Boca Unit Restoration
90% Design Basis Memorandum



Prepared for

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Revised January 13, 2022

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TRUCKEE RIVER WATERSHED COUNCIL

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Attachments

Introduction

The following is an update to the prior Truckee River Wildlife Area (TRWA) 30% Design Basis Memorandum (Memo) dated March 19, 2021 and 65% Memo dated September 24, 2021. The current document is focused solely on the Boca Restoration Project which has moved forward to 90% design development. The second of the two locations under the TRWA, the Polaris Restoration Project, is presented separately.

The purpose of this Memo is to describe the investigations and analysis conducted to date and how the results of those investigations have shaped the designs through 90%. This document has been updated following field investigations in summer 2021 and resubmitted with the 90% plans, specifications, and Engineer's estimate in January 2022.

The original background information for the Boca site setting is provided below along with design analysis results used to develop the 30%, 65% and 90% designs. Alterations and additions to the 90% plans and next steps are summarized at the end.

Project Background

Following the completion of the Truckee River Revitalization Assessment (2018 Assessment) (Balance Hydrologics, Inc., et al., 2018), the Truckee River Watershed Council (Council) collaborated with the technical advisory committee (TAC) composed of public landowners within the assessment area and identified two key sites suitable for the next phase of the TRWA Restoration Project. These sites, Boca (otherwise known as the California Department of Fish and Wildlife (CDFW) Riverbend Site) and Polaris (which encompasses the historic ice dam near the Truckee River Legacy Trail) were chosen based on their potential to improve water quality, habitat, and hydrologic function. Attachment 1 provides the summary sheet for the Boca project area that was produced under the 2018 Assessment.

A key focus of the 2018 Assessment was to identify areas along the middle Truckee River corridor where site restoration and BMP implementation could reduce sediment inputs. Sediment reduction efforts are part of the Lahontan Regional Water Quality Control Board's Total Maximum Daily Load (TMDL) to address the Truckee River's 303(d) listing as an impaired water body for suspended sediment concentration. A sizable portion of the Boca Site has been subject to human alteration which may have contributed to increased sediment loading to the river. The site specific historic alterations to the Boca site are described below. The underlying geology has contributed to an entrenched stable sinuous river form confined within the glacial and volcanic terraces with floods typically causing only minor meander migration and intermittent bank erosion. According to the 2018 Assessment, terraces nearest the river are associated with outwash from glaciation rather than more recently abandoned floodplains, having formed during glacial-fluvial processes more than 14,000 years ago.

Based on field observations, we agree with the 2018 Assessment's general characterization of the channel bed material described as a bi-modal grain size distribution with fairly steep boulder riffles separated by lower-gradient gravel and cobble reaches within the confines of the entrenched channel. We will be sampling for channel bed particle size distribution and conducting pebble counts on September 28, 2021, to provide more specific channel substrate information to inform Manning's n designations and river design elements. Average river gradient along the Boca reach is roughly 0.5% with shorter steeper sections within the overall average. The Boca site was mapped in the 2018 Assessment as severe erosion hazard due to the steep volcanic soils.

The Truckee River is regulated by several dams and impoundments under the Truckee River Operations Agreement (TROA) implemented in 2017 where rates and timing of flow releases are governed by a variety of water management factors including water supply, flood control, environmental needs, and water quality. Flow regulation has reduced peak flows causing insufficient sediment transport through the system (flushing) and degraded fish habitat as a result of sediment filling in spawning gravels and scour pools. Effective discharge was estimated to range between 4,300 and 4,800 cfs in the TRWA reaches with a recurrence probability of 7 to 10 years. This means that flushing flows to help clear out spawning habitat are only taking place one or two times a decade (Balance Hydrologics, Inc., et al., 2018).

The Boca site, located between the second and third bridge along I-80 near road marker mile 21 (Figure 1), includes a railroad spur built in the late 1800s for the Nevada Ice Company and is now an actively used highway pullout area for fishing. The 2018 Assessment recommended removing fill along the left riverbank to reactivate the historic floodplain surface, limiting vehicle access, and establishing a parking area with stormwater treatment to prevent erosion and sediment inputs to the river, while maintaining river access for fishing (Attachment 1).

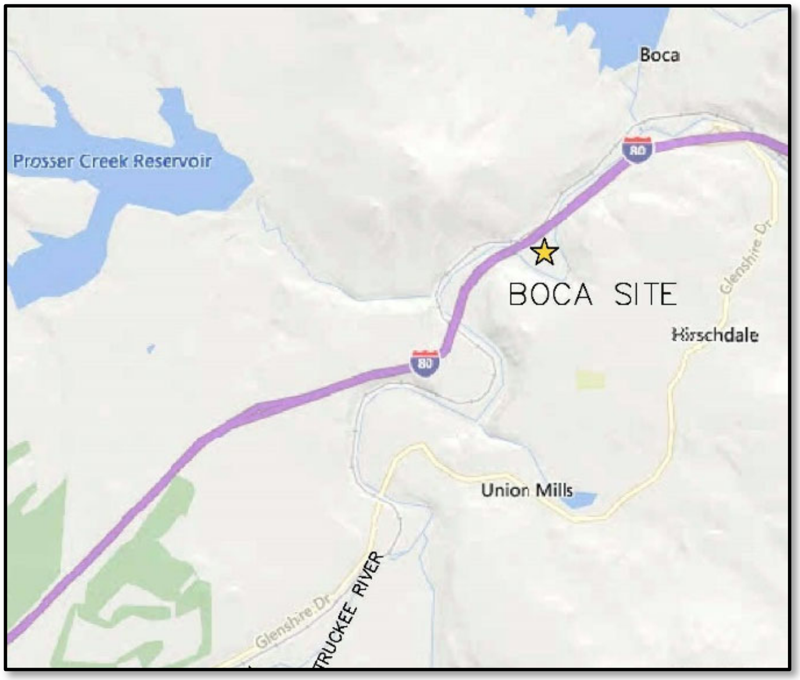

Figure 1. Site Location

Project Goals

The restoration goals for the Boca Restoration Project are to reduce sediment delivery to the Truckee River, re-establish floodplain connectivity, and improve instream and riparian habitat. To meet these goals and in recognition of the sensitive historical significance of these areas, Wildscape Engineering completed the following design steps:

1. Review of physical setting and historical impacts from the Watershed Assessment and related documentation.
2. Field data collection to determine baseline existing conditions including topographic and botanical surveys.
3. Site reconnaissance to assess site opportunities and constraints.
4. Generate hydrology input and set up a hydraulic model of existing conditions.
5. Analyze and review model results.

Project Setting

Boca Site – Past and Present

Driven by the completion of the Central Pacific Railroad in 1868, three main historical facilities impacted this large bend in the Truckee River. The first was construction of Camp 16 Pacific (a station on the Central Pacific Railroad) in 1868. The second was operation of the Nevada Ice Company from 1872 to 1875. And the third was The Pacific Shingles Company in 1874 (Balance Hydrologics, Inc. et al 2018). The general location of these facilities is shown in Figure 2. The most significant land manipulation during this time was construction of the railroad spur extending south along the left bank (looking downstream) of the Truckee River. The spur was most likely constructed during the operational years of the Nevada Ice Company, from 1872 to 1875 (Balance Hydrologics, Inc. et al 2018). The railroad spur grade (Figure 3) can still be observed today where conifers grow. A ring count conducted on a recently felled tree in 2020 on the downslope side of the railroad spur grade dated the tree to be approximately 130 years old (Figure 4). This indicates that the railroad spur had reduced activity by 1890.

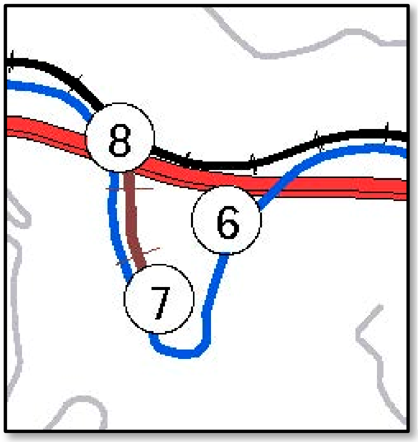

Figure 2. Boca historic sites taken from the Truckee River Revitalization Assessment (Balance Hydrologics, Inc. et al 2018)

6	Pacific Shingle Co	Ca. 1874
7	Nevada Ice Co and railroad spur	1872-1875
8	Camp 16-Pacific (station on Central Pacific RR)	Ca. 1868-

Figure 3. June 2018 photo showing former railroad spur and approximate size of ring dated tree (Google Street View, 2020)

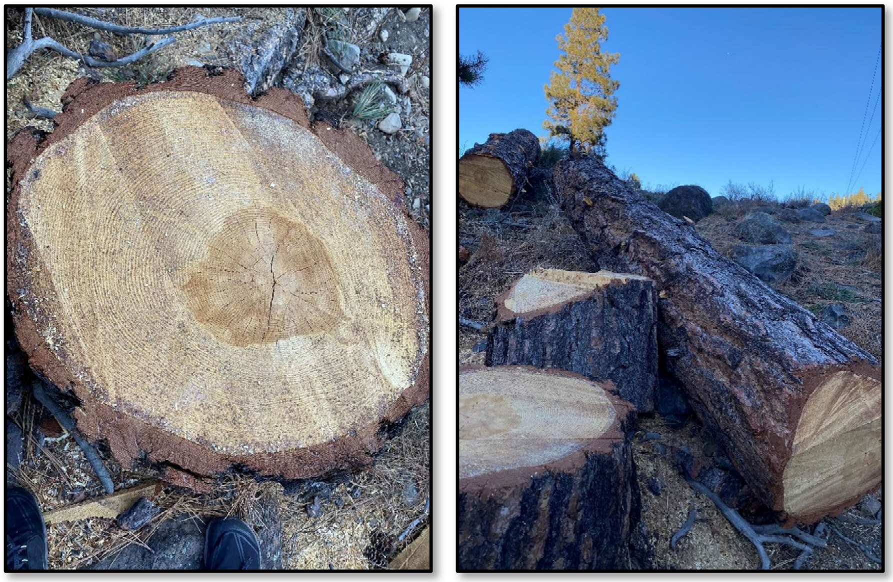

Figure 4. Photo images of tree stump where ring count was conducted on railroad spur slope in December 2020.

Major roads transecting this site also impacted local topography and sediment inputs to the Truckee River. In and around the Boca site it started with the Dutch Flat Wagon Road in 1864, the Lincoln Highway in 1913 (later named the Victory Highway in 1921), and present day Interstate 80 completed in 1964 (Figures 5 and 6). Interstate 80 and its precursors impacted the site by straightening the channel upstream from the bend, likely leading to higher shear forces on the bank (Balance Hydrologics, Inc., 2018). Today, vehicle access (Figure 7) to the river, which remains a popular fishing spot, compacts soils and limits vegetation growth thereby producing direct sediment loads to the Truckee River (Balance Hydrologics, Inc., 2018). The most recent structural changes to the river channel at Boca were constructed by Trout Unlimited in the fall of 2018 to improve available habitat for large adult fish and fishing opportunities. Three separate boulder structures configured in a 'W' pattern were installed across the river channel on the west side of the bend staggered evenly between the I-80 crossing and the beginning of the bend (Figure 8). The channel habitat structures installed at Boca by Trout Unlimited was part of a larger project, the Glenshire Drive Project. Coincidentally, the second phase of this project installed habitat improvement structures just downstream of the other TRWA site, Polaris, in the fall of 2020.

Figure 5. June 1, 1948, photo image showing Victory Highway and railway infrastructure at Boca Site (*Source: USGS Photo Aerial Single Frames*)

Figure 6. August 16, 1969, photo image showing Interstate 80 construction completed at Boca Site (*Source: USGS Photo Aerial Single Frames*)

Figure 7. Evidence of vehicle access disturbance, photos taken July 8, 2020.

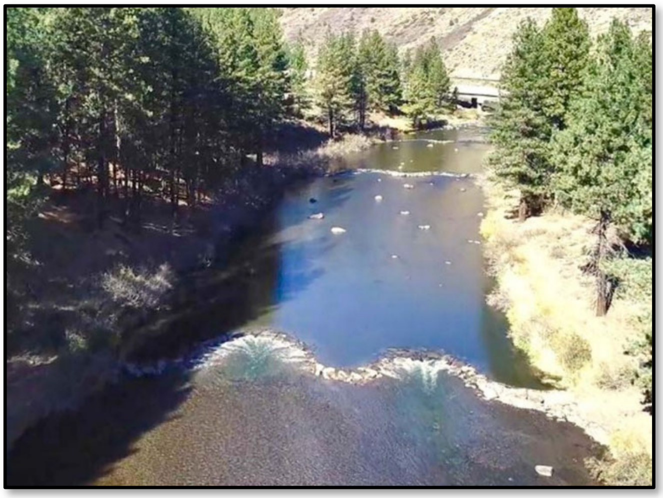

Figure 8. (Image left) Drone footage of series of three W-weirs looking upstream (Trout Unlimited). (Image right) Photo of W-weir taken from left bank looking S/W taken December 2020.

Field Data Collection

Figure 9. Collecting additional bathymetric data in deep water areas August 12, 2021.

The bathymetry for the model domain was constructed using a combination of LiDAR data downloaded from the Open Topography website (Feehan, 2019) and supplemental topographic data field collected in the fall of 2020 using Real-Time-Kinematic GPS (RTK) survey. Cross section data of the channel were collected to supplement the LiDAR bathymetry for the hydraulic model and spot elevations were collected on the floodplain and terrace surfaces. Survey (GPS) data points along the secondary flow channels within the inside bend were also collected with an EOS Arrow 100 unit to confirm that the LiDAR data sufficiently represented them.

The LiDAR data used purportedly contains stream channel bathymetry in inundated areas where the LIDAR laser can penetrate the water and obtain a return from the channel bed. However, our assessment of these data is that they are of limited use for hydraulic modeling, possibly due to the depths of the channel. Therefore, mass points from the LiDAR below the water surface were clipped from the dataset and an existing condition surface model was constructed from the survey points collected during the summer of 2020. The combined dataset was used to produce a DEM of the channel and floodplain for subsequent use in hydraulic modeling and design. Flows during the 2020 field survey were too high to safely collect data in the deeper pools, therefore additional bathymetric data was collected in those areas in late summer 2021 when flows were reduced. The data processing just described was repeated and the newly updated surface is being used to further refine the hydraulic model (Figure 9). This result is considered best available data.

