOTE TO DESIGNER:

This drawing is used for designing. The span lengths, concrete class, estimated strand losses and deflections will provide reasonable preliminary design information. For final design, select a slab number to establish the strand pattern. Determine final concrete strength requirements and deflections based on actual project conditions.
DO NOT INCLUDE THIS DRAWING IN PROJECT PLANS.

OREGON DEPARTMENT OF TRANSPORTATION
TECHNICAL SERVICES
DETAILS

PRECAST PRESTRESSED CONCRETE SLAB DESIGN SHEET

DETAIL NO. DET3450



PARTIAL PLAN

NOTE "A" (Slab End Bar)

2-#4 x 10'-0", slab 4, 5 and 6
4-#4 x 15'-0", slab 7, 8 and 9
Place bars each end of slab (epoxy coat).

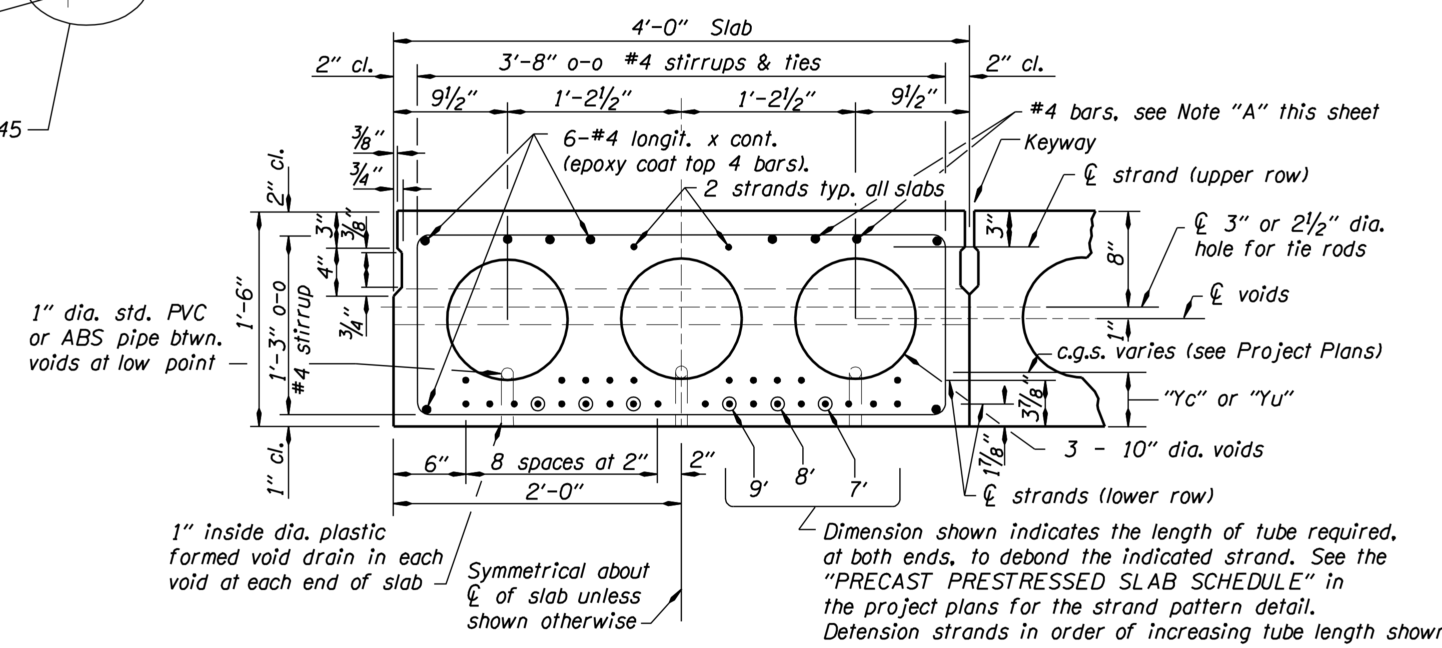
Note:
Grout keyway as specified in General Notes.
Omit keyway on exterior side of exterior boxes.
Keyway is continuous.

