Jacobs

I-70 West Vail Pass Auxiliary Lanes

Eagle County, Colorado

Value Engineering Study Report - Final

R | 0

May 20, 2021

Project: NHPP 0702-404 / FBR 0702-403

Subaccount: 23982 / 23929

COLORADO
Department of Transportation

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Jacobs Project No:	WXXZ3900
Document Title:	Value Engineering Study Report - Final
Document No.:	R
Revision:	0
Date:	May 20, 2021
Client Name:	Colorado Department of Transportation Region 3
Project:	NHPP 0702-404 / FBR 0702-403
Subaccount:	23982 / 23929
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File Name:	CDOT West Vail Pass VE Study Final Report.docx

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Document history and status

Revision	Date	Description	Author	Checked	Approved
R0	05/20/2021	Final Report	John Corcoran	Randy Sprague	

CERTIFICATION STATEMENT

The undersigned Certified Value Specialist (CVS®) facilitator attests that the Value Study was facilitated in accordance with the SAVE International Standards of Conduct.

John Corcoran
CVS® No. 201909001
Facilitator

Contents

1.0 Executive Summary

This report documents the results of a 3½-day Value Engineering study of the West Vail Pass Auxiliary Lanes project for the Colorado Department of Transportation (CDOT). The project proposes upgrades to an existing emergency truck escape ramp at milepost (MP) 182.2. The truck ramp is part of the INFRA Grant scope and Field Inspection Review / Final Office Review (FIR/FOR) submittal. The study also encompassed an extensive series of improvements proposed in both directions of the West Vail Pass corridor from MP's 180 to 191 as covered in the Environmental Assessment of the Proposed Action Plan.

The Value Engineering (VE) Study of the West Vail Pass Auxiliary Lanes and Environmental Assessment projects was conducted from April 6-9, 2021. Due to travel restrictions created by the COVID-19 pandemic, the entire study was conducted virtually using the Teams application. All participants attended remotely. The full-time VE team was comprised of the VE team leader, a landscape architect, and an environmental / wildlife specialist from Jacobs; a bridge / structural engineer, a highway engineer, and an entry-level transportation engineer from RS&H; a traffic / ITS specialist from Apex Design; a materials engineer and a resident engineer from CDOT, and a constructability expert from Kiewit. Kiewit is the Construction Manager / General Contractor (CM/GC). There was also part-time participation by two representatives from the Federal Highway Administration (FHWA). See the VE study team contact list in Section 2.1. See a list of all attendees for the Design and VE Presentations in Sections 2.3 and 2.8 respectively.

The basis of the VE study included FIR/FOR submittal plans, the Environmental Assessment plans, CAP1 (Contractor Agreed upon Price) Specifications, a Structure Selection Report (SSR), an Aesthetics Guidance Report, a Risk Register Report, phasing diagrams, a final ROM (Rough Order of Magnitude) cost estimate dated December 22, 2020, and numerous technical memos.

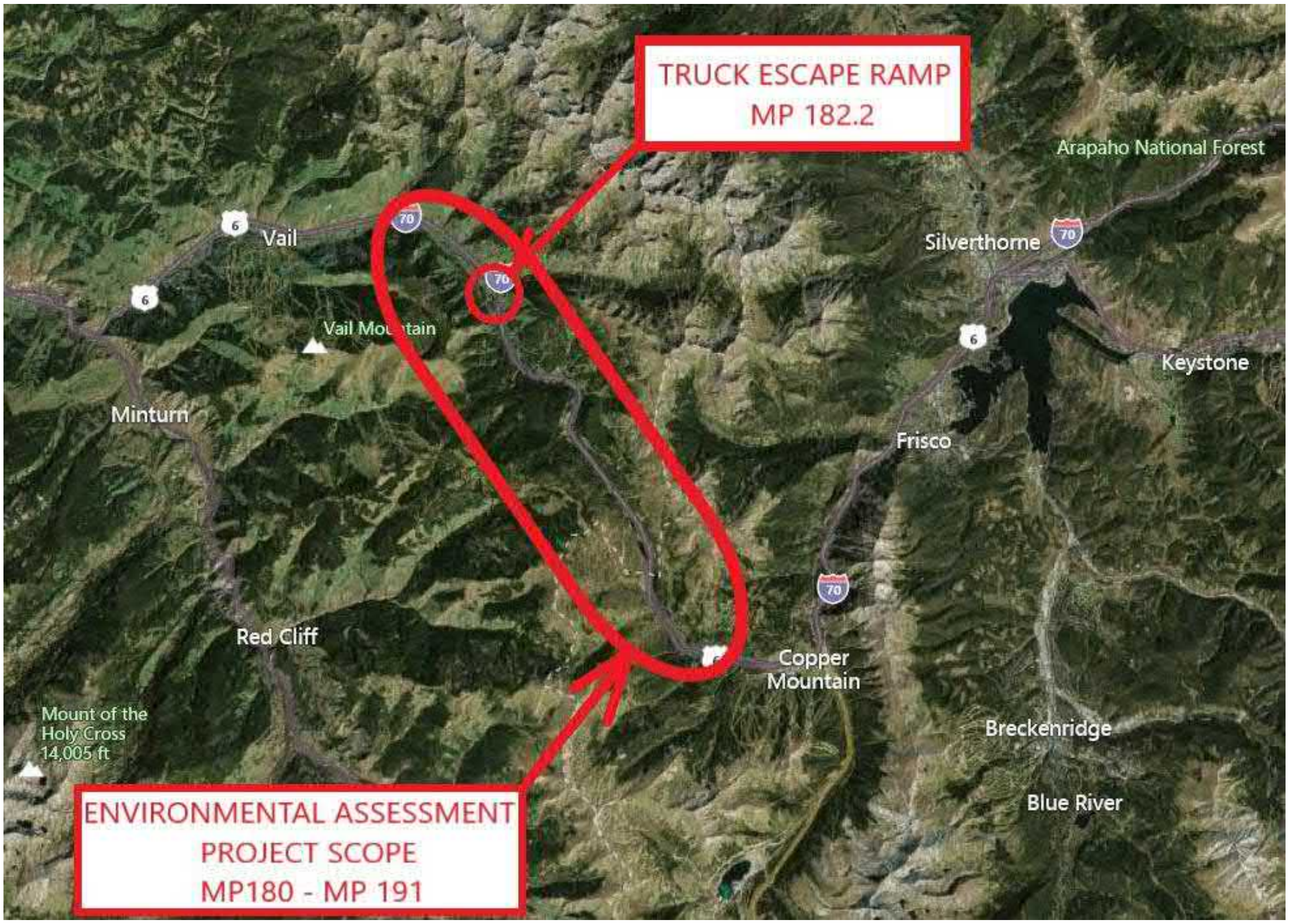
1.1 Project Description

The Environmental Assessment project area is a segment of Interstate 70 (I-70) known as West Vail Pass in Eagle County, Colorado. The project limits are from MP 180 in the town of Vail to MP 191 at the top of Vail Pass. The purpose of the project is to improve safety and operations in both directions of West Vail Pass. The Pass has experienced an extremely high crash rate due substandard geometry, inadequate cross section width, and limited pull-off and breakdown areas. The Pass often has heavy tractor trailer congestion due to the steep slopes, which results in significant differences in speed trucks, and between cars and trucks. The Pass is closed frequently due to traffic incidents. The inadequate road width limits the ability of emergency response vehicles to reach incident and accident locations when necessary. Weather also has a significant impact on the Pass. During winter months, the travel lanes and shoulders are severely impacted by snow accumulation.

To enhance the operations and safety of the Pass, various upgrades and improvements are proposed. A 12' auxiliary lane will be added in each direction for nearly the entire length of the pass. For most of the corridor, the inside shoulders will be widened to 6' and the outside shoulders will be widened to 8'. There will be additional shoulder widening at truck pullouts. Several horizontal curves will be modified to address the substandard geometry. The modified curves will allow the design and posted speed limits to be increased so vehicle speeds can be maintained through these locations. Various bridges and retaining walls that are nearing the end of their service life will be replaced. Several safety measures will be incorporated. The pass will incorporate a remote lane closing system to allow for fast closures and avalanche protection will be installed in appropriate locations.

Several miles of an existing recreational trail will be relocated to accommodate the Pass improvements. The relocated recreation trail and all architectural components of the Pass improvements will match the scenic and historical character of the surrounding areas.

An aerial photo of the project location is shown on the next page:



1.2 Initial Cost Estimate

The construction cost estimate used for the VE Study was dated December 22, 2020. The construction cost estimate indicates the auxiliary lanes project will cost $138,004,170.58. The entire Environmental Assessment project scope is estimated to cost $740 million. Additional information regarding the estimate is discussed in section 2.4.

1.3 Summary of VE Idea Development

During the Creative Phase of this VE study, fifty-six (56) ideas were generated. After further evaluation, forty-one (41) of these ideas were developed into Proposals. The ideas developed into proposals offer design alternatives to the current highway and bridge alignment, retaining walls and earthwork, barriers, shoulders, wildlife crossings, guardrail, asphalt mix, electrical and power supply, grading and reforestation, and permitting and mitigation strategies. In the Evaluation Phase, the general economic impact, the perceived likelihood of implementation, and the effect on the overall project objectives were considered.

The VE team proposals are summarized in Section 1.6. Details of the proposals along with their advantages and disadvantages are shown in Section 1.7.

1.4 Design Suggestions

In addition to the recommendations, Design Suggestions (DS) are provided to the project team for consideration as the design continues to develop. In some cases, the design suggestions may possibly yield cost savings, but a cost analysis could not be performed beyond concept level as the full extent of the design alternative could not be estimated within the time constraints of the VE study workshop.

1.5 Disclaimer

The calculated savings shown in this Value Engineering Report are *potential* cost savings and are the best projections based on the submission documents available for the study. Actual savings would have to be based on detailed quantity calculations, which could not be made unless final design plans with detailed quantities were to be developed for both the original concept and the VE concept. Once the VE concept is adopted, however, the cost estimate for the original concept is no longer current which precludes a direct comparison with the VE concept estimate. Also, the cost estimate represents the amount needed to construct the project in present day costs. This does not necessarily mean that there will be funds available for this amount and thus, any amount saved by a VE concept is not necessarily available for other projects.

The VE study does not validate the design or the project estimate. The VE team does comment on any design or estimate issues that might observed during the VE study.

1.6 Summary of VE Proposals

Prop. No.	Description	Cost Savings	Added Cost
1	Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area.	$5,994,862	
2	Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.	E	
3	At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.		$86,846
4	Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.	DS	
5	Consider historic tub shape using alternate structural concrete members.	DS	
6	Shift Westbound Alignment and Replace Structure F-11-AX on Existing Alignment.	E	
7	Incorporate a public turnaround point halfway up the pass.		$2,864,809
8	Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.	$7,333,093	
9	Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.	E	
10	Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.	$3,259,997	
11	Shorten north end of bridge over Polk Creek and convert to MSE wall.	$4,801,402	
12	Consider anchor slab on top of walls.	DS	
13	Consider anchor slabs for short walls.	DS	
14	Reduce offset of MSE walls from shoulder to reduce height.	$2,506,614	
15	Consider use of reinforced soil slope in lieu of retaining walls.	DS	
16	Eliminate additional 3' offset to higher cut walls in trail section.	DS	
17	Look for opportunities to balance earthwork.	DS	
18	Keep eastbound and westbound grades consistent to minimize median retaining walls.	$672,476	
19	Incorporate excess excavation as MSE backfill.	DS	
20	Incorporate additional height into Type 9 barrier.		$813,112
21	Incorporate type 9 barrier with glare screen.		$307,581
22	Consider a typical construction section wider than minimum required with temporary shoulders.		$3,765,678
23	Expand interior shoulder from 4' wide to 10' wide.		$21,476,029
24	Reduce inside shoulder to four feet wide.	$10,470,600	
25	Consider Contech concrete arch-type structures versus concrete box or metal arch.	DS	
26	Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.	DS	
27	Reduce size of wildlife crossing structures.	$1,935,019	
28	Consider lynx in-lieu fee mitigation program.	DS	
29	Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1.	$1,512,575	

Prop. No.	Description	Cost Savings	Added Cost
30	Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.	$208,070	
31	Incorporate alternative bridge de-icing system into design.	DS	
32	Consider warm mix asphalt due to remote location.		$275,097
33	Use stone matrix (mastic) asphalt for wearing course.		$761,035
34	Use unmodified mix in lieu of modified HMA on the trail.	$299,795	
35	Propose smart lighting where lighting is needed, i.e. chain up, parking areas, and runaway truck ramp.	DS	
36	Incorporate Smart Work Zone technology for construction.		$72,372 / month
37	Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.	DS	
38	Incorporate Electronic / Automated powered road closure gates.		$1,257,102
39	Dispose haul off material in interchange infield areas and grade aesthetically.	DS	
40	Explore federal or state reforestation grants to offset costs.	DS	
41	Incorporate Programmatic permitting and mitigation strategies.	DS	
Maximum Coincident Savings		$32,258,082	
Potential Added Value			$8,735,470
Potential Added Monthly Construction Cost			$72,372 / month

Notes: Maximum coincident savings is the sum of proposals which can be simultaneously implemented (shown in bold type) and would produce the maximum savings. Maximum coincident savings and potential value added exclude overlapping costs or alternatives that are mutually exclusive.
DS – Design Suggestion, E - Eliminated

1.7 VE Proposals

Proposal 1: Shift Big Horn Road alignment to shorten I-70 mainline bridges in EA area.

Current Design: At Milepost 181.7, I-70 is planned to cross over Gore Creek and Big Horn Road on structures spanning 900' in the eastbound direction, and 650' in the westbound direction.

Cost Savings: $5,994,862

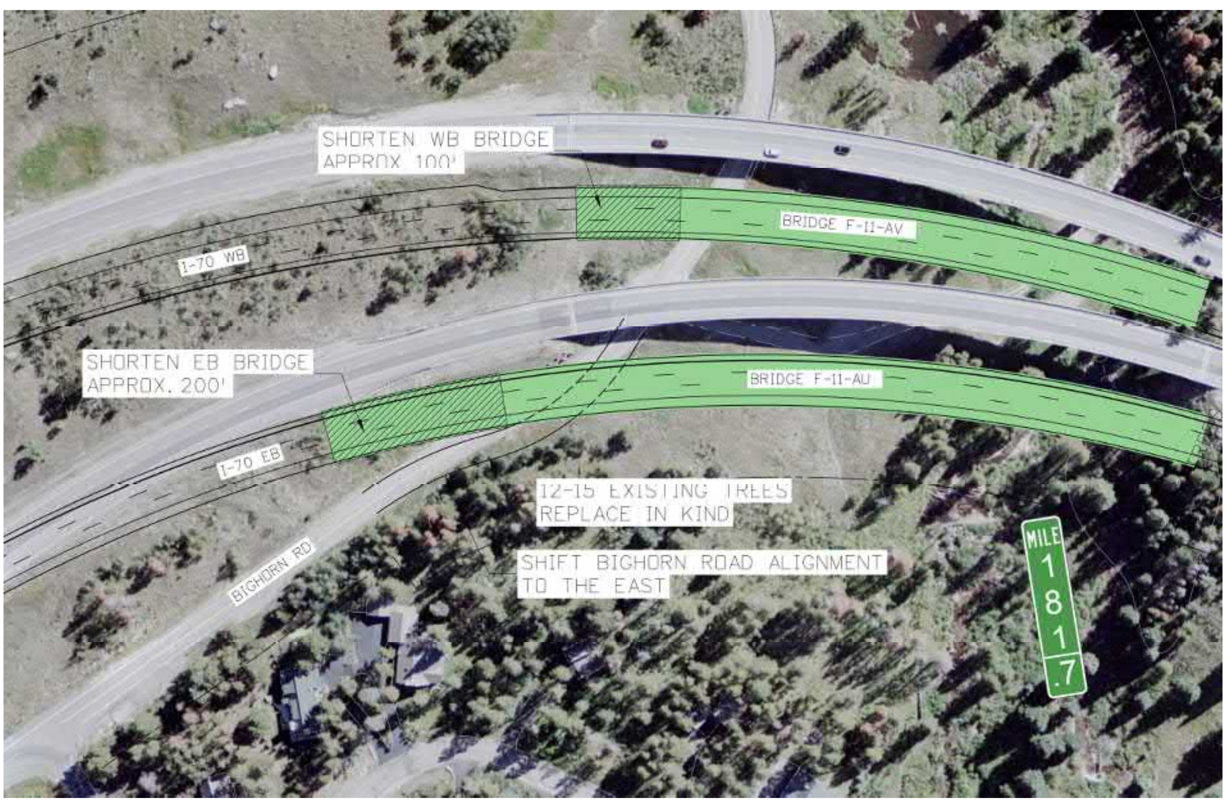
Advantages	Disadvantages
· Saves cost · Possible reuse of onsite spoils	· Requires realignment of Big Horn Road · Changes aesthetics of long span bridge · Impacts a small grove of trees along Big Horn Road.

Idea 1

Discussion:

Under this concept, the alignment of Big Horn Road would be adjusted so that the west abutments of both WB I-70 bridges could be shifted east, shortening the bridge spans. It appears the EB structure could be shortened by approximately 200' and WB could be shortened by 100'.

Big Horn Road would need to be re-constructed through the realignment area. The roadway realignment would impact approximately 12 to 15 trees and these could be replaced in-kind within the nearby ROW. Where the currently planned structures are shortened, it would be necessary to provide embankment fill and this could be done using excess material which is anticipated to be available from the project.



Estimate:

COST WORKSHEET					Proposal No:	1
					Idea No:	1
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
				$ -		
Proposed Design						
Site Grading/Prep	1	LS			$200,000	$ 200,000
Reduce Bridge Deck	-16,500	SQ FT			$220	$ (3,630,000)
Repave Big Horn Road	840	TON			$121	$ 101,640
Replacement Trees	15	EACH			$1,000	$ 15,000
Total:				$ -		$ (3,313,360)
Markup	80.93%			$ -		$ (2,681,502)
Totals				$ -		$ (5,994,862)
Savings:				$ 5,994,862		

Consensus:

The proposal will be held for further consideration with future phases.

Proposal 2: Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.

Current Design: At Milepost 181.7, I-70 makes a sweeping curve over Gore Creek and Big Horn Road with the EB direction at near-minimum horizontal radius.

Proposal Eliminated

Advantages	Disadvantages
· Increase mainline curve radii and design speed · Shortens EB bridge	· May impact ROW to the north · May impact truck ramp · Increased excavation requirements · May have to lower Big Horn

Idea 2

Discussion:

The intent of this idea is to increase the radius of curvature for I-70 through this curve to accommodate a higher operating speed if possible. The modification to the concept plan would be to construct each new structure to the outside of the curve instead of inside as currently planned.

In this configuration it appears the EB bridge could be shortened, reducing overall cost. However, the transition back to existing alignment on the east and west ends could be challenging, as follows:

- West of this location is a sidehill condition where retaining walls are already needed. The shifted alignment would likely increase the need for walls.
- East of this location is the reconstructed truck ramp, which constrains the space available and is also a steep sidehill area.

In follow-up CADD study, this item will conflict too severely with the truck ramp. The idea has been discarded.

Consensus:

The proposal will be held for further consideration with future phases.

Proposal 3: At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.

Current Design: The eastbound auxiliary lane is dropped at Exit 190 in the current concept.

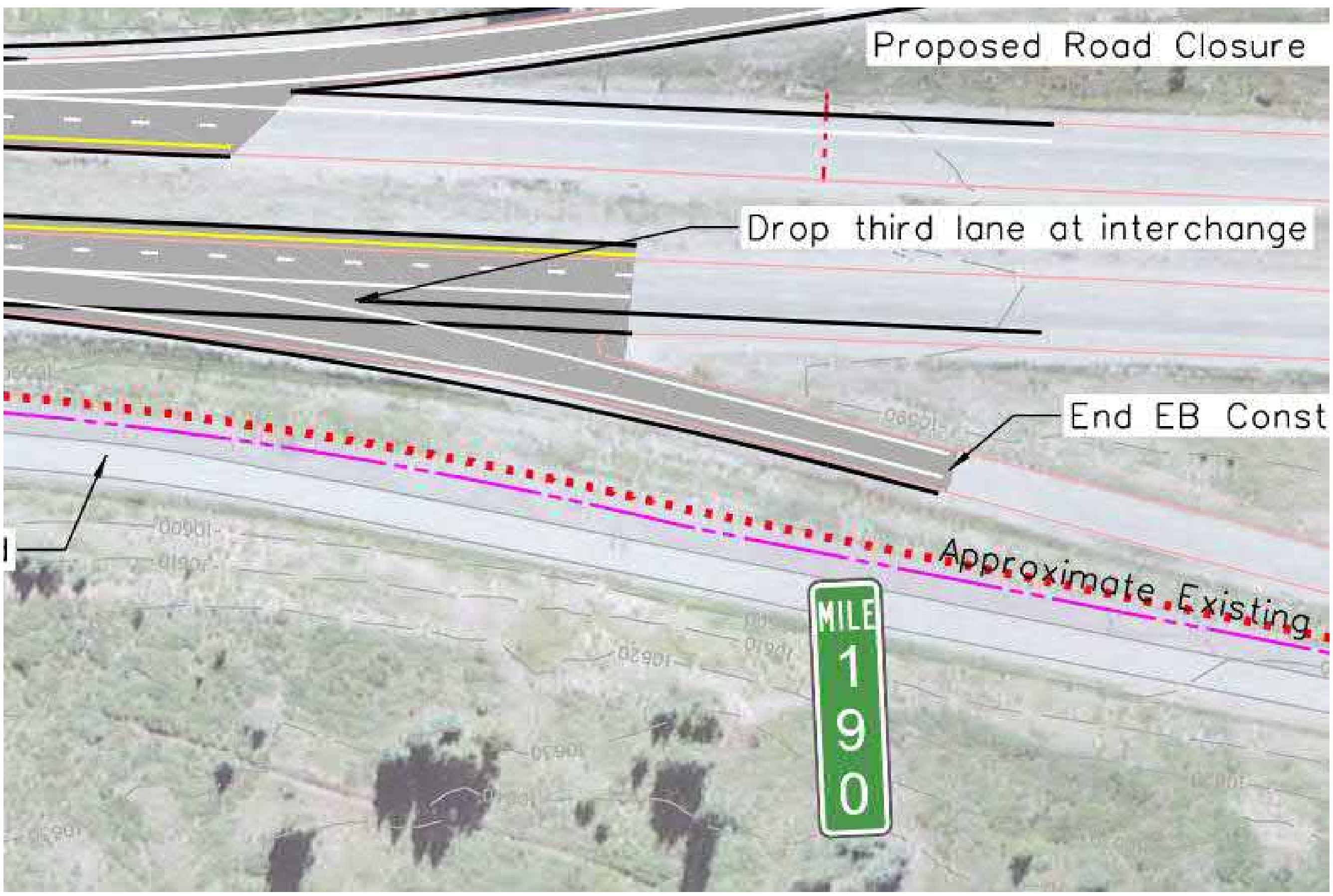
Added Cost: $86,846

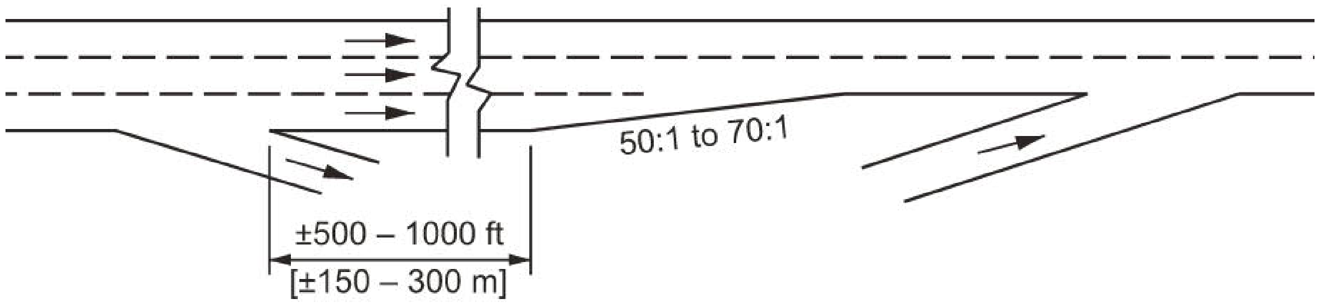
Advantages	Disadvantages
· Improves operation · Adds recovery capability	· Adds initial cost for more pavement to this phase

Idea 29

Discussion:

This measure would allow for a recovery area beyond Exit 190 for errant vehicles, per CDOT's desired practice. It could also be configured as a lane taper beyond the exit to improve





Auxiliary Lane Dropped within an Interchange

– C –

Estimate:

COST WORKSHEET					Proposal No:	3
					Idea No:	29
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
				$ -		
Proposed Design						
1500' Tapered Drop Lane	1,200	TON			$40	$ 48,000
						$ -
Total:				$ -		$ 48,000
Markup	80.93%			$ -		$ 38,846
Totals				$ -		$ 86,846
Savings:				$ (86,846)		

Notes: This cost would contribute toward the ultimate continuation of auxiliary lane 1500 x 12 lane, plus 600' taper, full depth

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design.

Proposal 4: Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.

Current Design: In general, existing bridges throughout the project will be replaced and removed.

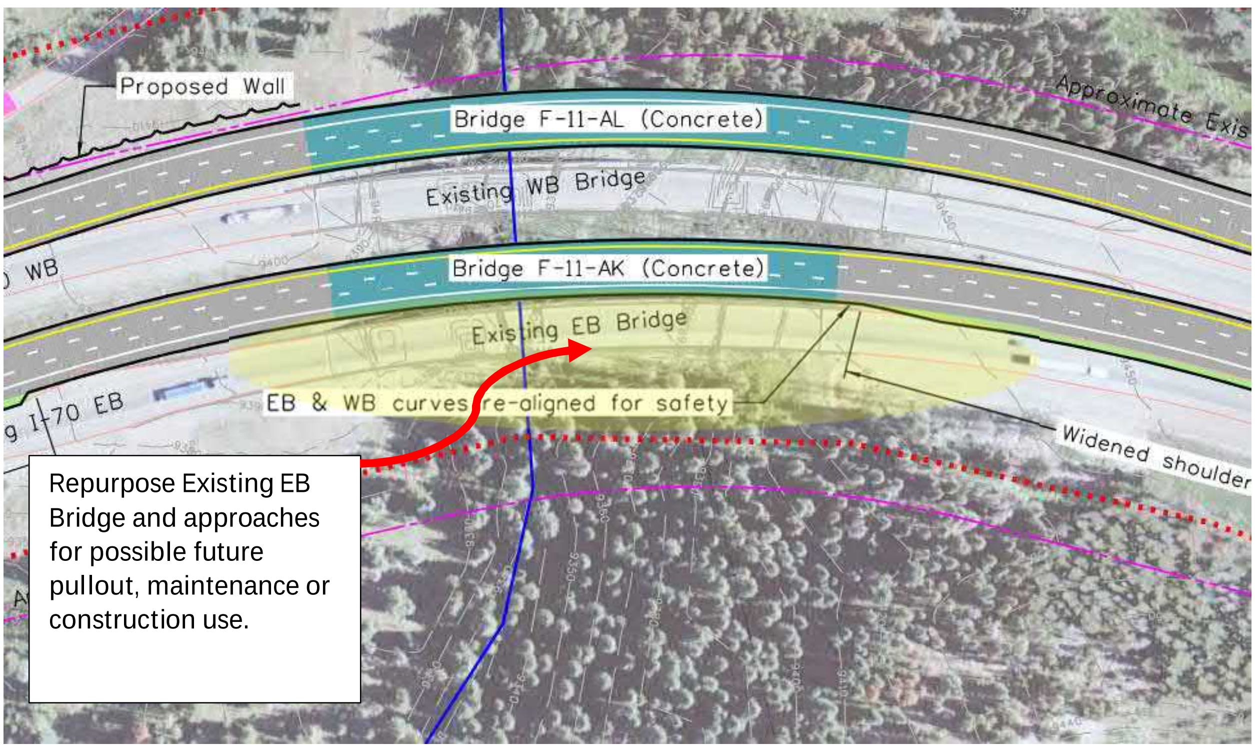
Design Suggestion

Advantages	Disadvantages
· Saves demolition cost in current contract · Less environmental disturbance during demolition · Better sustainability as opposed to landfill alternative · Potential functional benefit to CDOT and road users.	· Continued maintenance responsibility · Remains on bridge inventory · Potential aesthetic issues.

Idea 30

Discussion:

This item encourages the design team to determine if it is desirable to retain existing bridge structures in lieu of demolition. Repurposing a structure would represent a sustainable design approach but would need to be considered in light of the advantages and disadvantages outlined above.



Consensus:

The proposal will be held for further consideration where feasible.

Proposal 5: Consider historic tub shape using alternate structural concrete members.

Current Design: Welded steel box girders are currently proposed.

Design Suggestion

Advantages	Disadvantages
· Potential cost savings · Reduces maintenance · More concrete availability · Utilizes more readily available material	· More difficult erection · Concrete beams are more difficult to frame ·

Idea 44

Discussion:

This proposal simply reinforces what will likely be determined through the structure selection process. Subsequent to construction of the Vail Pass bridges, concrete structure types have come into more widespread usage because of such considerations as initial cost, maintenance costs and local availability. If the concrete structure type can satisfy Aesthetic Guidance/PA/EA requirements (shape, form, color, etc.) while remaining cost-effective and constructible it should be retained as a candidate solution in the structure selection process.

Consensus:

An alternative tub shape will be considered in the INFRA Grant scope design. The proposal is accepted with modifications.

Proposal 6: Shift Westbound Alignment and Replace Structure F-11-AX on Existing Alignment.

Current Design: The current design proposes to shift the WB alignment to the north at structure F-11-AX and replace this bridge north of the existing bridge. The alignment shift results in substantial tiered cut wall on north side of I-70 east of the structure.

Proposal Eliminated

Advantages	Disadvantages
· Eliminates Bridge · Reduction of north side cut walls · Potential to stabilize landslide · Provides opportunity to use site material	· Adds large retaining wall · Potential political fatal flaw · Drainage considerations · Aesthetic concerns

Idea 45

Discussion:

This suggestion is to look for opportunities to replace structure F-11-AX on the existing alignment. If this can be accomplished, there could be substantial cost savings resulting from the elimination of the structure as well as reductions in cut wall heights on the north side of the highway.

This idea proposes to use fill walls along with slope stabilization techniques to eliminate the bridge, use embankment material to fill this gap, and buttress the landslide area.

Ultimately, after additional consideration and development this proposal was eliminated from being recommended due the location of this wall with regards to the aesthetic and political considerations in this area.

The design team could continue to look for phasing, temporary bridge options to the north to minimize impacts of the alignment shift.

Consensus:

The proposal will be held for further consideration.

Proposal 7: Incorporate a public turnaround point halfway up the pass.

Current Design: The current design does not include a public turnaround point on Vail pass between Exits 180 and 190 to return to the town of Vail.

Added Cost: $2,864,809

Advantages	Disadvantages
· Improves operations · Clears traffic jams · Adds mobility · Facilitates traffic turnaround	· Adds cost · May need acceleration lane or police control · May need FHWA approval · Adds maintenance · Promotes illegal parking · Environmental impacts

Idea 49

Discussion:

Currently turn around points on Vail Pass between exits 180 and 190 are full diamond interchanges. There are also median emergency vehicle turnaround points on the pass typically used for police, fire and authorized vehicles. The public does not have the opportunity to turn around and is often held in long traffic jams and experiences excessive waiting on the highway while accidents are cleared, during closures, when chain laws are implemented, when weather turns, etc.