The restoration specialist, Julie Etra of Western Botanical Services, Inc. (WBS, Inc.) conducted a preliminary Boca site botanical investigation in late summer 2020, a suboptimum time for maximum species identification. However, this survey was adequate for evaluating the onsite native materials for salvage and incorporation into preliminary revegetation designs. Julie returned to the site in early summer 2021 to conduct a more detailed botanical survey and used the results to develop site specific seed tables, onsite salvageable materials, and 65% revegetation designs and specifications (Figure 10).

Figure 10. Downstream reference site for inset floodplain.

Subsurface soil and channel bed sediment investigations including particle size distribution analysis, Wolman pebble counts, and agricultural analysis were conducted in late September 2021 and the results are provided in Attachment 3. Based on those results Manning's n was updated from 0.4 to 0.45 in the upstream reach and 0.4 to 0.5 in the downstream reach.

Hydrology and Hydraulics

Given the high degree of channel complexity (i.e., an elongated meander bend) and topographic variability within the inside bend (i.e., several existing overbank channels) a two-dimensional hydraulic model was chosen for the Boca Site. The focus of the model prepared was to determine the discharge (and the flood recurrence interval) that activates the inside of the large meander bend within the study reach and where on the floodplain overbank flows concentrate. Model results also provide estimates of velocities and shear stresses in the areas where improvements will be made and will serve as the basis for subsequent design developments. This model will help to determine the amount of water that gets into the remnant channels on the inside of the meander bend, as well as reveal how often these remnant channels are activated. In addition, it will allow the project team to look at erosion potential in the two areas of concern on the right bank of the channel and at secondary channel return flow locations. Finally, the model will help to guide design decisions with regards to breaching or lowering the anthropogenic berm on the left bank to achieve more active floodplain area and sediment sequestration opportunities.

Methodology

The DEM/bathymetric data were developed using GIS software. The results were imported into HEC-RAS (Version 5) and RASMapper (a GIS type tool used to manage model data and results) to develop the geometric and hydraulic data used for hydraulic modeling. The flow area boundaries were drawn in RASMapper to define the solution domain for a two-dimensional hydraulic model. As introduced above the two-dimensional hydraulic model is appropriate for the Boca site focus area because of the complex flow patterns as flows cross the left overbank/floodplain, bypassing the main channel for some distance, then merge with the main channel again downstream from the left overbank/floodplain area. Breaklines that define the flow channels over the floodplain were drawn to guide development of the solution mesh of that portion of the model domain. A solution mesh of computational cells was developed from the domain boundary, the bathymetry, and the breaklines. A cell size of 10 feet (ft) by 10 ft was selected as a reasonable compromise between cell density and computational effort. The cells are sufficiently small to capture the flow dynamics of both the river and the floodplain.

The hydrology was developed by analysis of the long-term USGS stream gage at Farad, California and comparing those results to those from the USGS stream gage at Boca bridge. About 100 years of data were available at Farad and about 16 years of data at the Boca bridge. Bulletin 17C computational procedures in HEC-SSP were used to define the flood frequency curve for this reach of the Truckee River. HEC-RAS was operated using discharges from the flood frequency curve at the Boca bridge for recurrence intervals of 2-, 5-, 10-, 50-, and 100-years.

Preliminary Assumptions

Two broad areas of surface roughness were defined more specifically following the March 2021 interim memorandum. Within the channel banks, Manning's *n* was chosen to be 0.04. This is consistent with field observations, review of professional literature, and professional experience. Similarly, Manning's *n* for the floodplain was chosen to be 0.06 for the same reasons. These values are considered reasonable and further subdivision of the areas for defining surface roughness is not appropriate at this time.

Model Updates

For 65% and 90% design checks, updates made to the Boca Reach HEC-RAS model input are summarized below:

1) Split of the channel zone into two reaches -- an upstream reach and a downstream reach. The split is located at the grade change about 200 feet downstream from the most downstream W-weir. The grade change is evident in aerial imagery. From field inspection, the presence of large roughness elements (cobble to boulder size) increases downstream from the grade change.

2) The upstream reach was assigned a roughness of 0.045. The downstream reach was assigned a roughness of 0.050. These estimates are based partly on the pebble counts and grain-size distribution test and partly on Barnes (1967). Data to calibrate the model at design discharges are not currently available and calibration at low flow is likely to lead to estimates inappropriate for the greater depth of flow present during the design events.

3) The solution domain was slightly adjusted to eliminate some unused computation cells. Breaklines for the small channels on the left floodplain were also adjusted slightly.

4) The 65% and 90% post-project topography was included for the post-project runs. The proposed roughness and grade control elements along the floodplain area have not been specifically incorporated into the model but have been designed to be stable under the velocities and shears reported by the model in those locations.

Preliminary (30%) Results

Preliminary (30%) results of existing conditions showed flows from the 2-year event are generally contained entirely with the main channel. At a 5-yr recurrence event beyond the artificial berm the lower floodplain overflow channels are beginning to be activated (Figure 11). During the rarer larger flood events, unsurprisingly the entire suite of secondary channels within the inside bar are inundated. The upper terrace and berm/borrow area are not inundated even at the more extreme flood events, including the 100-yr recurrence event. It should be noted the water surface that shows up in the borrow area in Figure 11 is simply residual from the model set up showing a draining phenomenon rather than an overbank occurrence.

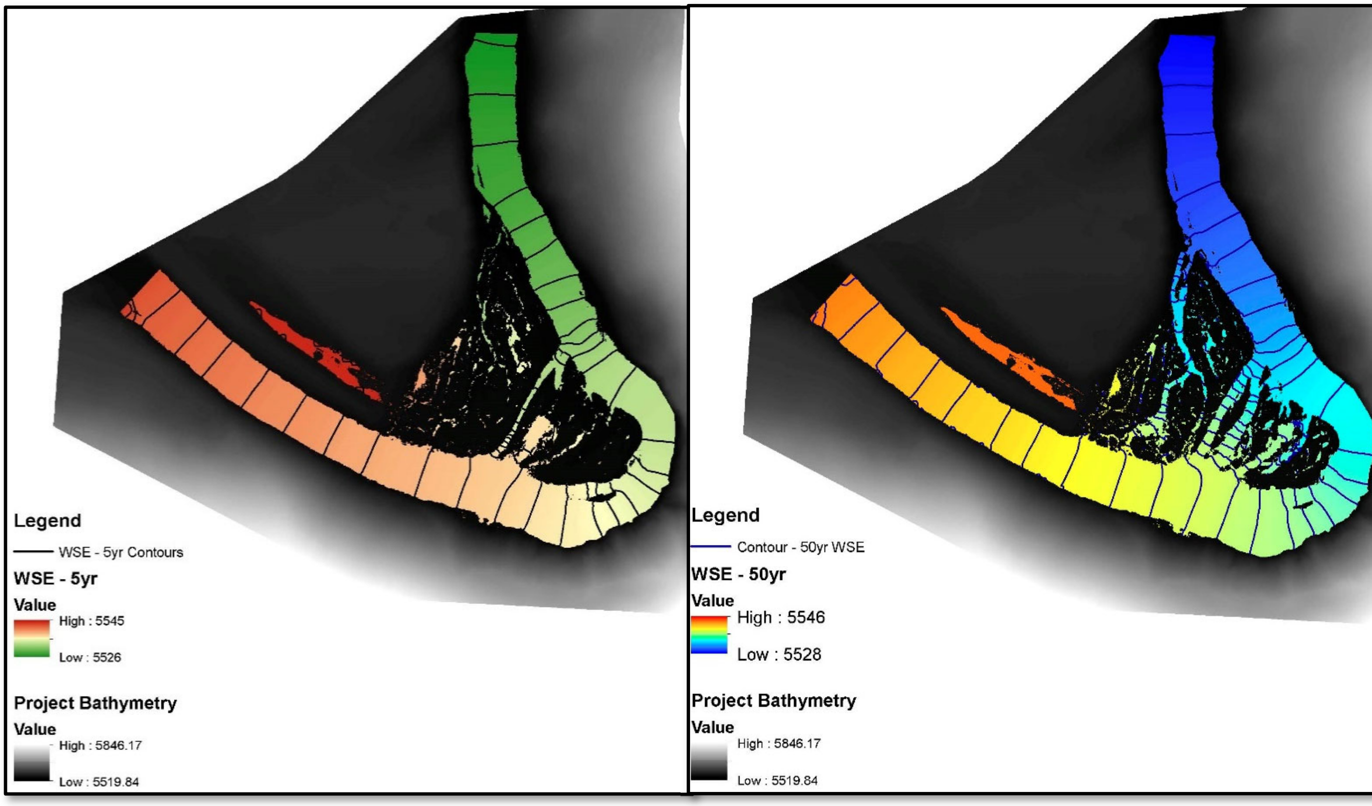

Figure 11. (Left image) Existing conditions 5-yr recurrence event water surface elevation (Right image) 50-yr recurrence event water surface elevation.

Also notable are the high velocities which equate to high shear forces within portions of the channel (Figure 12). During the 5-yr and 50-yr events mid to high velocities appear throughout the channel reach with the highest values, 12 to 14 feet per second (fps) within and downstream of the outermost bend. Under the 5-yr event the floodplain secondary channel along the toe of the terrace slope starts to undergo increased velocities while the other secondary overflow channels remain low. Under a 50-yr event the same floodplain channel plus the one adjacent start to see increased velocities while the other overflow channels remain low.

What is most striking in the topography and hydraulic model results is how hydraulically disconnected the upper terrace, railroad spur berm and borrow area are from any overbank flows. The lowest elevation of the borrow site sits more than four feet above the 2-year inundation elevation and even in a 100-year flood event these areas exhibit zero inundation. Therefore, if the artificial berm were simply breached to the elevation of the bottom of the borrow area as suggested in the watershed assessment, increased floodplain area and activation would not be attained.

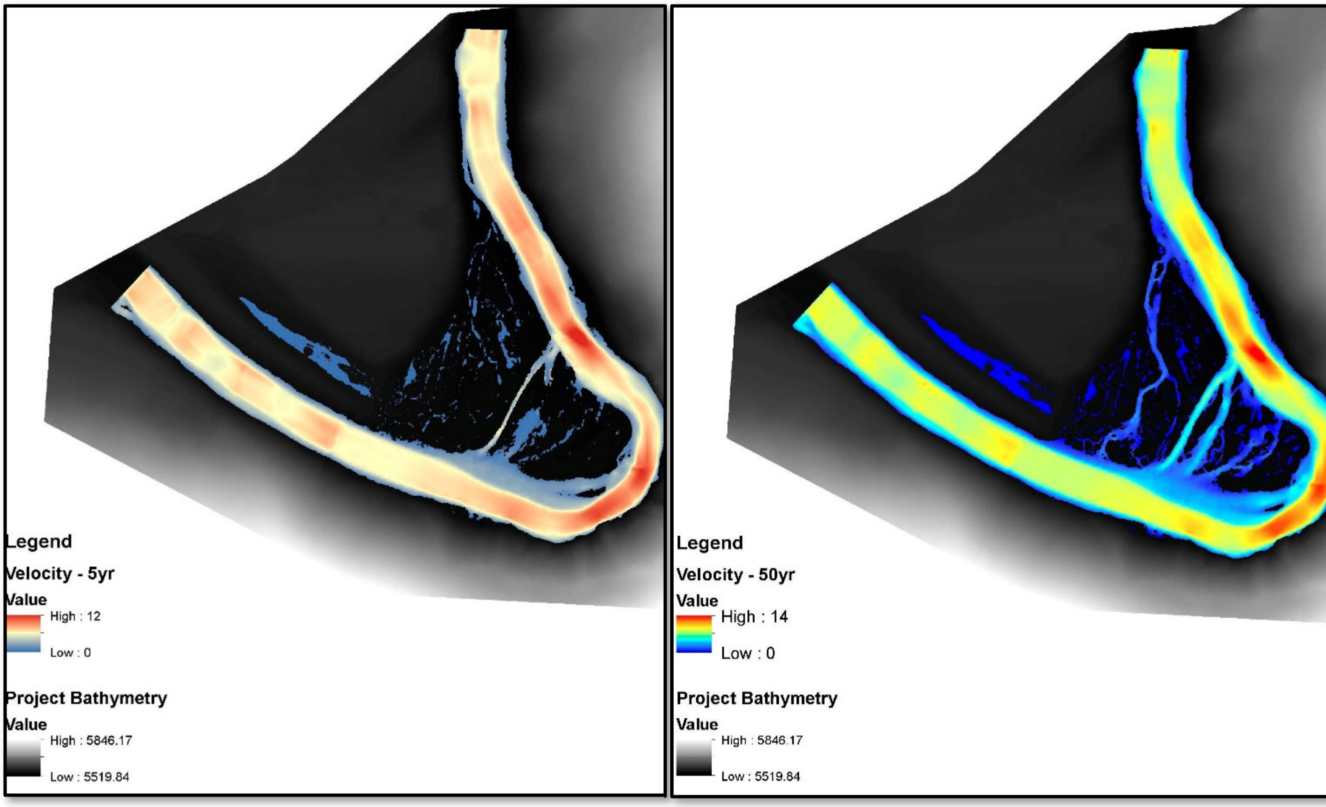

Figure 12. Existing conditions, velocities under a 5-yr (image left) and 50-year (image right) recurrence

30% Concept Design Recommendations

Upon further examination of the topography, historic aerial imagery, and hydraulic model results, it became clear that the area where material was borrowed from to construct the railroad berm was not part of a recently abandoned floodplain feature but likely a glacial outwash terrace that formed long ago as the river incised. Given this combined with the Interstate 80 infrastructure on both sides of the meander bend, it would be infeasible to raise the channel enough to reactivate the higher elevation terrace in this setting. As added evidence, even the bottom elevation of the southern portion of the borrow site sits 4.5 feet above the 2-year water surface elevation. Therefore, rather than breaching through the artificial berm as was discussed during initial field walks, we recommend constructing a left bank inset floodplain bench in the vicinity of the berm and laying back the berm feature above the floodplain bench to a more natural terrace slope. This will allow for floodplain restoration while reusing the fill material on site and avoiding expensive off haul and disposal costs. The new inset floodplain bench would be compatible with the recently installed W-Weirs providing overbank relief where in-channel bars are forming at their downstream apex. The floodplain bench designs require a buffer around the W-Weir keyways so as not to compromise their stability

In order to preserve the historical context of the railroad spur and some of the mature large conifers, we recommended keeping a roughly 200 ft section of the berm on the northwest end and incorporating historical signage or interpretive panels and possibly a lookout at its terminus. Adjacent to the preserved portion of the railroad berm, the former borrow site is proposed to be converted to a stormwater basin in order to collect and treat stormwater from the highway access and parking areas. Any large trees that require removal will be salvaged and incorporated into floodplain or bank treatments.