SECTION PROPERTIES

Area = 621 in²
c.g. = 8.94 in
I = 21,626 in⁴
St = 2386 in³
Sb = 2420 in³
Weight = 668 lbs/ft
J = 52,200 in⁴
K = 0.71
V/S = 4.7
Form wt (tubes) = 14 lbs/ft
Total wt w/forms = 682 lbs/ft

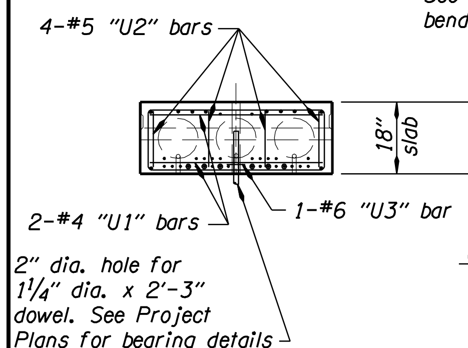
Diaphragm Weight

No Skew	260 lb
15°	430 lb
30°	740 lb
45°	1170 lb

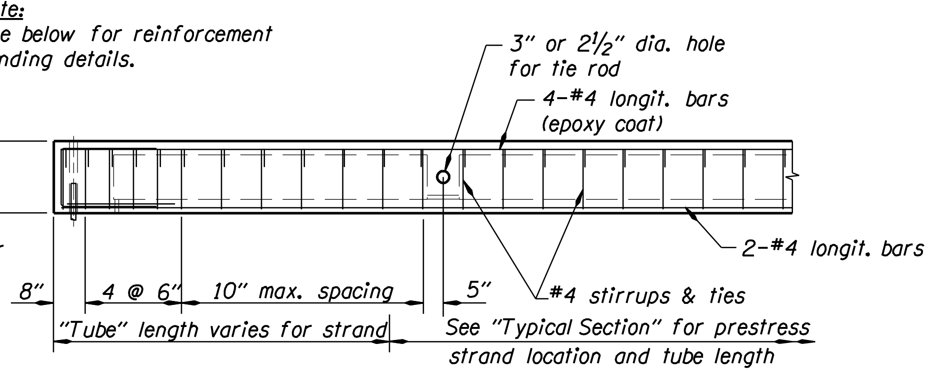


TYPICAL SECTION

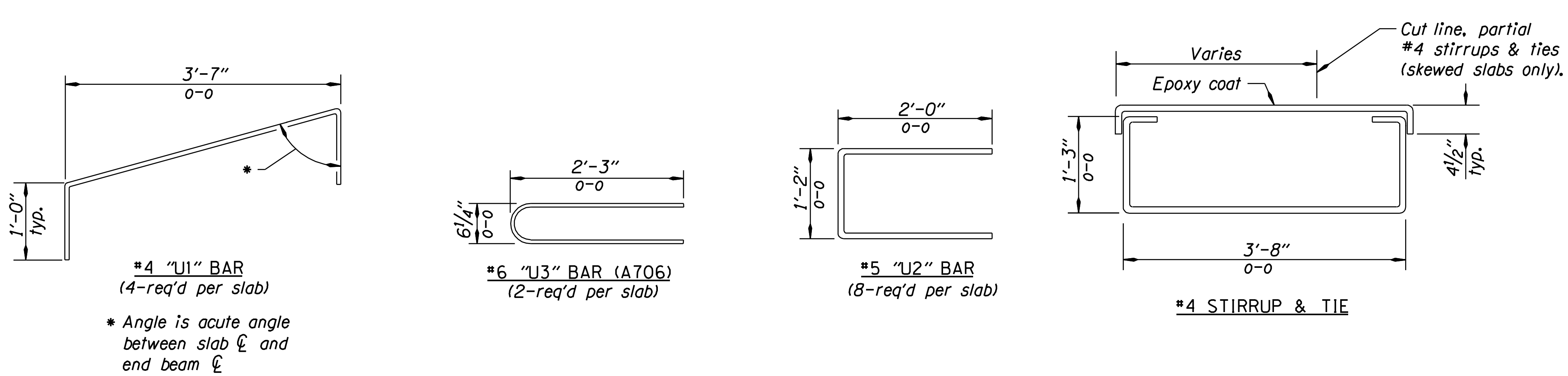
Note:
See below for reinforcement bending details.