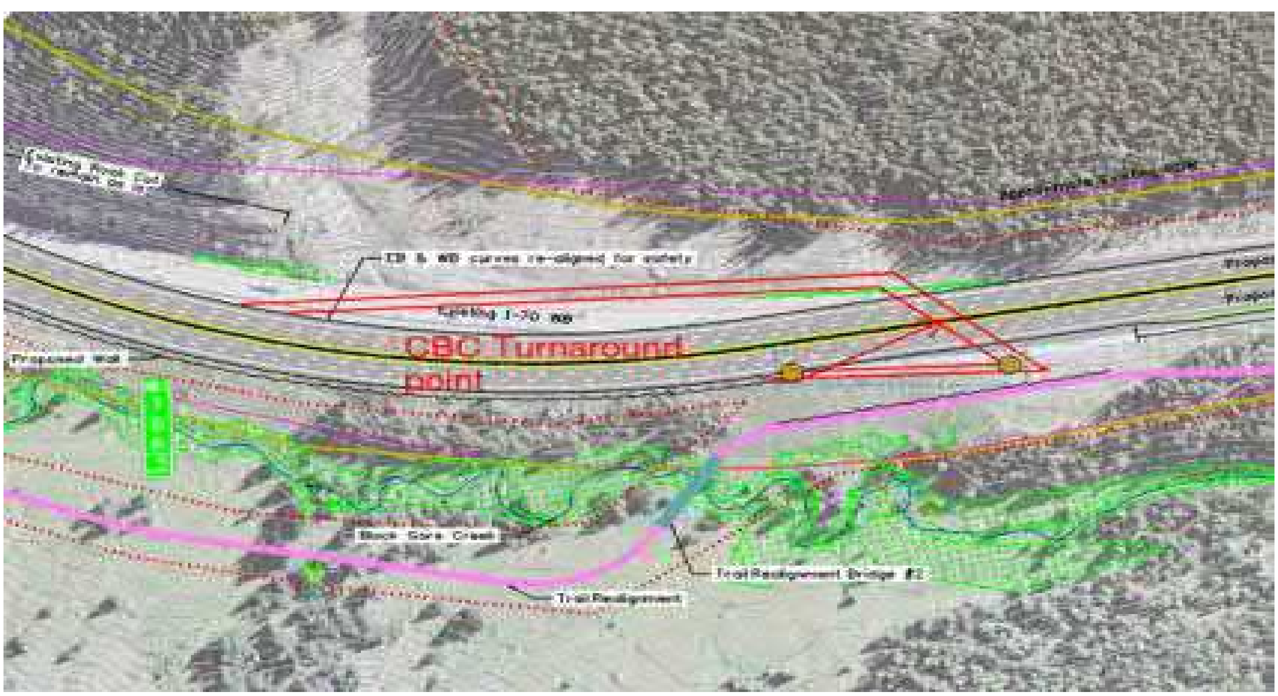
This proposal suggests an EB turnaround point half way up the pass that could be used either daily, only during incidents to bleed off the highway, only for cars not trucks, all vehicles, at all times, only as directed by police, designed for single lane use and large enough for commercial vehicles, etc. The overall plan set shows 5 median turn around points, but these would not be useful for general purpose traffic. If general purpose traffic is to turn around during incidents and with the direction of the police, it puts all of those involved in harm's way and in unsafe conditions. It also at times can force a closure in the opposite direction to bleed off the highway using the turnaround which congests the opposite direction of traffic and requires additional resources and coordination. Therefore, the drivers and police have very little choice than to sit on the highway.

This proposal suggests a box culvert similar to the Eisenhower Tunnel grade which has a taper type exit and entrance exit, is not signed, and is only used for emergencies with the allowance for all vehicles to use this suggested box culvert. Gates may be installed to control access during normal operations when the turnaround point is not needed.

A similar turnaround point is on I-70 in the EB direction on the Eisenhower Tunnel grade but is only used by emergency vehicles and is a one-way culvert box as see in the picture on the next page. This turnaround is not signed for use and it is not clear how it is used and by whom. The box large enough to fit a fire truck. The box can fill with ice making maintenance difficult.

Figure 1 - Example of Box Culvert for Emergency Vehicle Turn Around half way between Silverthorne and Eisenhower Tunnel

Figure 2 - Concept design and location MP 186.2 to 186.5 EB I-70



Estimate:

COST WORKSHEET					Proposal No:	7
					Idea No:	49
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
				$ -		
Proposed Design						
37'X13' Conc box (precast) Item 603-73713	108	LF			$5,500	$ 594,000
CBC Wingwall (precast) Item 603-72100	125	LF			$6,500	$ 812,500
HMA (item 310 8-12in)	6,720	SY			$4	$ 26,880
Road Closure Gates with power and lights	2	Each			$50,000	$ 100,000
Guardrail and end anchorages	1	LS			$50,000	$ 50,000
						$ -
Total:				$ -		$ 1,583,380
Markup	80.93%			$ -		$ 1,281,429
Totals				$ -		$ 2,864,809
Savings:				$ (2,864,809)		

Consensus:

The proposal will be held for further consideration where feasible.

Proposal 8: Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.

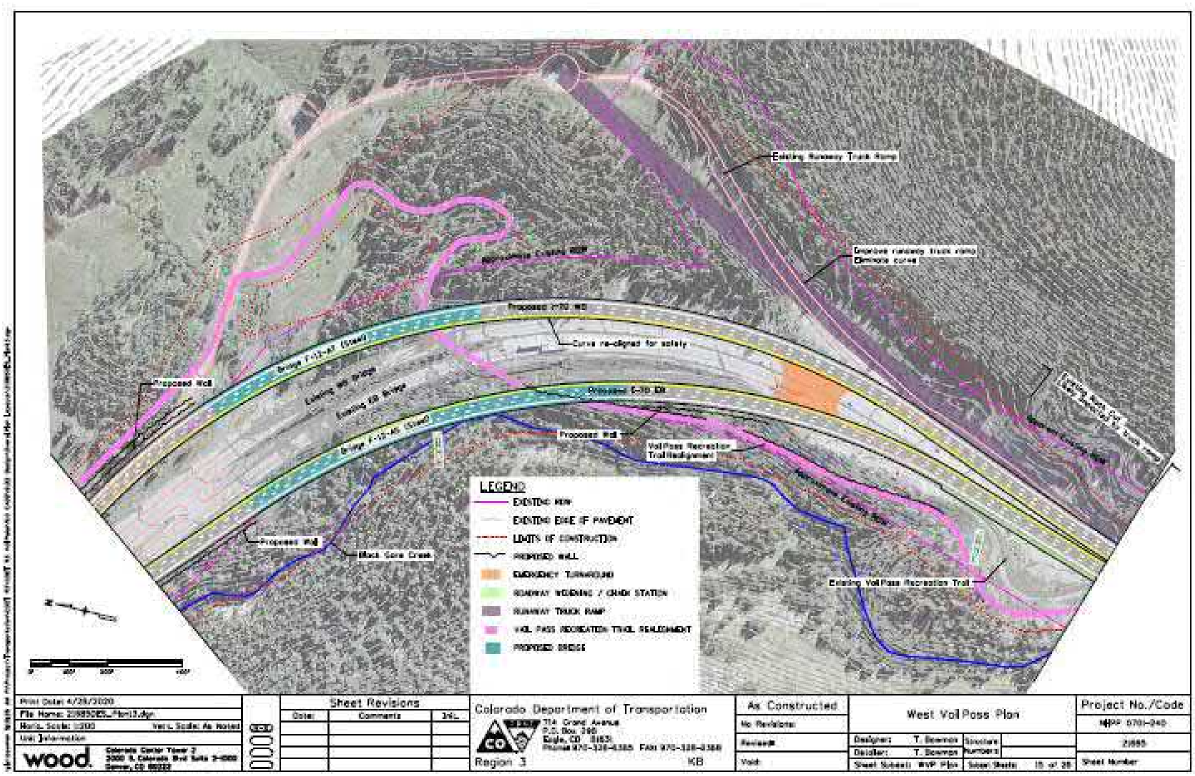
Current Design: The current design constructs a new WB bridge at a larger radius adjacent to the current WB bridge. It also constructs a new EB parallel to the existing EB bridge

Cost Savings: $7,333,093

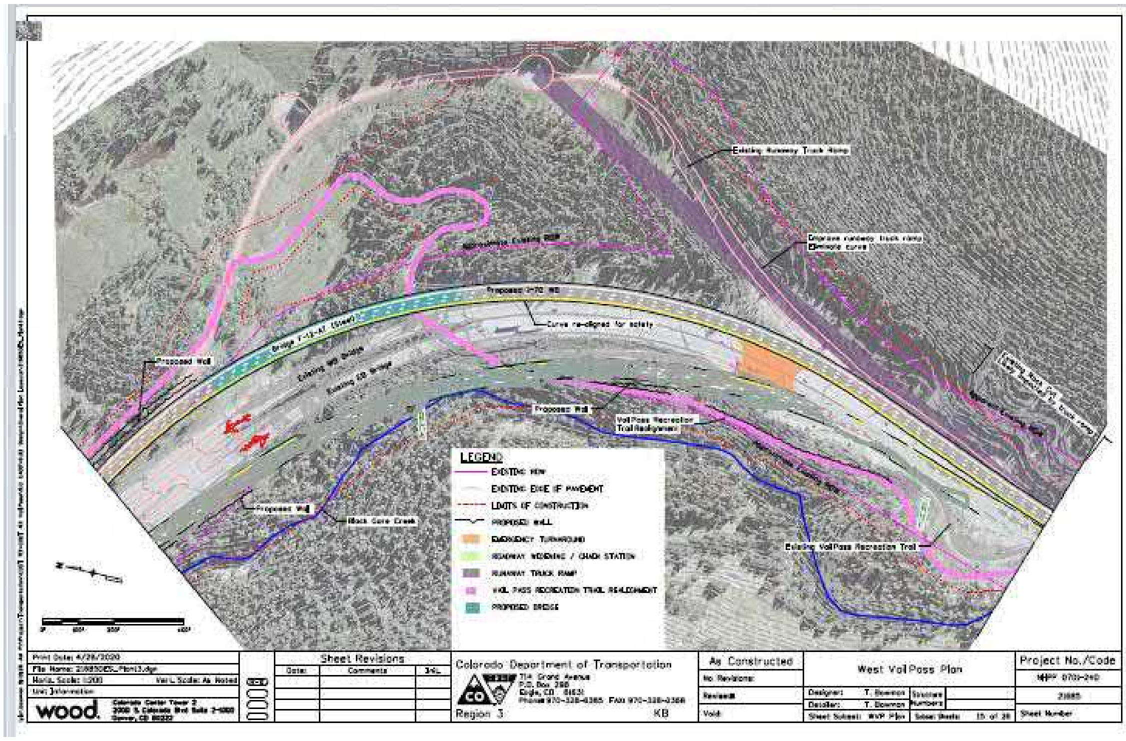
Advantages	Disadvantages
· Improve EB radius · Saves cost · Maintain or improve geometry · Less Environmental Impact	· Increases construction time · Loss of emergency turnaround

Idea 47

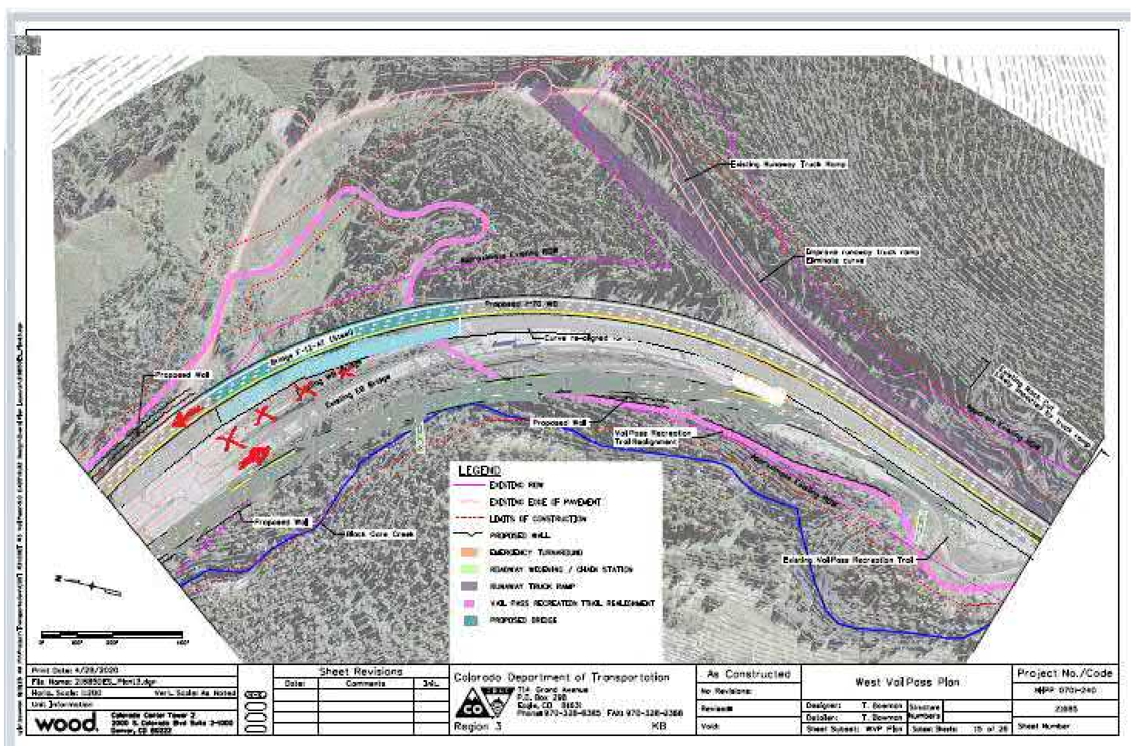
Discussion:



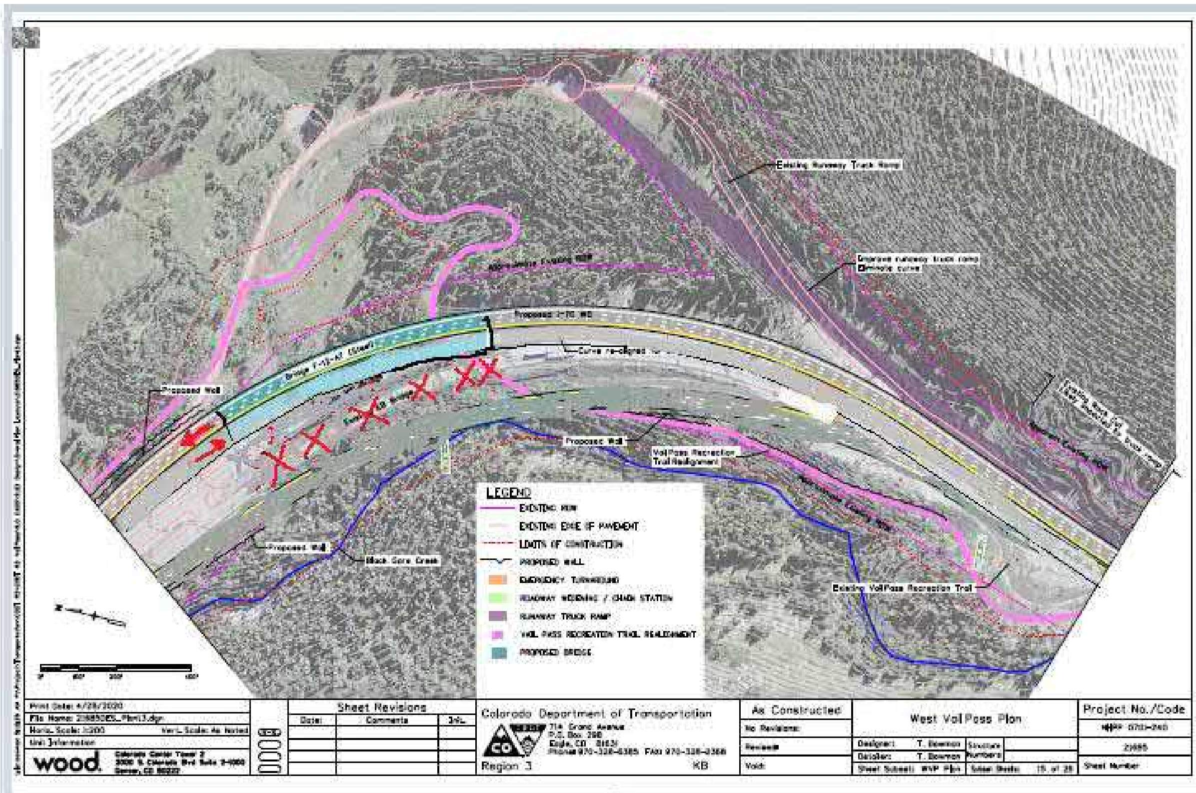
The current design constructs a new WB bridge at a larger radius adjacent to the current WB bridge. It also constructs a new EB parallel to the existing EB bridge with a larger radius.



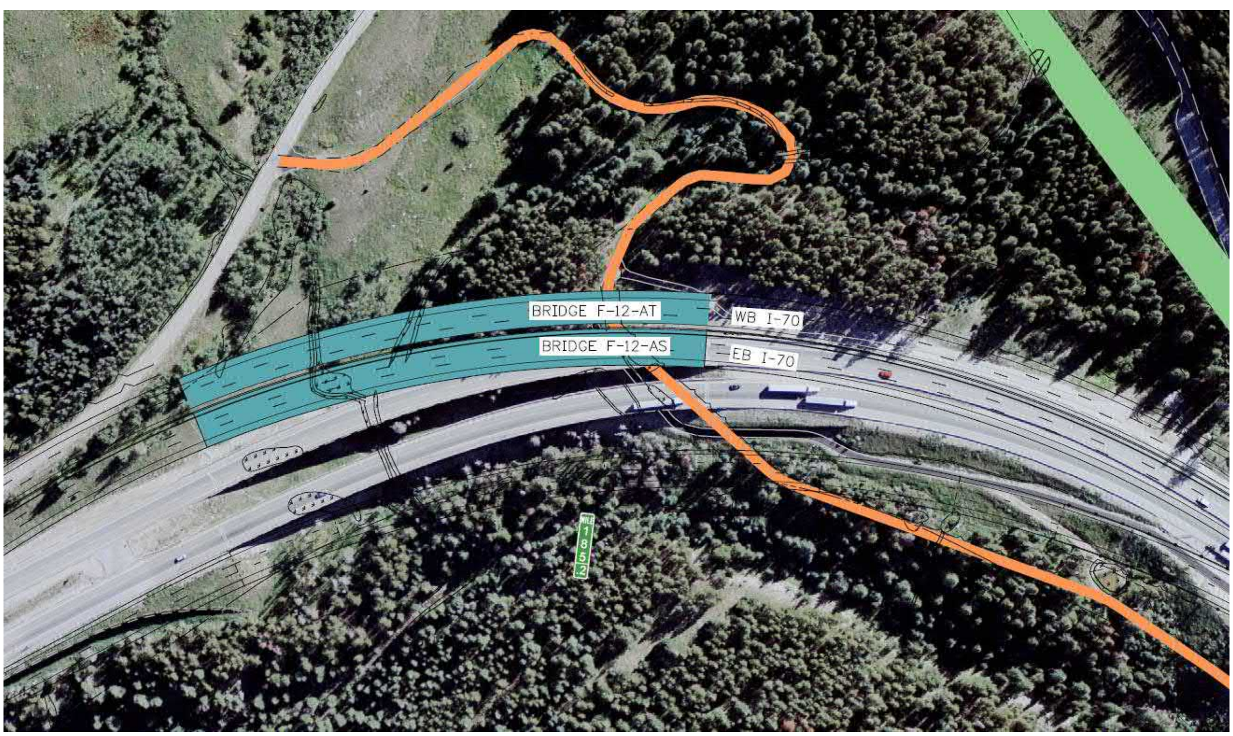
The Proposed Design constructs the same new WB as the original Design. EB & WB traffic remains on their respecting existing during construction.



Once the new WB bridge is complete, WB traffic is shifted on to it. The existing WB bridge is demolished and a new EB Bridge is constructed parallel to it. EB traffic remains on its existing bridge.



Once the new EB bridge is complete, EB traffic is shifted on to it. The existing EB bridge is demolished.



Proposed Condition

The benefits to this approach are

- Improve EB radius – The Proposed EB radius is much larger than the Current Design.
- Saves cost -
- Maintain or improve geometry
- Less Environmental Impact – Black Gore Creek runs parallel to the existing EB alignment. Since the Proposed EB alignment is moved to be on top of the existing WB alignment, there will be less environmental impact than pushing the alignment to the outside of the existing embankment footprint and impacting the area adjacent to the creek.

The Disadvantages are:

- Increases construction time – The construction will take longer because the existing WB bridge must be demolished before the new EB bridge can be constructed.
- Loss of emergency turnaround – Because the two alignments are being pushed together, there is no wide inside shoulder to allow for an emergence turn around.

Estimate:

Most savings are the savings in the EB bridge length.

There will be some savings in earthwork by reusing the WB embankment for the EB realignment.

Current Design:

- EB Bridge Length – 980'
- WB Bridge Length – 760'
- Bridge width = 3 x 12 ft + 6 ft shoulder + 10 ft Shoulder + 2 x 1.5 ft barriers = 55 ft
- Embankment for New EB Bridge Construction
    - 55 ft wide x 300 ft long x 30 ft high /27 ft3/yd3 x ½ for the wedge x 2 sides of bridge = 18,333 yd3, say 18,500 yd3

Proposed Design:

- EB Bridge – 730'
- WB Bridge – 760'
- Bridge width = 3 x 12 ft + 6 ft shoulder + 10 ft Shoulder + 2 x 1.5 ft barriers = 55 ft

COST WORKSHEET					Proposal No:	8
					Idea No:	47
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
WB Bridge						
760 ft x 55 ft	41,800	SF	$ 220	$ 9,196,000		
EB Bridge						
980 ft x 55 ft	53,900	SF	$ 220	$ 11,858,000		
Embankment	18,500	CY	$ 30	$ 555,000		
Proposed Design						
WB Bridge						
760 ft x 55 ft	41,800	SF	\		$220	$ 9,196,000
EB Bridge						
760 ft x 55 ft	41,800	SF			$200	$ 8,360,000
Total:				$ 21,609,000		$ 17,556,000
Markup	80.93%			$ 17,488,164		$ 14,208,071
Totals				$ 39,097,164		$ 31,764,071
Savings:				$ 7,333,093		

Consensus:

The proposal will be held for further consideration by Bridge Enterprise in the INFRA Grant scope design.

Proposal 9: Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.

Current Design: The current design, according to Appendix C document, reconstructs new WB and EB on new concentric alignments

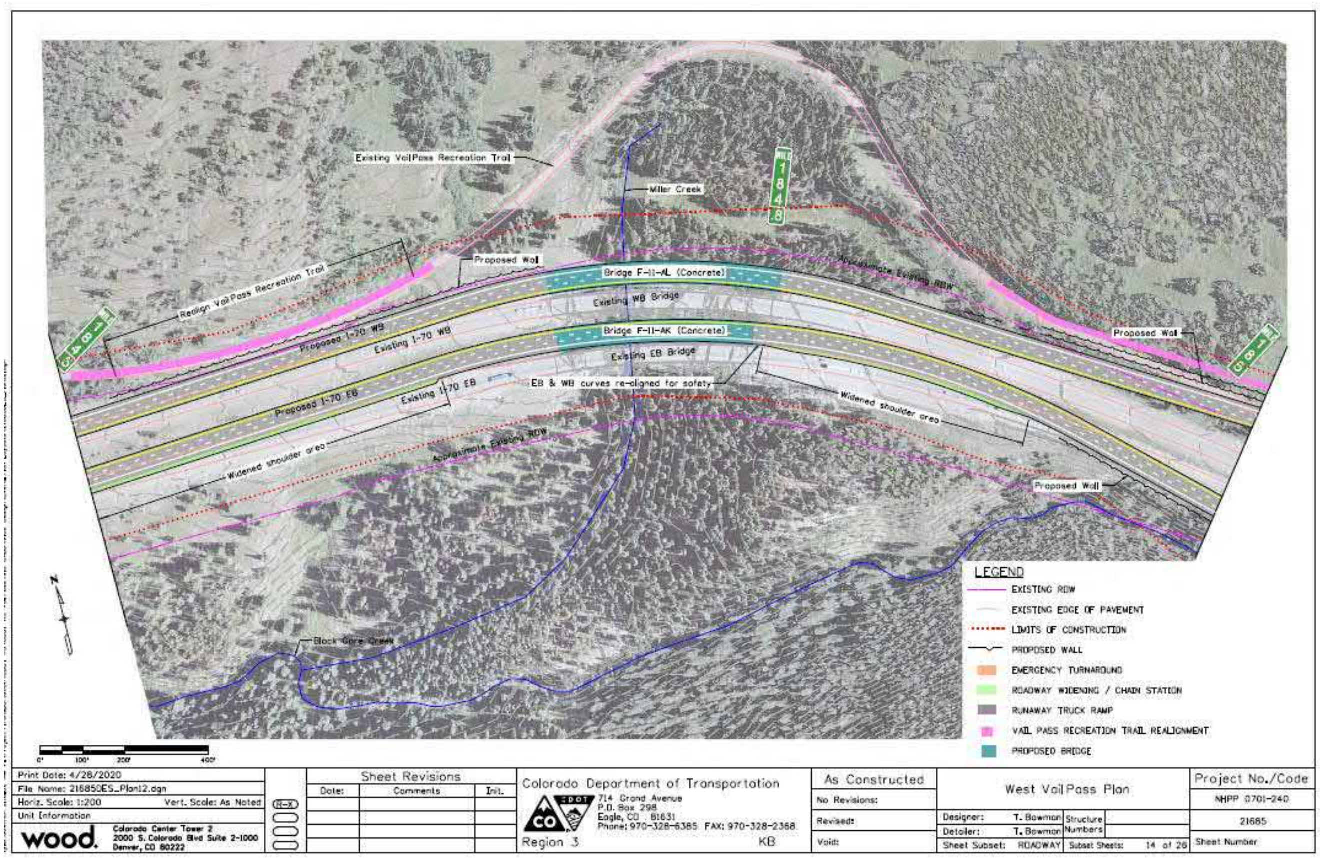
Proposal Eliminated

Advantages	Disadvantages
· Improve EB radius · Saves cost · Maintain or improve geometry	· Increases construction time

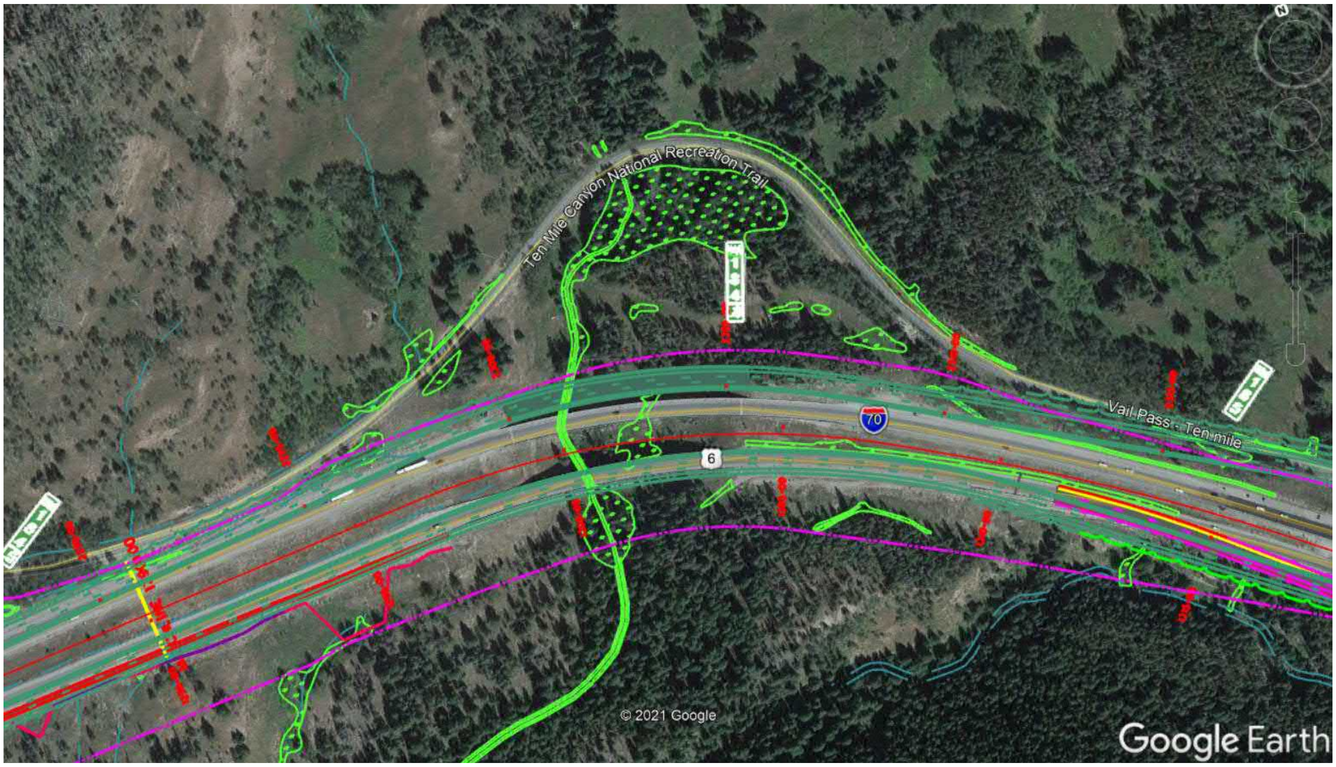
Idea 48

Discussion:

The new WB and EB alignments are parallel (or concentric) to the existing alignments. This makes construction straight forward.



Upon review of the Google Earth KMZ file, it appears the design team has also adopted this idea of building the new EB alignment on its existing alignment.



As this proposal is already within the scope of the project further consideration is eliminated.

Consensus:

The proposal will be held for further consideration.

Proposal 10: Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.

Current Design: The current design enhances the existing truck parking which begins at approximately MP 189.25. The existing pull off for a truck to remove chains is widened to provide a safer area to park and or perform the chain removal and allow other trucks to drive by. A widened area between the truck parking and I-70 is intended to provide more area for snow storage.