In-channel flow redirection elements shown as bendway weirs were proposed for two locations along the toe of the eroding right bank (looking downstream). The furthest upstream set of bendway weirs would be below the last W-Weir in the vicinity of the lower floodplain bench to help redirect and alleviate the forces on that bank and aid in increased activation of the left bank floodplain channels. The second group of bendway weirs would be positioned immediately downstream of the outermost bend, just past the exposed volcanic scarp and immediately upstream of the not yet eroded right bank where there is still a finer-grained material surface that will likely continue to erode in the future without intervention. This second group will be further assessed in terms of how the hydraulics they set up may or may not cause undesirable effects to the left bank return flow channels along the river main stem.

A relocated trail segment could exit from the railroad spur lookout terminus (as is shown in the 30% plans) and slope down gradually along the toe of the restored hillside and towards the top of the new floodplain bench to loop around the project site. As shown in the 30% plans, the relocated trail segment as proposed would still tie into the single track fishing access trails recently constructed along river left bank. All existing roads beyond the parking area would be decommissioned by ripping, incorporating water bars on steep sections, seeding, mulching, and dropping in boulder or log blockades where needed prior to demobilizing.

Temporary staging shown on the 30% plans would be within CDFW property and allow for ample space for ingress and egress from the busy highway. Temporary access would be along existing disturbed roads and trails and is currently proposed as a one-way loop to minimize vehicle conflicts during construction.

65% Design Update

The design approach proposed under 30% above was generally carried forward with the following alterations and additions based on client and stakeholder input at 30% design review and further field investigation.

Inset Floodplain Bench: In order to gain additional floodplain area and consequent habitat, overbanking and sediment deposition benefits, the lowered left bank floodplain bench to be activated under a 2-year or greater event was widened further to 30 to 40 feet. New plan and profile sheets display this information.

Activated Floodplain Channels: Floodplain roughness was incorporated within the northernmost overflow channel in order to ensure its increased activation as a result of lowering the left bank floodplain would not significantly reduce activation of the smaller overflow channels to the south. Buried grade control features were incorporated where the same overflow channel steepens before its confluence with the Truckee River to prevent channel incision as the velocities are fairly high. Handwork under field direction is called out along the smaller overflow channels on the south end of the apex and will entail filling in some of the deeper pools to prevent fish stranding and thinning some dense thicket of lodgepole. Most of the return flow outlets for these smaller channels are already nicely armored with cobbles, therefore the 65% designs only call for a constructed armored outlet on the most northern larger swale.

Hydraulic Model Check: The 2-D hydraulic model surface was rerun for the 65% proposed designs and analyzed for all recurrence events and the results were used to recheck and refine floodplain surfaces and overflow channel installations to ensure functionality and stability. Additional field assessments were also conducted and revealed the majority of return flow channels were already well-armored along their outfall and therefore did not need additional treatment.

In-Channel Structures Eliminated: After further field assessment and analysis the right bank bendway weirs proposed at 30% to redirect flows towards the new floodplain activation area and away from the eroding right banks were eliminated given the constructability challenges, risk of provoking further disturbance and limited contribution to project success as follows:

- Given the height and steepness of the right banks in the erosional areas there is risk of causing further instability during installation.
- In the downstream location only a short bank segment remains with the more friable material still vulnerable to future erosion (Figure 13). The amount of erosion and sediment production prevented by installing a bendway weir upstream of this area may not be much more then the amount of sediment disturbed during installation of the temporary river diversion and the bendway weirs.
- In the upstream location, the lowering of the left bank floodplain should activate under a 2-year or greater flow event regardless of whether the right bank bendway weirs are included in the designs. In other words, the bendway weirs would enhance overbanking but are not necessary to achieve overbanking.
- The river diversions likely required for access and installation of the bendway weirs will add a significant cost to the project.

Figure 13. Right bank section with erodible layer (lighter colored material) still intact bordered by stable hardpan section upstream and protected by vegetated floodplain bench downstream.

Cut/Fill Balance: The grading plan was revised in order to accommodate the widened floodplain bench and descending trail while incorporating the remaining fill into a gently sloped hillside. More of the existing borrow site was eliminated by extending the hillslope and transitioning it into a smaller stormwater basin in order to counter the additional cut from the wider floodplain bench. There still remains around 6,000 cubic yards of excess spoils, which will be further reduced moving to 90 percent by steepening the hillslope and incorporating additional topographic features surrounding the stormwater basin area which currently has more than enough capacity for the area discharging to it.

Preserved Railroad Spur: During additional field visits, the design team members assessed and agreed that a longer length of the railroad spur should be preserved (total ~340 feet) from what was proposed at 30% designs for the following reasons:

- An intermittent right bank floodplain exists for the first 400 feet of channel across from the railroad spur berm, lessening the need for a constructed floodplain in this area along the left bank.
- The widened floodplain bench described above compensates for the reduction in floodplain in this area.
- It is an opportunity to lessen the upland disturbance where there is a lot of mature vegetation including large conifers and native shrubs.

Stormwater Basin: A 3300-sq ft stormwater basin was added within the footprint of the former borrow site of which the majority of the disturbed highway access area should still drain to (Figure 14). The 65% plans include a spillway and outflow swale which will rarely, if at all, see outflow given the capacity of the basin relative to the area draining to it is more than adequate. The size and configuration of the basin and the need to armor the swale where it crosses the trail and heads down the slope will be further examined and refined moving to 90%.

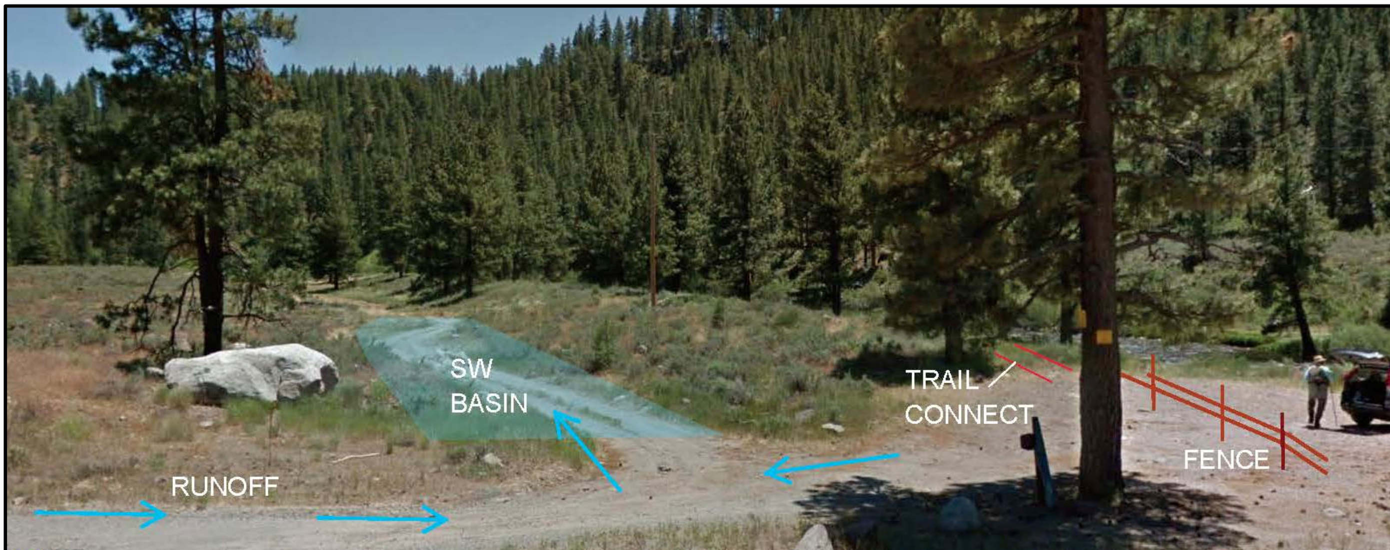

Figure 14. Illustration of maintaining drainage to stormwater basin and restoring northwest corner of project area.

Trail Updates: New grading contours and section details were developed for the descending trail from the railroad berm terminus down to the floodplain. A trail connection connects the descending trail to an existing road on the upper terrace that would be decommissioned down to the trail width. The upper terrace (former road) trail would provide continued access where it already exists, will prevent volunteer trails from forming on the newly restored hillslope, and provides a nice overlook opportunity of the unique volcanic outer bank and channel at the apex of the bend.

A new single track trail was designed within the floodplain graded area in order to maintain access to the center W-weir. The remaining trails and roads are still designated to be decommissioned as proposed at 30%.

Parking Area Improvements: The majority of 65% site improvements are proposed on CDFW owned lands including new boulder blockades to prevent new encroachment and disturbance. The designs avoided incorporating improvements within the Caltrans ROW for the following reasons:

- The current ingress/egress from Interstate 80 is significantly limited, therefore encroaching into that space with any parking improvements would likely require significant traffic analysis and highway improvements per Caltrans standards including signage, striping and even an exit ramp.
- This area is generally flat and further away from the river, significantly lessening the potential for erosion and associated sediment reaching the river.

The more circular parking area with boulder perimeter on CDFW land is proposed to be entirely decommissioned however the design team will consult with Liberty power company to determine if there are any maintenance access or easement requirements that need to be considered for that location and incorporated into 90% designs.

Temporary and Permanent Erosion Control and Revegetation: Temporary and Permanent Erosion Control and Revegetation plans, details and specifications have been added to the plan set to protect water quality during construction, stabilize the site post-grading, and improve native habitat.

90% Design Update

The following describes the activities and major changes made to the designs moving into 90% detailed plans and specifications.

Activities

- The 2-D hydraulic model surface was rerun for the 90% proposed designs and analyzed for all recurrence events and the results (Attachment 2) will be used to recheck and refine if needed floodplain and overflow channel installations prior to finalizing construction documents to ensure functionality and stability.

- Updated construction costs for 90% Engineer's Estimate.

Design Changes

- Added a rock-lined channel to convey the I-80 highway drain inlet overflow along its current "eroded" path to prevent further aggravated erosion.
- Updated the contours to better balance cut/fill quantities and eliminate the need for off-haul and preserve more large trees (a 48-inch and 18-inch dbh) on the lower end of the former borrow site that had previously been in the graded area.
- Added a rock-lined trail within the new floodplain bench area per CDFW request during 65% design review meeting.
- Reconnected the loop trail within the area left undisturbed in order to preserve the trees listed above.
- Incorporated salvaged logs into the boulder grade control elements on the overflow channel to soften the look. Field direction will be critical to ensuring these structures are low profile and functional.

Steps for Final Construction Documents

The following summarizes the next steps following client and stakeholder review and feedback on the Boca 90% Plans in order to complete final construction documents.

- Clarify location of boat out take and eliminate the proposed slope improvements and boulder blockade currently on Draft 90% plans.
- Incorporate reference photo of an existing return flow armored rock outfall in the final plans as added guidance for armoring the northwest overflow channel outfall in order to prevent an over-engineered appearance.
- Update construction limit (exclusion) fencing and signage to allow the public to still access the river from the highway bridge crossing to the most upstream "W-weir" during construction.
- Add a submittal requirement to the specifications requiring the Contractor to provide a Safety Plan for review and approval.
- Add note that final inspection and approval of the lower overflow channel improvements will be conducted by CDFW fisheries biologists.
- Modify Floodplain Trail detail to specify 6" minus rock to be keyed in rather than "flat" rock to facilitate easier salvage and construction.
- Recheck boulder/log sizes for floodplain grade control elements against the 90% model shear and velocity output to determine if any adjustments are needed.
- Submit Admin 100% plans, specifications and cost estimate for review and approval.

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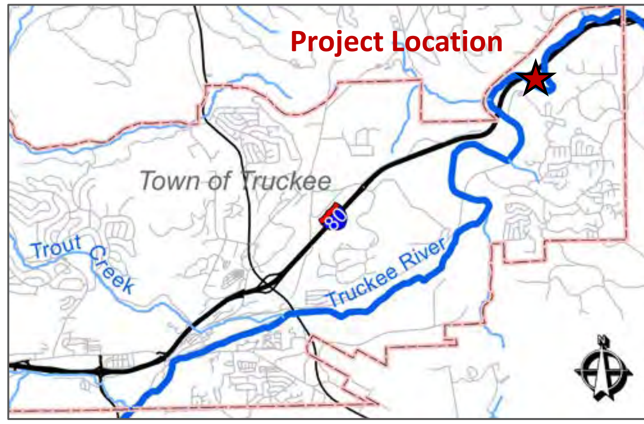
Sierra College Press https://www.sierracollege.edu/ejournals/jsnhb/v2n2/I-80.html (Sierra College, provided by California Department of Public Works, Division of Highways) Aerial Single Frame Photos courtesy of the U.S. Geological Survey

Attachment 1 – 2018 Assessment Project Sheet

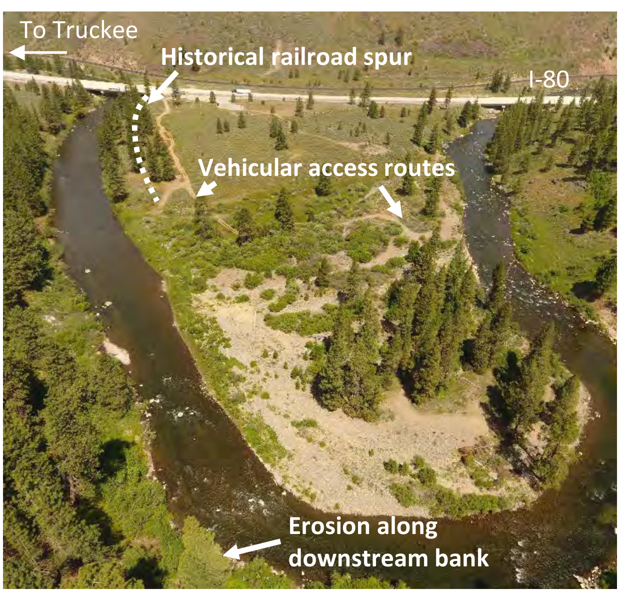
TRUCKEE RIVER REVITALIZATION: CDFW River Bend (Horner's Corner)

Problem: Erosion along banks, sediment from vehicular access and loss of floodplain function
Project: Aquatic habitat, floodplain and public access improvements
Location: CDFW River bend along east bound I-80 between second and third bridge (Horner's Corner)



General Description of problem:
The CDFW River Bend site contains an historical railroad spur from the Nevada Ice Company and is currently a popular fishing location along the Truckee River. The railroad spur appears to have disconnected the floodplain from the river and confined the river to a straight channel that has exacerbated erosion on the downstream bend. Additionally, vehicular access has compacted soils on river bars and limiting vegetation growth. Runoff from access routes conveys sediment directly to the Truckee River.