END ELEVATION



PARTIAL ELEVATION FOR NORMAL SLAB



Accompanied by dwg. BR445.

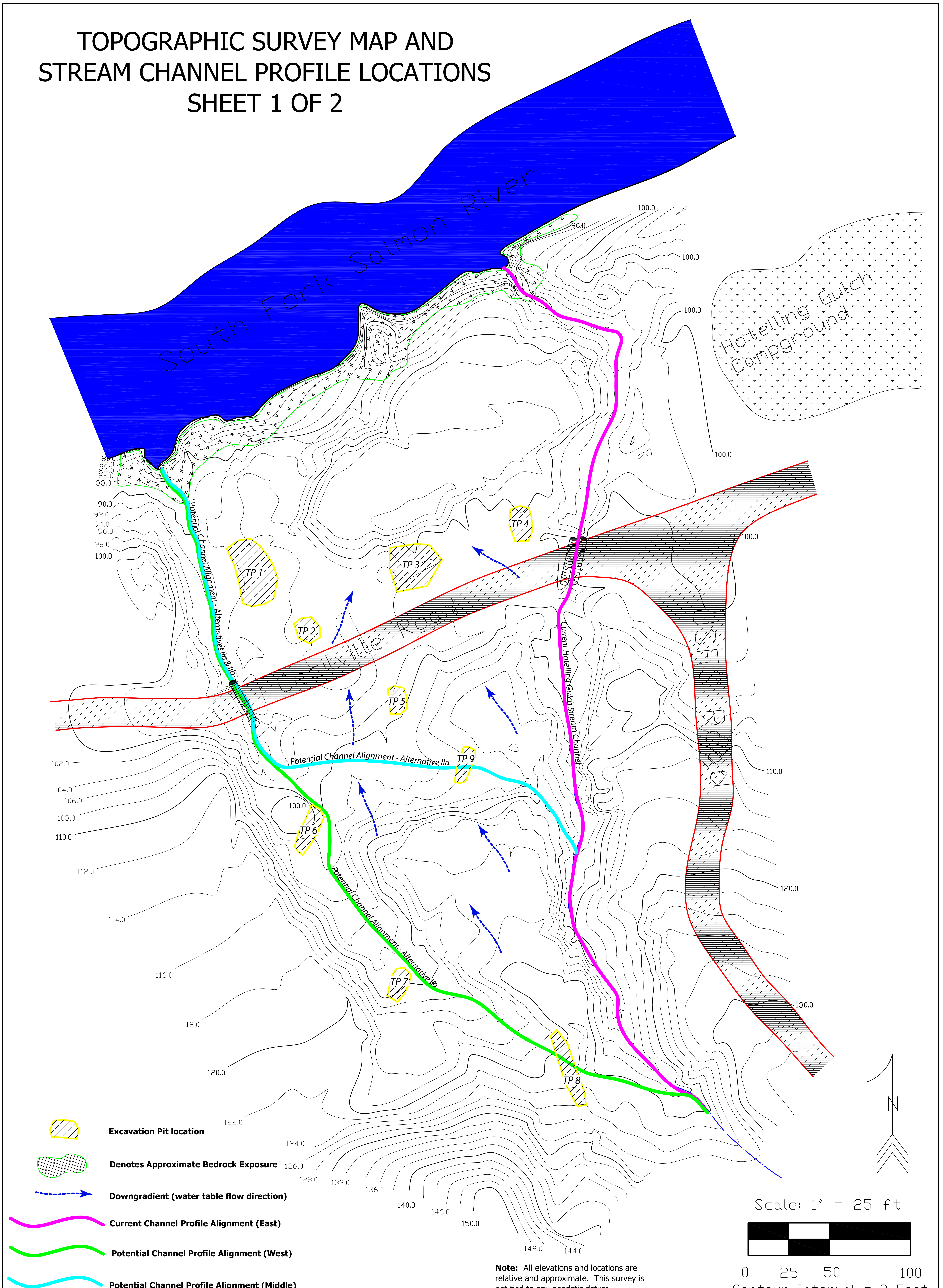
CALC. BOOK NO. 4754, 4755 & 4854	BASELINE REPORT DATE 01-JAN-2009
The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.	NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications OREGON STANDARD DRAWINGS 18" PRECAST PRESTRESSED SLAB 2008