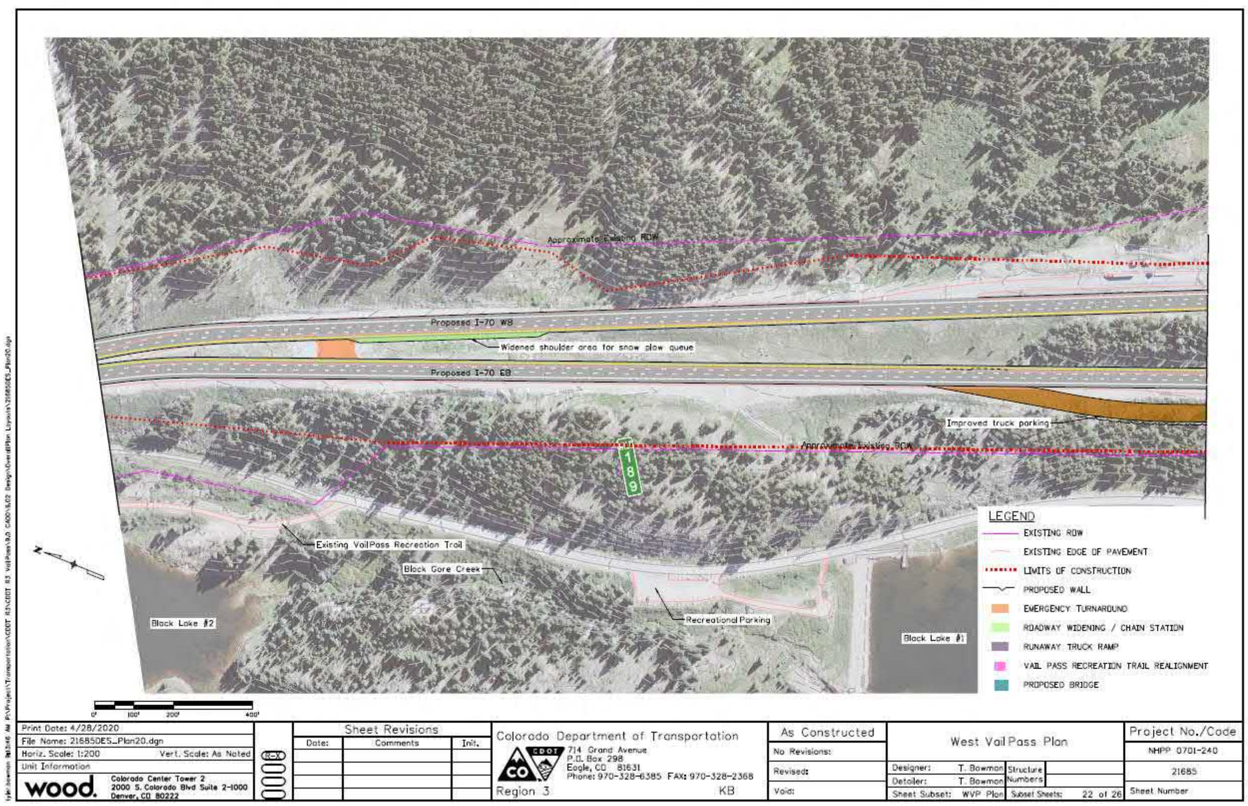
Cost Savings: $3,259,997

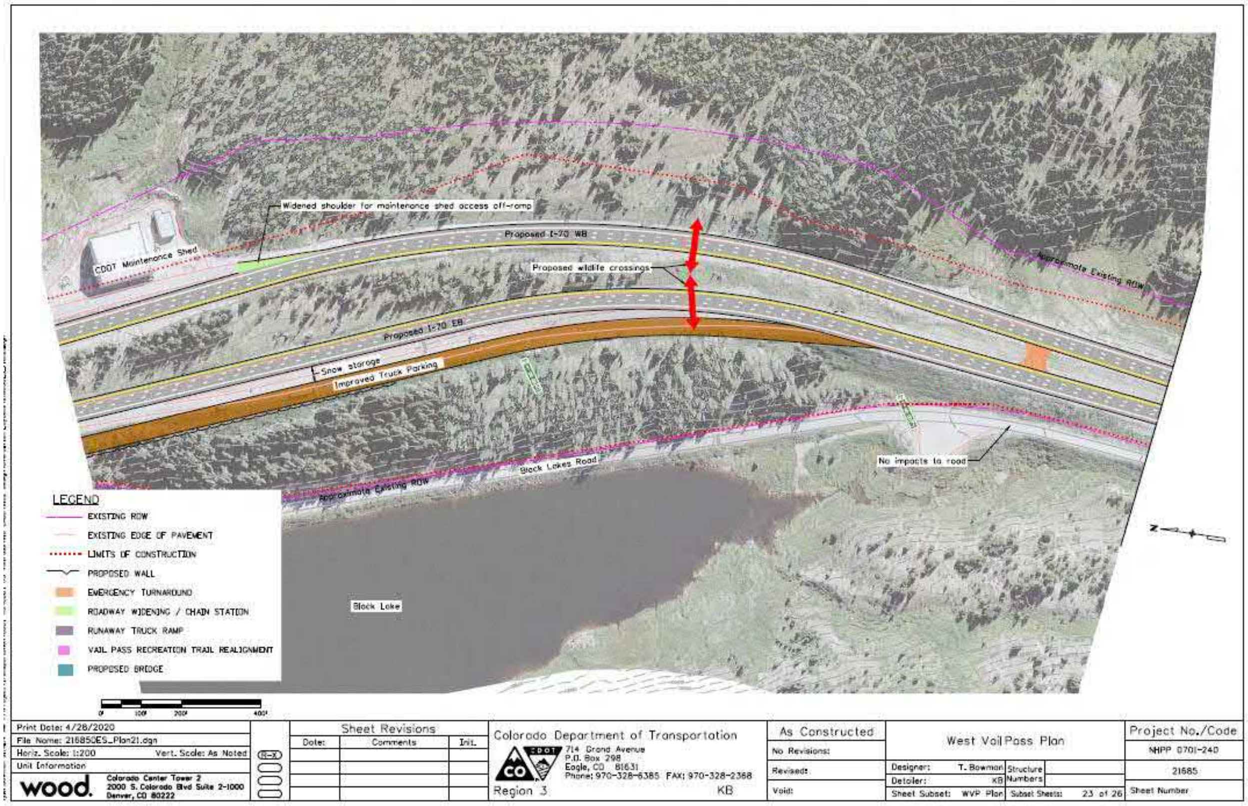
Advantages	Disadvantages
· Saves cost · Possibly less impact to environmentally sensitive area · Reduce wildlife crossing width · Snow storage area not needed · Eliminates retaining wall	· Less chain down area for trucks

Idea 34

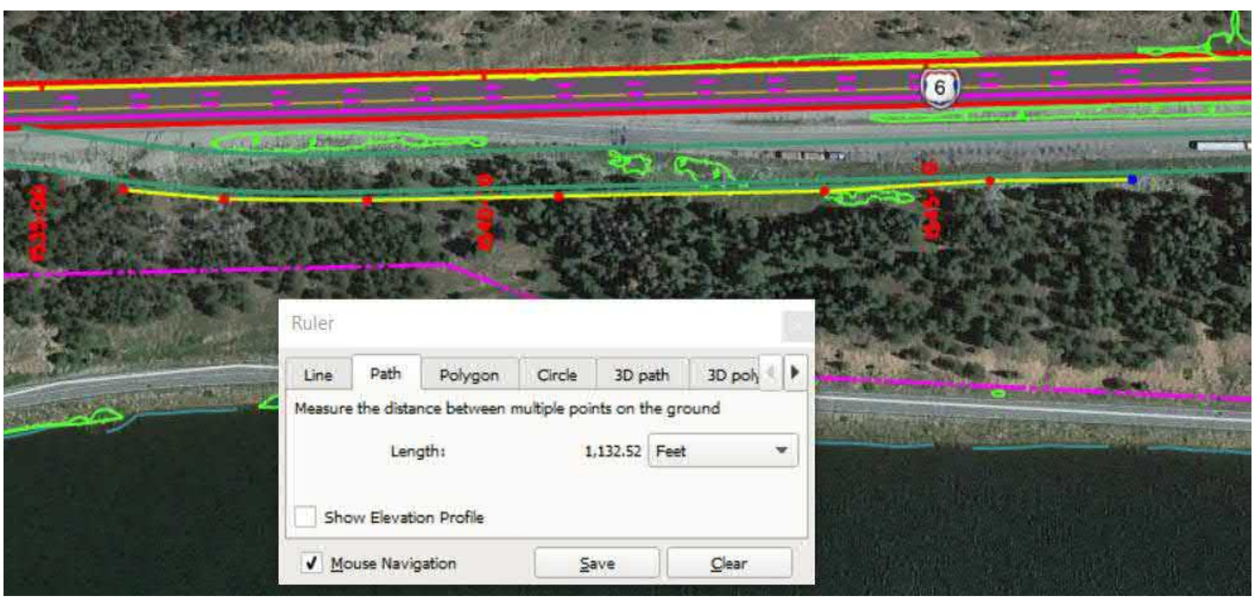
Discussion:

The following two drawings are from the I-70 Auxiliary Lanes report – Appendix C:





Using the provided Google Earth KMZ file, it appears the wall draw is approximately 1100 feet long.

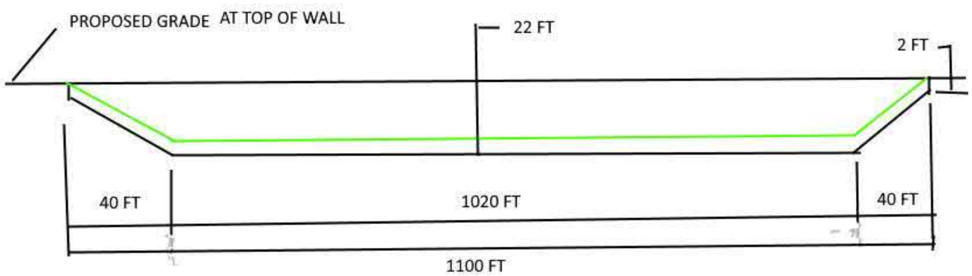


Based on the contours in the project roll plots, the wall could be as high as 20-25 feet to catch the slope heading towards Black Lake Number 1. The construction of the wall and presence of the additional truck parking would have a negative visual impact for the trail users along the Ten-Mile Canyon National Recreation Trail.

Assuming the truck parking is needed, the pavement section will be used wherever it is placed. The real savings is due to eliminating the retailing wall.

Estimate: The approximate square footage of the wall is estimated below.

- 1100 feet long
- Starts at 0 feet high with 2 feet embedment and ends at 0 feet high with 2 feet embedment
- Taper at a 2:1 slope along the wall to 20 ft exposed with 2 feet embedment



Area of wall = 2 X 1100 FT + 20 X 40 FT X 2 / 2 + 1020 FT X 20 FT = 23,400 SQ FT

COST WORKSHEET					Proposal No:	10
					Idea No:	34
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
See sketch	23,400	SFT	$ 77.00	$ 1,801,800		
Proposed Design						
					$0	$ -
Total:				$ 1,801,800		$ -
Markup	80.93%			$ 1,458,197		$ -
Totals				$ 3,259,997		$ -
Savings:				$ 3,259,997		

Notes: Assume that additional parking will be provided in an area that will not require a retaining wall

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design.

Proposal 11: Shorten north end of bridge over Polk Creek and convert to MSE wall.

Current Design:

The EB I-70 Bridge over Polk Creek (Structure F-12-ASA, M.P. 185.2) is preliminarily designed with 7 spans and a total length of 1,203'. The overall width is 55'. Structure type is Welded Steel Box Girder (Continuous). Abutments appear intended to be full height MSE Walls; MSE walls retain roadway approaching abutments on the right side.

Cost Savings: $4,801,402

Advantages	Disadvantages
· Saves cost · Reduces bridge cost · Reduces long-term bridge maintenance · Faster construction	· Aesthetic impact · Trail needs to be rerouted around MSE wall abutment · Additional MSE wall requirements

Idea 35

Discussion:

The proposal is to eliminate the south span and reduce the next span of the bridge (overall length reduction of approximately 300') and replace with MSE Wall on the right side and fill on the left side. Roadway pavement, base, and guardrail would be extended accordingly, see Figures 1 and 2.

In addition, the Trail alignment would be modified to push out around the shifted abutment location, but then kept parallel to the new MSE wall to reduce the overall amount of wall needed for the Trail.

See Figure 3 for Cross Sections of this area.

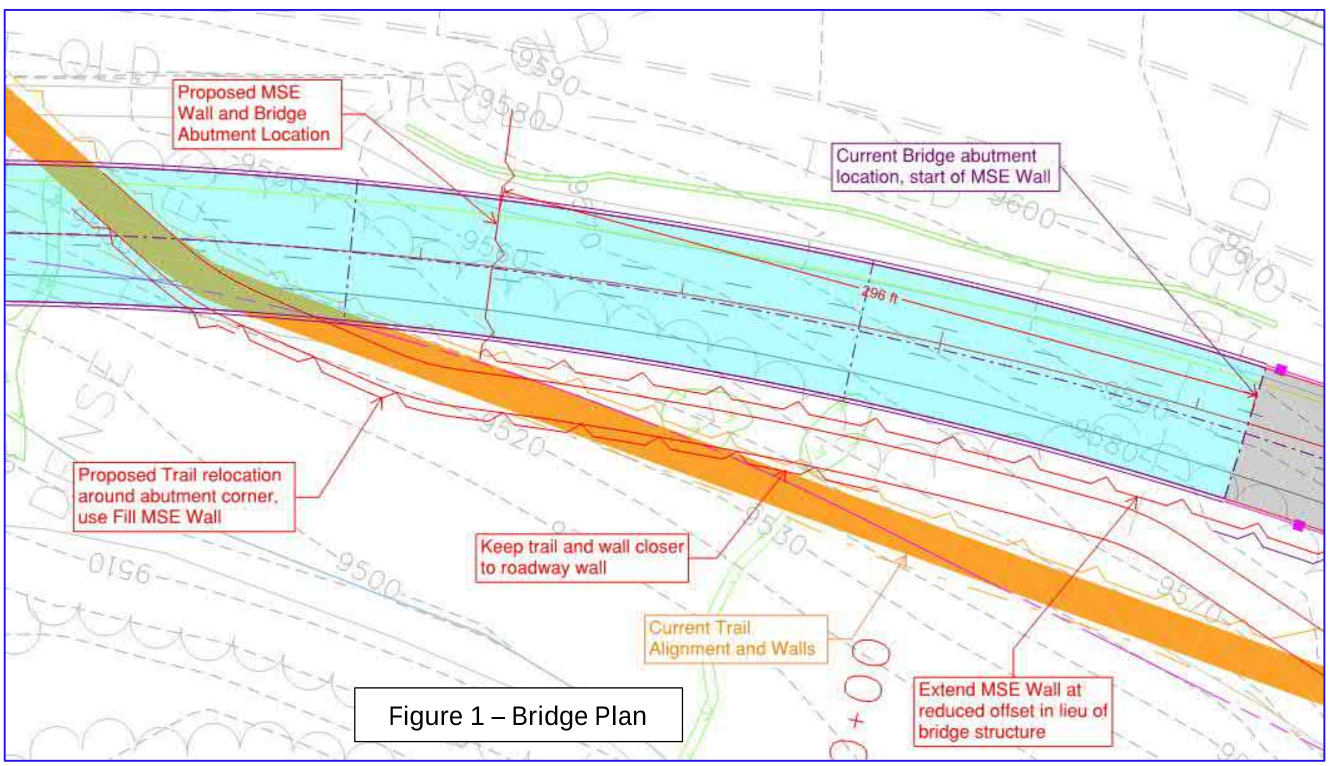


Figure 1 – Bridge Plan

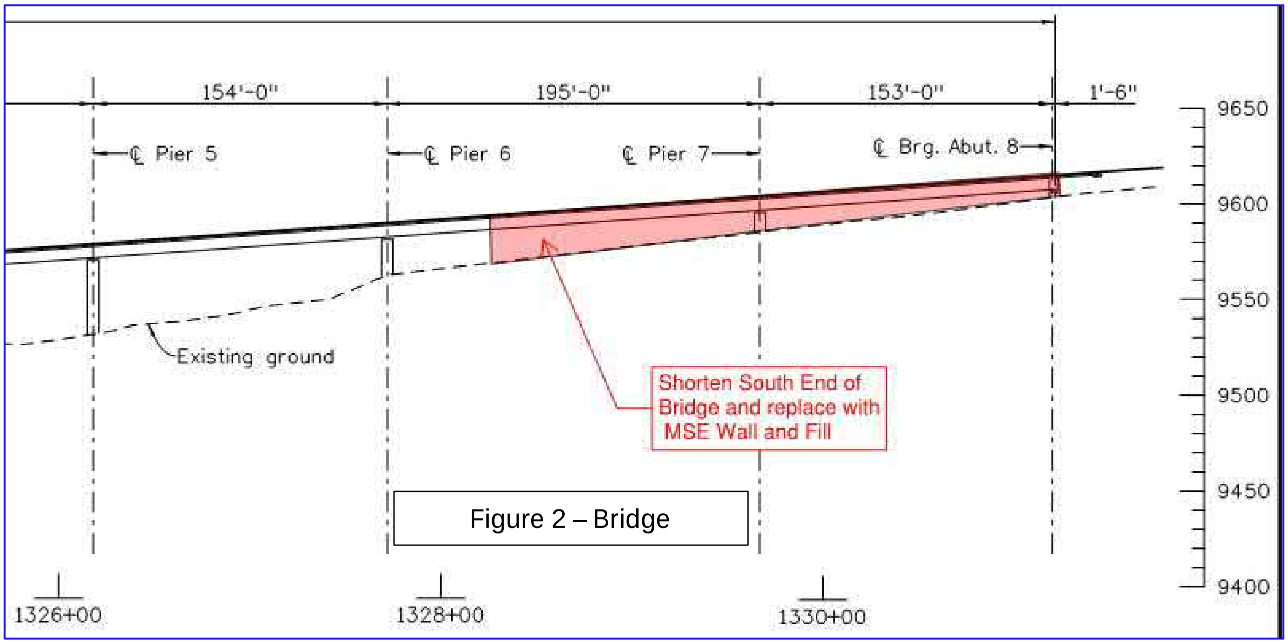


Figure 2 – Bridge

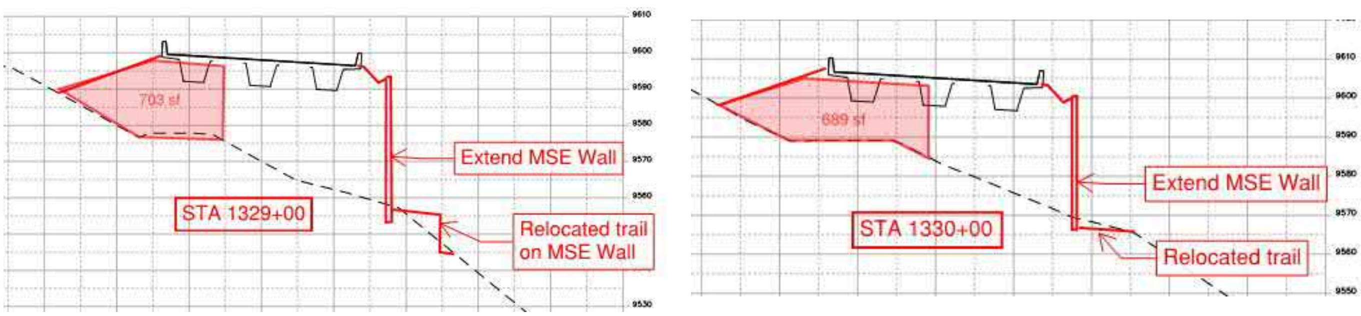


Figure 3 – Cross Sections

Estimate:

COST WORKSHEET					Proposal No:	11
					Idea No:	35
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Bridge Deck	16,280	SF	$ 220	$ 3,581,600		
MSE Wall in Front of Abut	1,500	SF	$ 77	$ 115,500		
MSE Wall for Trail	9,000	SF	$ 65	$ 585,000		
				$ -		
				$ -		
Proposed Design						
Bridge Deck	0	SF		$ -	$ 220.00	$ -
MSE Wall in Front of Abut	1,875	SF		$ -	$ 77.00	$ 144,375
MSE Wall Parallel to Road	8,700	SF		$ -	$ 77.00	$ 669,900
MSE Wall for Trail	6,000	SF		$ -	$ 65.00	$ 390,000
Roadway Pavement	1,040	TON		$ -	$ 121.00	$ 125,853
Roadway Base Course	549	TON		$ -	$ 34.00	$ 18,681
Roadway Embankment	7,778	CY		$ -	$ 29.00	$ 225,556
Guardrail Type 9	600	LF		$ -	$ 90.00	$ 54,000
Total:				$ 4,282,100		$ 1,628,365
Markup	80.93%			$ 3,465,504		$ 1,317,836
Totals				$ 7,747,604		$ 2,946,201
Savings:				$ 4,801,402		

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope bridge design.

Proposal 12: Consider Anchor Slab on Top of Walls.

Current Design: The current design proposes constructing fill walls that have a bench and offset from the roadside barrier to the top of wall.

Design Suggestion

Advantages	Disadvantages
· Reduces footprint · Reduces wall height · Potential to save cost	· Potentially more difficult to construct next to travel lanes · Access for future repairs

Idea 40

Discussion:

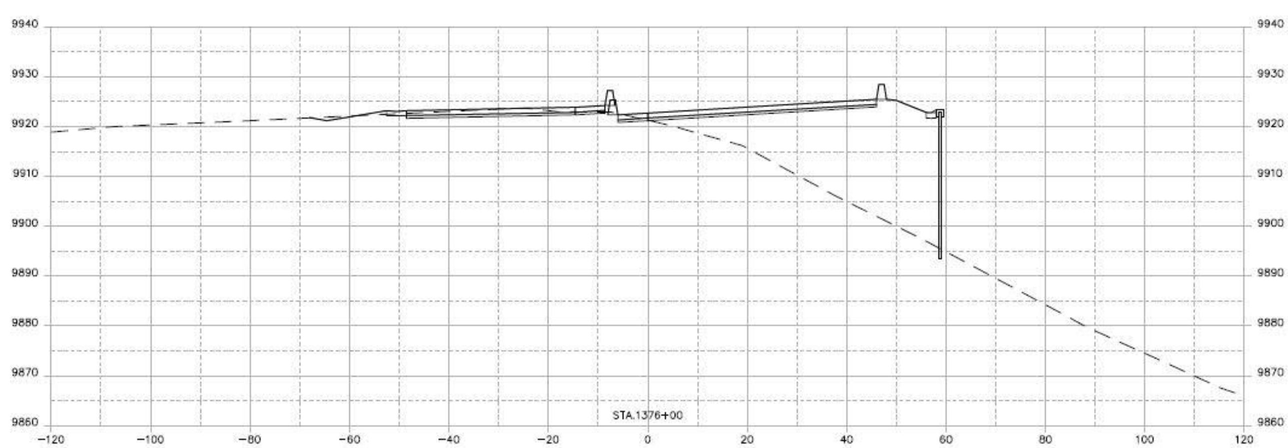
This design suggestion is to consider using an anchor slab on top of the fill walls with integral barrier in select locations as opposed to the current offset proposed in the current design. Quantification of the cost/schedule impacts are unknown without further design/refinement but could be advanced by the design/contractor team if this proposal is considered further.

The current design approach for the fill walls use as offset from the back of barrier/guardrail to provide the stability for the roadside barrier with the bench and slope to the top of wall. This proposal would use the anchor slab to provide the stability required and allow the wall to be shifted back towards the roadway towards the base of the barrier.

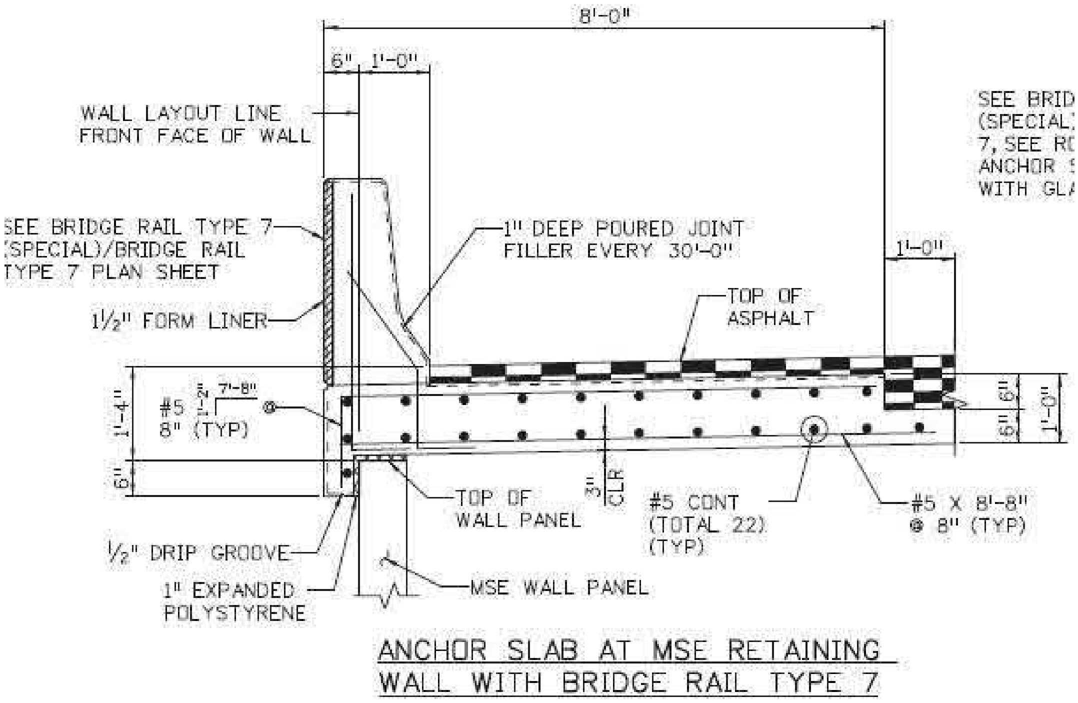
Benefits of this design suggestion would include reduction of wall height/facing, reduction of fill material required, and reduction of wall footprint/impacts. Additional considerations should include maintenance access, loss of snow storage over the barrier onto bench, as well as balancing earthwork. Depending on the location of the wall and phasing, constructability adjacent to the travel lanes should also be considered regarding the retained and reinforced fill zones as well as back slopes required for construction.

Costs that need to be considered would need to include concrete/steel for the anchor slab versus the additional fill material and wall height in the current design.

The following figures present a project cross section and an example detail for the anchor slab for reference.



Project Cross Section



Example Anchor Slab Detail

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design where snow storage and sediment capture is not needed behind barriers.

Proposal 13: Consider anchor slabs for short walls

Current Design: The current design proposes to construct fill walls that transition to cut/fill slopes at short heights with steep back slopes.

Design Suggestion

Advantages	Disadvantages
· Potential to save cost · Potential to improve aesthetics in constrained visible areas	· Potentially more difficult to construct next to travel lanes

Idea 39

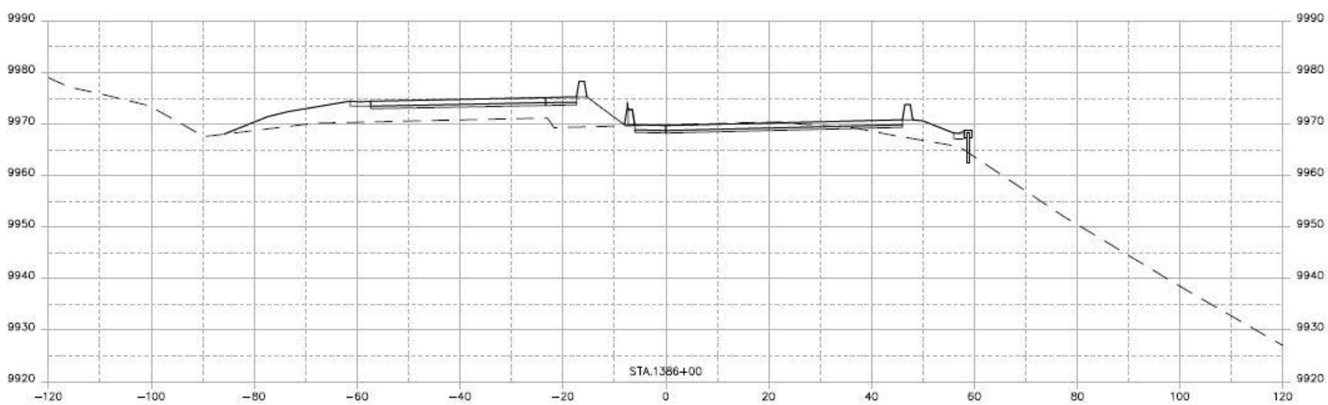
Discussion:

This design suggestion is to consider using an anchor slab in lieu of retaining wall in select locations that have a grade difference of less than approximately three feet. Instead of a retaining wall in these locations, this suggestion is to use an anchor slab system that is able to retain the material without the need for an additional retaining wall.

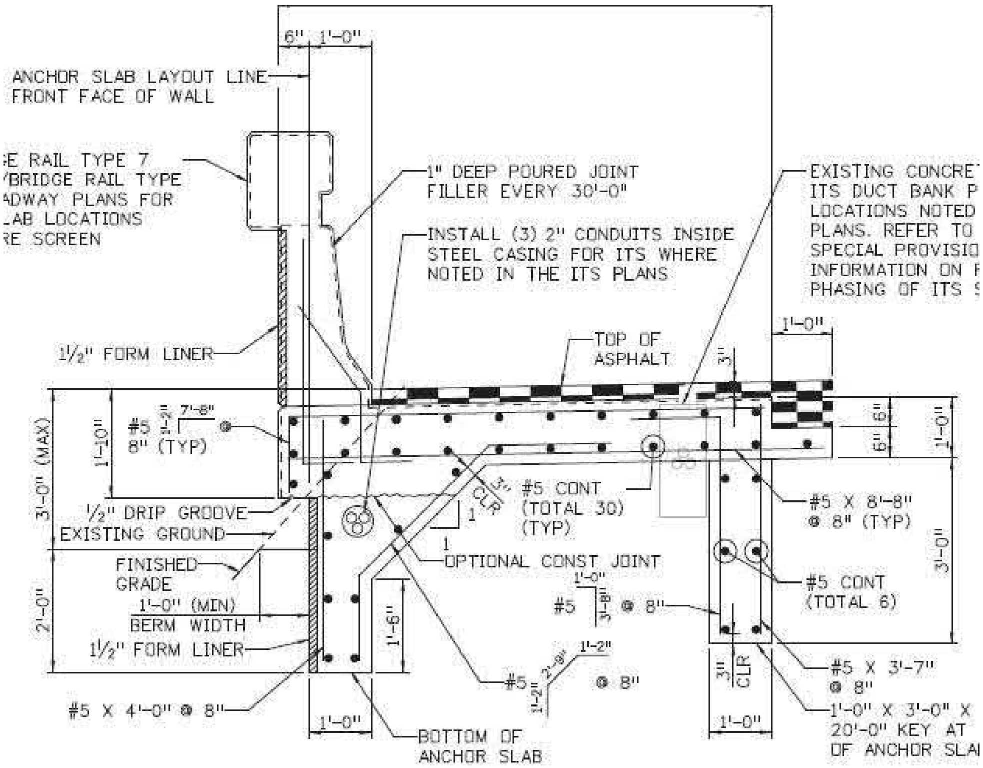
Application of this design suggestion would be for areas where widening with walls is proposed in a constrained area such as the median that has aesthetic requirements that could be incorporated into the slab face or as a fascia. Conversely, this application may also be used in exterior widening areas.

Quantification of the cost/schedule impacts are unknown without further design/refinement but could be advanced by the design/contractor team if this proposal is considered further. Costs that need to be considered would include concrete/steel for the anchor slab versus the wall materials required for these shorter walls.

The following figures present a project cross section and an example detail for the anchor slab for reference.



Project Cross Section and Potential Application Locations



Example Anchor Slab Detail

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design.

Proposal 14: Reduce offset of MSE walls from shoulder to reduce height.

Current Design: The face of the MSE walls is currently shown at a 13' offset from the edge of roadway shoulder. A Type 9 barrier is used at edge of shoulder, with slope paving and a gutter between the barrier and wall coping.

Cost Savings: $2,506,614

Advantages	Disadvantages
· Reduces MSE wall height and overall earthwork · Reduces project footprint · Saves cost	· Reduces maintenance access · May impact SCAP conveyance/collection behind wall

Idea 37

Discussion:

The proposed alternative is to reduce the offset to the face of MSE Walls to at least 9' (used recently on the I-25 MIRA D-B Project with Type 3 Guardrail, Fig 1), or even 4' (used on the US-36 D-B Project with Type 7 Guardrail, Fig 2). The CDOT Wall Worksheet B-504-E1 (Fig 3) allows a 3' offset to back of Type 3 guardrail post (approximately 5' to face of post/shoulder).

For wall offsets down to 5', Type 3 guardrail could be used in lieu of Type 9 for additional cost savings where allowed by drainage.

Wall offset reductions are proposed to be applied at the following locations within the INFRA Grant project (similar approach could be taken for ultimate):

- 1312+00 – 1319+20 (wall is being placed at ultimate location)
- 1331+20 – 1333+50
- 1355+50 – 1363+10
- 1370+80 – 1387+30
- 1443+00 – 1453+20
- 1462+75 – 1467+75
- 1489+00 – 1492+50
- 1502+20 – 1503+50

The estimate is based on changing from a 13' offset to a 9' offset and keeping Type 9 barrier and assumes a 2:1 slope at the toe for an average height reduction of 2', and an average 20' wall height for earthwork calculations.