Goal(s)	Sources of degradation	Objectives to achieve goal(s)
Reduce excess sediment delivery to the Truckee River and re-establish floodplain function	I-80; Historical railroad spur and vehicular access	Re-establish floodplain, remove fill, and control vehicular access



CDFW River Bend Project Site

Restoration or Management Approach:
Historical impacts associated with the spur railroad grade and modern impacts associated with vehicular access could be addressed by removing fill along the left river bank and limiting vehicle access throughout the inside of the river bend. Removing the fill would reintroduce flows to the historical floodplain surface, slowing flows and possibly reducing the potential for erosion along the downstream river bank. A parking and river access area could be established to include sufficient stormwater treatment and boulder bollards could be used to limit disturbance to the floodplain and riparian zone. It should be noted that this is a popular location for fishing access and vehicle access to freedom campsites could be affected.

Cost Estimate:

Less than $10K
$10K-$100K
$100K-$500K
$500K-$2M
$2M +

Balance Hydrologics, Inc.
foriver TRUCKEE RIVER WATERSHED COUNCIL

TRUCKEE RIVER REVITALIZATION: CDFW River Bend (Horner's Corner)

Target Conditions/Success Criteria:

- Reduced sediment to Truckee River.
- Increased floodplain area.
- Increased floodplain inundation frequency.

Implementation Timeframe

- Conceptual design (3-5 weeks)
- 60% design (8-10 weeks)
- 90% design (8-10 weeks)
- Permitting (3-6 months)
- Implementation (4-6 weeks)
- Project monitoring (3-5 years)

Monitoring recommendations:

- Repeat cross-sectional channel surveys.
- Stage recorders.
- Vegetation monitoring.

Restoration Options

- Remove fill or create breach in railroad spur and if needed generate inset floodplain
- Limit vehicular access along floodplain and provide designated parking area.
- Revegetate and stabilize compacted areas.

Constraints

- Historical site preservation.
- Potential channel cut-off across floodplain and meander abandonment.

Railroad spur grade channelizes river and limits floodplain inundation

Parking area off I-80

Possible historical railroad spur artifacts

Vehicular access routes compacted soils and divert runoff to the Truckee River

Attachment 2- Boca 2-D Model 90% Design Results

To rerun the model for proposed 90% conditions the 90 percent surface was created in CAD and merged with the existing surface. This new combined surface was used to create the proposed terrain used in the model. The manning's n roughness values that were adjusted slightly at the 65% design level based on pebble counts conducted in September 2021 remained the same.

The following figures display the 2-yr, 5-yr, 10-yr, 50-yr and 100-yr model results for 90% proposed conditions as compared to existing conditions.

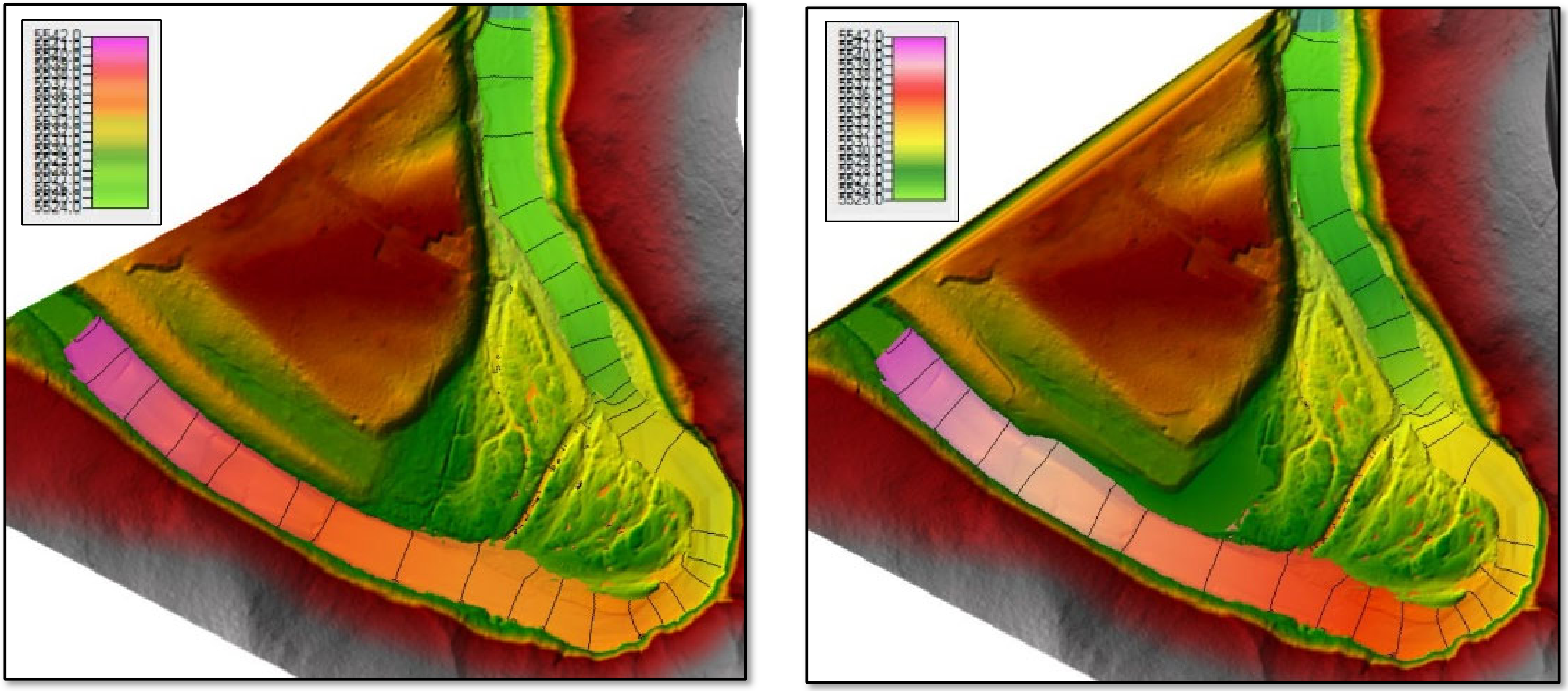


Figure 1a. Existing vs Proposed 2 Year Water Surface Elevation

Most increased overbank activity occurs sometime between a 2-yr and 5-yr event. Image on right shows the new floodplain bench starting to be activated however the overbank channels are not yet seeing any significant changes

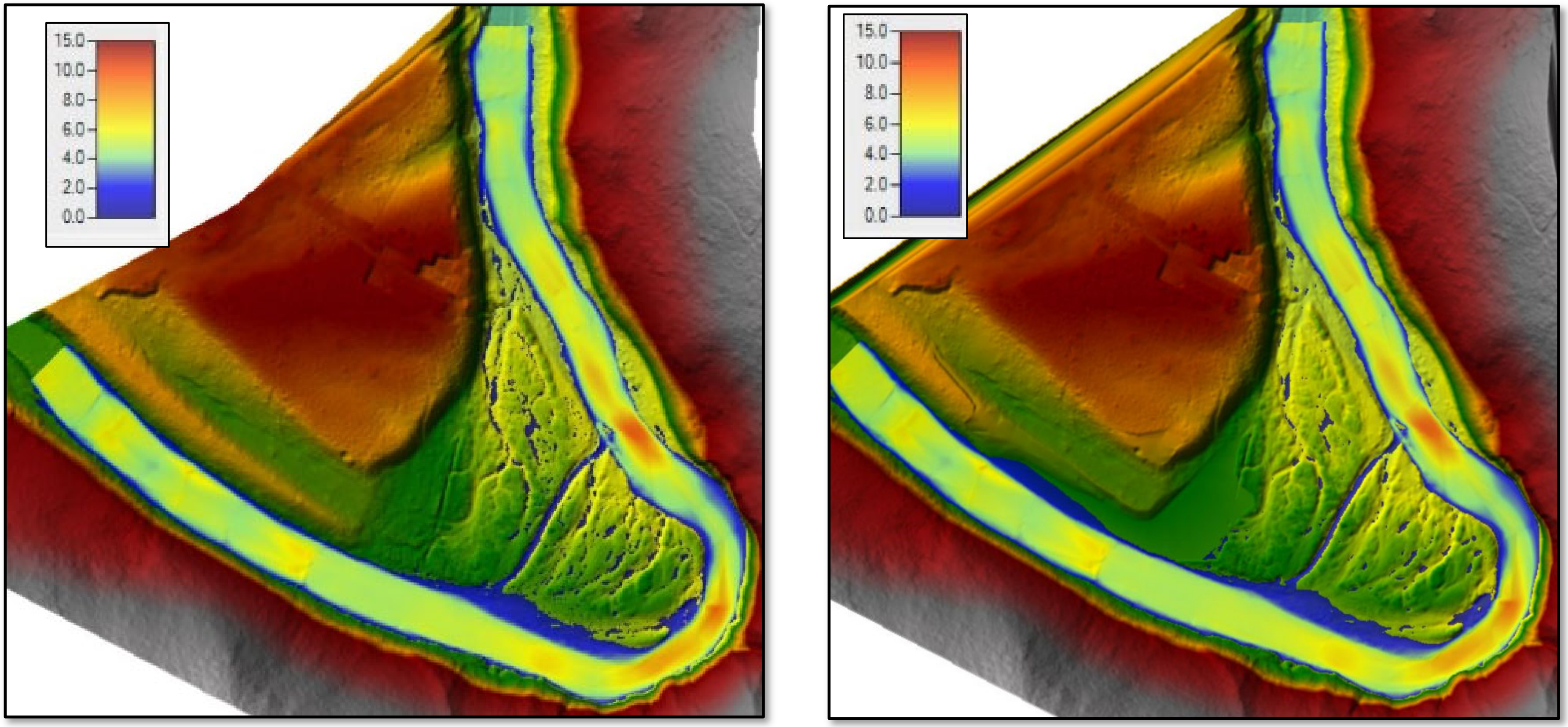


Figure 1b. Existing vs Proposed 2 Year Velocity

No observable change in velocity or shear under the 2-year event.