DATE	REVISION DESCRIPTION

br410.dgn 12-08

BR410

TOPOGRAPHIC SURVEY MAP AND STREAM CHANNEL PROFILE LOCATIONS SHEET 1 OF 2



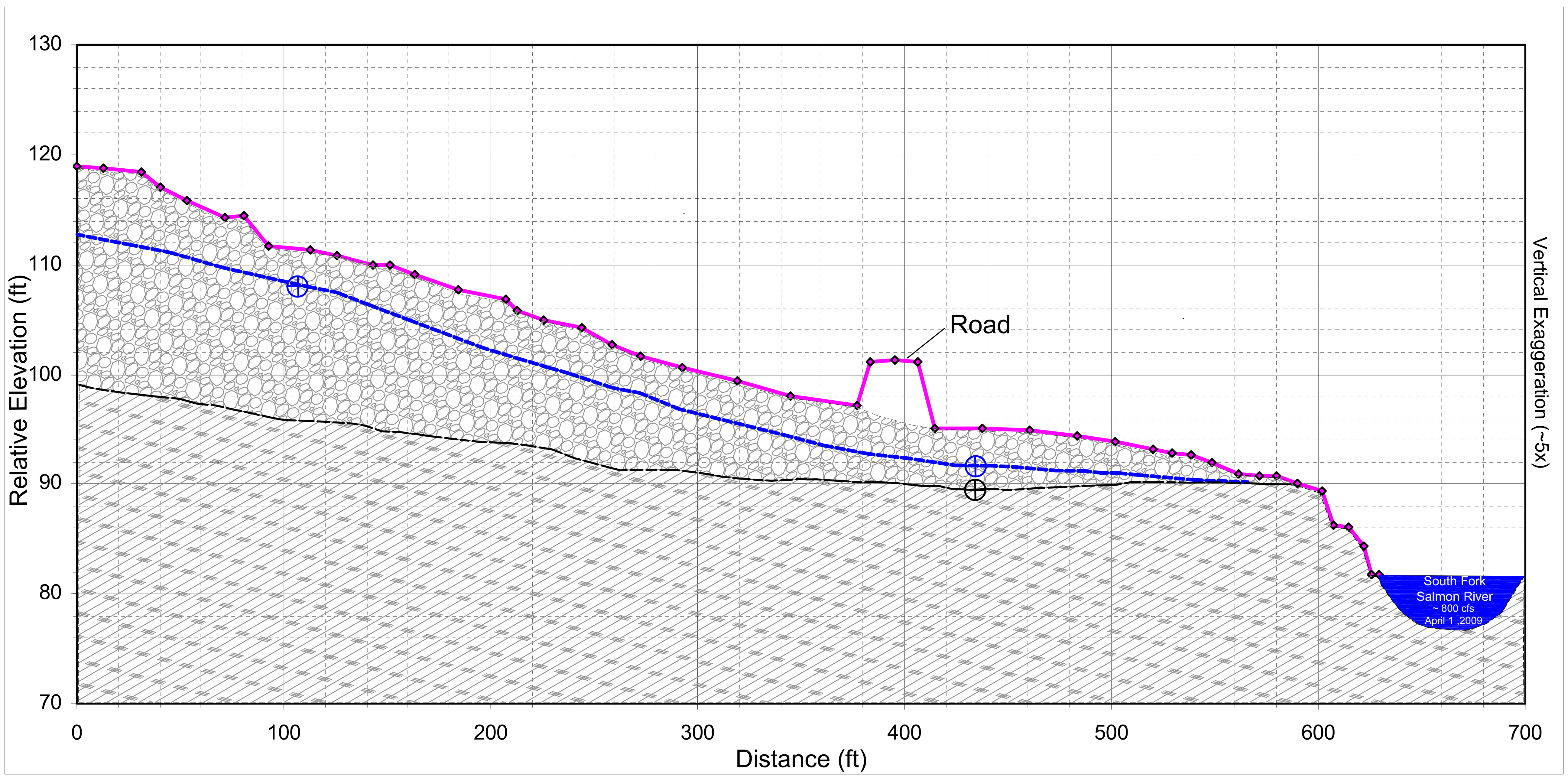
Note: All elevations and locations are relative and approximate. This survey is not tied to any geodetic datum.