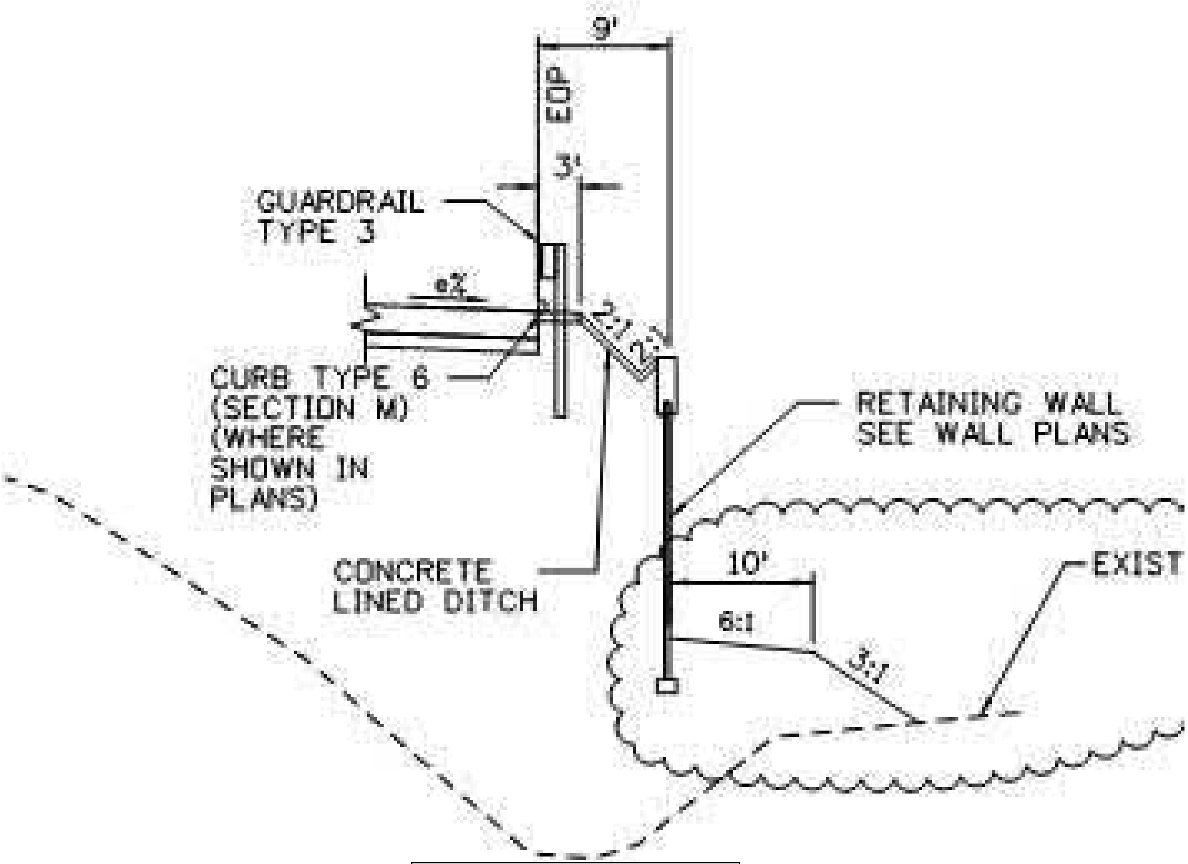


Figure 1 – I-25 MIRA D-

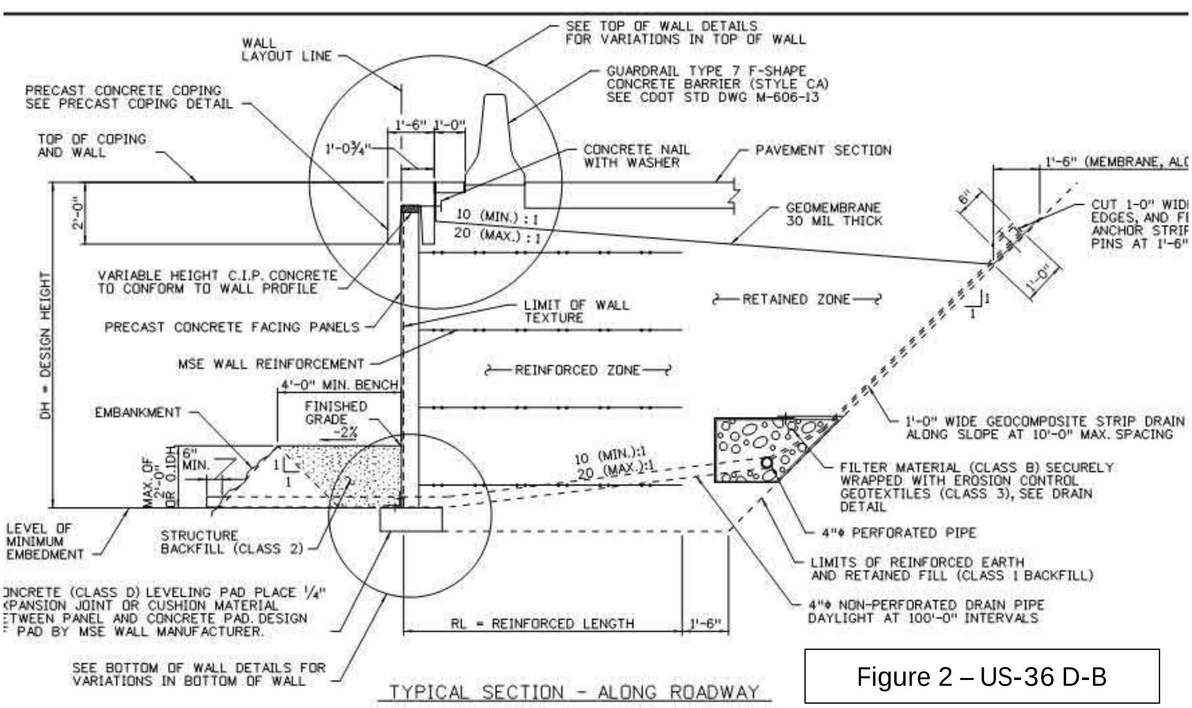


Figure 2 – US-36 D-B

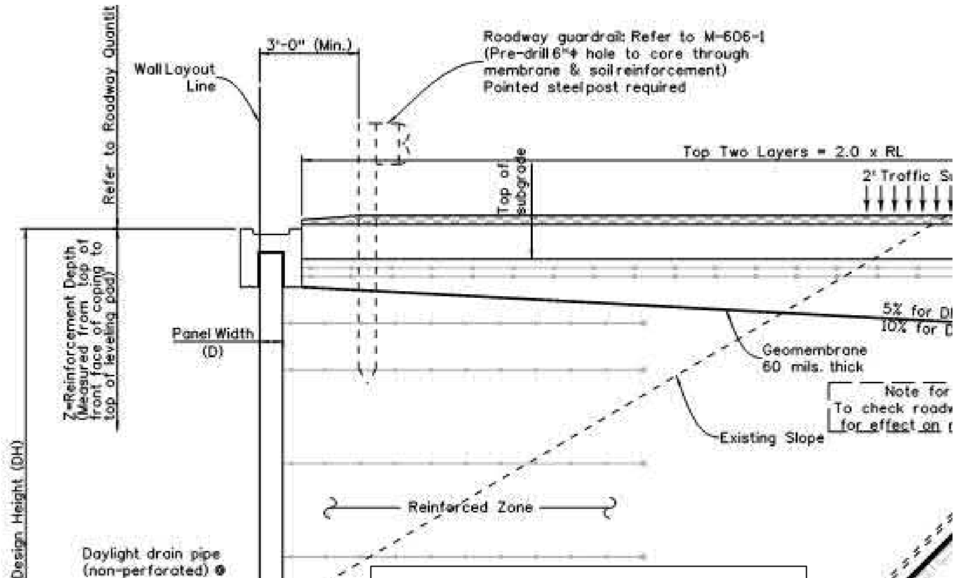


Figure 3 – CDOT Wall Worksheet

Estimate:

COST WORKSHEET					Proposal No:	14
					Idea No:	37
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
MSE Wall Extra Area at 13' Offset (2' height savings, 8 locations)	10,660	SF	$ 77	$ 820,820		
Slope Paving Extra Area at 13' Offset	21,320	SF	$ 5	$ 106,600		
Earthwork for Extra width (assume 20' avg height)	15,793	CY	$ 29	$ 457,985		
Proposed Design						
Current Quantities above would be eliminated	0	SF		$ -		$ -
Total:				$ 1,385,405		$ -
Markup	80.93%			$ 1,121,208		$ -
Totals				$ 2,506,614		$ -
Savings:				$ 2,506,614		

Consensus:

The proposal will be considered where feasible in the INFRA Grant scope design. The proposal is accepted with modifications. Sediment collection needs to be considered.

Proposal 15: Consider use of reinforced soil slope in lieu of retaining walls.

Current Design: Use of MSE Walls appear to be planned to retain new fill required for alignment shift and/or widening of the roadway on the downhill side of existing alignment.

Design Suggestion

Advantages	Disadvantages
· Saves cost over conventional MSE wall · More natural appearance · Potential to use existing soil for backfill · Less vulnerable to differential deflection	· Requires a larger footprint · May take more construction time · More susceptible to erosion

Idea 33

Discussion:

The use of MSE walls appears planned where alignment shifts and/or widening of existing lanes to the outside require fill placement on the downhill side of the road. MSE walls with pre-cast concrete faces can be expensive to construct, prone to differential settlement/distress, and can require periodic maintenance to address backfill materials loss at facing joints, displaced panels, graffiti, etc.

A design suggestion is being offered to consider reinforced soil slopes as an alternate to precast faced MSE walls. Use of reinforced soil slopes could eliminate costly precast wall facing units and could potentially be constructed at angles of up to 70 degrees from horizontal. Reinforced soil often uses on-site materials as backfill in lieu of an engineered or manufactured structure backfill if accounted for in design properties. Given that there is no hard facing on reinforced soil slopes, reinforced soil is more forgiving in terms of accommodating deflection due to differential settlement in transition areas of shallow to deep bedrock and differing soil foundation conditions. If revegetated properly, the reinforced slopes can be more natural in appearance.

Depending on the planned wall construction (height/benching/tiering), use of reinforced soil slopes may in some cases extend the toe of the fill slope beyond current limits which may encroach on ROW or environmentally sensitive areas. Since they do utilize reinforced soil, they may be more susceptible to sheet or rill type erosion, which, if left unaddressed over time, can result in gully erosion. Generally, more layers of reinforcement geotextiles or geogrids are required, and additional care is required when placing fill over these materials to avoid damage. This combination may result in additional construction time requirements in lieu of conventional MSE wall systems.

Consensus:

The proposal is not feasible due to erosion and sediment control needs. The proposal is rejected.

Proposal 16: Eliminate additional 3' offset to higher cut walls in trail section

Current Design: Typical Section for the Trail where adjacent to cut walls >3.5' in height shows an additional 3' offset between 2' ABC shoulder and face of wall.

Design Suggestion

Advantages	Disadvantages
· Reduced outside wall height · Reduced section width · Reduced footprint and impacts	· Possibly less snow storage for trail · More closed-in feeling to users

Idea 8

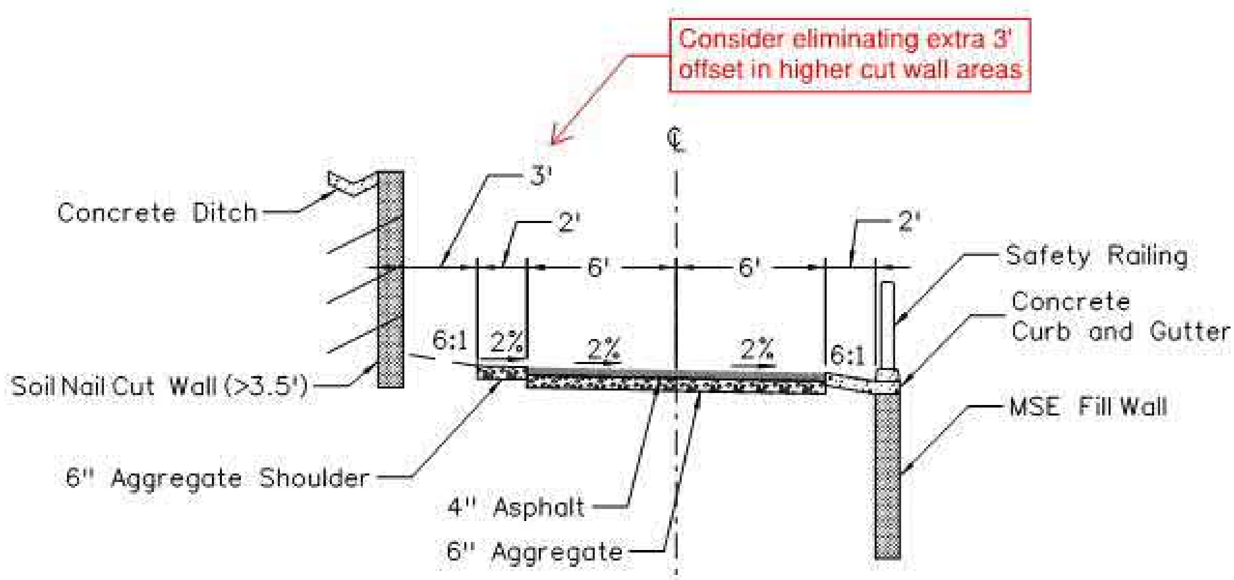
Discussion:

The proposal is to eliminate or reduce the extra 3' offset to face of walls. The trail paved section is 12' wide, with 2' ABC shoulders on each side, which already mitigates the closed-in feeling when adjacent to walls.

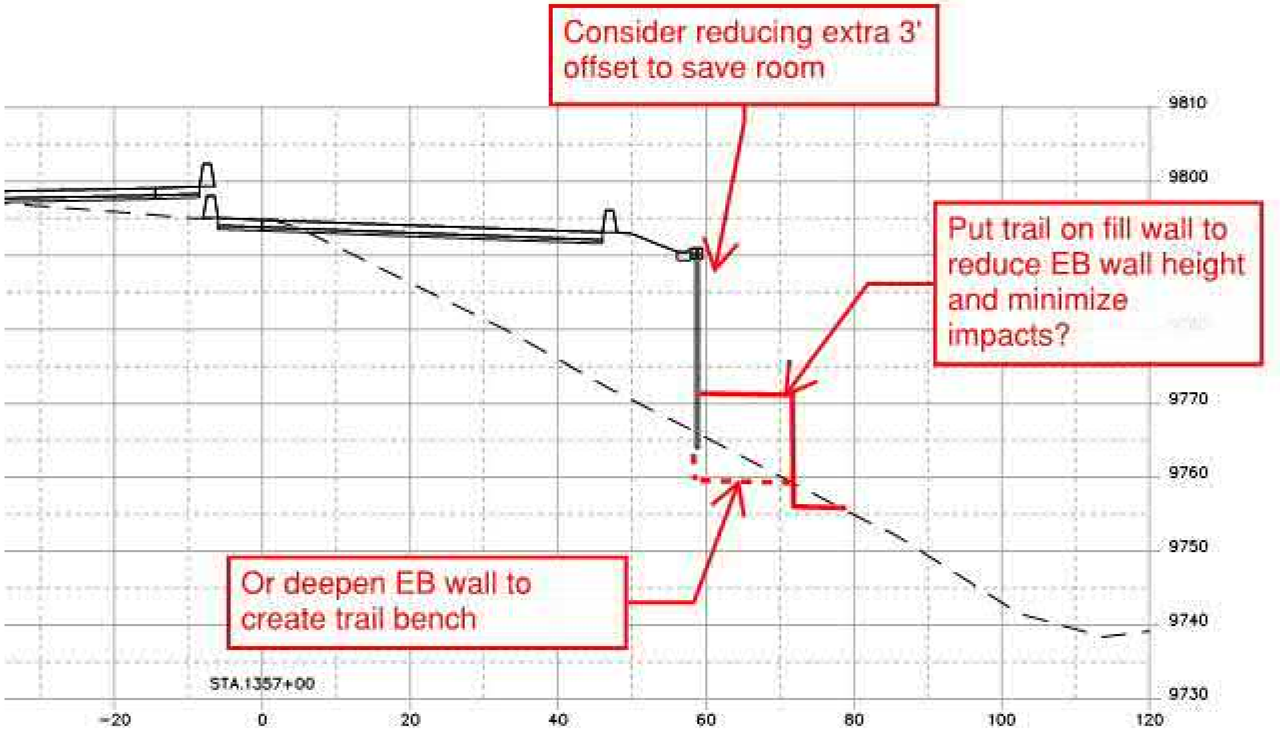
Trail to wall offset reductions are proposed to be applied at the following locations within the INFRA Grant project (similar approach could be taken for ultimate):

- 1328+00 – 1331+00: Trail is against extended bridge abutment MSE wall and has a fill wall on the outside in this area. Reducing offset would reduce outside wall height.
- 1356+00 – 1362+00: Trail is between roadway MSE wall on the left and adjacent creek and wetlands on the right. Reducing offset would reduce impacts to wetlands and potentially creek

See graphics that follow:



WVP Rec Path Typical Section
Cut and Fill Walls



Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 17: Look for opportunities to balance earthwork

Current Design: Per CAP 1 estimate, the project has a large excavation and net export quantity of nearly 250,000 CY.

Design Suggestion

Advantages	Disadvantages
· Saves cost · Reduce material haul off	· May result in modified profiles · May complicate construction phasing

Idea 36

Discussion:

Given the large excavation and net export quantity of nearly 250,000 CY shown in the CAP 1 estimate for the project, as well as the estimated haul distance required for disposal, modifying the design of the project to better balance cut and fill could save on significant export/waste costs.

While there does not appear to be significant flexibility in the I-70 profiles due to the overall steep longitudinal grades, and tight conditions between cut on the left and steep fill slopes or walls on the right, even adjustments of 1’-3’ can result in a benefit to the overall earthwork balance. The potential increase in construction phasing complexity should be considered if profile change moves the proposed grades further from existing grades.

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 18: Keep eastbound and westbound grades consistent to minimize median retaining walls

Current Design: For portions of the INFRA Grant project from M.P. 185.8 and 186.4, the elevations of the inside edges of EB and WB pavements are greater than 3', which would require a retaining wall vs. Type 9 Style CE offset barrier. Also, from M.P. 186.6 to 187, the EB grade is set some lower than existing, making it more challenging to preserve the existing median scalloped walls, and likely forcing the need to rebuild the scalloped median walls in the future.

Cost Savings: $672,476

Advantages	Disadvantages
· Saves median retaining wall cost · Minimize need for median scalloped walls · Reduces interior median wall maintenance · Reduce throwaway by using spoil material	· Possible cut and fill cost increase · May complicate phasing · Impacts median aesthetics if scalloped walls eliminated

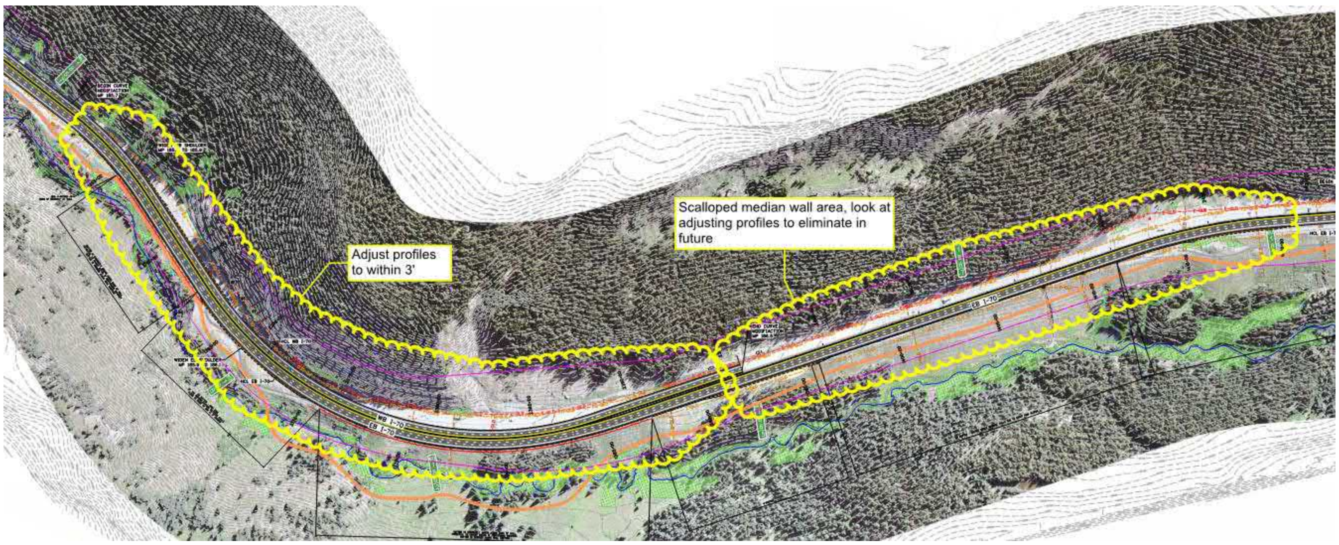
Idea 6

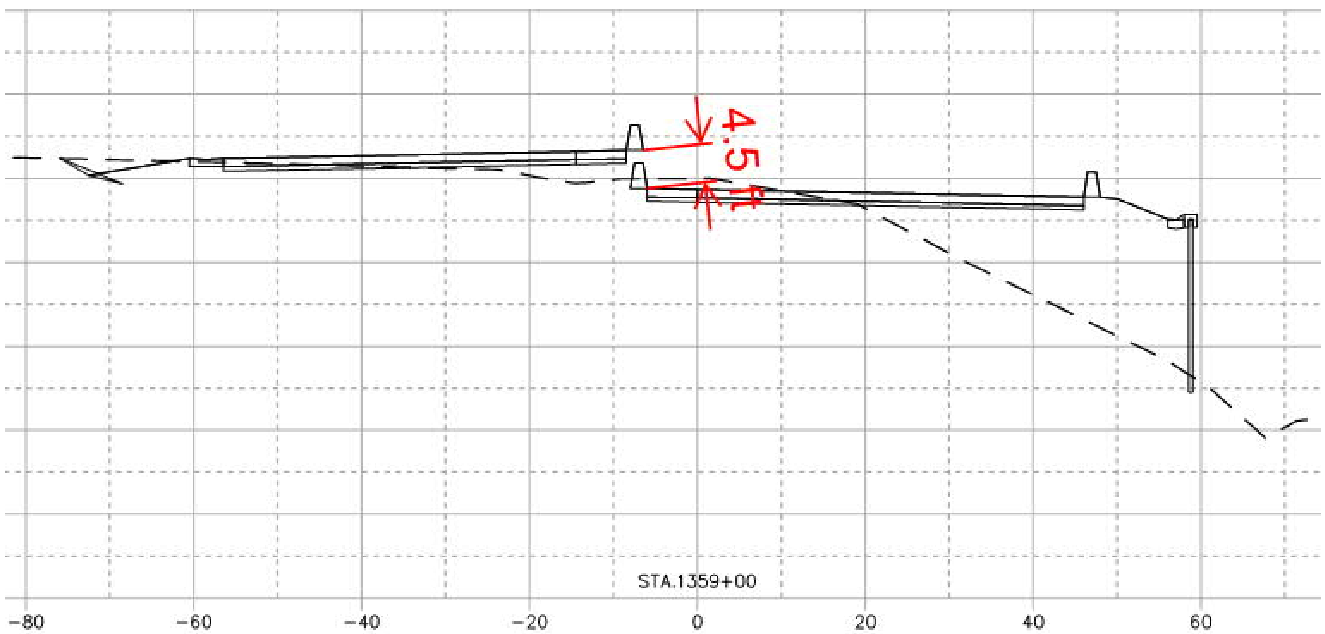
Discussion:

The proposal is to raise the EB profile (or lower WB, or a combination) to keep the inside edges within 3' so Type 9 Style CE offset barrier can be used without the need for median retaining walls. In some areas, an outside retaining wall is already proposed, which would increase in height and resultant cost, but adding height to an already moderate height wall is likely less costly than building a wall in the narrow median. Profile adjustments are proposed to be applied at the following locations within the INFRA Grant project (similar approach could be taken for ultimate):

- 1355+00 – 1361+00, raise of 0'-1.5', outside MSE Wall would increase in height
- 1361+00 – 1365+00, raise of 0'-0.6, in cut, excavation would be reduced, reducing waste
- 1380+00 – 1385+00, raise of 0'-1', outside MSE Wall would increase in height

In the existing median scalloped walls section from M.P. 186.6 to 187, profile should be adjusted to preserve these in the interim, and the ultimate design should be reviewed to see if a combination of raising EB and lowering WB could eliminate the need to reestablish the scalloped walls in the future if a simple grass slope median can be established.




4.5 ft
STA.1359+00
-80
-60
-40
-20
0
20
40
60


If needing to do new scalloped wall or preserve existing, look at lowering WB or raising EB lanes to allow grass median
STA.1389+00
-80
-60
-40
-20
0
20
40
60
80
100

Estimate:

COST WORKSHEET					Proposal No:	18
					Idea No:	6
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Median CIP Wall in areas >3'	5,480	SF	$ 100	$ 548,000		
Excavation Waste	1,996	CY	$ 10	$ 19,963		
				$ -		
Proposed Design						
Additional Outside MSE Wall Ht	790	SF		$ -	$ 77	$ 60,830
Additional Roadway Embankment	878	CY		$ -	$ 29	$ 25,456
Guardrail Type 9 (CE)	1,000	LF		$ -	$ 110	$ 110,000
Total:				$ 567,963		$ 196,286
Markup	80.93%			$ 459,652		$ 158,854
Totals				$ 1,027,615		$ 355,139
Savings:				$ 672,476		

Consensus:

The proposal will be considered in the INFRA Grant scope design. The proposal is accepted with modifications.

Proposal 19: Incorporate excess excavation as MSE backfill.

Current Design: MSE walls are planned to support the road/embankment in fill areas where planned widening or alignment shifts are shown. Typical CDOT construction methodology for MSE walls utilizes CDOT Class 1 Structure Backfill within the reinforced zone of these walls for materials consistency and engineering property characteristics.

Design Suggestion

Advantages	Disadvantages
· Reduces material import and export · Saves backfill material cost	· May need more conservative retaining wall design · Material may not meet backfill requirements

Idea 7

Discussion:

Given the large excavation and net export quantity of nearly 250,000 CY's shown in the CAP 1 estimate for the project, as well as the estimated haul distance required for disposal, finding locations within the project limits to re-use any amount of this material in areas other than overall general embankment could save on significant import/export costs. If the materials excavated on-site either meet, can be engineered to meet through crushing/scalping/processing, or the MSE walls are designed using on-site materials properties, significant savings both in import and export may be realized.

A design suggestion is being offered to consider investigating/evaluating on site planned excavation materials to determine suitability/engineering properties to see if they can be used as backfill within the reinforced zone of the planned MSE walls. Even if longer reinforcement lengths are required to account for lower engineering properties than would be seen using the standard Class 1 Structure Backfill, using on-site materials as backfill in lieu of an engineered or manufactured structure backfill may prove cost effective.

Concern with this proposal would be if the materials are variable such that consistent properties cannot be determined requiring multiple design alternates. Additionally, lower quality materials may result in additional required reinforcement lengths to satisfy internal stability/pullout requirements. This could have additional detrimental effects if this requires additional backslope excavation and encroachment or impacts to existing traveled way.

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 20: Incorporate additional height into Type 9 barrier.

Current Design: Current design estimate (CAP 1) calls for 31,693 LF of Type 9 Barrier (Style CA and CG combined).

Added Cost: $813,112

Advantages	Disadvantages
· Accommodates future overlays	· Adds cost · Bottom width may increase

Idea 11

Discussion:

Current typical engineering rehabilitation practices for this roadway consist of mill/fill type HMA treatments due to guardrail/barrier height restrictions. As initially proposed, the thought was to maintain the top barrier dimension and side slope, which would increase the base width. As modified, the proposal as presented now would include adding an additional 4" of height added to the top of the planned barrier during construction of the barrier. This would allow for subsequent roadway treatments to potentially consist of overlays only, eliminating the immediate need for milling/planing of the existing roadway prior to subsequent HMA placement. With 4" of added height to the barrier, it is possible that 2 HMA overlays could be accomplished before milling/planing of the roadway to maintain height is needed.

The project would see an initial cost increase of $813,112 based on an assumed 4" x 12.5" added section of concrete along the length of the barrier, as well as an additional approximately 77,000 LF of added reinforcing steel (assumption was 2 additional #5's along the length with 38" lap splice, as well as an additional 4" length on each side of the vertical #4 stirrups at 6" on center). This equates to an additional 408 CY of Class D concrete and nearly 79,000 pounds of reinforcing steel. Unit costs of $802/SY and $1.55/lb of bar were used, resulting in an additional cost per LF of barrier at $14.18.

While initially the project would see increased cost, future savings could be realized if elimination of planing prior to subsequent HMA treatments could be achieved. Assuming a planing quantity of 145,620 SY as used in the CAP 1 pricing, and a calculated planing cost of $2.10 based on quantity and typical pricing, three subsequent treatments that eliminate milling prior to an HMA overlay could offset the initial cost increase.

Estimate:

COST WORKSHEET					Proposal No:	20
					Idea No:	11
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Guardrail Type 9 (Style CA)	15,361	LF	$90	$ 1,382,490		
Guardrail Type 9 (Style CG)	16,332	LF	$110	$ 1,796,520		
				$ -		
Proposed Design						
Guardrail Type 9 (CA) with 4" height	15,361	LF			$104	$ 1,600,309
Guardrail Type 9 (CG) with 4" height	16,332	LF			$124	$ 2,028,108
						$ -
Total:				$ 3,179,010		$ 3,628,417
Markup	80.93%			$ 2,572,773		$ 2,936,478
Totals				$ 5,751,783		$ 6,564,894
Savings:				$ (813,112)		

Notes: CAP I pavement quantity used. Cost for SMA based on maximum anticipated cost for similar tonnage projects over the last 5 years.

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design.

Proposal 21: Incorporate Type 9 Barrier with glare screen.

Current Design: The current design proposes Type 9 Single Sloped Barrier in the median and along the south edge of the roadway shoulder.

Cost Addition: $307,581

Advantages	Disadvantages
· Reduces glare · Improves safety · Incidental noise reduction	· Additional cost · Reduces viewshed from

Idea 50

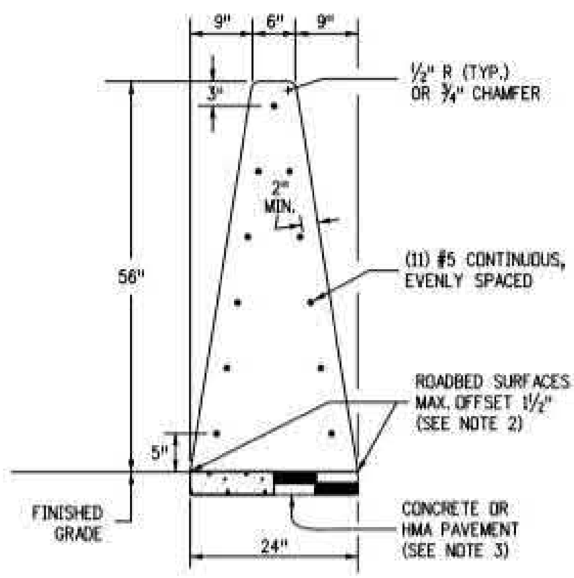
Discussion:

Consider the use of Type 9 with Glare Screen at strategic locations throughout the project. The glare screen can be used in typical safety applications in the median but can also be used where there may be a desire to achieve an incidental benefit for noise reduction for adjacent receptors or shield the highway from outside of the highway prism.

CDOT Region 1 has used this application with success on projects where there was not a noise analysis/wall required but there was an interest in increasing the concrete barrier height to decrease the noise from the highway and provide visual separation from the highway. Considerations should include view shed impacts from the highway as well as cost implications for this additional barrier.

It was noted after establishing this proposal that glare screen has already been proposed in the median for safety, so this barrier was not included in the analysis.

An area that could be considered is Sta. 1050+00 to 1135+00 which is located on south side of roadway through Vail residential area.



CONCRETE BARRIER STYLE CG (56")

MONOLITHIC CONCRETE GLARE SCREEN/BARRIER

Estimate:

COST WORKSHEET					Proposal No:	21
					Idea No:	50
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Type 9 CA	8,500	LF	$90	$ 765,000		
				$ -		
Proposed Design				$ -		
Type 9 CG (56")	8,500	LF		$ -	$110	$ 935,000
				$ -		$ -
Total:				$ 765,000		$ 935,000
Markup	80.93%			$ 619,115		$ 756,696
Totals				$ 1,384,115		$ 1,691,696
Savings:				$ (307,581)		

Notes:
Costs from ROM for additional barrier height through Vail residential area.

Consensus:

The proposal will be held for further consideration where appropriate in the INFRA Grant scope design.

Proposal 22: Consider a typical construction section wider than minimum required with temporary shoulders.

Current Design: The proposal is suggesting a wider than normal construction typical section to avoid a gauntlet type situation.

Added Cost: $3,765,678

Advantages	Disadvantages
· Improves operations · Better facilitates emergency response · Easier transition back to winter season · Additional shoulder width might be more economical than barrier · Improves quick response times for injured parties	· Adds cost · Potential increase in cuts and fills

Idea 5

Discussion:

A narrow construction typical section (Figure 1) usually includes 2' shoulders and 2-11' lanes (26'total width) with temporary barrier on both sides of traffic and in some situations a median temporary glare screen. While this typically protects the work and workers and allows construction on both sides of traffic, it causes sever congestion during incidents and makes emergency response times much slower. During incidents this type of typical section also causes secondary incidents while traffic accordions through the incident. The proposal is to achieve a typical section that would only include temporary barrier on one side of traffic as shown on the next page (Figure 2) or use a wider typical, for example 4' shoulders with 12' lanes (32' total width). The wider construction typical section or open typical section to one side allows for emergency vehicle response and quick clearance. Since the project has very limited turnaround points, incidents can be expected to congest the highway for hours and may occur daily. During a winter shutdown a wider typical may allow for use and not require any modifications thus saving costs in the long term.

Figure 1

Figure 2

Estimate:

COST WORKSHEET					Proposal No:	22
					Idea No:	5
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Conc Barrier (Temp) 630	211,200	LF	$40	$ 8,448,000		
Proposed Design						
Conc Barrier (Temp) 630	211,200	LF			$40	$ 8,448,000
HMA Item 310 8-12 in	70,400	SY			$4	$ 281,600
Temp Attenuators	40	Each			$20,000	$ 800,000
Glare Screen (Temp)	26,400	LF			$20	$ 528,000
Excavation	15,723	CY			$30	$ 471,690
Total:				$ 8,448,000		$ 10,529,290
Markup	80.93%			$ 6,836,966		$ 8,521,354
Totals				$ 15,284,966		$ 19,050,644
Savings:				$ (3,765,678)		

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design.

Proposal 23: Expand interior shoulder from 6' wide to 10' wide.

Current Design: The current design calls for 6-foot inside shoulders

Added Cost: $21,476,029

Advantages	Disadvantages
· Better disabled vehicle storage · Frees up another through-lane for emergency response · Complies with AASHTO guidance	· Wider roadway section · Additional cost ·

Idea 10

Discussion:

The purpose of this proposal is to explore, in a ROM sense, the cost of meeting desirable AASHTO and CDOT guidance of 10' width for the inside shoulder criteria. The VE team has also examined a counterpart proposal (Proposal No. 24) which considers reducing shoulder widths from 6' to 4' and it follows this Proposal 23.

<u>In favor of 10' shoulder:</u>

- Complies with guidance from both AASHTO and CDOT to provide 10-foot shoulders on Interstate Highways.
- Accommodates stalled vehicle and in some instances, would provide operational advantage during "lane-plus-one" incident management.
- More flexibility to avoid collisions

<u>Working against 10' shoulder:</u>

- Considerable cost
- Larger project footprint and impacts
- Additional construction time
- This is not new construction. We are trying to improve safety with available funding.

Safety has been identified as one of the highest orders of considerations for this VE study. It is beneficial to understand what safety benefits could be expected from the considerable cost of a 10' shoulder and similar cost/benefits for the 4' and 6' scenarios. These benefits can be estimated through a study of crash history and correlation to different shoulder widths. Indeed, the design team described this kind of process at the VE kickoff meeting. Leveraging an understanding of crash history, mitigation options and costs are likely the best path forward for improving safety performance within the limitations of funding and other project constraints.

Estimate:

COST WORKSHEET					Proposal No:	23
					Idea No:	10
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
				$ -		
Proposed Design						
HMA	25,800	TON			$121	$ 3,121,800
Aggregate Base	14,000	TON			$34	$ 476,000
Bridge Deck	37,600	SQ FT			$220	$ 8,272,000
						$ -
						$ -
Total:				$ -		$ 11,869,800
Markup	80.93%			$ -		$ 9,606,229
Totals				$ -		$ 21,476,029
Savings:				$ (21,476,029)		

Notes: Assumes widened inside shoulder for entire project length (ABC, HMA, and SF Bridge)

Assumes 10 HMA and 6in ABC

Consensus:

The proposal is rejected because the widening has many impacts that are not offset by improvements in safety.