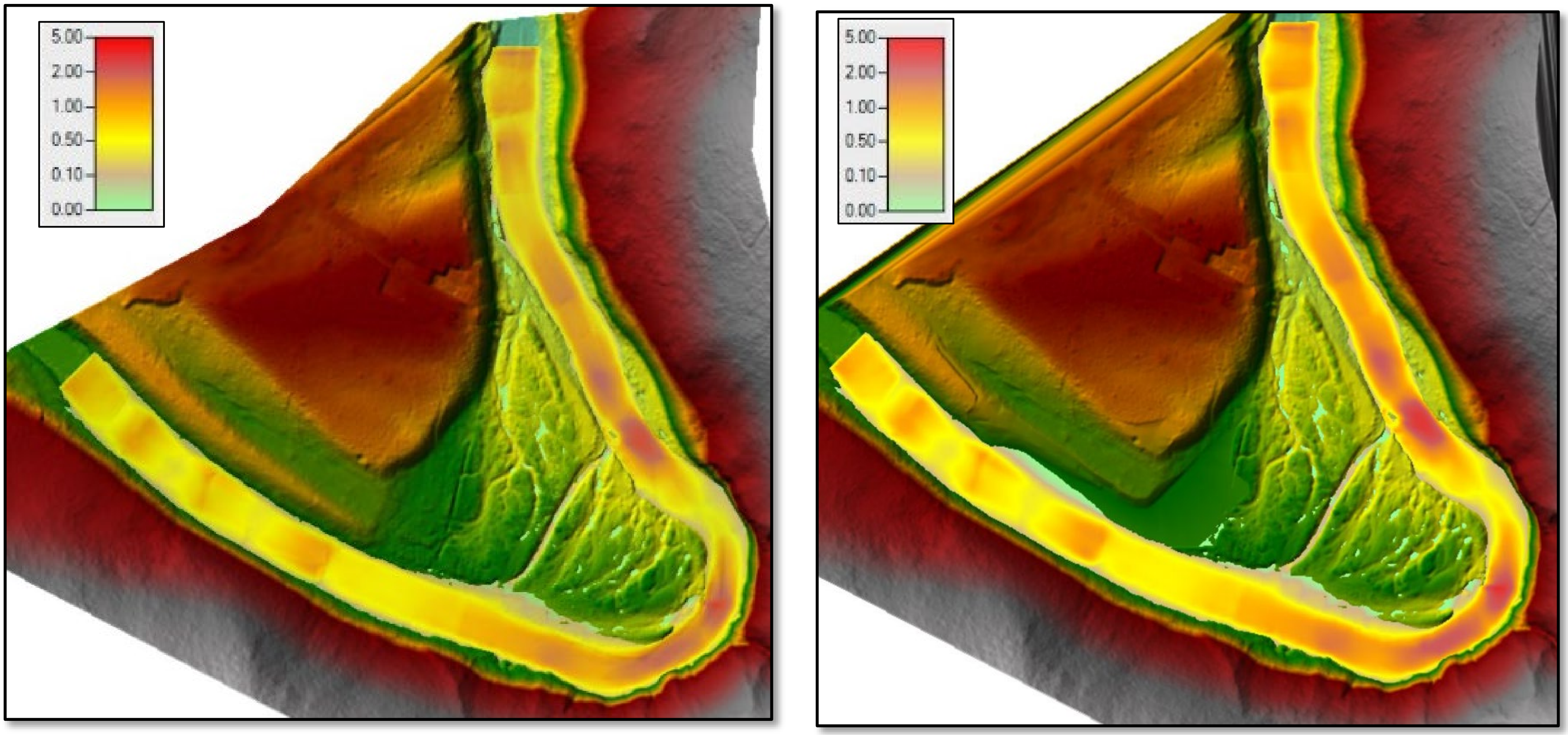


Figure 1c. Existing vs Proposed 2 Year Shear Stress

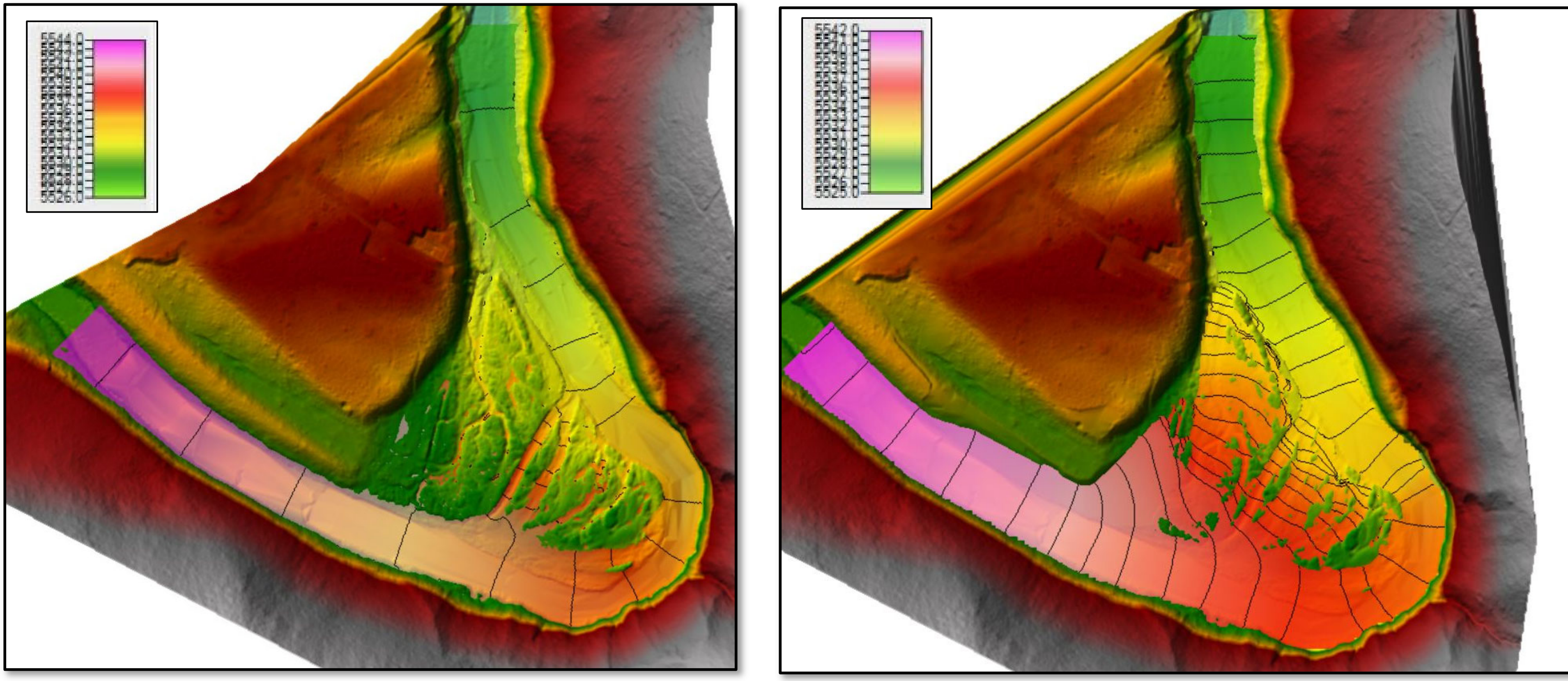


Figure 2a. Existing vs Proposed 5 Year Water Surface Elevation

The new floodplain bench and overflow channels are noticeably activated under the 5-year event.

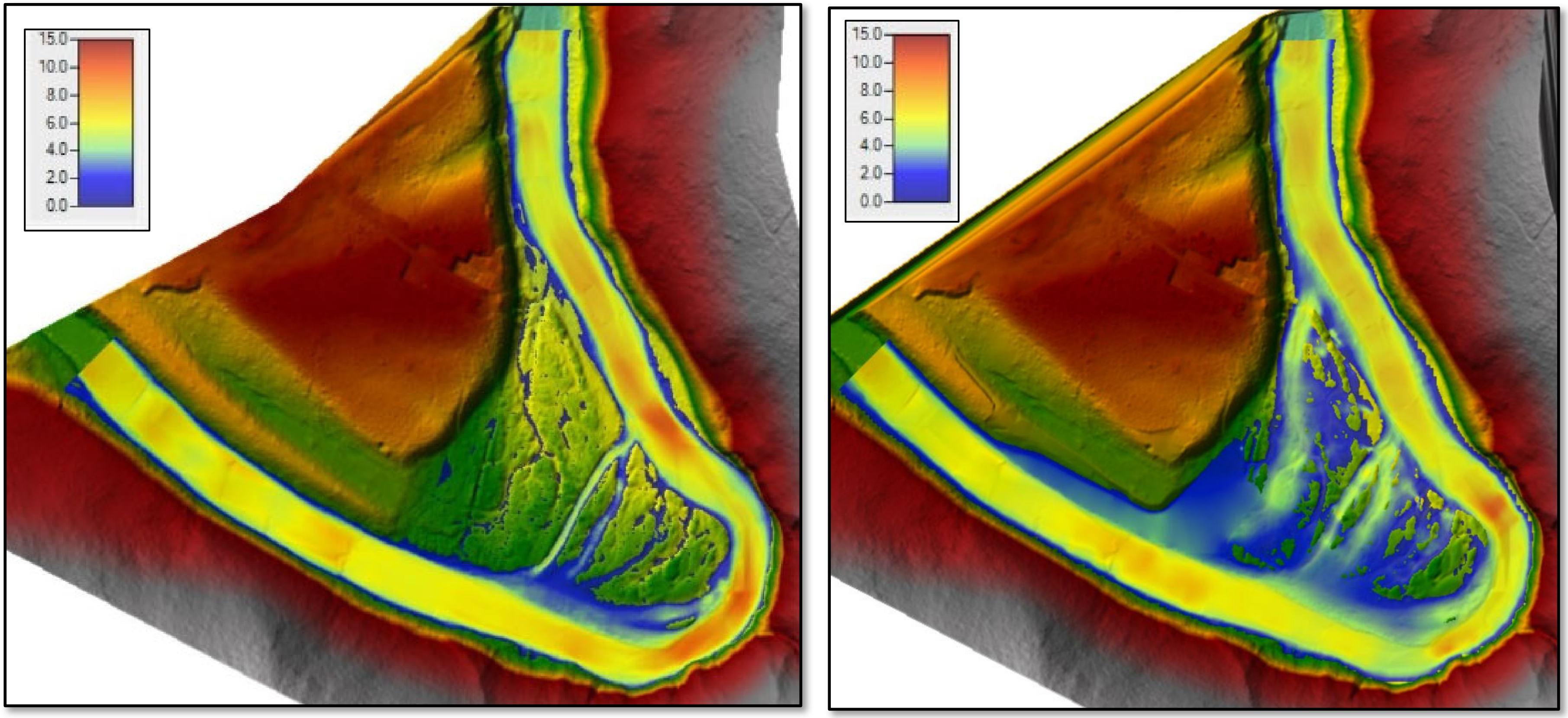


Figure 2b. Existing vs Proposed 5 Year Velocity

Velocities in the floodplain range from 2 to 4 feet per second (fps) with the higher velocity on the downstream end of the overflow channels.

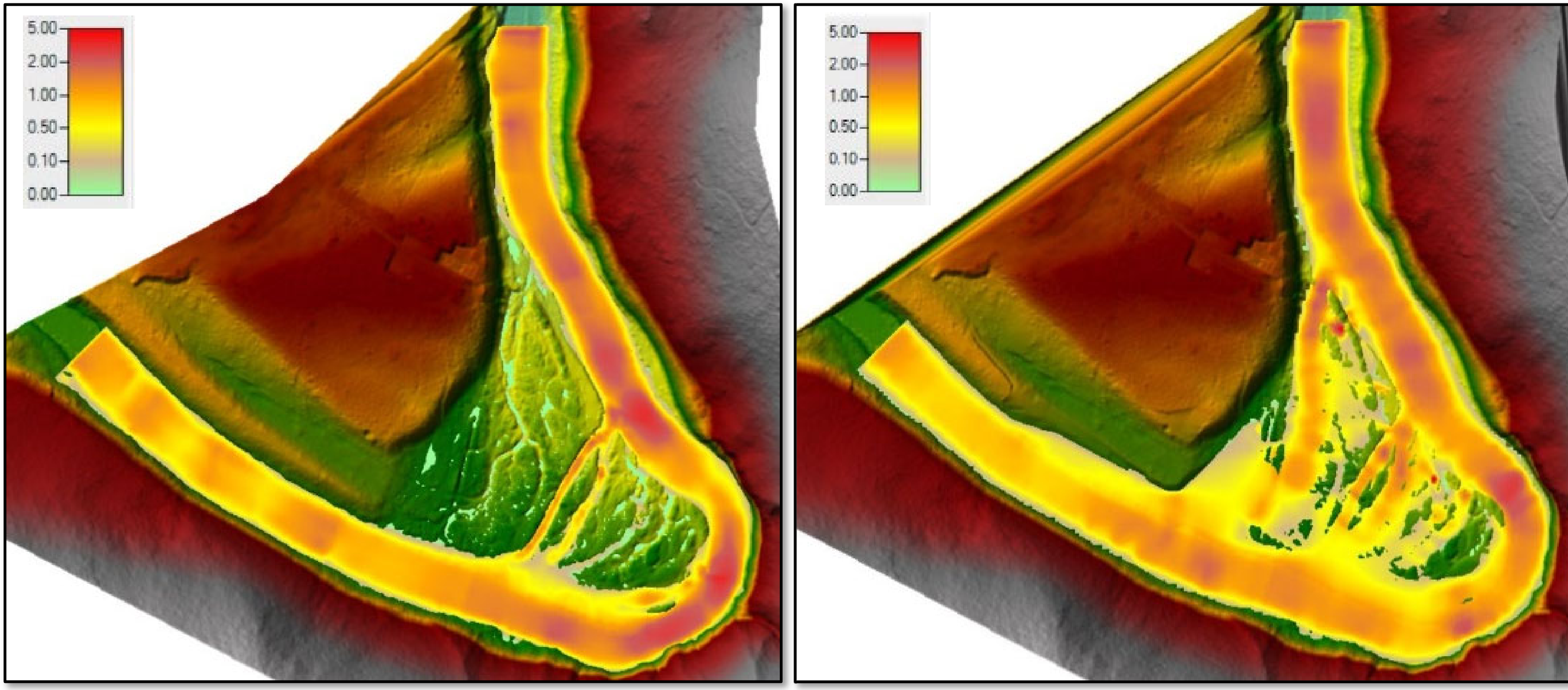


Figure 2c. Existing vs Proposed 5 Year Shear Stress

The inset floodplain bench appears to reduce shear slightly along the W-weirs and also within the channel at the apex bend. Shear increases similar to velocity along the activated overflow channels with the highest shear values around 2 pounds per square feet (psf) within the downstream portion of the overbank channels.

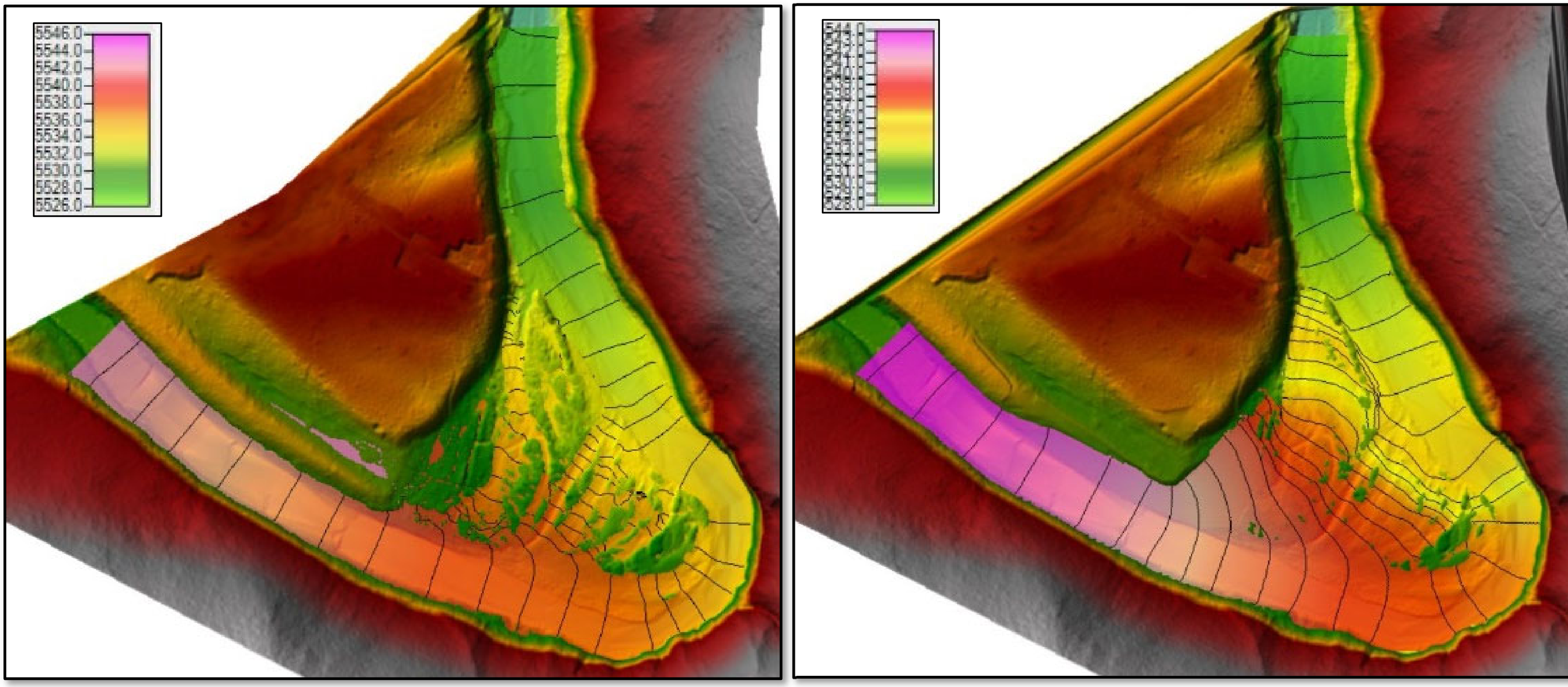


Figure 3a. Existing vs Proposed 10 Year Water Surface Elevation

Slightly more of the floodplain is inundated under a 10-year event as compared to a 5-year event.