Hotelling Gulch Stream Modification Feasibility Study Prepared For The Salmon River Restoration Council P.O. Box 1089 Sawyers Bar, California 96027	Subject Property: United States Forest Service South Fork Salmon River Watershed	Prepared By: PACIFIC WATERSHED ASSOCIATES, INC. Geologic and Geomorphic Studies Wildland Hydrology - Erosion Control Septic Evaluation - Environmental Services P.O. Box 4433, Arcata, CA 95518 PH: (707) 839-5130 FX: (707) 839-8168	Professional License Seal	Figure Created By: RWL (PWA) Base Files Created By: PWA Survey 2008 Job Number: 0882801
				Date Created: April 2009 Drawing Number: Phase I - Topographic Survey Sheet Number: 1 of 2

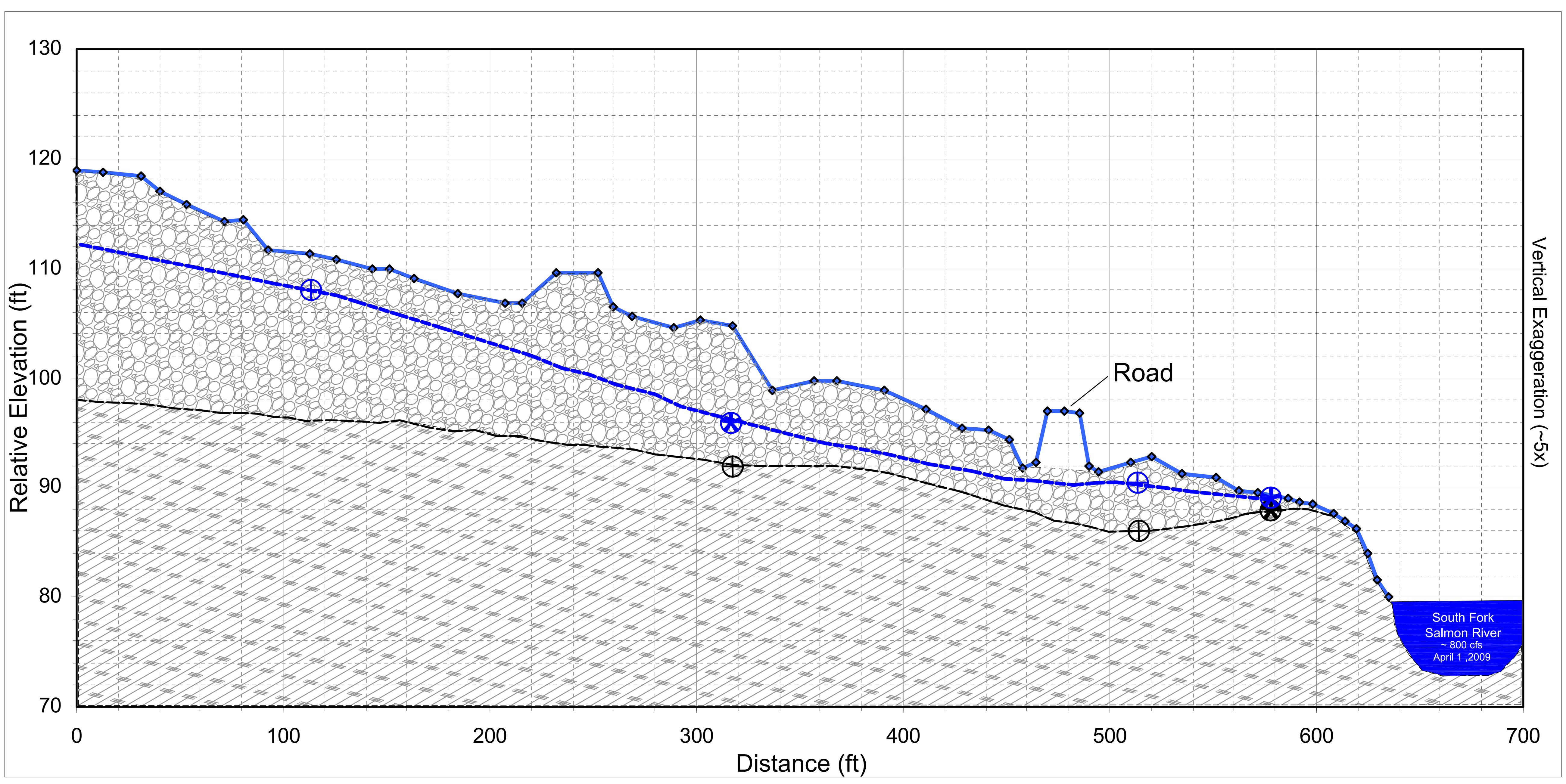
CHANNEL PROFILE VIEWS - EXISTING CONDITIONS

SHEET 2 OF 2

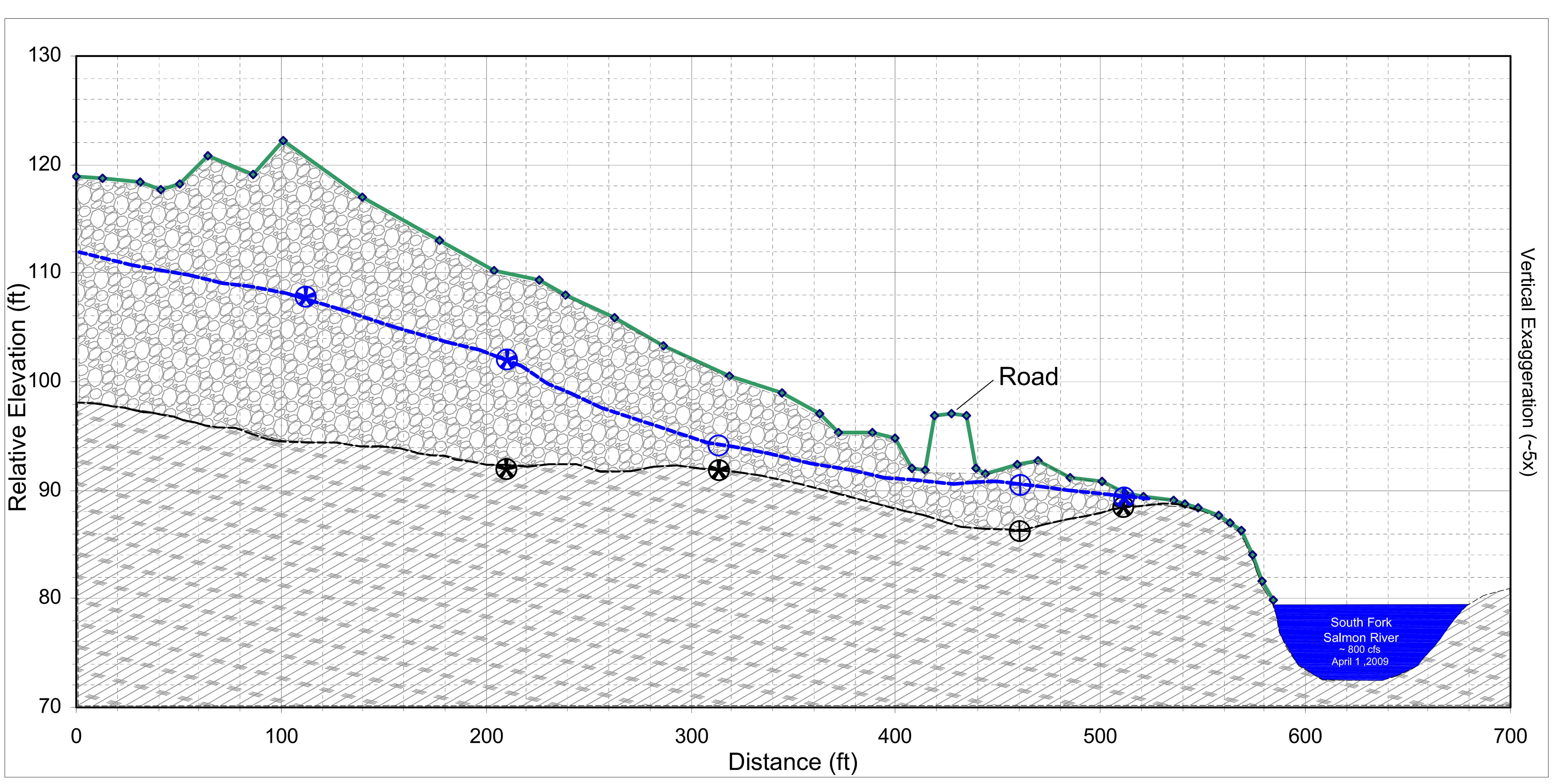
Current Channel Alignment (East Channel) - Alternative I