Proposal 24: Reduce inside shoulder to four feet wide.

Current Design: The current Vail Pass Project design proposes reconstructing eastbound and westbound I-70 with a typical section that includes three 12-foot lanes, a 6-foot inside shoulder and a 10-foot outside shoulder.

Cost Savings: $10,470,600

Advantages	Disadvantages
· Reduces highway footprint and overall project impacts · Reduces project cost	· Potential to decrease safety · Potential loss of snow storage area · May not meet INFRA Grant typical section.

Idea 32

Discussion:

This proposal is to consider reducing the inside shoulder from six feet to four feet throughout the project. This proposal has the potential to reduce project cost with the quantity reduction of HMA, ABC, and bridge area, among other project elements.

This reduction meets current shoulder width criteria (AASHTO A Policy on Design Standards – Interstate System, 2016) for a mountainous two to three lane directional interstate facility but does not meet the 10-foot general preferred shoulder in AASHTO's 2018 Policy on Geometric Design. It does however meet the emerging best practice to utilize a performance-based practical design to make informed decisions on how to use limited available resources on highway facilities. It also considers the environmental context by reducing impacts in a constrained and historically significant corridor and has been used on other I-70 Mountain Corridor Projects.

A very preliminary analysis was performed by CDOT's Safety Team which compared the inside shoulders with widths of 4, 6, and 10 feet for a general Colorado mountainous highway which is presented below. Note that the shoulder reduction would still need to be fully evaluated by the design team and through a detailed project specific safety analysis to confirm the safety implications of this reduction.

Expected Safety Performance for CO 6 - Lane Mountainous Freeway with 26,000 AADT*		
Inside Shoulder Width	Total Crashes/mile/year	Fatal and Injury Crashes/mile/year
4 ft	11.67	3
6 ft	11.32	2.9
10 ft	10.65	2.71

*Using Highway Safety Manual CMFs for inside shoulder widths on freeways in concert with Colorado SPF models for 6-lane mountainous freeways. Additional project specific safety analysis should be conducted prior to reducing shoulder width. Source CDOT HQ Safety 4/7/21.

Estimate:

COST WORKSHEET					Proposal No:	24
					Idea No:	34
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Proposed Design						
Tons HMA	-12,100	Ton			$121	$ (1,464,100)
ABC	-5,500	Ton			$34	$ (187,000)
Bridge Deck	-18,800	SF			$220	$ (4,136,000)
Total:				$ -		$ (5,787,100)
Markup	80.93%			$ -		$ (4,683,500)
Totals				$ -		$ (10,470,600)
Savings:				$ 10,470,600		

Notes:
Assumes reduced inside shoulder for entire project length (ABC, HMA, and SF Bridge)
Does not include potential savings from alignment optimization or wall reductions.

Consensus:

The proposal will be held for further consideration along tangent sections in the INFRA Grant scope design.

Proposal 25: Consider Contech arch-type structures versus concrete box or metal arch.

Current Design: The current selection for the larger wildlife crossings is not yet determined but the choices indicated are Concrete Box Culverts or Multi-Plate Steel Arches.

Design Suggestion

Advantages	Disadvantages
· May satisfy wildlife crossing design · May reduce cost	· May change roadway profile

Idea 23

Discussion:

The West Vail Pass CSS Memo Draft 04-20-20 lists Locations at MP 187 – 187.5 and 188.3 as needing a Large Mammal underpass. Potential structures listed are Concrete Box Culverts or Multi-Plate Steel Arches.

Anticipated sizes for these crossings are shown as

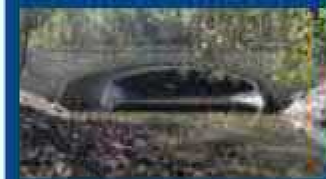
- 23 x 13 for the arch
- 20 x 10 for the box

The arch structure is a more efficient structural form for a span of this size and may be perceived as more aesthetically pleasing.

It is anticipated that the excavated base of material is rock or weathered rock, providing sufficient support for either of these type structures to bear on spread footings.

The arch structure is bottomless, allowing for a natural material for the wildlife walking surface. The box structure is anticipated to be bottomless to also allow for natural material bottom.

From a maintenance perspective the precast concrete composition of the Arch type structure would have less maintenance requirement over the Multi-plate Arch which is comprised of bolted corrugated steel panels to make the arch structure. The concrete structure of the precast arch is also easier to repair in the event of damage or deterioration over the metal arch.

PRECAST		
	CON/SPAN® Bridge Systems O-Series® & B-Series	12′ to 65′
	BEBO® Arch Systems	12′ to 102′

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 26: Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes

Current Design: Project base design is to install wildlife crossing structures in six new locations.

Design Suggestion

Advantages	Disadvantages
· Saves cost	· May not be appropriately sized · May require very specific retrofitting measures

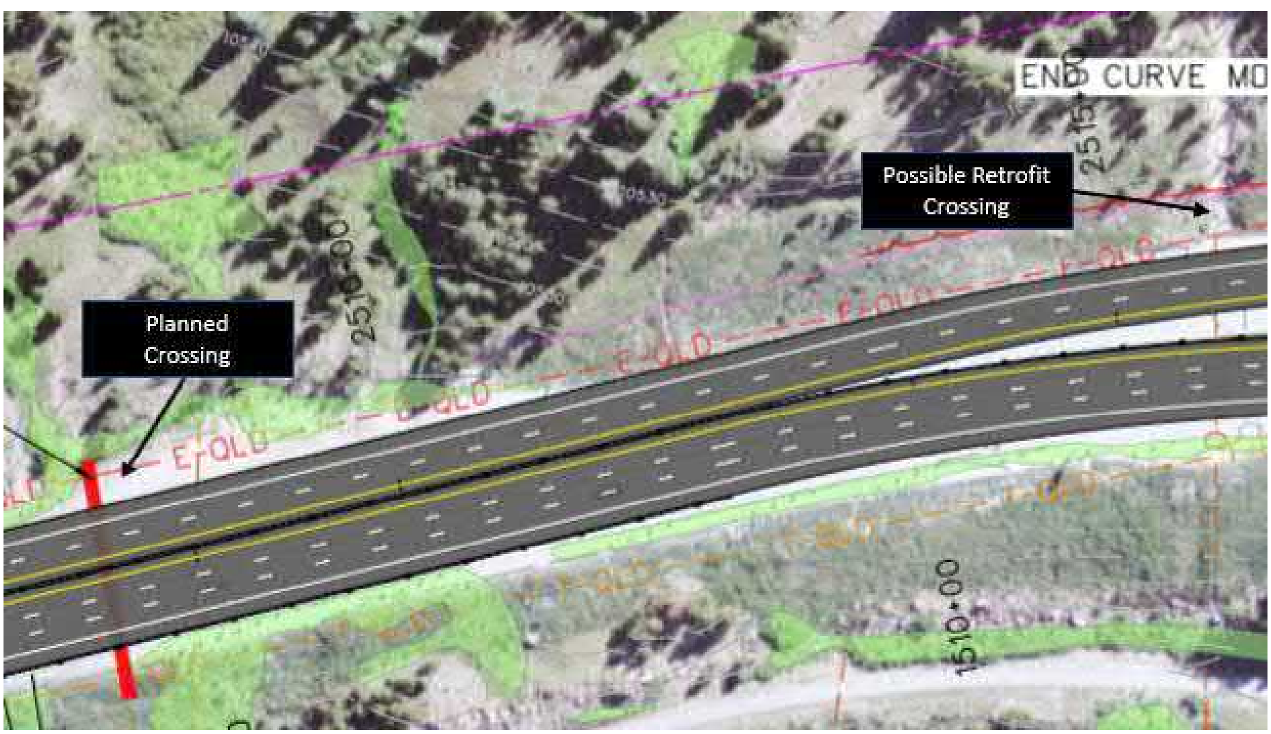
Idea 15

Discussion:

The current design requires installing new structures in six locations to provide wildlife crossing opportunity. A culvert inventory should be conducted to determine if existing cross culverts are sized appropriately and/or can be retrofitted to meet the intent of providing wildlife passage. Ideally the retrofit of an existing structure would replace the need for a new stand-alone structure. Examples:

- Provide small mammal shelves if an existing crossing conveys hydrology.
- If hydraulic structures are to be replaced with flat bottom concrete, consider a V-bottom instead to concentrate flows and provide dry area for small mammal passage.
- Using existing crossing locations in better topography may minimize cut/fills associated with a new structure.
- Dual-use structures (aquatic and terrestrial species) will provide greater ecological benefit than dry crossings only.

A specific example would be to retrofit the existing crossing at STA 1512+00 instead of placing a new structure at STA 1505+00.



Drainage at STA 1512+00 for possible retrofit

Consensus:

The proposal is rejected because the existing culverts are in poor condition. The largest culvert is 30" in diameter. It is desired to separate wildlife from drainage.

Proposal 27: Reduce size of wildlife crossing structures

Current Design: The base design is to install two 55’x14’x221’ (234’) arch bridges and four 8x10 box culverts.

Cost Savings: $1,935,019

Advantages	Disadvantages
· Saves cost · Reduces roadway icing impacts · Adds flexibility to maintain roadway profile	· Commitments already made to sizes · May reduce wildlife use

Idea 52

Discussion:

This proposal concept is to reduce the width of the two arch-type structures from 55 feet to 35 feet. This would reduce costs while still providing wildlife connectivity. This proposal only covers a reduction in size of the two largest structures. The cost savings presented do not include grading or construction savings or the reduction in cost associated with reducing the size or type of the planned 8x10 structures.

- The primary target species for these structures is Canada lynx, with a secondary objective of providing crossing opportunity for large mammals. FHWA guidance (Wildlife Crossing Structure Handbook 2011) recommends a minimum size of 32 feet for large mammal underpasses.
- The same FHWA publication recommends an openness ratio of at least 1.5 for elk. A 35-foot wide structure provides a ratio of 2.09 for the 234-foot long structure.

Estimate:

COST WORKSHEET					Proposal No:	27
					Idea No:	52
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
2 underpasses @ 55x14x221/234	20,763	s.f.	$235	$ 4,879,305		
Proposed Design						
2 underpasses @ 35x14x221/234	16,212	s.f.			$235	$ 3,809,820
Total:				$ 4,879,305		$ 3,809,820
Markup	80.93%			$ 3,948,822		$ 3,083,287
Totals				$ 8,828,127		$ 6,893,107
Savings:				$ 1,935,019		

Notes: Sq ft proposed based on 35x(221+234) averaged with CDOT base 16,500 sf

Consensus:

The proposal has been accepted and is already being incorporated in the INFRA Grant scope design.

Proposal 28: Consider lynx in-lieu fee mitigation program.

Current Design: The current design assumes the lynx in-lieu fee program is not used to save costs.

Design Suggestion

Advantages	Disadvantages
· May reduce need for or number of wildlife crossings · Reduces construction time · May provide funding opportunity	· Requirements of using the in-lieu fee program may not be met · Cost-benefit to be determined

Idea 42

Discussion:

There are two pathways that could potentially utilize the Canada lynx in-lieu fee program to improve project efficiency and cost:

- The project may contribute funding to the program for mitigation of impacts to lynx in lieu of installing all or some crossing structures.
- The project could use funds from the in-lieu fee program to supplement the cost of a crossing structure installation.

Consensus:

The proposal is rejected because the wildlife structures are included in the Environmental Assessment commitment.

Proposal 29: Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1.

Current Design: Install 52,800 lf of wildlife fence, 20 wildlife game escape ramps, and 4 20-ft gates.

Cost Savings: $1,512,575

Advantages	Disadvantages
· Saves cost · May be able to shift funding and installation to a future phase or allow for additional Phase 1 construction with saved costs · Preserves corridor aesthetics	· Commitment already made to fencing · Reduced use of crossing structures · Would not eliminate AVCs

Idea 24

Discussion:

If post-construction monitoring indicates crossing structures are effective and animal-vehicle collisions (AVCs) are reduced without fencing, fencing and associated jump outs and gates would not be needed.

- Defer fencing until after the INFRA-grant project to allow monitoring of structure effectiveness and AVC data. Suggest that fencing of the 10-mile corridor becomes its own future construction phase, occurring as the last phase of the project, to determine ultimate need.
- The West Vail Pass Linkage Interface Zone was identified as low to moderately low for AVCs, having the lowest AVC/mile/year rate of all LIZs studied – only 0.38 AVC/mile/year (CDOT Region 1 Screening Document). This indicates low potential for AVCs under current conditions without fencing.
- Low AVC numbers are typically associated with the total barrier effect of the highway, indicating animals are not even trying to cross. Installation of crossing structures may provide opportunity without fencing.
- Depending on the fence selected, the current project estimate of $10/linear foot of fencing may be an underestimate. Washington State DOT completed a five-year study of several types of wildlife exclusionary fence for use on a mountain pass with high snow loads. The design selected was the "Canada Wildlife Fence." This robust design was estimated at $30.69/linear foot in 2010 dollars. Using this estimate with markup, eliminating fencing would save $3.49M.

A photo of the fence currently intended to be installed with a 16' post spacing is as follows.

Estimate:

COST WORKSHEET					Proposal No:	29
					Idea No:	24
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Wildlife fence	52,800	lf	10	$ 528,000		
Wildlife Game Ramps	20	ea	15,000	$ 300,000		
20-ft gate	4	ea	2,000	$ 8,000		
Proposed Design						
Total:				$ 836,000		$ -
Markup	80.93%			$ 676,575		$ -
Totals				$ 1,512,575		$ -
Savings:				$ 1,512,575		

Consensus:

The proposal is rejected because the wildlife fence is included in the Environmental Assessment commitment and is used to support crash reduction factors.

Proposal 30: Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.

Current Design: Concrete Guardrail Type 9 appears to be used exclusively throughout the corridor, even on uphill sides of pavement and in cut areas with room for a ditch behind the barrier.

Cost Savings: $208,070

Advantages	Disadvantages
· Reduce number of inlets · Reduce closed storm system quantity · Saves cost	· Additional guardrail maintenance · Additional drainage and sand removal methods may be needed

Idea 38

Discussion:

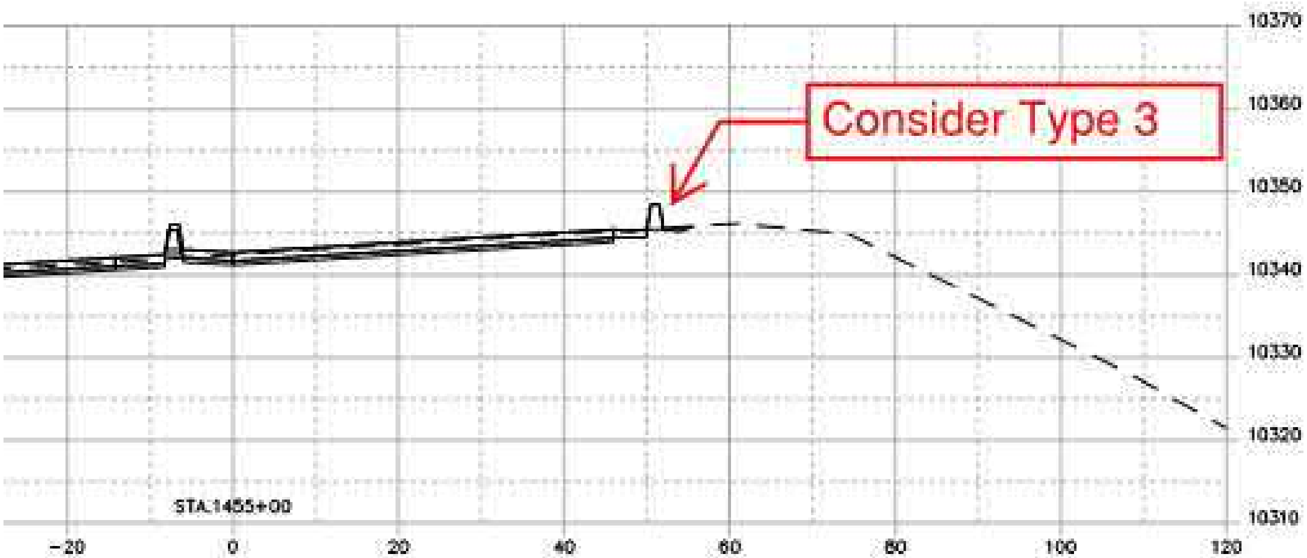
The proposal is to utilize metal Type 3 guardrail in lieu of concrete Type 9 barrier in the following situations:

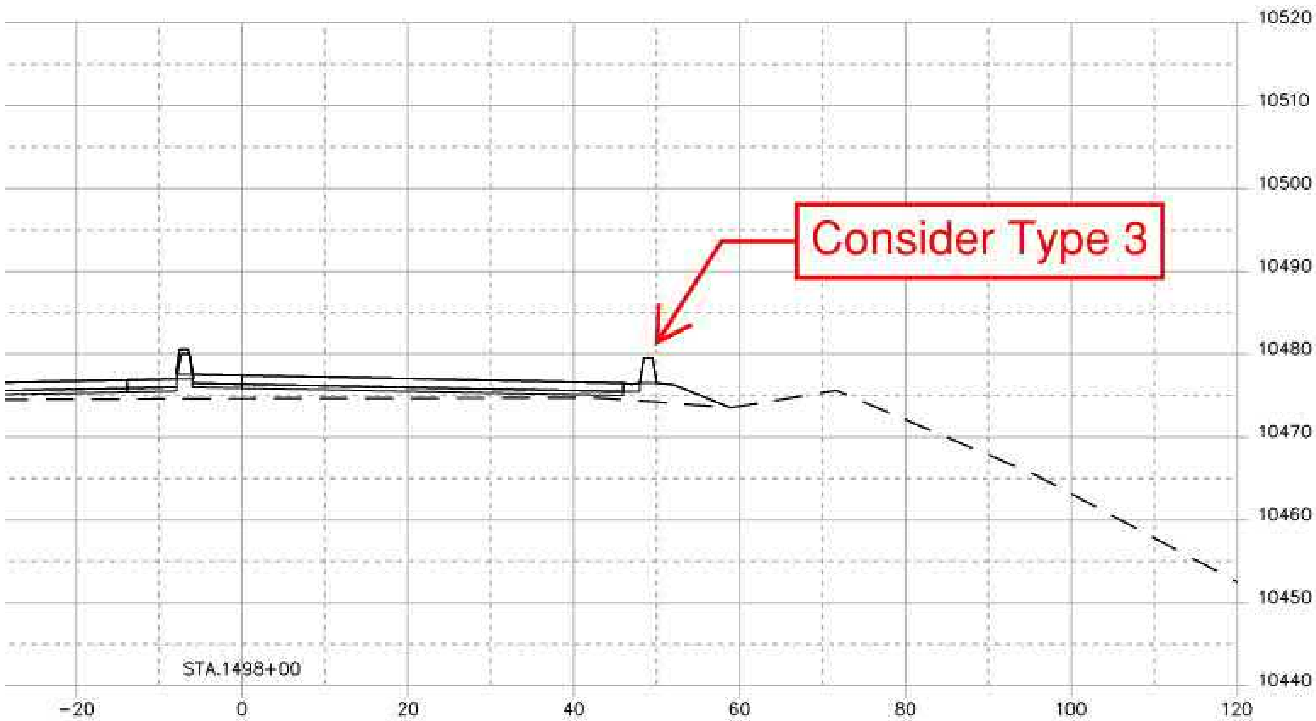
- High or left side of EB pavement where solid barrier is not needed to retain fills from WB lanes
- Right side of EB pavement where barrier is shown adjacent to ditch sections, or sufficient bench exists beyond the barrier to accommodate drainage which comes through the Type 3 guardrail.

Potential locations include:

- 1313+00 – 1318+00, RT
- 1315+00 – 1318+00, LT
- 1454+00 – 1461+00, RT
- 1493+00 – 1501+00, RT

Overall length of Type 9 that is proposed to be changed to Type 3 is estimated to be 2,300 LF. Since Type 9 barrier on the low side would also require inlets and an enclosed storm system, there may some savings in allowing the drainage to come through the Type 3 and conveying flow in ditches to a single collection point. This tradeoff is not included in the estimate.





Estimate:

COST WORKSHEET					Proposal No:	30
					Idea No:	38
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Guardrail Type 9	2,300	LF	$ 90	$ 207,000		
Proposed Design						
Guardrail Type 3	2,300	LF		$ -	$ 40.00	$ 92,000
Total:				$ 207,000		$ 92,000
Markup	80.93%			$ 167,525		$ 74,456
Totals				$ 374,525		$ 166,456
Savings:				$ 208,070		

Consensus:

The proposal is rejected because the Type 3 guardrail does not last through the winter snow conditions.

Proposal 31: Incorporate alternative bridge de-icing system into design.

Current Design: INFRA Grant Component 9 – Fixed Automated Spray Technology (FAST) Anti-icing installation is proposed on the EB bridge at MP 184.4.

Design Suggestion

Advantages	Disadvantages
· Improves safety · May reduce maintenance	· Adds cost · Effectiveness not known

Idea 12

Discussion:

Various FAST systems have been installed at bridge locations in Colorado. When properly maintained, and functioning as intended, they can provide a benefit. However, from a Maintenance perspective, the use of a fixed automated system can be challenging for a variety of reasons. The system requires a dedicated area to house the pumps and storage tanks for the product used. Along with this, access to these components is also required so that they can be filled/serviced routinely. Running and maintaining conduit on or within a structure can also be challenging given the movement/vibrations from both dynamic loading and expansion/contraction. Inspection and maintenance of conduits that deliver product is required on a routine basis. Some past FAST Systems used in Colorado used a potassium acetate deicer solution. Use of this solution was found to lead to accelerated Alkali-Silica Reactivity and a moratorium on its use was implemented. The systems that used potassium acetate either would not function with other chemical liquid de-icers or would have required very expensive retrofits to use other products.

It is recommended that during design, other alternates to a FAST system be evaluated and/or considered. Can the desired effect (improved safety through reduction in accidents) be achieved through application of a surface that provides a higher surface friction coefficient, such as a High Friction Surface Treatment (HFST)? Or can materials be applied on the bridge deck that may allow for pre-treatment of the area in question and that will effectively reduce or release the anti-icing chemicals over time. Consideration of the cost and effectiveness of these alternate materials in lieu of the FAST system may warrant further discussion especially considering the maintenance requirements a fixed de-icer system will surely require.

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 32: Consider warm mix asphalt due to remote location.

Current Design: The current pavement typical section calls for a reconstruction/new pavement section of 10” HMA over a total of 14” ABC. No specifications regarding the HMA were included in the CAP 1 specifications package.

Added Cost: $275,097

Advantages	Disadvantages
· Increases workability for cooler temperatures · Expands paving window in terms of temperature · May enhance compaction leading to better quality	· Adds cost

Idea 26

Discussion:

Due to the remote location which may lead to a long haul distance, as well as lower ambient temperatures typically seen along the corridor, this proposal would be to include a warm mix technology requirement/usage for the asphalt pavement to extend the workability window of the mix, as well as to facilitate compaction. This could be used with either dense graded HMA as specified or SMA if utilized.

Use of Warm Mix Technology or Additives can result in an asphalt mixture that exhibits a longer workability window to facilitate haul, placement, and compaction. WMA is allowed on virtually all asphalt projects in the State of Colorado as a permissive specification at the discretion of the Contractor. This proposal would require the use of a WMA additive in all the asphalt used for the project, extending workability windows and facilitating compaction of the asphalt. Use of WMA technology may also allow for placement/compaction at temperatures lower than currently listed in our CDOT Standard Specifications, with Region concurrence of course. It is understood that this would typically be specified by the Region for projects in this area.

While the per ton price of the mix with a typical WMA additive does cost more from a materials perspective, expanded placement/compaction windows, as well as facilitation of compaction should be a benefit to the project and corridor as a whole, both in terms of speed of construction and improved quality. A price increase of $2/ton was assumed based on typical additive percentages used and cost information provided in the past by WMA technology representatives.

Estimate:

COST WORKSHEET					Proposal No:	32
					Idea No:	26
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
SX(100)(PG 76-28) - ROADWAY	70,104	ton	$121	$ 8,482,584		
SX(100) (PG 76-28) TRAIL	4,253	ton	$121	$ 514,613		
SX(100)(PG 76-28) - TRUCK RAMP	1,666	ton	$121	$ 201,586		
				$ -		
				$ -		
Proposed Design						
SX(100)(PG 76-28) ROAD w/WMA	70,104	ton			$123	$ 8,622,792
SX(100) (PG 76-28) TRAIL w/WMA	4,253	ton			$123	$ 523,119
SX(100)(PG 76-28) - RAMP w/WMA	1,666	ton			$123	$ 204,918
						$ -
						$ -
Total:				$ 9,198,783		$ 9,350,829
Markup	80.93%			$ 7,444,575		$ 7,567,626
Totals				$ 16,643,358		$ 16,918,455
Savings:				$ (275,097)		

Notes: CAP I pavement quantity used. Cost for SMA based on maximum anticipated cost for similar tonnage projects over the last 5 years.

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 33: Use stone matrix (mastic) asphalt for wearing course.

Current Design: The current pavement design calls for utilization of a conventional 2" thick dense graded asphalt (SX 100) (PG 64-28) as the wearing surface on I-70. This proposal would replace the 2" top mat of HMA with an equivalent thickness of SMA.

Added Cost: $761,035

Advantages	Disadvantages
· May be more durable · Potentially more resistance to tire chain wear · Has been used in Colorado · Reduces maintenance	· Adds cost · More difficult paving ·

Idea 53

Discussion:

Consider replacing the 2" top mat of HMA with an equivalent thickness of SMA.

Use of Stone Matrix Asphalt (SMA) for the top lift wearing course of the pavements along this stretch of I-70 may provide a more durable surface that can be more resistant to the chain wear abrasion seen on the corridor. SMA relies on stone-on-stone contact to provide a durable mixture and requires a higher durability aggregate to be used. Additionally, the aggregate used for the SMA shall have no more than a 30 percent loss when tested in accordance with AASHTO T 96 (LA Abrasion). Conversely, the aggregates for dense graded HMA only need to meet a percent loss of no more than 45 when tested per the same procedure. The stone-on-stone contact, along with the requirement for a harder, more durable aggregate may prove to be more resistant to the abrasion/impact forces caused by the use of truck tire chains/studded tires along the roadway.

Initially, the use of SMA will add cost due to higher unit pricing typically seen for SMA versus dense graded HMA. However, if the SMA proves to be more durable and resistant to chain wear and can extend the time between subsequent pavement rehabilitation treatments, this initial cost can quickly be recouped.

Use of SMA in EJMT has shown that better resistance to truck chain wear was seen in comparison to past dense graded HMA usage.

Estimate:

COST WORKSHEET					Proposal No:	33
					Idea No:	53
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
SX(100) PG 76-28	70,104	ton	$121	$ 8,482,584		
Proposed Design						
SMA (1/2") with fibers	70,104	ton			$127	$ 8,903,208
Total:				$ 8,482,584		$ 8,903,208
Markup	80.93%			$ 6,864,955		$ 7,205,366
Totals				$ 15,347,539		$ 16,108,574
Savings:				$ (761,035)		

Notes: CAP I pavement quantity used. Cost for SMA based on maximum anticipated cost for similar tonnage projects over the last 5 years.

Consensus:

The proposal is rejected because tire chains result in a short service life for stone matrix asphalt.

Proposal 34: Use unmodified mix in lieu of modified HMA on the trail.

Current Design: The current pavement section included in the CAP 1 estimate shows 4" HMA over 6" ABC Class 6, with the HMA utilizing PG 76-28 binder.

Cost Savings: $299,795

Advantages	Disadvantages
· Eliminate more expensive modified binder currently shown · Modified high-temp binder not needed for light trail traffic · Can be same asphalt mix proposed for lower paving lifts on roadway	· None apparent

Idea 56

Discussion:

Finalization of the pavement designs may not be complete, so the cost estimate may be based on initial discussions. Given that the trail will not be subject to heavy truck traffic similar to the mainline roadway, use of an HMA with a modified binder should not be warranted/needed for performance. The suggestion is to utilize a dense grade HMA with PG 58-28 unmodified binder. This binder may prove easier to work/place with the anticipated lighter equipment anticipated to be used when paving the trail and compacting the materials. If the same mix is used for the trail paving that is planned for the lower lifts of the roadway, a separate mix design will not be needed, and the unit pricing should reflect the economy of scale overall quantity.

Estimate:

COST WORKSHEET					Proposal No:	34
					Idea No:	56
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
SX (100) PG 76-28 (trail)	4,253	ton	121	$ 514,613		
Proposed Design						
Grade SX (PG 58-28)	4,253	ton			$82	$ 348,916
Total:				$ 514,613		$ 348,916
Markup	80.93%			$ 416,476		$ 282,378
Totals				$ 931,089		$ 631,294
Savings:				$ 299,795		

Notes: CAP I pavement quantity/pricing for trail used. For pricing of unmodified HMA, pricing was based on Grade SX (75) (PG 58-28) - pricing may better reflect pricing for larger quantity anticipated with lower lift mainline paving.

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 35: Propose smart lighting where lighting is needed, i.e. chain up and parking areas, and runaway truck ramp.

Current Design: The current design only shows lighting on the road closure gates.

Design Suggestion

Advantages	Disadvantages
· Turn on only for chain station operations · Can be turned on remotely · Reduces light pollution · Can turn on by vehicle sensor · Energy savings · Lighting levels are adjustable · Reduces maintenance	· Requires fiber optic cable to locations for control · Technology glitches

Idea 3

Discussion:

The current design only includes lighting on the road closure gates. This proposal is to include lighting in the truck chain station, run away truck ramp, and truck parking area on the EB I-70 at the top of the pass if not already being considered. The proposal is to include automated lighting control instead of using the typical photo cells or power disconnects to illuminate the lighting on demand.

The smart lighting is able to reduce lighting pollution by dimming based on conditions instead of maintaining a steady burn. It can be controlled remotely from a traffic center or illumination can be provided when a vehicle driving underneath is sensed. The system requires a fiber connection to a controller and control software and is being used in major cities to reduce light pollution. The upfront costs can be more than the traditional lighting design but in the long term the system may save money by being turned off when it is not in use.

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design. No lighting is being proposed in the INFRA project but the proposal will be considered with future projects where lighting is being modified.

Proposal 36: Incorporate Smart Work Zone technology for construction.

Current Design: The project at completion includes elements for motorist alert and quick closure of the highway using ITS devices.

Added Cost: $72,372 per month includes 30 VSL's, que warning, travel time, portable message boards, engineering, software and staff to operate based on the I-25 Gap estimates.

Advantages	Disadvantages
· Improves safety · Speed limits can be changed and displayed instantly · Improves traveler information · Allows for encroachment warning devices · Scalable per season and other needs	· Adds cost · Adds maintenance

Idea 17

Discussion:

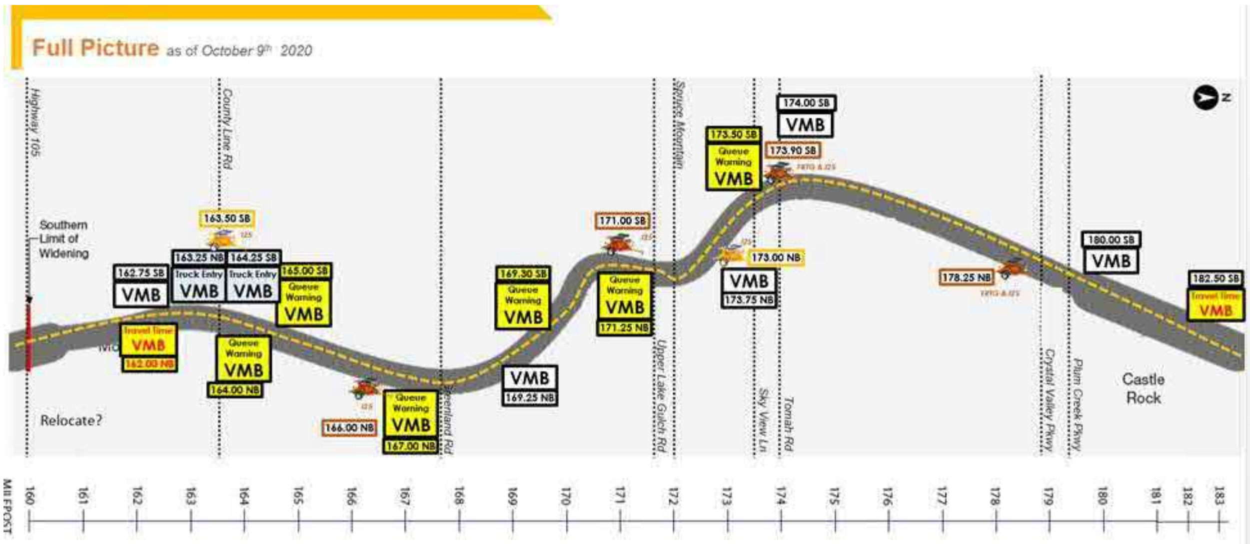
Several goals of the project are to be able to alert motorists of delays, perform quick closure of the highway, capacity improvements and safety. It is possible to maintain these goals during construction by using Smart Work Zone (SWZ) technology. This is used on the current $350 million CMGC CDOT i-25 gap project between Castle Rock and Monument and is showing good results by reduced accidents and quick response times. The noted project has 2 years of experience using this technology and has a fully operational satellite project operations office to control the equipment staffed for the core work hours. The SMZ equipment (see below for examples of signs and SWZ deployment maps) are portable rented trailers that can be saleable to any project length and size using a customer off the shelf software. The system is provided by a vendor called Street Smart and can be set up in weeks and be fully operational without the need for power and communications. The equipment is solar and uses a local cellular network. It is unknown how it would perform however on Vail pass in less than ideal conditions. The SWZ equipment can include a variety of devices such as variable speed limits, travel time, queue warning for slowdowns, programmable message boards, closed circuit TV, road and weather information systems, automated flagging systems, temporary signals, remote controlled beacons, etc. On a typical construction project, the ability to remotely control portable devices is not widely used and delays for notices causes driver frustration and additional congestion. The ability to control remotely would be invaluable.