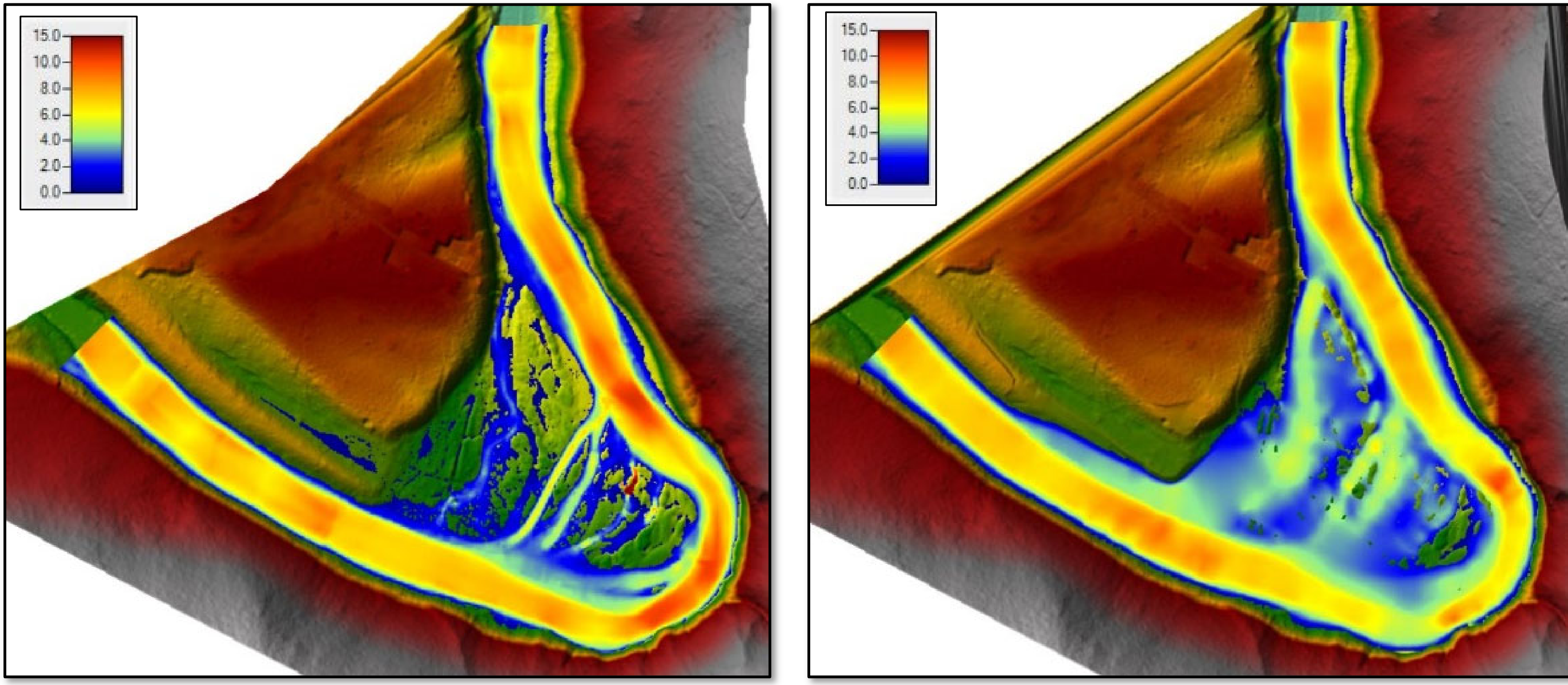


Figure 3b. Existing vs Proposed 10 Year Velocity

Velocities increase further to 4 to 5 fps along the overflow channels where they steepen along their return to the Truckee River. Velocities in the main channel remain less than existing around the bend apex and where the smaller activated channels return to the main channel.

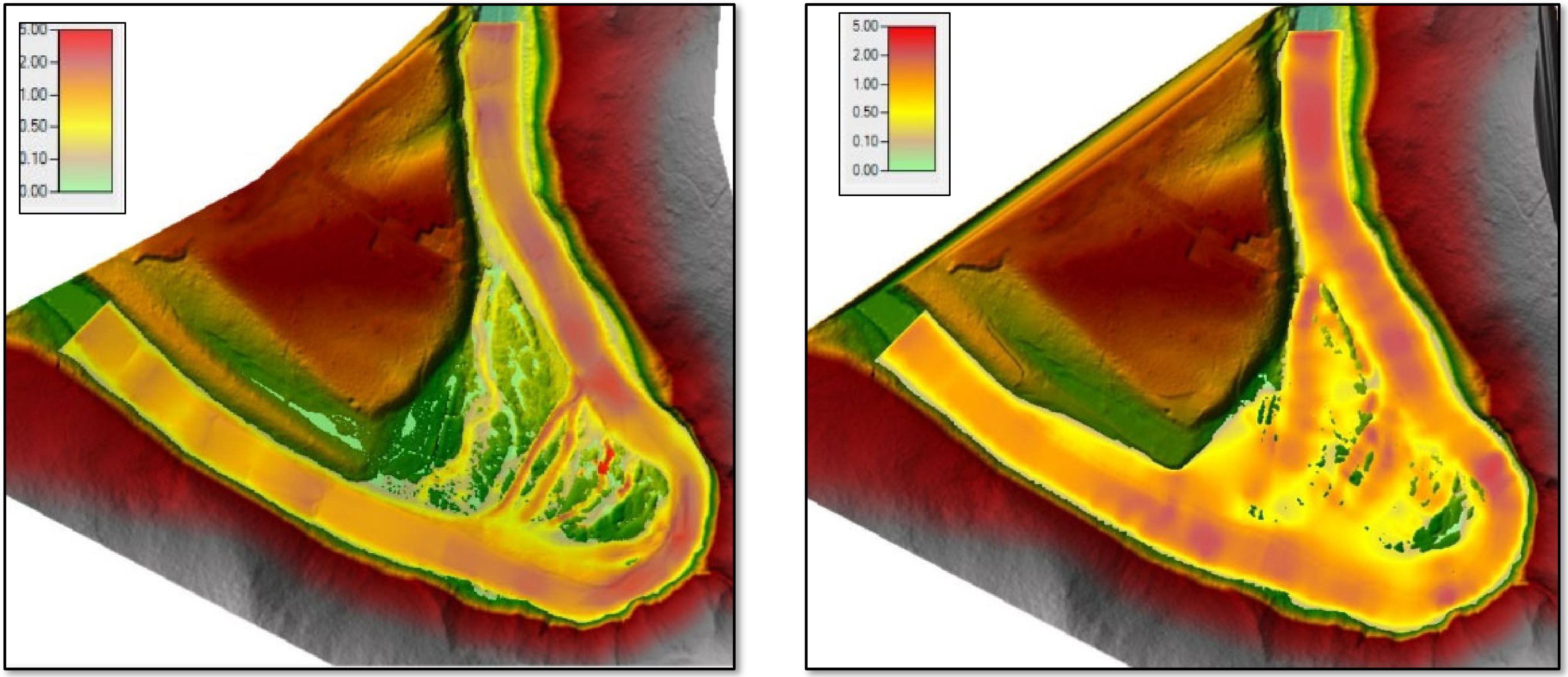


Figure 3c. Existing vs Proposed 10 Year Shear Stress

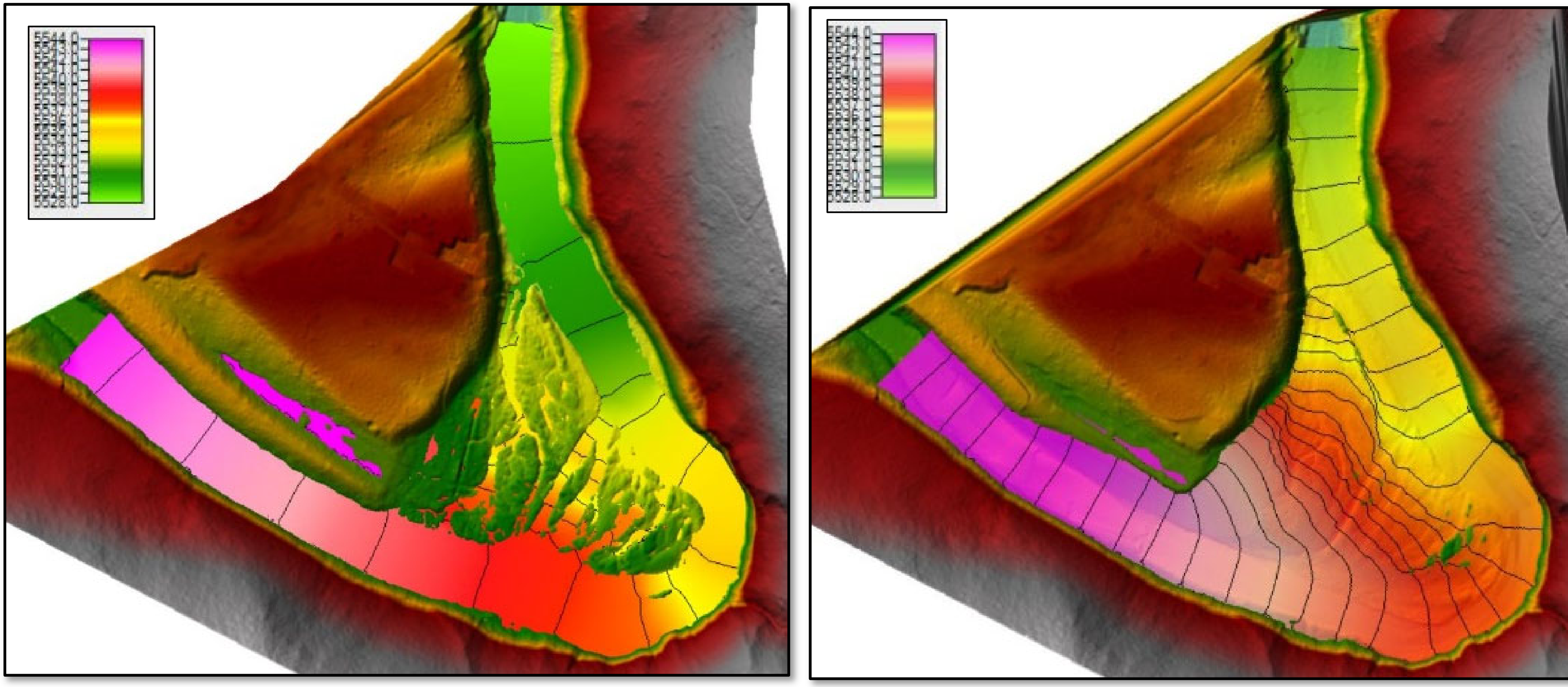


Figure 4a. Existing vs Proposed 50 Year Water Surface Elevation

Under a 50-year recurrence event the entire floodplain along the apex is essentially inundated, whereas under existing conditions its largely still contained within the overflow channels.

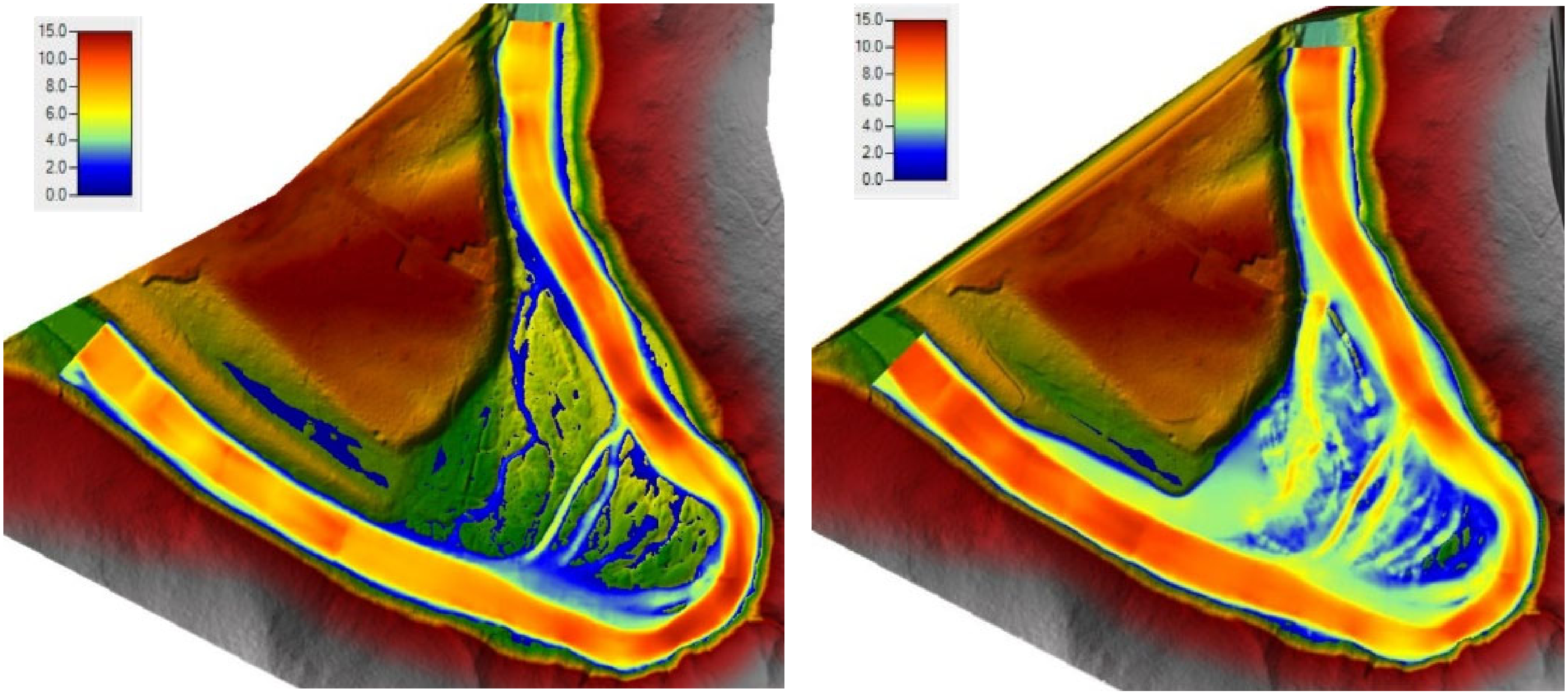


Figure 4b. Existing vs Proposed 50 Year Velocity

Under a 50-year recurrence event, velocities in the overbank area get as high as 6 to 8 fps and the same locations where velocities were reduced within the main channel still show the same reaction.