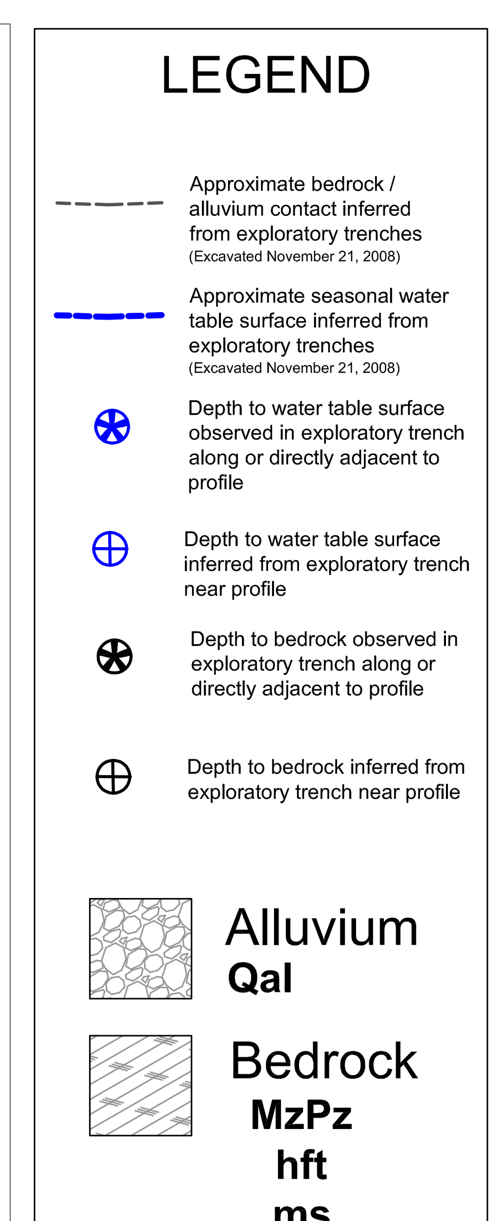


Alternative Channel Alignment (Middle Channel) - Alternative IIa



Alternative Channel Alignment (West Channel) - Alternative IIb





Note: All elevations and locations are relative and approximate. This survey is not tied to any geodetic datum.

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