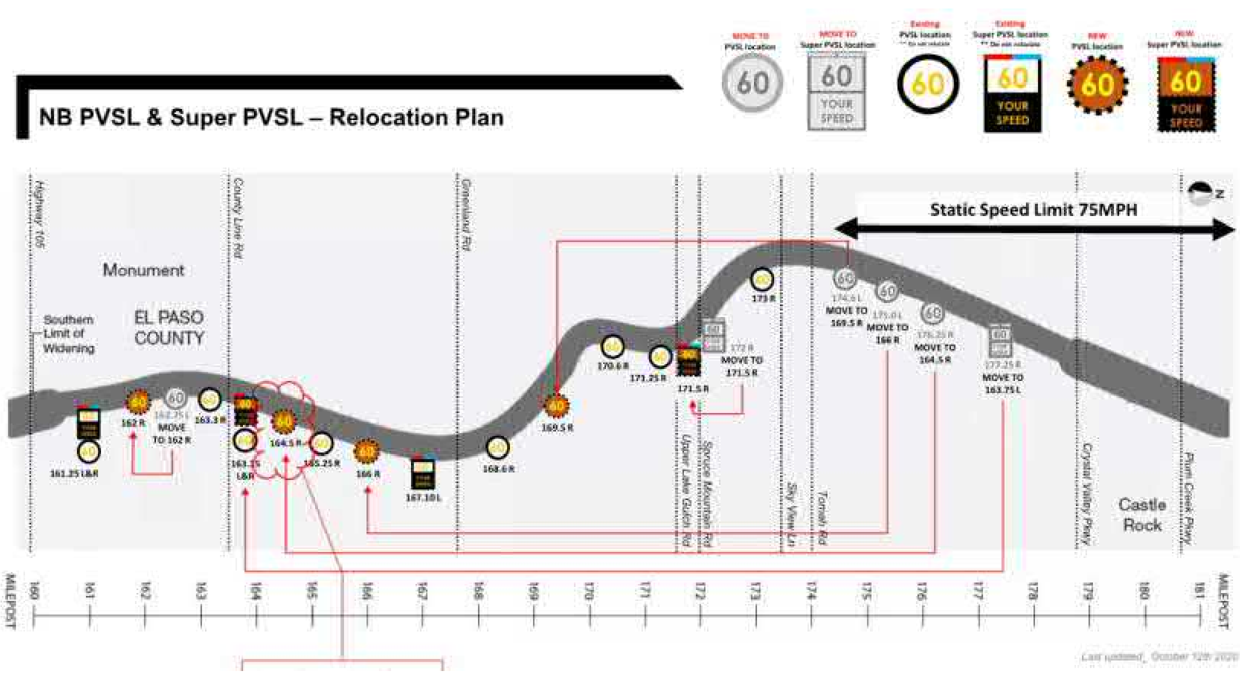

182
Wilcox St
Wolfensberger Rd

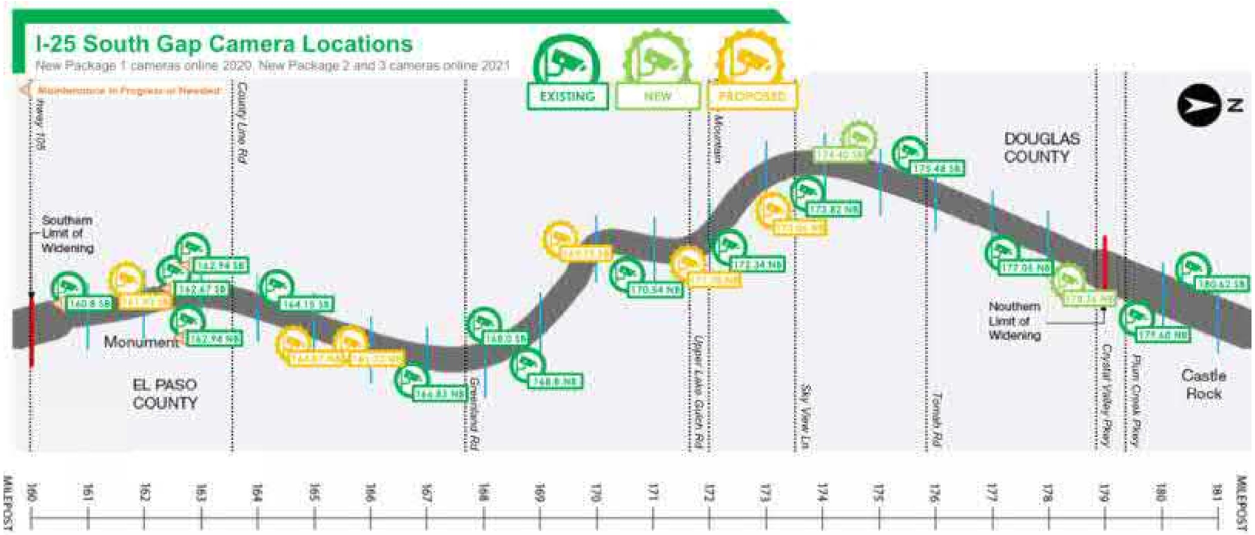

SPEED
LIMIT


WORK ZONE
SPEED
LIMIT


CHAIN
STATION
WHEN FLASHING


Full Picture as of October 9th 2020
Highway 105
County Line Rd
Greenland Rd
Spruce Mountain
Upper Lake Gulch Rd
Sky View Ln
Tomah Rd
Crystal Valley Pkwy
Plum Creek Pkwy
Southern Limit of Widening
Relocate?
Castle Rock
162.75 SB
VMB
163.50 SB
163.25 NB
164.25 SB
Truck Entry
165.00 SB
Queue Warning
Travel Time
162.00 NB
164.00 NB
166.00 NB
167.00 NB
169.30 SB
169.25 NB
171.00 SB
171.25 NB
173.50 SB
173.00 NB
173.75 NB
174.00 SB
173.90 SB
178.25 NB
180.00 SB
182.50 SB
MILEPOST
160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183


NB PVSL & Super PVSL – Relocation Plan
MOVE TO PVSL location
MOVE TO Super PVSL location
Existing PVSL location
Existing Super PVSL location
NEW PVSL location
NEW Super PVSL location
60
YOUR SPEED
Static Speed Limit 75MPH
Highway 105
County Line Rd
Greenland Rd
Upper Lake Gulch Rd
Spruce Mountain Rd
Sky View Ln
Tomah Rd
Crystal Valley Pkwy
Plum Creek Pkwy
Monument
EL PASO COUNTY
Southern Limit of Widening
Castle Rock
161.25 L&R
162 R
MOVE TO 162 R
163.3 R
164.5 R
165.25 R
166 R
167.10 L
168.6 R
169.5 R
170.6 R
171.25 R
171.5 R
MOVE TO 171.5 R
173 R
MOVE TO 169.5 R
MOVE TO 166 R
MOVE TO 164.5 R
MOVE TO 163.75 L
MILEPOST
160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181



Estimate: This is a monthly Cost

COST WORKSHEET					Proposal No:	36
					Idea No:	17
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
Current Design						
Proposed Design						
SWZ	1	LS			$40,000	$ 40,000
						$ -
Total:				$ -		$ 40,000
Markup	80.93%			$ -		$ 32,372
Totals				$ -		$ 72,372
Savings:				$ (72,372)		

Consensus:

The proposal has been accepted and will be considered in the INFRA Grant scope design.

Proposal 37: Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.

Current Design: The current design does not address power. It has not been fully designed for all the ITS elements.

Design Suggestion: Added Cost

Advantages	Disadvantages
· Improved power reliability for the town and CDOT · May replace outdated services · May not increase cost by using the public private partnership CDOT guidelines	· Additional utility coordination · Added construction complexity ·

Idea 18

Discussion:

When the I-70 fiber was extended to the town of Vail, Xcel approached CDOT and proposed a joint trench which would include a high voltage line in the I-70 right of way from Copper Mountain to the Vail Rest Area. This area often experienced power outages due to unreliable and outdated overhead power. CDOT partnered with Xcel and shared the joint trench. CDOT provided a design, bid, build set of plans and one contractor built the project for both CDOT and Xcel. This was considered a public private partnership but since Xcel is a utility it was not necessary to complete a RFP for this work and a simple contract was drafted by CDOT and Xcel. The joint trench (fiber and high voltage line) has break out boxes for the fiber and power to avoid electrocution and secondary services as needed by CDOT for power along the highway.

This proposal is to continue the high voltage line to the town of Vail if desired by Holy Cross power and Xcel Energy; which have not been approached with this idea. The full ITS plan for VSL's, LUS's, etc will require power and it is intermittent on the west side of the pass. It is uncertain how much of the fiber backbone is to be moved and can remain. In the areas where the backbone is moved, it may make sense to partner with the local power company and in other areas it may be beneficial to allow a utility trench for power under the public private partnership guidelines. Below is an example of the many high voltage and secondary service boxes along I-70 between Copper Mountain and the top of Vail Pass. The CDOT ITS Branch has the design plans for this work.

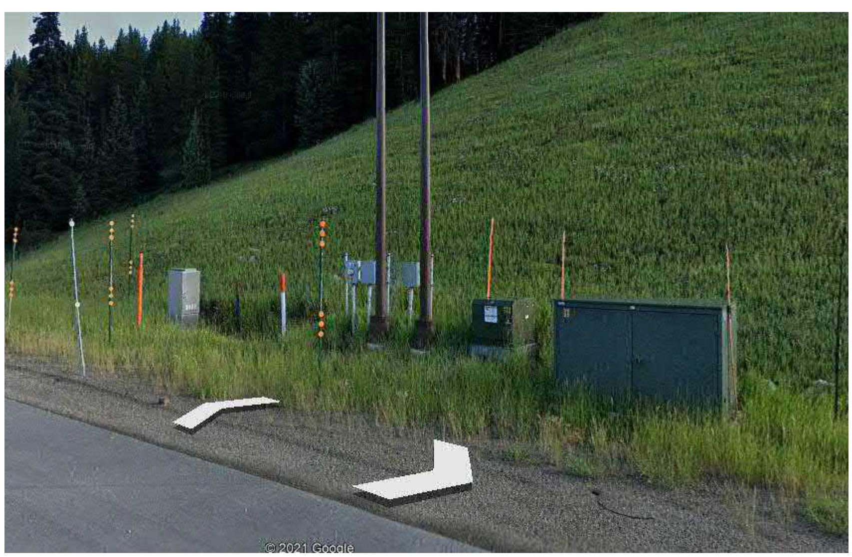


Figure 1 - I-70 High Voltage and Secondary

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design and also beyond the INFRA Grant project limits.

Proposal 38: Incorporate Electronic / Automated powered road closure gates.

Current Design: The current design shows a total of 4 road closure points on EB and WB I-70. These locations are in the EB direction at Exit 180 and in the WB direction at Exit 190. The number of gates is estimated at 6 (two for mainline each direction and one on each ramp).

Added Cost: $1,257,102

Advantages	Disadvantages
· Railroads have this technology · This technology is used in HOV lanes in Denver metro on I-25 · Can be incorporated into smart technology	· Adds cost · Potential technology failure · May need manual override

Idea 20

Discussion:

This proposal is to change the current design from a manually lowered road closure gate to an automated closure gate for both directions of I-70 and the on-ramps. This technology is used by the railroads and in Denver on the I-25 HOV lanes. While road closures are maintained by the DOT, when in place an automated closure would allow quicker opening of the highway but not necessarily for closing since these are manned locations by state personnel due to drivers possibly going around the gates. However, during opening an automated system could alleviate some personnel the burden of sitting on the highway before an opening. In addition, the gates can at times be difficult to lower due to inclement weather, i.e. snow, wind, and ice. An enclosure system would ensure the gates are lowered in all weather conditions. This proposal will require fiber connectivity and software development to remotely control the gates by the traffic operations center(s).

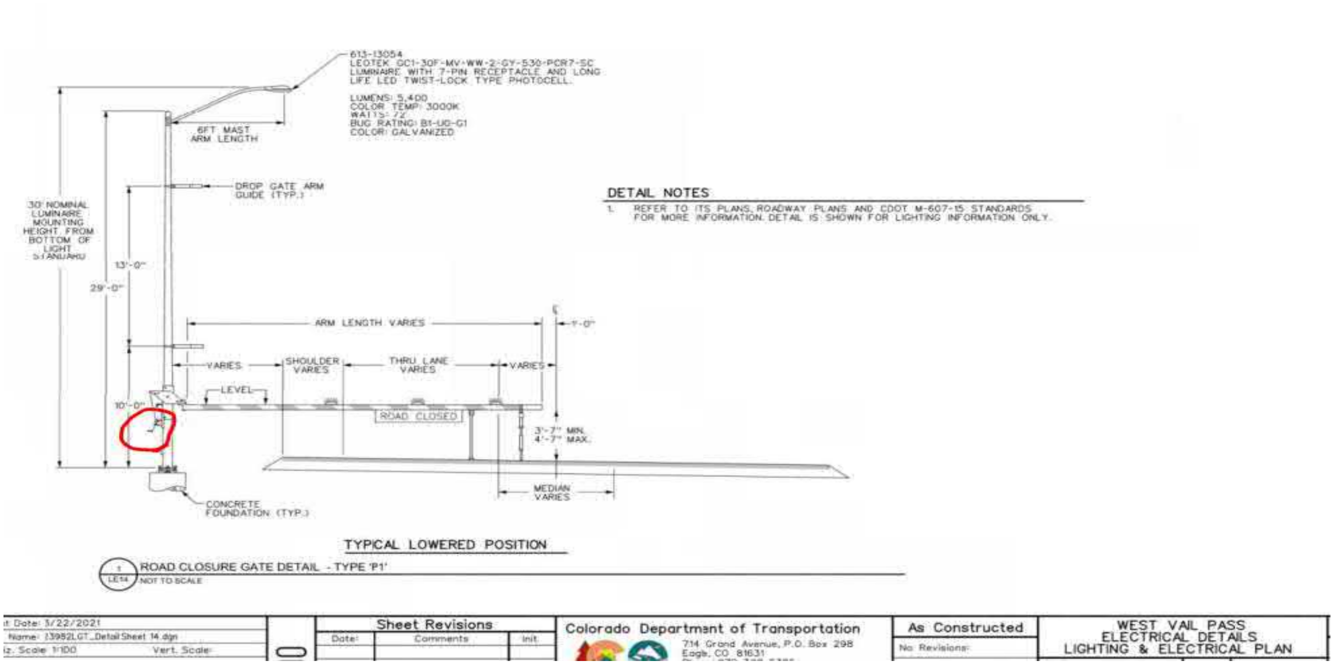


Figure 1 FIR/FOR plan sheet 104 of 174 shows crank arm on gate

Figure 2 HOV Automated gates in Denver

Estimate:

COST WORKSHEET					Proposal No:	38
					Idea No:	20
Item	Qty	Unit	Original Estimate		New Estimate	
			Cost	Total	Cost	Total
<u>Current Design</u>						
Road Closure Gate Item 607	6	Each	$20,950	$ 125,700		
<u>Proposed Design</u>						
Control Software	1	LS			$150,000	$ 150,000
Automated Gate	6	Each			$100,000	$ 600,000
Fiber 12 strand	500	LF			$9	$ 4,500
2-inch electrical conduit (bored)	500	LF			$32	$ 16,000
Ancillary control equipment (router, controller, etc.)	1	LS			$50,000	$ 50,000
Total:				$ 125,700		$ 820,500
Markup	80.93%			$ 101,729		$ 664,031
Totals				$ 227,429		$ 1,484,531
Savings:				$ (1,257,102)		

Consensus:

The proposal is rejected because staffing is required to physically close the gate when necessary.

Proposal 39: Dispose haul off material in interchange infield areas and grade aesthetically.

Current Design: Current design does not utilize interchange infields as potential waste site.

Design Suggestion

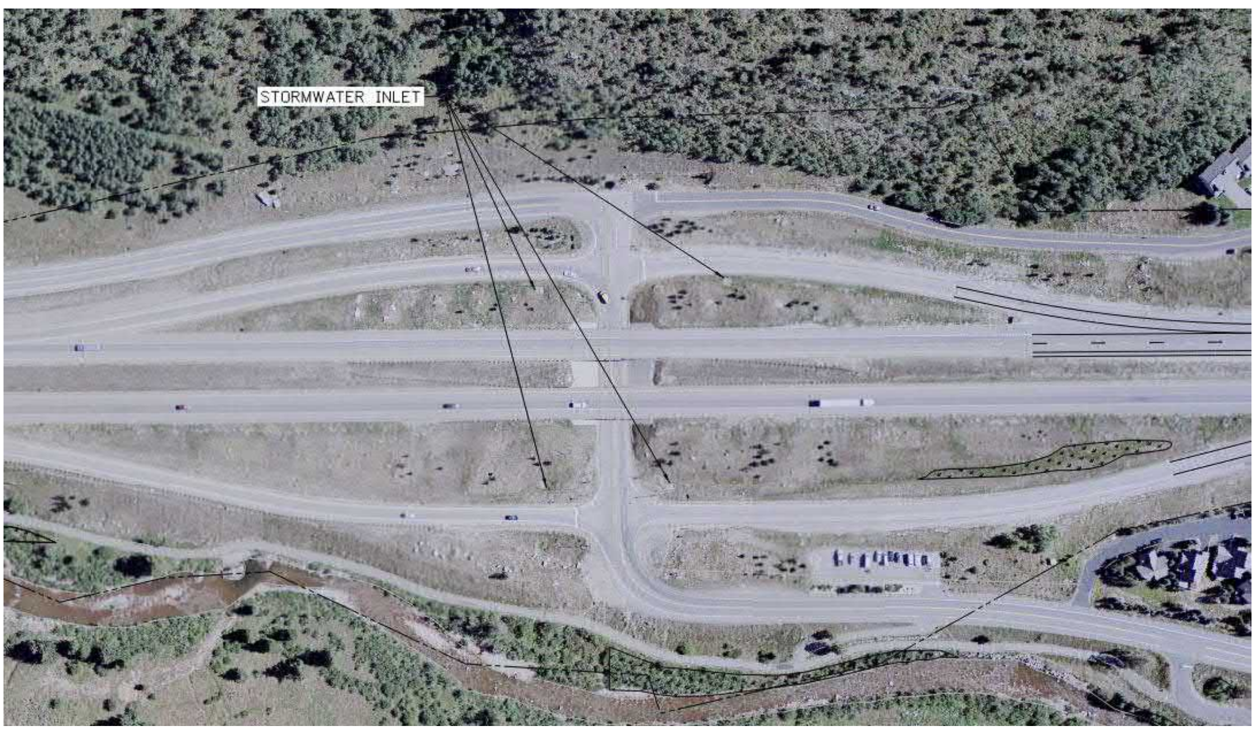
Advantages	Disadvantages
· Saves cost · Can be used to enhance aesthetics · Convenient waste site	· Wetlands impact · Could change drainage and grading patterns · Adds landscape cost · Could impact sight distance

Idea 54

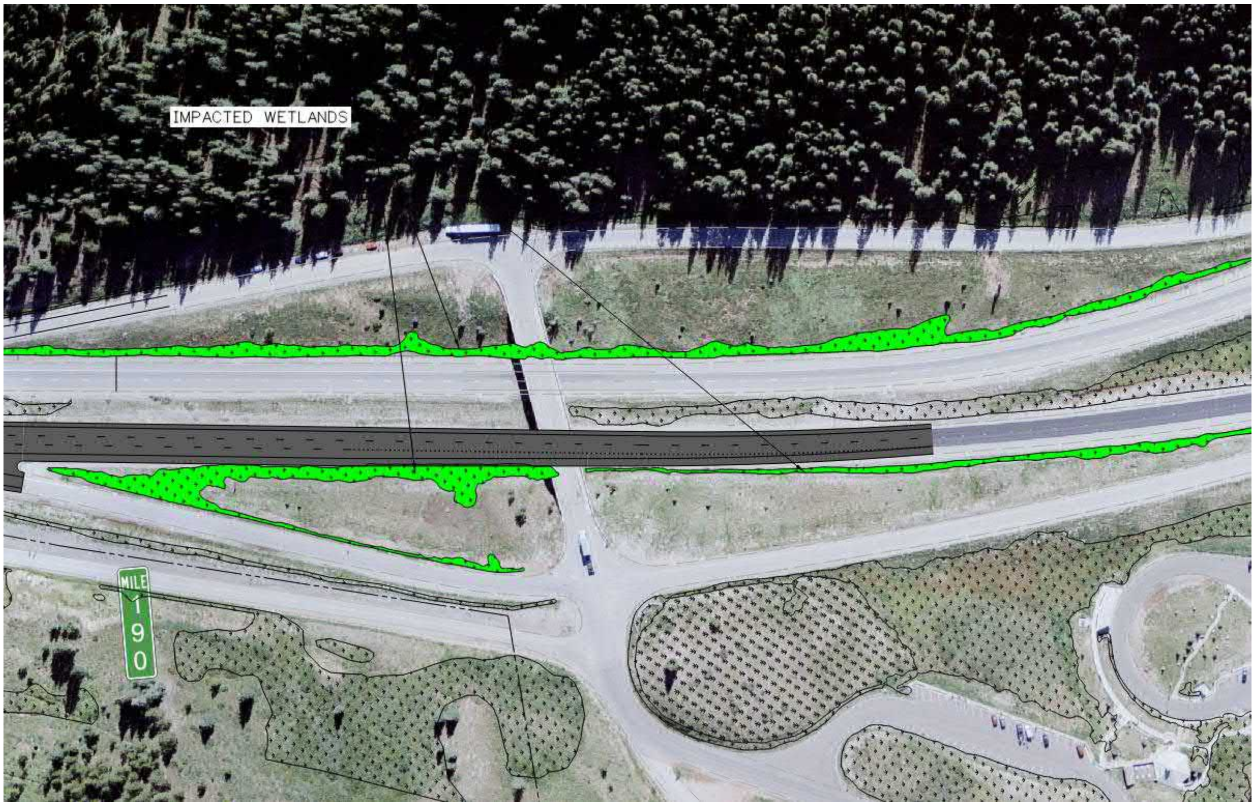
Discussion:

Interchange infields could potentially be used as a convenient waste disposal site to save on haul off material costs, as well as enhance the aesthetics of the area. Possible setbacks may include higher landscaping costs, negative impacts on the existing terrain, and sight distance issues.

There are 2 interchanges within the project limits (at MP 179.4 and MP 190). The interchange at MP 179.4 has stormwater inlets located within the infield areas. Adding waste material to these locations would likely significantly impact the drainage (see below).



The interchange at MP 190 would not have as drastic an effect on the drainage design, but it could have a wetlands impact of around 50,000 sf (see below).



Consensus:

The proposal is rejected because it was performed previously and issues were created with stopping sight distance.

Proposal 40: Explore federal or state reforestation grants to offset costs.

Current Design: Landscape installation of disturbed areas is approximately 106 acres.

Design Suggestion

Advantages	Disadvantages
· May provide additional project funding	· Application process · Funding qualifications

Idea 54

Discussion:

In order to reduce or offset landscape restoration costs it is proposed the team explore partnering opportunities with local agencies (Non-profits, Fire Protection Districts, Utility providers, etc.) to seek matching grant funds from Federal (i.e. USFS) or State (i.e CSFS) agencies for landscape efforts that can be deemed fire protection BMPs, erosion/rockfall protection, or land or stream habitat restoration efforts. While grant qualifications are often very specific and require back end monitoring and reporting, the Project covers a large swath of sub-alpine terrain and requires that special attention is paid to landscape mitigations and improvements to wildlife ecosystems. CSFS, for example, has in the past awarded grants between $3,000 and $250,000. While any successful efforts would likely result in small dollar capital relief, the partnerships formed during the efforts can result in positive projects sentiment with local agencies and advocacy groups.

Consensus:

The proposal will be held for further consideration in the INFRA Grant scope design. The option will be discussed with the United States Forest Service.

Proposal 41: Incorporate Programmatic permitting and mitigation strategies.

Current Design: Permits and approvals are to be acquired specifically for each phase.

Design Suggestion

Advantages	Disadvantages
· Saves cost · Removes environmental from critical path on future phases · Better mitigation ratios	· None apparent

Idea 25

Discussion:

Several efficiencies to project delivery, cost, and schedule can be achieved by utilizing a programmatic or corridor-level approach to permitting and mitigation. It is assumed the WVP Auxiliary Lanes project will be completed over several phases or funding cycles, starting with the INFRA-grant project as Phase 1. CDOT should consider acquiring programmatic environmental permits and approvals, including advance CWA 404 mitigation, that cover the entire EA project as part of Phase 1. Benefits are:

- Wetland mitigation could be provided by using a watershed-based advance compensatory mitigation strategy at a corridor level. Establishing an advance mitigation site now would lower costs by providing better ratios for future phases. A simple credit/debit ledger is used once a mitigation site is accepted and performing. Corps of Engineers prefers advance mitigation due to the increased success and certainty provided.
- If programmatic permits and approvals for the entire corridor are acquired as part of Phase 1, future phases will only require permit updates. This would save time and schedule by eliminating the need to start the regulatory clock for every phase.

Consensus:

The proposal will be considered when possible in the INFRA Grant scope design. The proposal is accepted with modifications.

2.0 Value Engineering Study

This study followed a value engineering job plan conforming to the Standards of SAVE International. The value engineering job plan is summarized as follows:

- *Preparation.* Prior to the study, the facilitator works with the project manager and client to plan the event. This planning includes determining the scope of the study, deciding where the study will be held, selecting team members, and choosing the starting date and duration of the study. The facilitator also gathers data and documents on the project (or arranges for them to be present on the first day of the study) and completes a cost model. This cost model often highlights "Pareto's Law of Distribution" which theorizes that 20% of the work items generally account for 80% of the cost. The facilitator uses this model to focus the team's attention on those parts of the project that have the greatest potential for savings.
- *Investigation Phase.* Some of the individuals on the study team may have an intimate knowledge of the project, others may have no prior involvement, and the remainder fall somewhere in between. Therefore, the primary goal of the Investigation Phase is for the team to develop a detailed and shared understanding of the project, its current design, and how the design functions to meet the project's purpose and need.
- *Function Analysis Phase:* The Team identifies functions, expressed in noun-verb pairs and categorizes them in a table. After identifying the project functions, a Function Analysis System Technique (FAST) Diagram is developed to illustrate the logical relationship between the functions. The purpose is to develop an agreement between VE Team members on the basic functions of the project, so that Creativity can be geared toward preserving those basic functions. Cost models are reviewed to gear the team toward project components with the greatest potential opportunity for cost savings.
- *Creative Phase*. During the Creative Phase, the team brainstorms based upon the function analysis to generate ideas for improvement. No attempt is made during this phase to restrain the free flow of ideas. Therefore, some ideas may be impractical, "far-fetched," or even nonsensical. This lack of restraint is essential to encourage creative thought. Ideas that are not feasible are eliminated in the next phase of the study.
- *Evaluation Phase.* During the evaluation phase, the team assesses each idea and develops a consensus of which ideas should be retained for further analysis. Advantages and disadvantages of each idea are discussed as part of the evaluation. A scoring system is used to aid in the selection of ideas for further development.
- *Development Phase*. In this phase, the ideas retained from the Evaluation Phase are developed into proposals for further investigation by the design team. In some cases, related ideas are combined into a single proposal. During the Development Phase, the team gathers information and prepares a written summary for each of the proposals. The team prepares sketches, performs calculations, and develops cost estimates to support its analysis of each proposals. The proposals are reordered from their original idea numbers by discipline for a more logical presentation.
- *Presentation Phase*. The study concludes with a presentation to key members of the design team, the client's staff, and or other stakeholders.

2.1 VE Study Team Personnel

The VE study team members are listed as follows:

Name / Role / Employer	Address	Phone	Email Address
John Corcoran, PE, CVS® Facilitator (Jacobs)	412 Mt. Kemble Avenue Morristown, NJ 07960	P 862.242.7135	John.Corcoran@jacobs.com
Craig Broadhead Environmental (Jacobs)	32 North 3rd Street, Suite 320 Yakima, WA 98901	C 509.312.0375	Craig.Broadhead@jacobs.com
Tim Siedlecki, RLA Landscape Architecture (Jacobs)	9189 South Jamaica St. Englewood, CO 80112	P 720.286.1147	Tim.Siedlecki@jacobs.com
Mark Talvitie, PE Transportation Engineer (RS&H)	4582 South Ulster Street, Suite 1100 Denver, CO 80237	P 720.586.6667	Mark.Talvitie@rsandh.com
Greg Grant Bridge Engineer (RS&H)	10748 Deerwood Park Blvd South Jacksonville, FL 32256	P 904.256.2152	Greg.Grant@rsandh.com
Ben Sterling, EIT Transportation Engineer (RS&H)	5690 DTC Blvd Suite 345W Greenwood Village, CO 80111	P 720.586.6694	Ben.Sterling@rsandh.com
Ted Rutledge, PE Constructability (Kiewit)	12510 Belford Avenue Englewood, CO 80112	P 303.325.0612	Ted.Rutledge@kiewit.com
Ken DePinto Highway / ITS (Apex Design)	1675 Larimer Suite 400 Denver, CO 80202	P 720.420.3424	Ken.DePinto@apexdesignpc.com
Neil Ogden, PE Resident Engineer (CDOT)	425 A Corporate Circle Golden, CO 80401	P 720.497.6928	Neil.Ogden@state.co.us
Craig Wieden, PE Materials Engineer (CDOT)	4670 Holly Street Denver, CO 80216	P 303.398.6501	Craig.Wieden@state.co.us
Jeff Bellen Region 3 Area Engineer (FHWA)	12300 W. Dakota Ave. Lakewood, CO 80228	P 720.963.3438	jeff.bellen@dot.gov
Armando Henriquez, PE Region 3 Area Engineer (FHWA)	12300 W. Dakota Ave. Suite 180 Lakewood, CO 80228	P 720.963.3031	armando.henriquez@dot.gov

2.2 Study Agenda

The agenda used for the VE Study workshop is shown as follows:

COLORADO Department of Transportation — I-70 West Vail Pass Auxiliary Lanes

VALUE ENGINEERING (VE) STUDY AGENDA
COLORADO DEPARTMENT OF TRANSPORTATION – REGION 3
I-70 WEST VAIL PASS AUXILIARY LANES
EAGLE COUNTY, CO

All workshop sessions will be conducted via Teams Meetings. Meeting invitations will be sent to attendees.

All times shown are in Mountain Daylight Time, MST.

Tuesday, April 6, 2021 (Day 1)

Information Phase-Overall Project – Design Team

8:30 a.m. Introductions – VE Facilitator.
Safety Moment.

8:40 a.m. Overview of VE Study and Agenda – VE Facilitator.
- The VE process
- Job Plan / Schedule

9:00 a.m. Overview briefing of the project scope / status by the Design Team.
- Project Premise
- Goals and Objectives
- Overall Project Scope
  - Roadway
  - Bridge/Structural
  - Traffic/ITS
  - Geotechnical/Materials
  - Wildlife
  - Aesthetics/Landscaping
  - Constructability (Kiewit)
- Project Constructability / Cost / Schedule Issues
- Risk identification, assessment and management
- Q&A with VE Team Members

10:00 a.m. Break.

Function Analysis Phase –VE Team:

10:15 a.m. VE Team Workshop – Function Analysis.
- Major project functions identified by team.
- Identify Stakeholders Needs / Desires / Constraints.
- Identify Basic, Secondary, and Higher Order Functions.
- Develop FAST Diagram.
- Review Budget Cost Estimate and Cost Model.

12:00 p.m. Lunch.

12:30 p.m. Complete Function Analysis.

Page 1 of 3

VALUE ENGINEERING (VE) STUDY AGENDA
COLORADO DEPARTMENT OF TRANSPORTATION – REGION 3
I-70 WEST VAIL PASS AUXILIARY LANES
EAGLE COUNTY, CO

Creative Phase (Brainstorming) – VE Team:

1:00 p.m. For each major work category (highway, stormwater management, construction, etc.) start brainstorming for creative design alternatives that meet project functions.

2:30 p.m. Break.