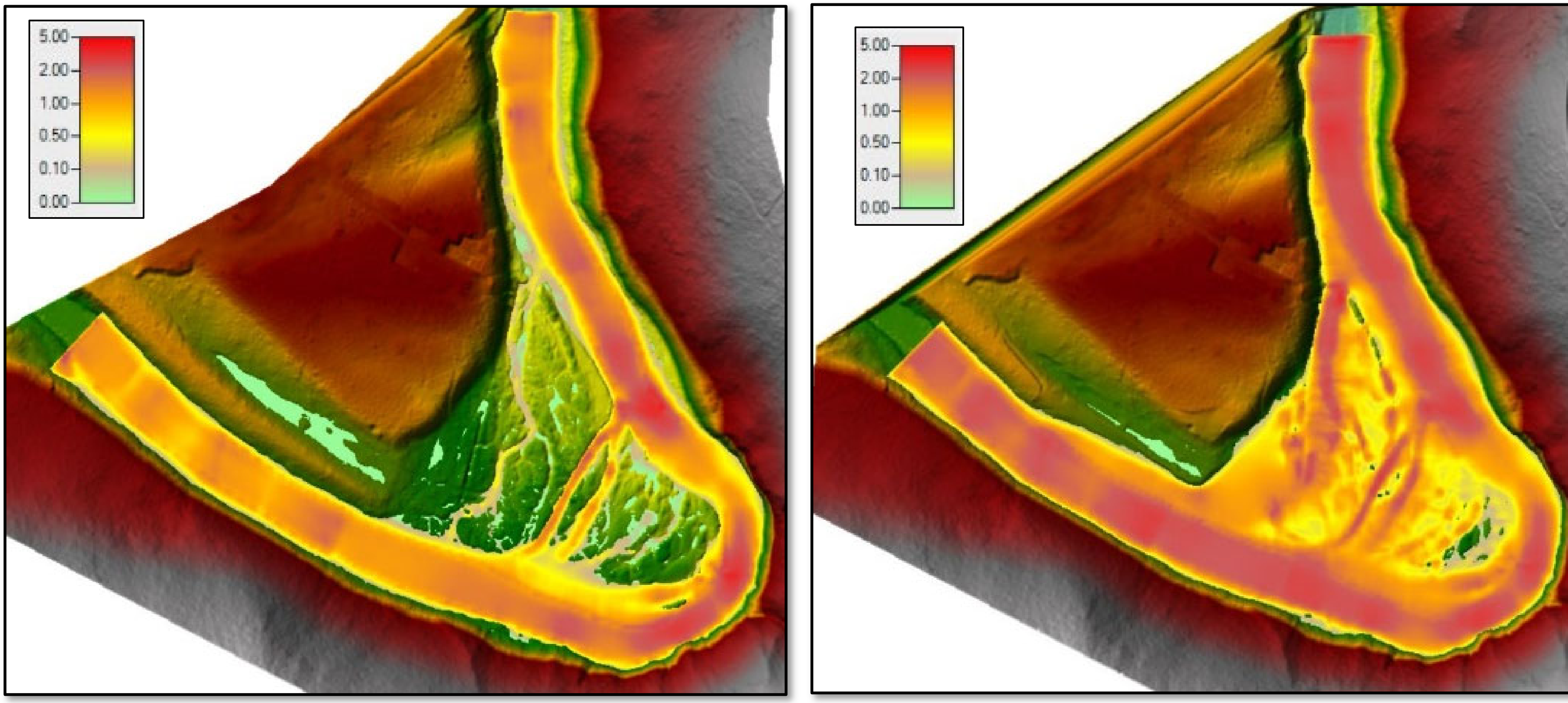


Figure 4c. Existing vs Proposed 50 Year Shear Stress

Under a 50-year recurrence event, shears also increase in the overbank area upwards to 2 to 4 psf.