2:45 p.m. Brainstorming continues.

4:00 p.m. Adjourn.

Wednesday, April 7, 2021 (Day 2)

Function Analysis Phase reviewed:

8:30 a.m. Previous day's Function Analysis and FAST Diagram reviewed for concurrence and to promote additional creativity.

Creative Phase continues:

9:00 a.m. Complete Brainstorming.

Evaluation Phase – VE Team:

9:30 a.m. The VE team analyzes the Creative Phase ideas. Each idea is discussed qualitatively relative to its feasibility, cost, schedule impact, implementation, and other factors.

10:00 a.m. Break.

10:15 p.m. Evaluation continues.

12:00 p.m. Lunch.

12:30 p.m. Complete evaluation. Brainstorming is revisited for potential spin-off ideas or for ideas to be combined. Ideas are rated and decisions made on those to be developed into proposals. Select ideas for further development into proposals.

2:30 p.m. Break.

Development Phase – VE Team:

2:45 p.m. Assign ideas to be developed by each team member. Team members begin developing specifically assigned ideas into proposals. This work includes completion of forms including complete description of the current and proposed condition, discussion (including advantages and disadvantages), sketches or graphics, rough calculations, and cost estimates.

4:00 p.m. Adjourn.

VALUE ENGINEERING (VE) STUDY AGENDA
COLORADO DEPARTMENT OF TRANSPORTATION – REGION 3
I-70 WEST VAIL PASS AUXILIARY LANES
EAGLE COUNTY, CO

Thursday, April 8, 2021 (Day 3)

Development Phase continues:

8:30 a.m. Proposal development continues. Begin production of VE study presentation.

10:00 a.m. Break.

10:15 a.m. Proposal development and production of VE study presentation continue.

12:00 p.m. Lunch.

12:30 p.m. Proposal development and production of VE study presentation continue.

2:30 p.m. Break.

2:45 p.m. Full team meeting. Status review of proposals and presentation. Team discusses revising / adding new ideas to list. Finalize proposals and out-brief presentation to design team.

4:00 p.m. Adjourn.

Friday, April 9, 2021 (Day 4)

Development Phase continues:

8:30 a.m. Full team meeting. Review and edit out-brief presentation to design team.

Presentation Phase – VE Team:

10:00 a.m. VE Presentation Meeting to Client / Design Team.

- Full meeting with project team. Present VE Team proposals and recommendations.
- Q&A with Design Team Members.
- Discussion of next steps by VE facilitator.
- Closing remarks.

12:00 p.m. Adjourn.

2.3 Investigation

Design Presentation Minutes

Meeting Location	All attendees participated remotely.
Meeting Date/Time	April 6, 2021, 8:30 am MDT
Subject	Colorado Department of Transportation – Region 3 I-70 West Vail Pass Auxiliary Lanes Eagle County, CO Information Session
Participants	Design Team: CDOT – John Kronholm, Matt Figgs; RS&H – Randal Lapsley; Kiewit – Jim Thomsen VE Team: Jacobs – John Corcoran, Craig Broadhead, Tim Siedlecki; RS&H – Mark Talvitie, Greg Grant, Ben Sterling; Kiewit – Ted Rutledge; Apex – Ken DePinto; CDOT – Neil Ogden, Craig Wieden; FHWA – Jeff Bellen, Armando Henriquez
Notes Prepared By	John Corcoran
Attachments	*Introduction to Value Engineering* Power Point Slideshow, Proposed Action Alternative Preliminary Plans

The meeting began at approximately 8:30 am.

John Corcoran gave an overview of the VE process in conjunction with the attached *Introduction to Value Engineering* Power Point Slideshow.

At approximately 9:00 am, members of the design team delivered the presentation in conjunction with the attached Proposed Action Alternative Preliminary Plans. The individual presenters and some highlights of the discussion presented are as follows:

John Kronholm

- Project objective is to improve the corridor between Glenwood Springs and Denver.
- Programmatic Environmental Assessment (EA) and Preferred Action plans were shared.
- A third lane is proposed in each direction for the length of Vail Pass.
- Vail Pass is steep and subject to tractor trailer congestion.
- An EA Tier 2 NEPA Evaluation was performed in 2016.
- The purpose and need were identified as improving safety and operations.
- The Pass is closed frequently due to traffic incidents.
- Traffic constraints include minimal lane width with few pull-off and breakdown areas.
- There is poor interaction between faster and slower moving vehicles
- West Vail Pass has the highest crash rate on all of I-70
- Auxiliary lanes proposed in each direction are 12' wide.
- Inside shoulders will be widened from 4' to 6' between mileposts (MP's) 180 and 190.
- Substandard geometry will be addressed. Curves will be modified to accommodate design and posted speed limits.
- Variable message (VM) signs and variable speed limit (VSL) signs will be incorporated.
- A remote lane closure system will be incorporated to allow for quick closures.
- There are often crash chain reactions when the highway is iced over.

- Two miles of the recreation trail must be relocated.
- Six wildlife underpasses are included in the design.
- The design will allow for increased commercial truck passing.
- Additional features proposed include widened shoulders at select locations, hot brake passes, and avalanche protection.
- The project has been funded through the Infra grant.
- The current 1st phase cost estimate is $140 million. The overall project estimate is $740 million.
- Kiewit is the CM/GC contractor.
- The aesthetic and historical character of the Pass must be maintained. Existing topography must be matched.
- The Vail Pass was the site of some of the first EA's in CDOT history.

<u>Randal Lapsley</u>

- Project location was shown on Google Earth.
- The Pass narrows near MP 186, resulting in a higher crash rate.
- Some embankments are specially sculpted to maintain aesthetics.
- A truck escape route proposed to be straightened was shown.
- Some failing retaining walls were shown.
- A section of the recreation trail in conflict with the proposed construction was shown.
- A wildlife underpass at MP 187.9 was shown. This is the second highest underpass. The horizontal alignment is wavy at this location.
- There are 16 existing wildlife crossings.
- The Vail Pass Interchange at MP 190 was shown.

<u>John Kronholm</u>

- The EA plans were shared to continue the presentation.
- There are private properties close to the interstate near the western project limits (MP 179.8).
- The bridges at MP 180.7 are scheduled to be replaced.
- The possibility of using the median for phasing was suggested. Suggestions for phasing improvements is appreciated.
- The bridges at MP 181.7 are scheduled to be replaced. An additional pull-off location is desired.
- The proposed runaway truck ramp improvement at MP 182 was discussed. The ramp is included in the FIR/FOR documents. The ramp will include some VM signs in to improve design to higher level.
- The chain station improvements at MP 182.5 were discussed.
- The bridge replacements east of MP 183.5 were discussed.
- The bridge replacements east of MP 184.0 were discussed. All post-tension cables are in the top of the structure. It is suggested more could be located in the bottom of the structure. The concrete segments have become separated.
- The bridges at MP 185.2 were identified as the top two bridges of the Pass.
- The corridor was identified as being narrower near MP 186 due to the nearby cliff.
- The design of the corridor between approximate MP's 186.5 and 187 was mentioned as being between 10% and FIR.
- There are six proposed wildlife underpasses. Four are defined as smaller and two identified as larger. The larger crossings may be as wide as 50'. The smaller crossings may be elliptical pipes or small boxes. Bridges are not desired for the larger crossings.
- MP 188.5 was identified as the approximate crest of the Pass.
- Water quality is a concern in this area. Traps are to be installed to collect sediment. Sand is placed on the roadway throughout the winter to mitigate slippery conditions. The sand must not enter Black Gore Creek.
- The proposed additional snow storage and improved truck parking at approximate MP 189.5 was discussed.
- Some field photos were shown. Structure F12AS is shown with no pier caps and contrasting colors.

Randal Lapsley

- Variances are required for 13 FHWA Controlling Design criteria (It was later clarified that there are only 10 controlling design criteria).
- Walls must be aesthetic to match the surroundings.
- Scalloped walls are the preferred finish in the historic linear district.
- MSE walls and shotcrete walls have been explored, but they must be in harmony with the landscape.
- Dead tree stumps are placed back in the landscape to maintain a natural appearance.
- There is concern about the aesthetic appearance of bridge pier caps.
- The CDOT ITS backbone will be installed in the westbound lanes.
- A utility corridor has been discussed. There is currently a gap in the electrical service toward the middle of the Pass.
- Wildlife passage is a serious concern. Lynx, deer, and elk are prevalent.
- There are wall height limits in certain locations. Wall encroachment on medians is also a concern.

Matthew Figgs

- Constructability and construction phasing are concerns.
- Maintaining traffic during construction is a challenge, any closures need to follow the Region 3 Lane Closure Strategy.
- There is concern about impact to tourism and local economy during construction. The Copper Triangle bikeway is a major attraction. Numerous guides and outfitters service the region. Trail cannot be closed, is assumed the trail must be relocated before the EB construction can begin.
- Summertime lane closings will be permitted only at night.
- Weather and wildlife habitats are also construction concerns.
- There is no nearby parallel route to provide an adequate detour.
- A risk register has been completed. Materials availability has been identified as a concern. There are no nearby gravel pits.
- The INFRA grant covers the corridor from MP 185 to the top of the Pass. There is one bridge replacement proposed in the INFRA grant. John Kronholm clarified that the VE scope includes the entire EA.

The meeting was opened for questions by VE team members. Highlights of the dialogue that resulted from the question and answer session are as follows:

- A question was asked whether incident response has been evaluated for construction. It was stated that the original PEIS addressed emergency response in identifying the need for improved operations and safety. The proposed third lane should almost eliminate full closures, but partial closures may still be necessary.
- There was a request for clarification of lane plus one safety requirements. It was stated that the proposed 10' outside shoulder would satisfy the requirement. There is no through traffic capability with a disabled vehicle parked on the inside shoulder, but project restraints prevent widening the cross section to that degree.
- There was a question about whether any part of the design is considered untouchable. There was a response that CDOT does not own the corridor ROW. The corridor is an easement allowed by the Forest Service. However, the Forest Service has been a very cooperative partner.
- There was a question about the availability of a geotechnical report. The reply was that the geotechnical investigation is in progress, so the report is not yet available. The assumed roadway section was currently assumed to be 10" of asphalt over 12" of Class 6 material. Depending on the 'R' values determined by the geotechnical investigation, there could be a slight section reduction, i.e. reduction of asphalt layer from 10" to 9½". There was discussion about using less pavement in left lanes. The pavement section design criteria for the new truck escape ramp are defined in the FIR / FOR documents. An innovation measure of reusing aggregate from the existing truck escape ramp was not desired due to the composition of the material. The project requires a lot of material to be exported, so innovations for more efficient materials handling may still be considered. Balancing earth cut and fill is desired.

The meeting was completed at approximately 10:30 am.

The *Introduction to Value Engineering* Power Point Slideshow is included in Appendix A. The Proposed Action Alternative Preliminary Plans are included in Appendix B.

2.4 Initial Cost Estimate and Cost Model

The auxiliary lanes construction cost estimate used for the VE study was dated December 22, 2020. The VE team used the cost estimate data to price VE proposals to the extent possible. Unit cost data presented in the VE estimates were used under the following circumstances:

- Where the VE proposal results in an adjustment in the quantity of established and itemized work that could be discretely identified in the cost estimate provided.
- Where the VE proposal generates a reduction to the scope of work.
- The unit costs shown in the cost estimate are specific only to the construction auxiliary lanes project segment but were assumed to be reasonably applicable to the entire corridor and were thus used in all VE cost estimates.
- The markup percentage of 80.93% used for the VE cost estimates was derived from the escalation from the direct subtotal breakdown of $76,273,175 to total cost with contingency of $138,004,170.58.
- VE Proposal estimates do not include redesign, added ROW or other non-construction costs.

A summary of the cost analysis approach for the auxiliary lanes project is shown on the following pages.

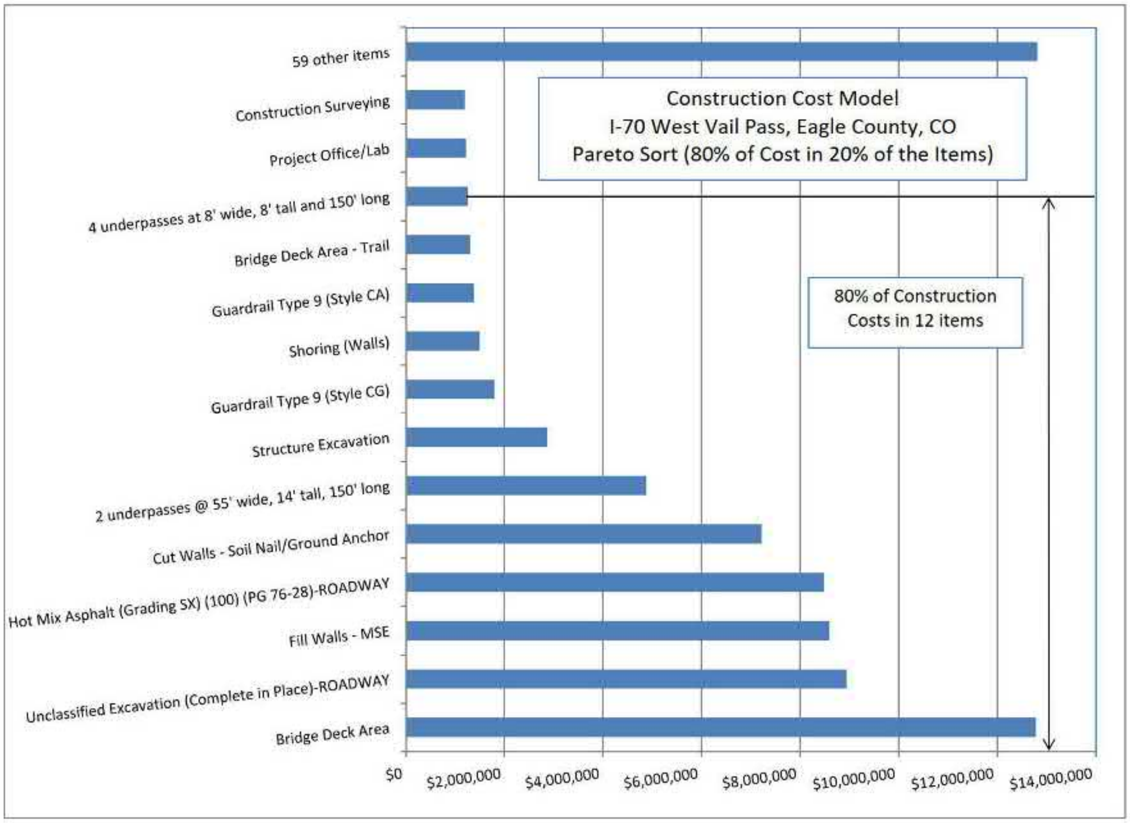
A. Cost Models

The cost estimate was reviewed as part of the VE workshop. Cost models based upon the project estimate direct subtotal breakdown of $76,273,175 were generated for the project and are shown as follows:

West Vail Pass Auxiliary Lanes Cost Distribution

CONSTRUCTION ITEM	DIRECT COST	PERCENTAGE	CUMULATIVE PERCENTAGE
Bridge Deck Area	$12,788,600	16.8%	16.8%
Unclassified Excavation (Complete in Place)-ROADWAY	$8,945,460	11.7%	28.5%
Fill Walls - MSE	$8,595,048	11.3%	39.8%
Hot Mix Asphalt (Grading SX) (100) (PG 76-28)-ROADWAY	$8,482,584	11.1%	50.9%
Cut Walls - Soil Nail/Ground Anchor	$7,222,345	9.5%	60.4%
2 underpasses @ 55' wide, 14' tall, 150' long	$4,879,305	6.4%	66.8%
Structure Excavation	$2,876,010	3.8%	70.5%
Guardrail Type 9 (Style CG)	$1,796,520	2.4%	72.9%
Shoring (Walls)	$1,500,000	2.0%	74.8%
Guardrail Type 9 (Style CA)	$1,382,490	1.8%	76.7%
Bridge Deck Area - Trail	$1,305,000	1.7%	78.4%
4 underpasses at 8' wide, 8' tall and 150' long	$1,261,600	1.7%	80.0%
Project Office/Lab	$1,220,000	1.6%	81.6%
Construction Surveying	$1,200,000	1.6%	83.2%
59 other items	$12,818,213	16.8%	100.0%
Total	$76,273,175		

West Vail Pass Auxiliary Lanes Cost Model



The cost model and estimate review highlight the following:

- Approximately 80% of the construction cost is in twelve construction items listed in the cost estimate, while the remaining 20% of the cost is in 61 other construction items. This closely matches the Pareto sort where it is hypothesized that 80% of costs are in 20% of work items.
- More than one-half of the cost is in the four construction items of Bridge Deck Area, Unclassified Excavation (Complete in Place)-ROADWAY, Fill Walls – MSE, and Hot Mix Asphalt (Grading SX) (100) (PG 76-28)-ROADWAY.

B. Life Cycle Costs

The team identified a monthly cost to Incorporate Smart Work Zone technology for construction (Proposal 36). Otherwise, the VE Team did not address quantitative life cycle costs, but qualitatively addressed life cycle cost impacts where appropriate.

2.5 Function Analysis

As part of the Function Analysis Phase of the VE Study, the VE Team identified the functions of the project and its specific design elements. The following pages contain a listing and categorization of the functions identified by the VE Team for the various project elements.

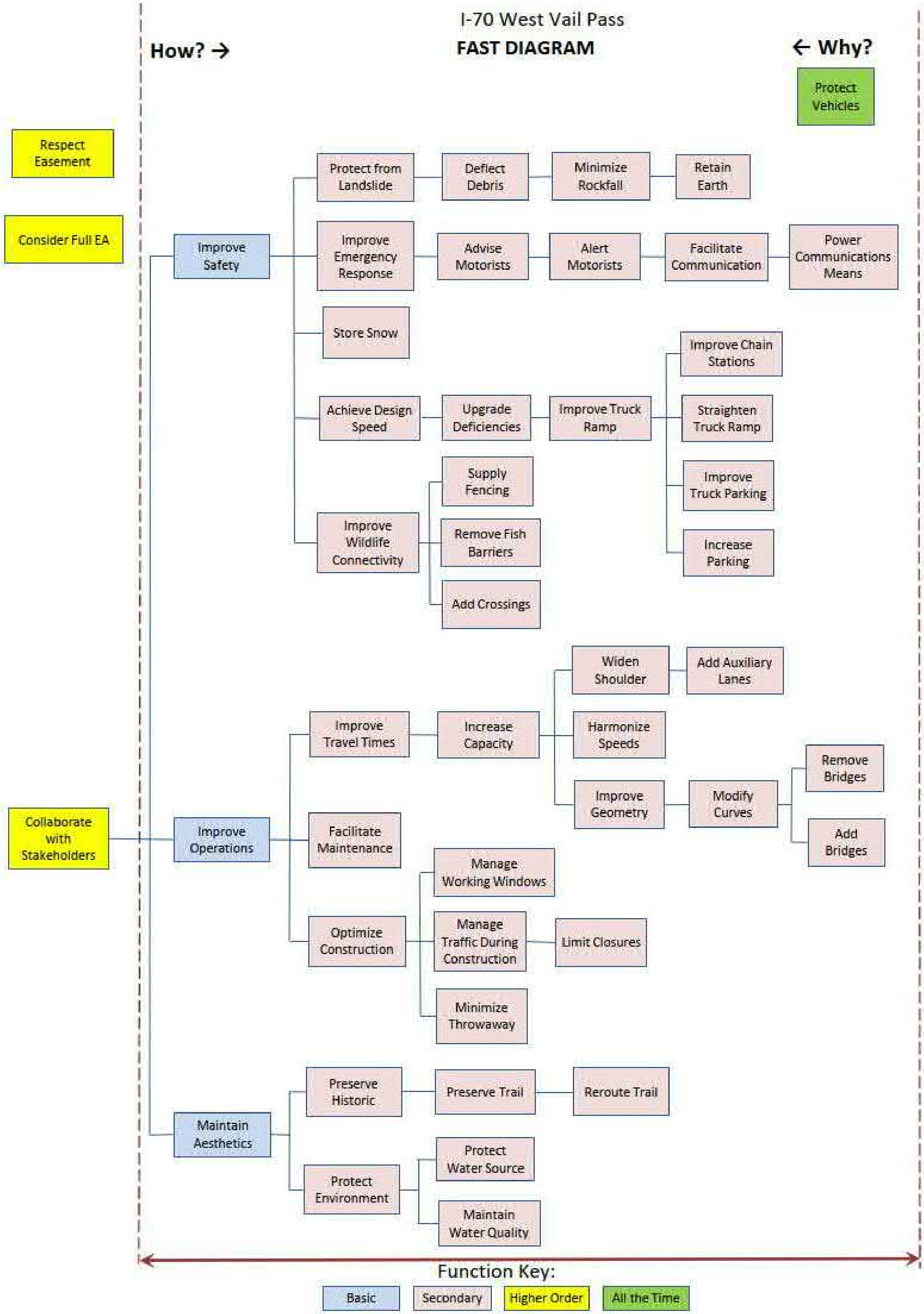
Project Element	Verb	Noun	Category: Basic / Secondary / Higher Order / All the Time
Project	improve	safety	B
	improve	travel times	S
	improve	operations	B
	increase	capacity	S
	protect	vehicles	All the Time
	maintain	aesthetics	B
	improve	wildlife connectivity	S
	deflect	debris	S
	store	snow	S
	increase	parking	S
	alert	motorists	S
	advise	motorists	S
	collaborate	w/ stakeholders	HO
	facilitate	maintenance	S
	improve	emergency response	S
	improve	geometry	S
	maintain	water quality	S
	protect	environment	S
	preserve	historic	S
	limit	closures	S
	preserve	trail	S
	protect	water source	S
	respect	easement	HO
	widen	shoulder	S
	supply	fencing	S
	achieve	design speed (65 mph)	S
	manage	traffic during construction	S
	manage	working windows	S
	modify	curves	S
	improve	truck ramp	S
	straighten	truck ramp	S
	improve	chain stations	S
	consider	full EA	HO
	minimize	throwaway	S
	optimize	construction	S
	facilitate	communication	S
	power	communication means	S
	retain	earth	S
	remove	fish barriers	S
	improve	truck parking	S

Project Element	Verb	Noun	Category: Basic / Secondary / Higher Order / All the Time
Project	add	bridges	S
(continued)	remove	bridges	S
	minimize	rock fall	S
	protect	from landslide	S
	harmonize	speeds	S
	reroute	trail	S
	upgrade	deficiencies	S
	add	crossings	S
	add	auxiliary lanes	S
Highway	correct	geometry	S
	add	auxiliary lanes	S
	widen	shoulders	S
	install	walls	S
	convey	traffic	B
	replace	pavement	S
	increase	design speed	S
	upgrade	guardrail	HO
	upgrade	barriers	HO
	install	wildlife crossings	HO
	update	cross section	S
	upgrade	highway	B
Bridges	maintain	aesthetics	B
	widen	cross section	S
	improve	geometry	S
	minimize	icing	S
	optimize	phasing	S
	improve	structural design	S
	simplify	design	S
	convey	traffic	B
	support	roadway	B
	spans	topography	B
	pass	wildlife	S
	maintain	hydraulic capacity	HO
	avoid	creek impacts	HO
	avoid	floodways	HO
	store	snow	S
Wildlife Crossings	minimize	roadway icing	S
	convey	wildlife	S

Project Element	Verb	Noun	Category: Basic / Secondary / Higher Order / All the Time
Wildlife Crossings	support	roadway	B
(continued)	connect	topography	S
	maintain	hydraulic capacity	HO
	deflect	snow	S
	incorporate	exclusionary fencing	S
	enhance	use	S
	reduce	fragmentation	B
	reduce	collisions	S
	manage	permeability	S
Drainage / SWM	convey	runoff	B
	drain	highway	S
	reduce	erosion	B
	increase	sand capture	S
	protect	Gore Creek	HO
	facilitate	cleanout	S
Lighting	improve	safety	HO
	standardize	chain station lighting	S
	minimize	light pollution	HO
	illuminate	space	B
	maximize	energy efficiency	S
	consider	maintenance	S
	protect	wiring	S
Signing	alert	motorists	S
	convey	information	B
	maintain	aesthetics	HO
	install	signs	S
	install	message boards	S
	inform	of closures	S
Communications	supply	power	S
	consider	single utility duct	S
	power	cameras	S
	facilitate	maintenance	S
	relocate	fiber	S
	connect	services	B
	extend	wiring	S
	relocate	telephone	S

Project Element	Verb	Noun	Category: Basic / Secondary / Higher Order / All the Time
Retaining Walls	retain	earth	B
	match	aesthetics	S
	leverage	construction advancements	S
	optimize	design	S
	define	shoulder limits	S
	minimize	retaining walls	S
	withstand	crash	S
	support	roadway	B
	accommodate	ultimate	HO
Noise Walls	deflect	sound	B
	consider	effectiveness	S
Constructability	maintain	traffic	S
	comply	w/ Region 3 lane closure strategy	S
	implement	winter shutdown	S
	balance	earthwork	S
	reuse	materials	S
	minimize	waste	S
	optimize	staging	S
	achieve	safe work zone	HO
	minimize	schedule	S
	promote	workforce development	HO
	maximize	quality	S
	facilitate	constructability	S
	manage	communications	S
	update	public	S
	optimize	construction phasing	S
	maximize	value	B
	maintain	operations	B

From the listing of project functions, the Function Analysis System Technique (FAST) Diagram was developed. For brevity, the FAST diagram includes just those functions listed for the overall project and not the specific project elements. The FAST Diagram is as shown on the following page:


I-70 West Vail Pass
FAST DIAGRAM
How? →
← Why?
Protect Vehicles
Respect Easement
Consider Full EA
Improve Safety
Protect from Landslide
Deflect Debris
Minimize Rockfall
Retain Earth
Improve Emergency Response
Advise Motorists
Alert Motorists
Facilitate Communication
Power Communications Means
Store Snow
Improve Chain Stations
Achieve Design Speed
Upgrade Deficiencies
Improve Truck Ramp
Straighten Truck Ramp
Supply Fencing
Improve Truck Parking
Improve Wildlife Connectivity
Remove Fish Barriers
Increase Parking
Add Crossings
Widen Shoulder
Add Auxiliary Lanes
Improve Travel Times
Increase Capacity
Harmonize Speeds
Remove Bridges
Improve Geometry
Modify Curves
Collaborate with Stakeholders
Improve Operations
Facilitate Maintenance
Add Bridges
Manage Working Windows
Optimize Construction
Manage Traffic During Construction
Limit Closures
Minimize Throwaway
Preserve Historic
Preserve Trail
Reroute Trail
Maintain Aesthetics
Protect Water Source
Protect Environment
Maintain Water Quality
Function Key:
Basic
Secondary
Higher Order
All the Time

2.6 Ideas

The team brainstormed and generated the ideas to improve the project and / or reduce its cost. The ideas generated are shown in the columns labeled 'Idea No.' and 'Description' as found on the table in the Section 2.7 Idea Evaluation, which follows. The remainder of the table was completed during the Evaluation / Analysis phase of the VE study.

2.7 Idea Evaluation

The following pages include a list of ideas generated by the Value Engineering (VE) Team during the Creative Phase of the study. The listing also displays advantages and disadvantages of each idea that were generated during the Evaluation Phase of the study. During the process each idea was ranked to decide if the idea should be developed into a proposal or if the idea should proceed no further at this time. Ideas ranked as '1' were carried forward to proposal development. As the ideas are developed, some of the advantages and disadvantages in this table may change. Ideas ranked as '-1' were not further pursued. Ideas not further pursued may be viable in the future or as a result of changed conditions. All ideas generated were retained on the list, as future considerations may warrant that these items be revisited.

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
1	1	Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area	· Saves cost · Possible reuse of onsite spoils	· Requires realignment of Big Horn Road · Changes aesthetics of long span bridge · Impacts a small grove of trees along Big Horn Road	+1
2	2	Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area	· Increase mainline curve radii and design speed · Shortens EB bridge	· May impact ROW to the north · May impact truck ramp · Increased excavation requirements · May have to lower Big Horn	+1
3	35	Propose smart lighting where lighting is needed, i.e. chain up, parking areas, and runaway truck ramp	· Turn on only for chain station operations · Can be turned on remotely · Reduces light pollution · Can turn on by vehicle sensor · Energy savings · Lighting levels are adjustable · Reduces maintenance	· Requires fiber optic cable to locations for control · Technology glitches	+1
4	-	Incorporate a public turnaround point halfway up the pass	· Improves operations · Clears traffic jams	· Adds cost · May need acceleration lane or police control · May need FHWA approval	-1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
5	22	Consider a typical construction section wider than minimum required with temporary shoulders	· Improves operations · Better facilitates emergency response · Easier transition back to winter season · Additional shoulder width might be more economical than barrier · Improves quick response times for injured parties	· Adds cost · Potential increase in cuts and fills	+1
6	18	Keep eastbound and westbound grades consistent to minimize median retaining walls	· Saves median retaining wall cost · Minimize need for median scalloped walls · Reduces interior median wall maintenance · Reduce throwaway by using spoil material	· Possible cut and fill cost increase · May complicate phasing · Impacts median aesthetics if scalloped walls are eliminated	+1
7	19	Incorporate excess excavation as MSE backfill	· Reduces material import and export · Saves backfill material cost	· May need more conservative retaining wall design · Material may not meet backfill requirements	+1
8	16	Eliminate additional 3' offset to higher cut walls in trail section	· Reduced outside wall height · Reduced section width · Reduced footprint and impacts	· Possibly less snow storage for trail · More closed-in feeling to users	+1
9	-	Reconsider need for 18' shoulder for hot brake areas	· 10' shoulder is adequate · Saves cost · Reduces cut and fill · 18' shoulder may not be where brake cool-down is needed	· Perceived safety reduction · Less separation from travel lane · Increased waiting time for trucker pulling back into traffic · May defy historical data · Lost tow truck staging · May promote recreational parking	-1
10	23	Expand interior shoulder from 4' wide to 10' wide (instead of 6') to store disabled vehicle where there is head-to-head traffic with median barrier	· Better disabled vehicle storage · Frees up another through-lane for emergency response · Complies with AASHTO guidance	· Wider roadway section · Additional cost	+1
11	20	Incorporate additional height into Type 9 barrier	· Accommodates future overlays	· Adds cost · Bottom width may increase	+1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
12	31	Incorporate alternative bridge de-icing system into design	· Improves safety · May reduce maintenance	· Adds cost · Effectiveness not known	+1
13	-	Propose concrete finish surface from middle chain station (MP 182) to top of pass in eastbound right lane	· Reduce chain rutting · Fewer overlays · Reduced maintenance	· Possible cost increase · Adds construction schedule · Complicates construction · May increase maintenance due to longitudinal joint · Loss of chain traction · May slow the snowmelt	-1
14	-	Incorporate bridge de-icing element into pavement mix (combine with 12)	· Improve safety · May reduce need for spraying of material	· Mixed results when used in other areas · Adds cost for pavement mixture · Possibly more maintenance	-1
15	26	Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes	· Saves cost	· May not be appropriately sized · May require very specific retrofitting measures	+1
16	-	Implement a wildlife monitoring program for collision reduction and crossing use before fencing	·	·	-1
17	36	Incorporate Smart Work Zone technology for construction	· Improves safety · Speed limits can be changed and displayed instantly · Improves traveler information · Allows for encroachment warning devices · Scalable per season and other needs	· Adds cost · Adds maintenance	+1
18	37	Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town	· Improved power reliability for the town and CDOT · May replace outdated services · May not increase cost by using the public private partnership CDOT guidelines	· Additional utility coordination · Added construction complexity	+1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
19	-	Propose Right lane restrictions EB and WB for heavy vehicles	·	·	-1
20	38	Incorporate Electronic / Automated powered road closure gates	· Railroads have this technology · This technology is used in HOV lanes in Denver metro on I-25 · Can be incorporated into smart technology	· Adds cost · Potential technology failure · May need manual override	+1
21	-	Determine if existing cross culverts can be retrofitted to meet the intent of providing wildlife passage	·	·	-1
22	-	Optimally site crossings to maximize target species use while minimizing cut and fill	· Saves cost · Would enhance wildlife usage · May promote material balance	· May require very specific retrofitting measures · May decrease crossing opportunity	-1
23	25	Consider Contech concrete arch-type structures versus concrete box or metal arch	· May satisfy wildlife crossing design · May reduce cost	· May change roadway profile	+1
24	29	Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1	· Saves cost · May be able to shift funding and installation to a future phase or allow for additional Phase 1 construction with saved costs · Preserves corridor aesthetics	· Commitment already made to fencing · Reduced use of crossing structures · Would not eliminate AVCs	+1
25	41	Incorporate Programmatic permitting and mitigation strategies	· Saves cost · Removes environmental from critical path on future phases · Better mitigation ratios	· None apparent	+1
26	32	Consider warm mix asphalt due to remote location	· Increases workability for cooler temperatures · Expands paving window in terms of temperature · May enhance compaction leading to better quality	· Adds cost	+1
27	-	Consider concrete box girder structure type versus Steel tub	·	·	-1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
28	-	Consider High polymer modified asphalt binder	· May provide more resistant paving material · More durable mix in terms of fatigue resistance · Possible thinner pavement section	· Not part of CDOT pavement design program · Unproven history in Colorado · Added cost	-1
29	3	At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.	· Improves operation · Adds recovery capability	· Adds cost for more pavement	+1
30	4	Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas	· Saves demolition cost in current contract · Less environmental disturbance during demolition · Better sustainability as opposed to landfill alternative · Potential functional benefit to CDOT and road users	· Continued maintenance responsibility · Remains on bridge inventory · Potential aesthetic issues	+1
31	-	Consider lane widening at sharp curves westbound	· Improves traffic operations · Reduces off-tracking and lane conflict	· Adds cost · Additional pavement width · Constructability and conformance with striping · Possible longitudinal joint in wheel path	-1
32	24	Reduce left shoulder to 4' wide	· Reduces highway footprint and overall project impacts · Reduces project cost	· Potential to decrease safety · Potential loss of snow storage area · May not meet INFRA Grant typical section	+1
33	15	Consider use of reinforced soil slope in lieu of retaining walls	· Saves cost over conventional MSE wall · More natural appearance · Potential to use existing soil for backfill · Less vulnerable to differential deflection	· Requires a larger footprint · May take more construction time · More susceptible to erosion	+1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
34	10	Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely	· Saves cost · Possibly less impact to environmentally sensitive area · Reduce wildlife crossing width · Snow storage area not needed · Eliminates retaining wall	· Less chain down area for trucks	+1
35	11	Shorten north end of bridge over Polk Creek and convert to MSE wall	· Saves cost · Reduces bridge cost · Reduces long-term bridge maintenance · Faster construction	· Aesthetic impact · Trail needs to be rerouted around MSE wall abutment · Additional MSE wall requirements	+1
36	17	Look for opportunities to balance earthwork	· Saves cost · Reduce material haul off	· May result in modified profiles · May complicate construction phasing	+1
37	14	Reduce offset of MSE walls from shoulder to reduce height	· Reduces MSE wall height and overall earthwork · Reduces project footprint · Saves cost	· Reduces maintenance access · May impact SCAP conveyance / collection behind wall	+1
38	30	Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations	· Reduce number of inlets · Reduce closed storm system quantity · Saves cost	· Additional guardrail maintenance · Additional drainage and sand removal methods may be needed	+1
39	13	Consider anchor slabs for short walls	· May save cost · Potential to improve aesthetics in constrained visible areas	· Potentially more difficult to construct next to travel lanes	+1
40	12	Consider Anchor Slab on Top of Walls	· Reduces footprint · Reduces wall height · Potential to save cost	· Potentially more difficult to construct next to travel lanes · Access for future repairs	+1
41	-	Tier the walls in lieu of tall vertical walls	· May save cost depending on how earth is being retained · More aesthetic · Allows landscaping opportunity	· Potential landscape maintenance cost · Increases footprint	-1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
42	28	Consider lynx in-lieu fee mitigation program	· May reduce need for or number of wildlife crossings · Reduces construction time · May provide funding opportunity	· Requirements of using the in-lieu fee program may not be met · Cost-benefit to be determined	+1
43	40	Explore federal or state reforestation grants to offset cost	· May provide additional project funding	· Application process · Funding qualifications	+1
44	5	Consider historic tub shape using alternate structural concrete members	· Potential cost savings · Reduces maintenance · More concrete availability · Utilizes more readily available material	· More difficult erection · Concrete beams are more difficult to frame	+1
45	6	Look for opportunities to shift WB alignment south and replace structure F11AX	· Eliminates Bridge · Reduction of north side cut walls · Potential to stabilize landslide · Provides opportunity to use site material	· Adds large retaining wall · Potential political fatal flaw · Drainage considerations · Aesthetic concerns	+1
46	-	Consider tunnel and alignment shift to the east or west between MP 186 and 186.5 (Floyd Hill)	· Better highway geometry · Avoids creek encroachment · Safety improvement · Removes need for avalanche protection · Eliminate rockfall hazard	· Adds construction cost · Adds LCC · Wetlands impact · Redundancy relevant to current design	-1
47	8	Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek	· Improve EB radius · Saves cost · Maintain or improve geometry · Less environmental impact	· Increases construction time · Loss of emergency turnaround	+1
48	9	Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek	· Improve EB radius · Saves cost · Maintain or improve geometry	· Increases construction time	+1