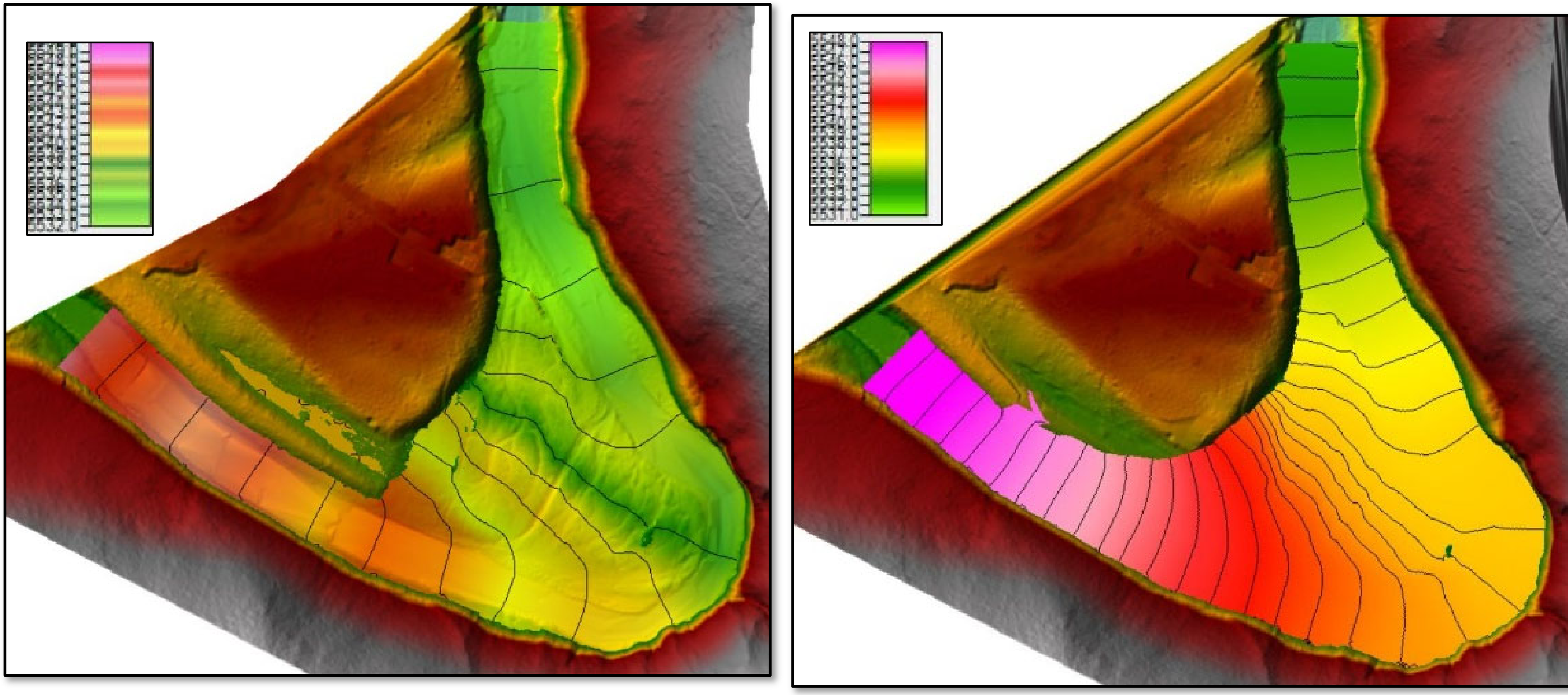


Figure 5a. Existing vs Proposed 100 Year Water Surface Elevation

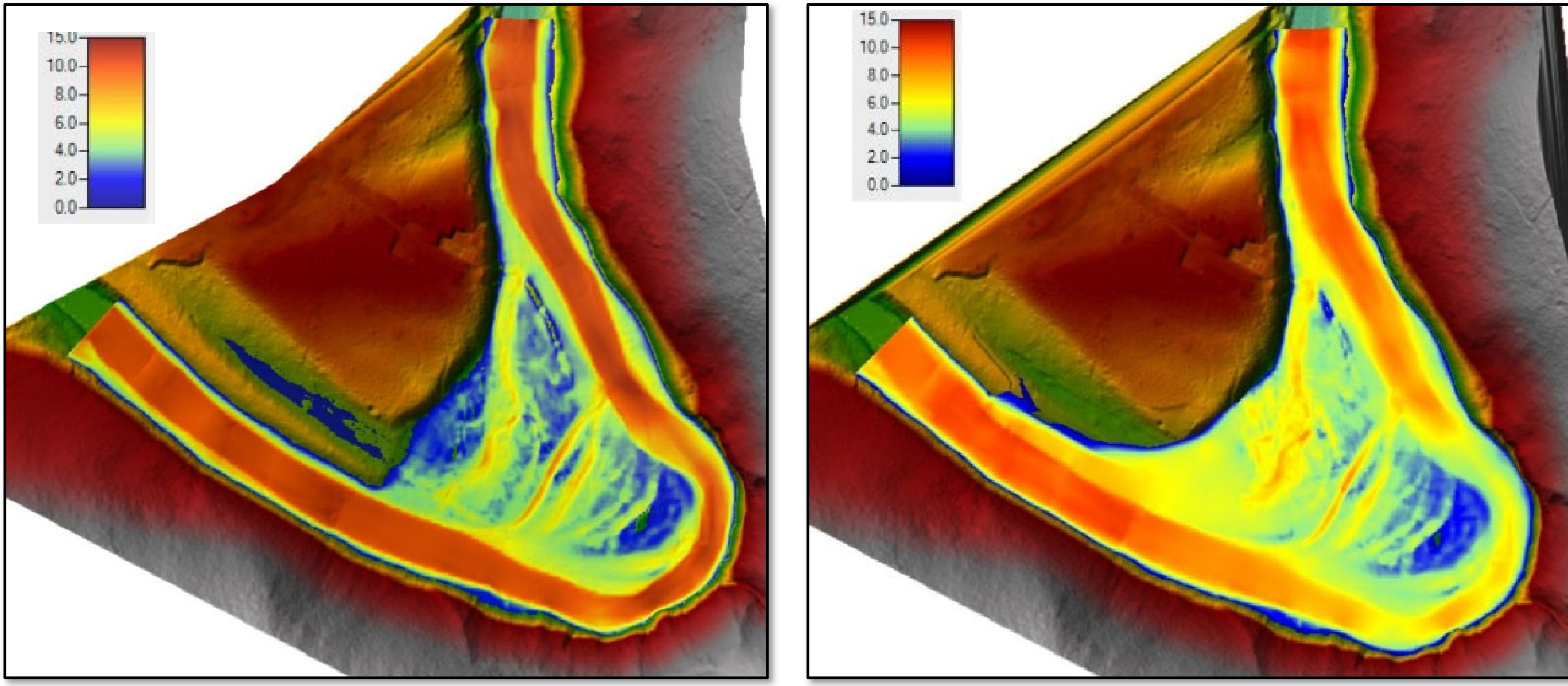


Figure 5b. Existing vs Proposed 100 Year Velocity

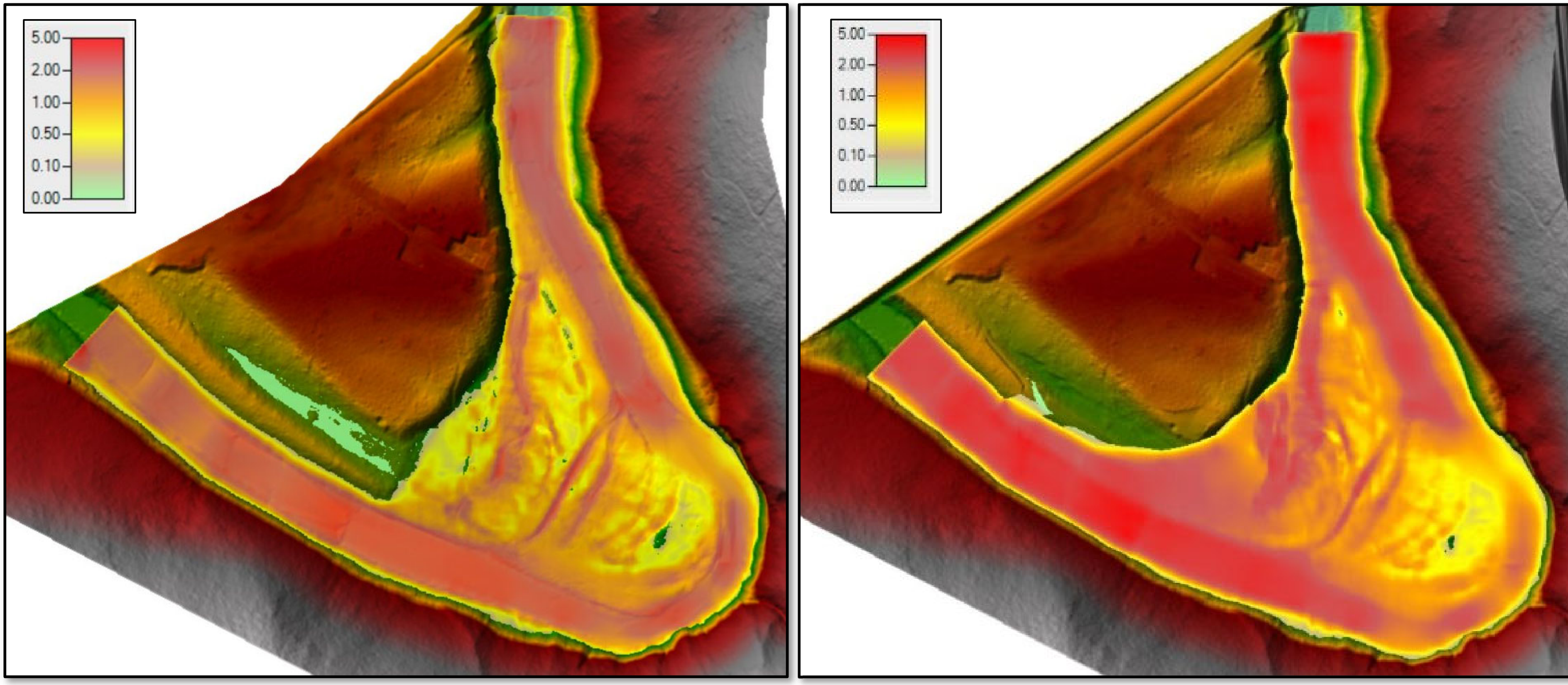


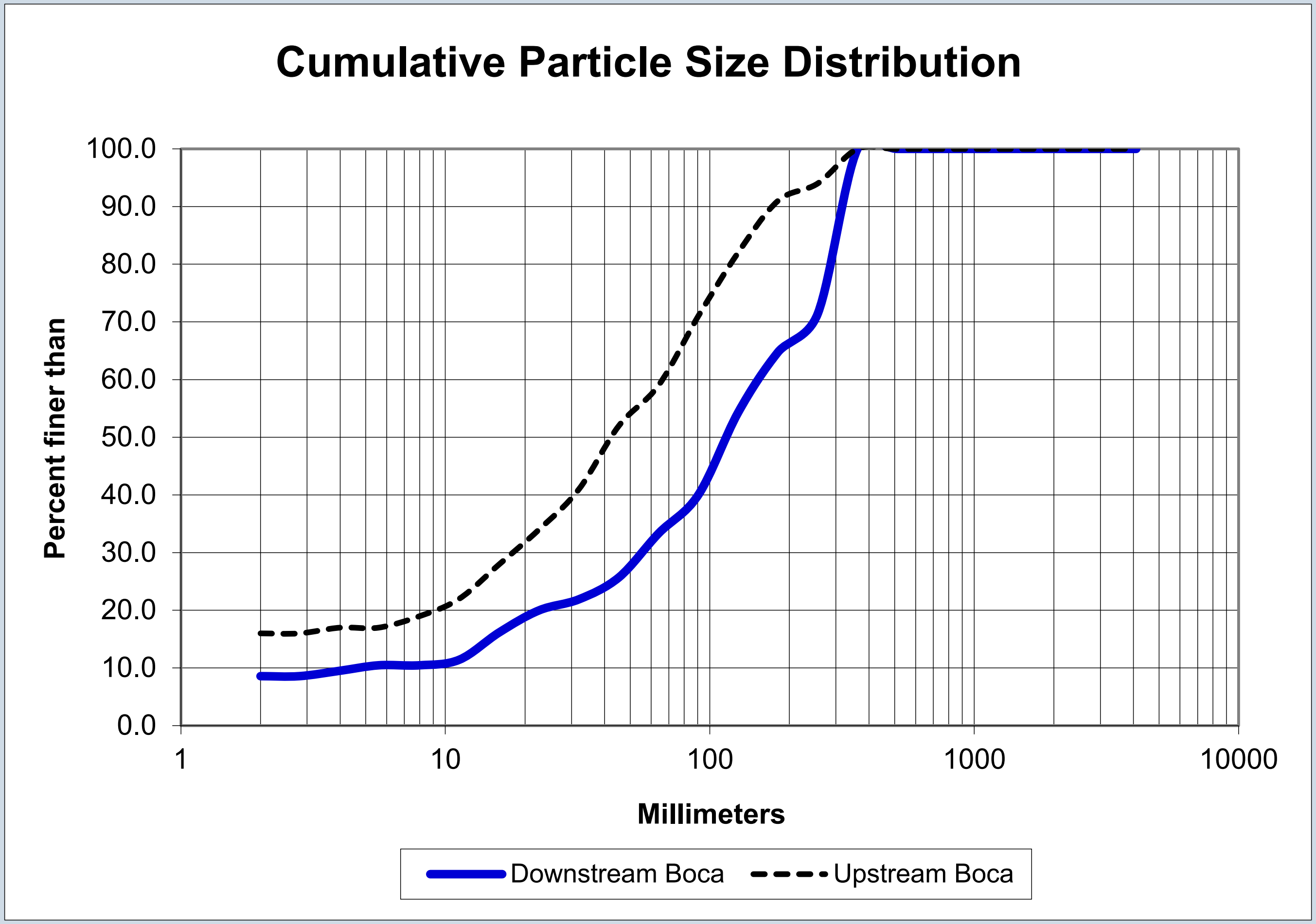
Figure 5a. Existing vs Proposed 100 Year Shear Stress

Attachment 3 - Boca Pebble Count and Particle Size Distribution Result

Soil Sampling & Pebble Count Results

Pebble Count Results

- We can see that the downstream section of Boca has a higher d50 and d84.
- The downstream riffle is steeper, while the W weirs upstream of the bend is likely affecting the sediment distribution in that reach.
- These distributions are being used to refine the Manning's n value in the hydraulic model.



Boca Pebble Count Results

Two Wolman Pebble Counts were conducted on September 28th, 2021 in the Boca study reach to gain a better understanding of the bedload in this reach. The two locations were: between the two upstream most W-weirs and in the steep riffle just downstream of the large hole and the bend. These locations were chosen because they are able to represent the reach as a whole while still capturing variations in sediment size across the reach.

The first location sampled was between the two upstream W-weirs (Figure 1). This reach contained a lot of large gravel and small cobble, as well as a lot of fines. The second location sampled was downstream of the large pool and in the middle of the steep riffle. This site contained somef fines as well, but also a lot of cobble and boulder sized sediment (Figure 2). There was interest in collecting a pebble count in the large pool as well. However, this area contained almost exclusively clay and it was determined that this area would not provide a representative look at any other part of the reach. As seen in Figure 3, the laboratory sieve analysis is similar to the first pebble count sample, but with a large proportion of fine sediment.

These pebble count results, coupled with soil sampling of the floodplain and terrace surfaces, give us a better picture of the sediment that is moving through this system. This will help inform design decisions and feasibility.

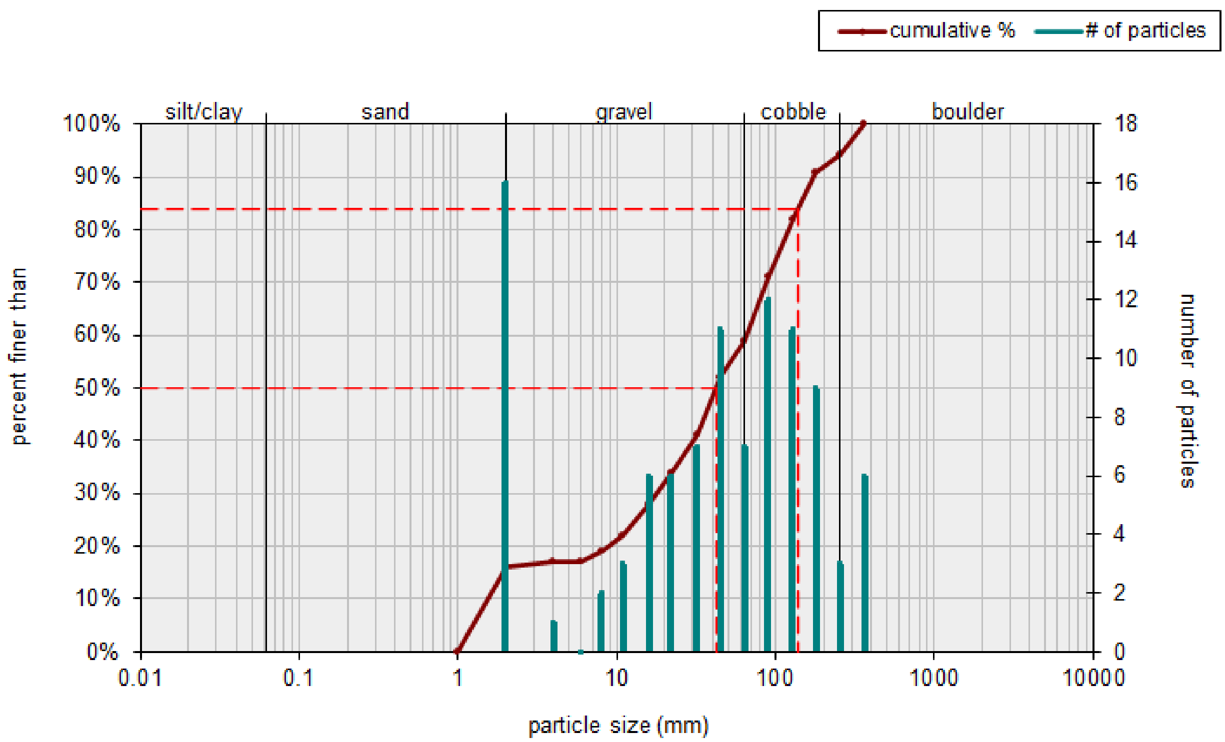


Figure 1. Pebble Count 1, Between the two upstream W-weirs

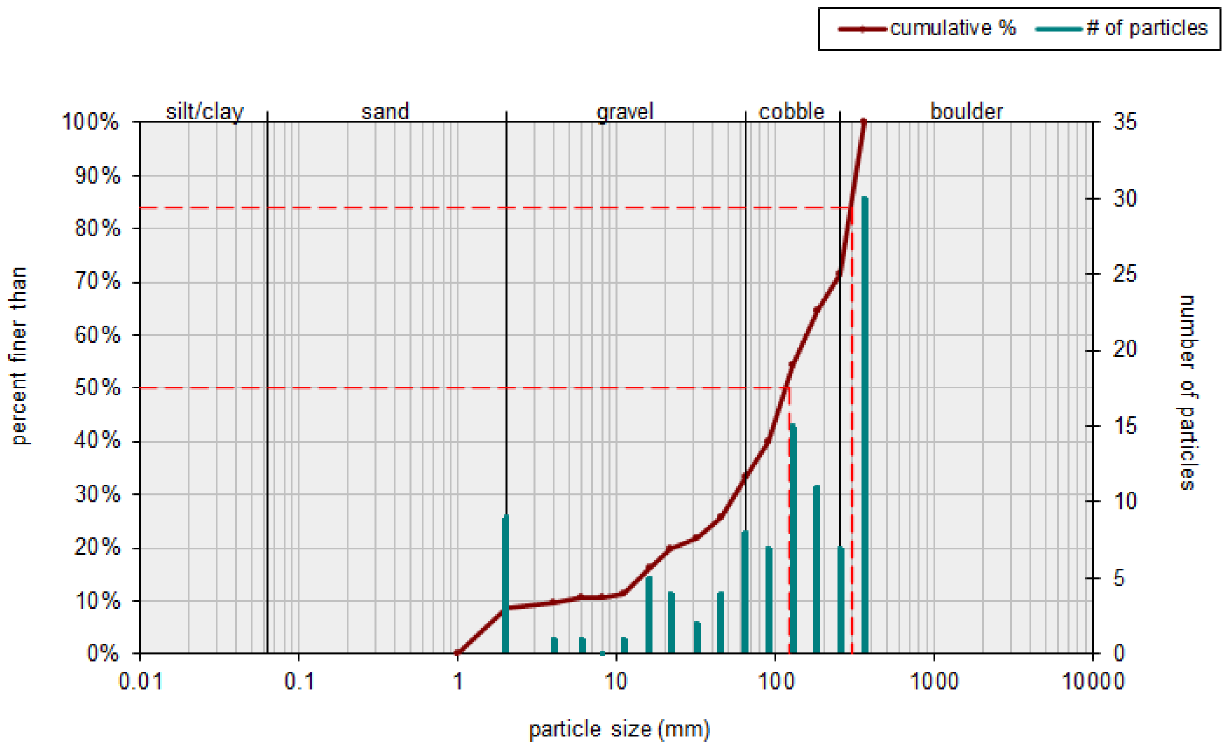


Figure 2. Pebble Count in the steep riffle downstream of the large pool.

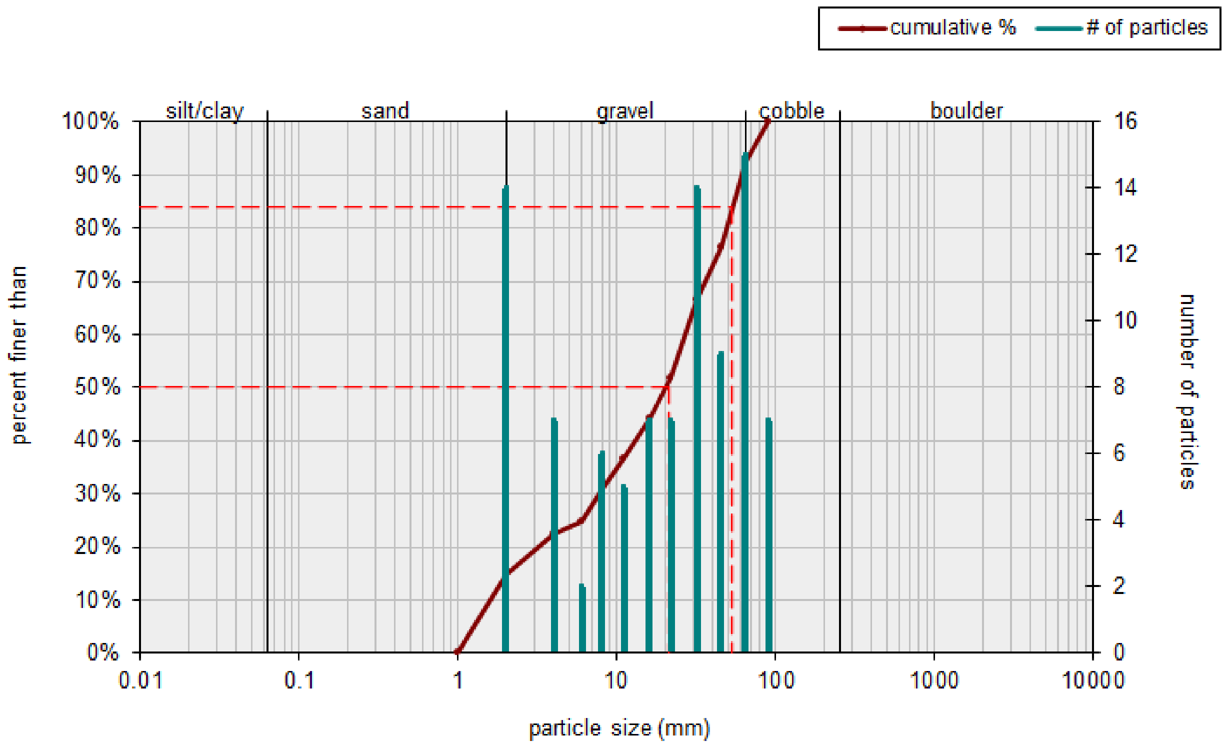


Figure 3. Sieve analysis between the two upstream W-weirs.