IDEA NO.	PROP. NO.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANK
49	7	Incorporate a public turnaround point halfway up the pass	· Improves operations · Clears traffic jams · Adds mobility · Facilitates traffic turnaround	· Adds cost · May need acceleration lane or police control · May need FHWA approval · Adds maintenance · Promotes illegal parking · Environmental impacts	+1
50	21	Incorporate type 9 barrier with glare screen	· Reduces glare · Improves safety · Incidental noise reduction	· Adds cost · Reduces viewshed	+1
51	-	Incorporate snow inlets	· Reduces snow pileup · Improves safety · Prevents refreezing	· Adds cost	-1
52	27	Reduce size of wildlife crossing structures	· Saves cost · Reduces roadway icing impacts · Adds flexibility to maintain roadway profile	· Commitments already made to sizes · May reduce wildlife use	+1
53	33	Use stone matrix (mastic) asphalt for wearing course	· May be more durable · Potentially more resistance to tire chain wear · Has been used in Colorado · Reduces maintenance	· Adds cost · More difficult paving	+1
54	39	Dispose haul off material in interchange infield areas and grade aesthetically	· Saves cost · Can be used to enhance aesthetics · Convenient waste site	· Wetlands impact · Could change drainage and grading patterns · Adds landscape cost · Could impact sight distance	+1
55	-	Build truck-only bridges parallel to existing bridges	· Separates trucks and cars · Addresses differential traffic speeds · Extends life of existing bridges	· Condition of existing bridges is not known · Additional plowing · Additional maintenance · Greater footprint	-1
56	34	Use unmodified mix in lieu of modified HMA on the trail	· Eliminate more expensive modified binder currently shown · Modified high-temp binder not needed for light trail traffic · Can be same asphalt mix proposed for lower paving lifts on roadway	· None apparent ·	+1

2.8 Value Engineering Presentation

VE Study Presentation Minutes

Meeting Location	All attendees participated remotely
Meeting Date/Time	April 9, 2021, 10:00 am MDT
Subject	Colorado Department of Transportation – Region 3 I-70 West Vail Pass Auxiliary Lanes Eagle County, CO VE Study Presentation
Participants	Design Team and Project Management: CDOT – John Kronholm, Matt Figgs, Karen Berdoulay, Rob Beck; RS&H – Randal Lapsley; Kiewit – Jim Thomsen VE Team: Jacobs – John Corcoran, Craig Broadhead, Tim Siedlecki; RS&H – Mark Talvitie, Greg Grant, Ben Sterling; Kiewit – Ted Rutledge; Apex – Ken DePinto; CDOT – Neil Ogden, Craig Wieden; FHWA – Jeff Bellen, Armando Henriquez Other Attendees: FHWA – Monica Pavlik, Dahir Egal, Nicole Bumpers; RS&H – Jeb Sloan; Kiewit – Mark Gutknecht
Notes Prepared By	John Corcoran
Attachments	*VE Study Presentation* Power Point Slideshow

The meeting began at 10:00 am.

John Corcoran (Jacobs) opened the meeting by discussing the nuances of a virtual presentation. In the interest of saving time, a formal roll call was not taken. John encouraged questions from the attendees as proposals are presented but stated that this meeting is not the forum to make decisions on the proposals. Proposals would be listed by discipline. Presenters were instructed to read the number and full description for each proposal to enhance the ability of attendees to follow the presentation. Due to overlap of the VE team member expertise, there would be a periodic change between presenters.

John began the VE study presentation in conjunction with the attached *VE Study* Power Point Presentation. John recapped the project existing conditions, need and purpose, and proposed improvements. John stated that the study was performed in accordance with SAVE International standards and recapped the various factors that comprise value on a project. John summarized the Function Analysis and Cost Model Analysis that preceded the Creative Phase (brainstorming session) and finally concluded that the Creative and Evaluation Phases resulted in 41 proposals to be presented.

The various subject matter experts on the VE team presented the proposals. The subject matter experts introduced themselves before delivering their proposals. The subject matter experts and the proposals that they presented are listed as follows:

Ted Rutledge - Kiewit

- Proposal 1 - Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area.
- Proposal 2 - Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.

- Proposal 3 - At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.
- Proposal 4 - Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.
- Proposal 5 - Consider historic tub shape using alternate structural concrete members.

Neil Ogden - CDOT
- Proposal 6 - Look for opportunities to shift WB alignment south and replace structure F11AX.

Ken DePinto - Apex
- Proposal 7 - Incorporate a public turnaround point halfway up the pass.

Greg Grant - RS&H
- Proposal 8 - Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.
- Proposal 9 - Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.
- Proposal 10 - Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.

Mark Talvitie - RS&H
- Proposal 11 - Shorten north end of bridge over Polk Creek and convert to MSE wall.

Neil Ogden - CDOT
- Proposal 12 - Consider Anchor Slab on Top of Walls.
- Proposal 13 - Consider anchor slabs for short walls.

Mark Talvitie - RS&H
- Proposal 14 - Reduce offset of MSE walls from shoulder to reduce height.

Craig Wieden - CDOT
- Proposal 15 - Consider use of reinforced soil slope in lieu of retaining walls.

Mark Talvitie - RS&H
- Proposal 16 - Eliminate additional 3’ offset to higher cut walls in trail section.
- Proposal 17 - Look for opportunities to balance earthwork.
- Proposal 18 - Keep eastbound and westbound grades consistent to minimize median retaining walls.

Craig Wieden - CDOT
- Proposal 19 - Incorporate excess excavation as MSE backfill.
- Proposal 20 - Incorporate additional height into Type 9 barrier.

Neil Ogden - CDOT
- Proposal 21 - Incorporate type 9 barrier with glare screen.

Ken DePinto - Apex
- Proposal 22 - Consider a typical construction section wider than minimum required with temporary shoulders.

Ted Rutledge - Kiewit
- Proposal 23 - Expand interior shoulder from 4’ wide to 10’ wide (instead of 6’) to store disabled vehicle where there is head-to-head traffic with median barrier.

Neil Ogden - CDOT

- Proposal 24 - Reduce left shoulder to 4' wide.

Greg Grant - RS&H

- Proposal 25 - Consider Contech concrete arch-type structures versus concrete box or metal arch.

Craig Broadhead - Jacobs

- Proposal 26 - Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.
- Proposal 27 - Reduce size of wildlife crossing structures.
- Proposal 28 - Consider lynx in-lieu fee mitigation program.
- Proposal 29 - Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1.

Mark Talvitie - RS&H

- Proposal 30 - Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.

Craig Wieden - CDOT

- Proposal 31 - Incorporate alternative bridge de-icing system into design.
- Proposal 32 - Consider warm mix asphalt due to remote location.
- Proposal 33 - Use stone matrix (mastic) asphalt for wearing course.
- Proposal 34 - Use unmodified mix in lieu of modified HMA on the trail.

Ken DePinto - Apex

- Proposal 35 - Propose smart lighting where lighting is needed, i.e. chain up, parking areas, and runaway truck ramp.
- Proposal 36 - Incorporate Smart Work Zone technology for construction.
- Proposal 37 - Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.
- Proposal 38 - Incorporate Electronic / Automated powered road closure gates.

Ben Sterling - RS&H

- Proposal 39 - Dispose haul off material in interchange infield areas and grade aesthetically.

Tim Siedlecki - Jacobs

- Proposal 40 - Explore federal or state reforestation grants to offset cost.

Craig Broadhead - Jacobs

- Proposal 41 - Incorporate Programmatic permitting and mitigation strategies.

After all proposals were presented, the meeting was opened to questions on VE Proposals or any other part of the presentation. There were no questions.

John Kronholm and Randal Lapsley thanked the VE team for their efforts.

The meeting adjourned at approximately 11:55 am.

2.9 Summary of VE Proposal Consensus

Subsequently to the VE study, the design team met with the end users to discuss all VE proposals and reach a consensus for each proposal. Consensus decisions were finalized in the time following the February 22nd meeting. A summary of the consensus for all proposals and the total cost impacts for accepted proposals are shown in the table as follows:

Prop. No.	Description	Consensus Decision
1	Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area.	Hold for further Consideration
2	Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.	Hold for further Consideration
3	At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.	Hold for further Consideration
4	Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.	Hold for further Consideration
5	Consider historic tub shape using alternate structural concrete members.	Accept with Modifications
6	Shift Westbound Alignment and Replace Structure F-11-AX on Existing Alignment.	Hold for further Consideration
7	Incorporate a public turnaround point halfway up the pass.	Hold for further Consideration
8	Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.	Hold for further Consideration
9	Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.	Hold for further Consideration
10	Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.	Hold for further Consideration
11	Shorten north end of bridge over Polk Creek and convert to MSE wall.	Accept
12	Consider anchor slab on top of walls.	Hold for further Consideration
13	Consider anchor slabs for short walls.	Hold for further Consideration
14	Reduce offset of MSE walls from shoulder to reduce height.	Accept with Modifications
15	Consider use of reinforced soil slope in lieu of retaining walls.	Reject
16	Eliminate additional 3' offset to higher cut walls in trail section.	Accept
17	Look for opportunities to balance earthwork.	Accept
18	Keep eastbound and westbound grades consistent to minimize median retaining walls.	Accept with Modifications
19	Incorporate excess excavation as MSE backfill.	Accept
20	Incorporate additional height into Type 9 barrier.	Hold for further Consideration
21	Incorporate type 9 barrier with glare screen.	Hold for further Consideration
22	Consider a typical construction section wider than minimum required with temporary shoulders.	Hold for further Consideration

Prop. No.	Description	Consensus Decision
23	Expand interior shoulder from 4' wide to 10' wide.	Reject
24	Reduce inside shoulder to four feet wide.	Hold for further Consideration
25	Consider Contech concrete arch-type structures versus concrete box or metal arch.	Accept
26	Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.	Reject
27	Reduce size of wildlife crossing structures.	Accept
28	Consider lynx in-lieu fee mitigation program.	Reject
29	Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1.	Reject
30	Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.	Reject
31	Incorporate alternative bridge de-icing system into design.	Accept
32	Consider warm mix asphalt due to remote location.	Accept
33	Use stone matrix (mastic) asphalt for wearing course.	Reject
34	Use unmodified mix in lieu of modified HMA on the trail.	Accept
35	Propose smart lighting where lighting is needed, i.e. chain up, parking areas, and runaway truck ramp.	Hold for further Consideration
36	Incorporate Smart Work Zone technology for construction.	Accept
37	Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.	Hold for further Consideration
38	Incorporate Electronic / Automated powered road closure gates.	Reject
39	Dispose haul off material in interchange infield areas and grade aesthetically.	Reject
40	Explore federal or state reforestation grants to offset costs.	Hold for further Consideration
41	Incorporate Programmatic permitting and mitigation strategies.	Accept with Modifications

Note: The Advantages and Disadvantages of each proposal are included in Section 1.7.

The table on the next page highlights all the proposals accepted by the end users whether fully or with modifications. A total of fourteen (14) proposals, including some design suggestions, were accepted fully or with modifications. The table also features the total accepted cost savings and cost added that could potentially be realized based on estimates performed during the VE study, however the disclaimer documented in Section 1.5 must be considered. Though many of the proposals were accepted only partially, the totals assume all proposals will be fully accepted. The actual realized cost savings will likely be an amount less than shown as the design advances and is refined. In addition to the cost savings and cost added represented in the table, which are all construction costs, there may also be life-cycle cost impacts. Any applicable life cycle cost impacts are discussed in the individual proposal developments in Section 1.7.

Prop. No.	Description	Cost Savings	Added Cost
5	Consider historic tub shape using alternate structural concrete members.	DS	
11	Shorten north end of bridge over Polk Creek and convert to MSE wall.	$4,801,402	
14	Reduce offset of MSE walls from shoulder to reduce height.	$2,506,614	
16	Eliminate additional 3' offset to higher cut walls in trail section.	DS	
17	Look for opportunities to balance earthwork.	DS	
18	Keep eastbound and westbound grades consistent to minimize median retaining walls.	$672,476	
19	Incorporate excess excavation as MSE backfill.	DS	
25	Consider Contech concrete arch-type structures versus concrete box or metal arch.	DS	
27	Reduce size of wildlife crossing structures.	$1,935,019	
31	Incorporate alternative bridge de-icing system into design.	DS	
32	Consider warm mix asphalt due to remote location.		$275,097
34	Use unmodified mix in lieu of modified HMA on the trail.	$299,795	
36	Incorporate Smart Work Zone technology for construction.		$72,372 / month
41	Incorporate Programmatic permitting and mitigation strategies.	DS	
Maximum Coincident Savings		$10,215,306	
Potential Added Value			$275,097
Potential Added Monthly Construction Cost			$72,372 / month

DS – Design Suggestion, E - Eliminated
The Advantages and Disadvantages of each proposal are included in Section 1.7.

A detailed spreadsheet was developed to record all decisions from the consensus discussions and capture relevant discussion comments. The spreadsheet is shown on the next two pages.

West Vail Pass - Safety & Operations
VE Study Review
5/6/2021

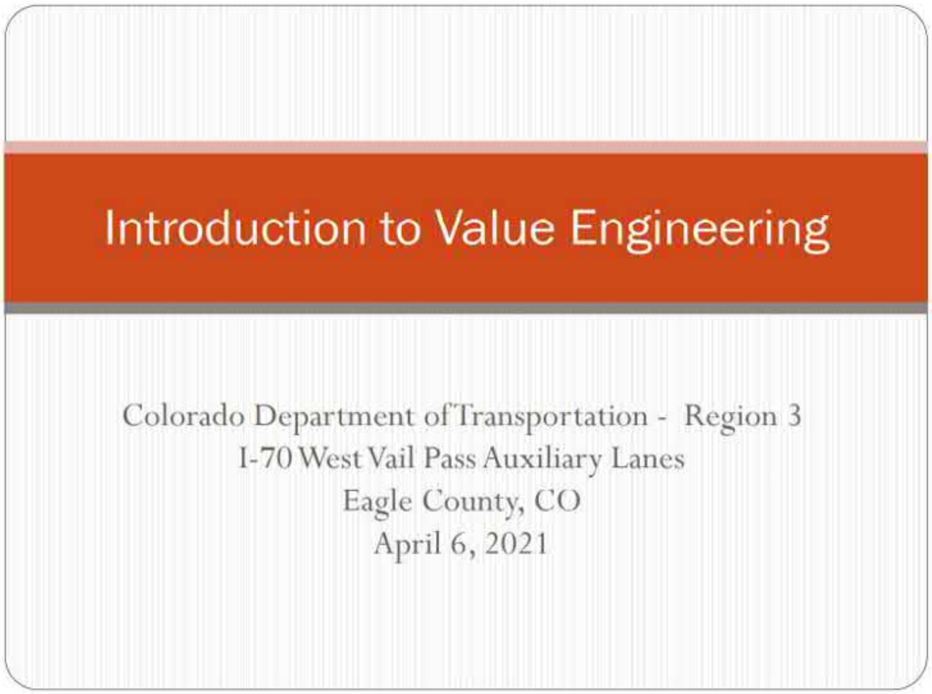
Prop. No.	Description	Applies to INFRA	Accept	Accept with Modifications	Reject	Hold for further Consideration	Comment
1	Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area.					x	Will consider with future phases
2	Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.					x	Will consider with future phases
3	At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.	x				x	Being considered with other design
4	Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.					x	Will consider where feasible
5	Consider historic tub shape using alternate structural concrete members.	x		x			All tub shape being considered
6	Look for opportunities to shift WB alignment south and replace structure F11AX.					x	
7	Incorporate a public turnaround point halfway up the pass.					x	Will consider where feasible
8	Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.	x				x	Being considered by BE
9	Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.					x	
10	Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.	x				x	
11	Shorten north end of bridge over Polk Creek and convert to MSE wall.	x	x				Will consider based on final bridge alignment
12	Consider Anchor Slab on Top of Walls.	x				x	Will consider where snow storage and sediment capture is not needed behind barrier
13	Consider anchor slabs for short walls.	x				x	
14	Reduce offset of MSE walls from shoulder to reduce height.	x		x			Will consider where feasible. Sediment collection needs to be considered.
15	Consider use of reinforced soil slope in lieu of retaining walls.	x			x		Not feasible due to erosion and sediment control needs
16	Eliminate additional 3' offset to higher cut walls in trail section.	x	x				
17	Look for opportunities to balance earthwork.	x	x				
18	Keep eastbound and westbound grades consistent to minimize median retaining walls.	x		x			
19	Incorporate excess excavation as MSE backfill.	x	x				
20	Incorporate additional height into Type 9 barrier.	x				x	
21	Incorporate type 9 barrier with glare screen.	x				x	Will use/consider where appropriate
22	Consider a typical construction section wider than minimum required with temporary shoulders.	x				x	
23	Expand interior shoulder from 4' wide to 10' wide (instead of 6') to store disabled vehicle where there is head-to-head traffic with median barrier.	x			x		Widening has many impacts not offset by improvement in safety.
24	Reduce left shoulder to 4' wide.	x				x	Will consider along tangent sections
25	Consider Contech concrete arch-type structures versus concrete box or metal arch.	x	x				
26	Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.	x			x		Existing culvert are in bad shape. The largess is 30". It is desired to separate wildlife from drainage.
27	Reduce size of wildlife crossing structures.	x	x				Already being incorporated
28	Consider lynx in-lieu fee mitigation program.	x			x		Wildlife structures are an EA commitment

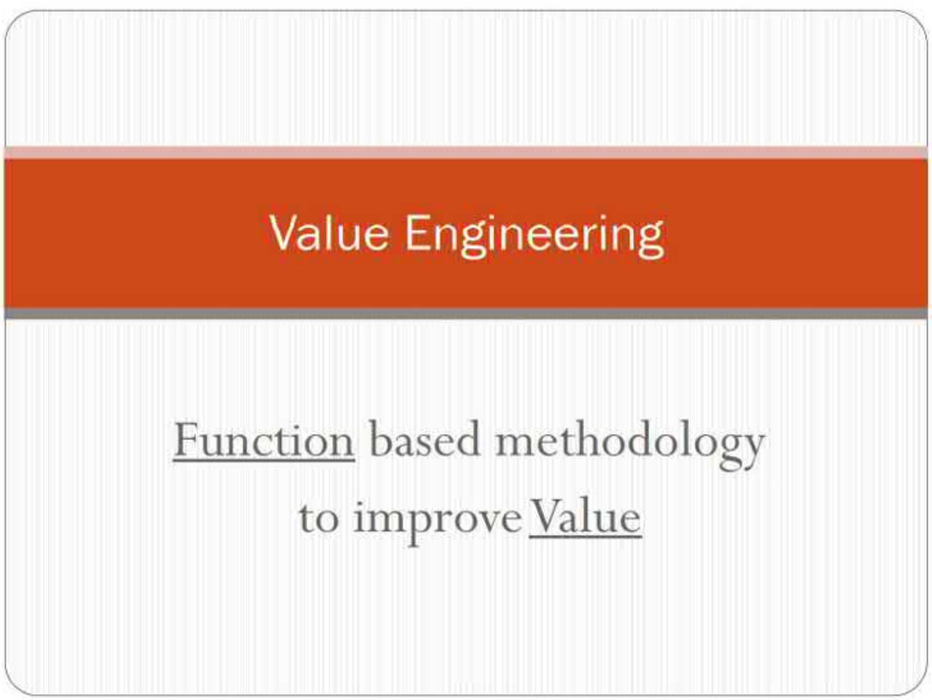
West Vail Pass - Safety & Operations
VE Study Review

5/6/2021

Prop. No.	Description	Applies to INFRA	Accept	Accept with Modifications	Reject	Hold for further Consideration	Comment
29	Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1.	x			x		Wildlife fence is an EA commitment and used to support crash reduction factors
30	Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.	x			x		Type 3 does not last through the winter snow conditions
31	Incorporate alternative bridge de-icing system into design.	x	x				
32	Consider warm mix asphalt due to remote location.	x	x				
33	Use stone matrix (mastic) asphalt for wearing course.	x			x		SMA does not last with tire chains
34	Use unmodified mix in lieu of modified HMA on the trail.	x	x				
35	Propose smart lighting where lighting is needed, i.e. chain up, parking areas, and runaway truck ramp.	x				x	No lighting being done with INFA project but will consider with future projects where lighting is being modified
36	Incorporate Smart Work Zone technology for construction.	x	x				
37	Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.	x				x	May be done outside project
38	Incorporate Electronic / Automated powered road closure gates.	x			x		Need persons to be physically at gate to close
39	Dispose haul off material in interchange infield areas and grade aesthetically.	x			x		Previously done. Creates SSD issues.
40	Explore federal or state reforestation grants to offset cost.	x				x	Will discuss with USFS
41	Incorporate Programmatic permitting and mitigation strategies.	x		x			Will do when possible

Appendix A. Introduction to Value Engineering Power Point Slideshow





What is Value?

Value - the lowest Cost to provide the essential Function in a reliable manner

$$V = F / R$$

Where V = Value

F = Function

R = Resources

How are Resources Measured?

- Cost
  - Capital
  - Life Cycle
- Space Usage (Square Footage)
- Improved Product
- Schedule
- Safety
- Environment
- Reduced Inconvenience
- Risk
- Constructability
- Flow Process

What is Value?

Value is

NOT

Cost-Cutting!

How did VE (VA/VM) Evolve?

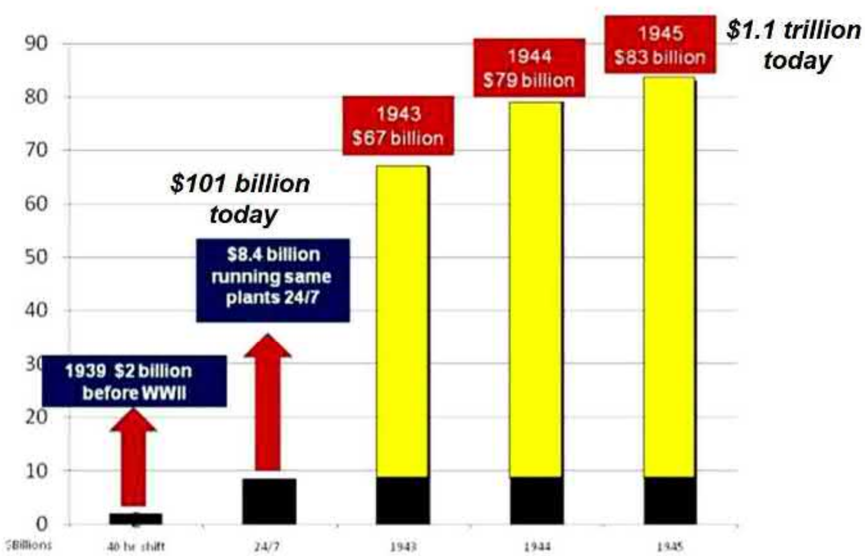
- General Electric Schenectady, NY
  - Purchasing agent
  - War years
  - Could not get originally intended materials
  - Developed Value Analysis
- SAVE organized 1947
- Users:
  - Manufacturers
  - Government
  - Design/Construction
  - Internationally
- SAVE International

Larry Miles

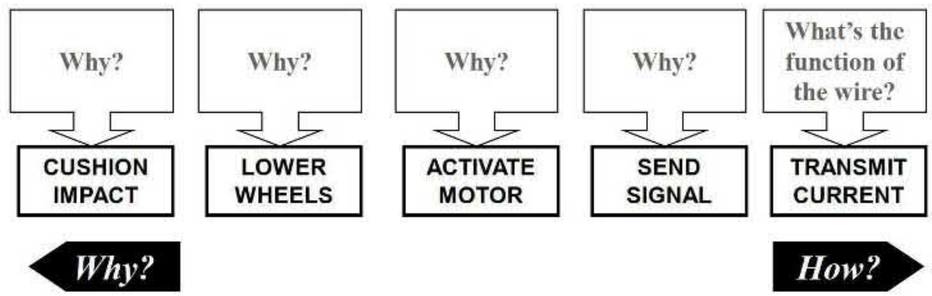
SAVE – Adding Value. Enhancing Ideas.

Boeing B-29

US Military Manufacturing in World War II

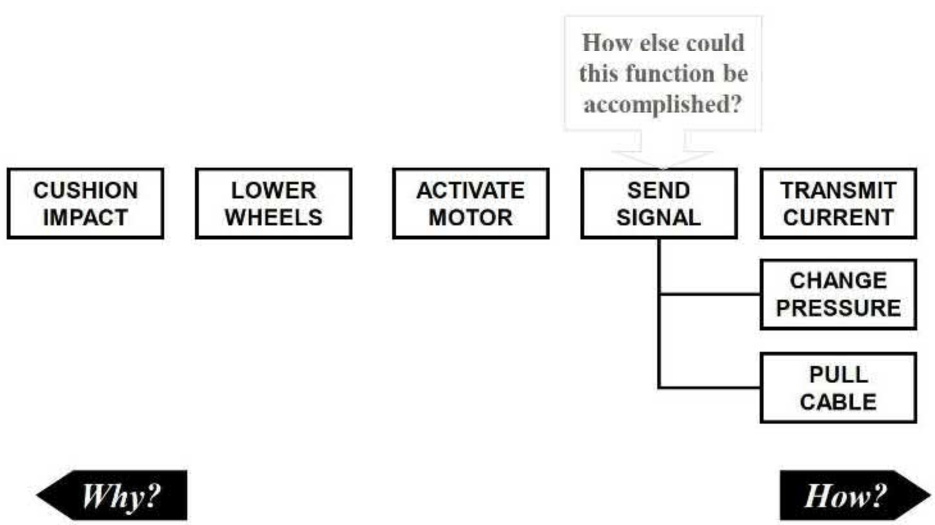


Function Analysis



*Larry Miles – If we **can't get the material**, we need to find a different way to **satisfy the function** that the material fulfills.*

Function Based Creativity



The VE Process

Pre-study (Preparation)

- Project scope
- Expectations
- Information available to the team
- Venue
- Team members
- Workshop logistics

The VE Job Plan

- **Information**
  - Introduction
  - Project briefing
  - Status
  - Risks
  - Constraints
  - Issues
  - Site visit
  - Performance measures
- **Function Analysis**
  - Random
  - Hierarchical
  - FAST
- **Creative**
  - Brainstorming
  - Other techniques
  - Performance, cost, risk, impact, safety…

The VE Job Plan

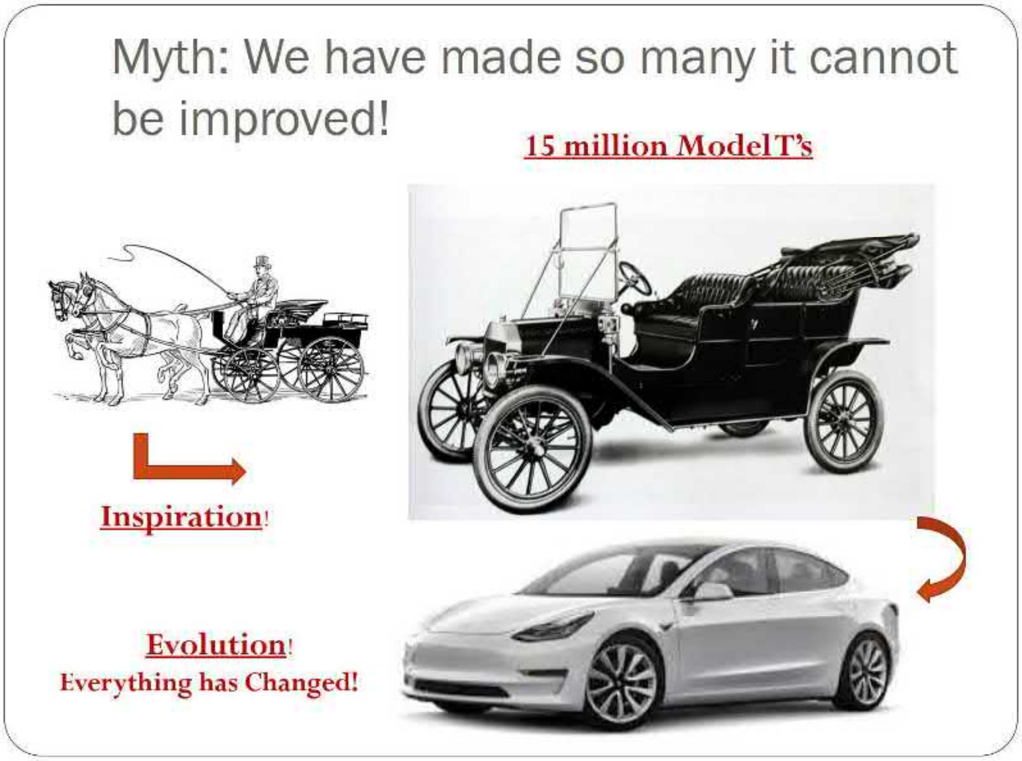
- **Evaluation**
  - Advantages and disadvantages of each idea
  - Rating
  - Selection of ideas for further development
- **Development**
  - Validation/ assessment within the constraints of the workshop
- **Presentation**
  - Emphasis on findings

Post-study (Implementation)

- Preliminary VE report delivery
- Discussion and decisions on VE proposals
- Final VE report delivery
- Implementation as design advances

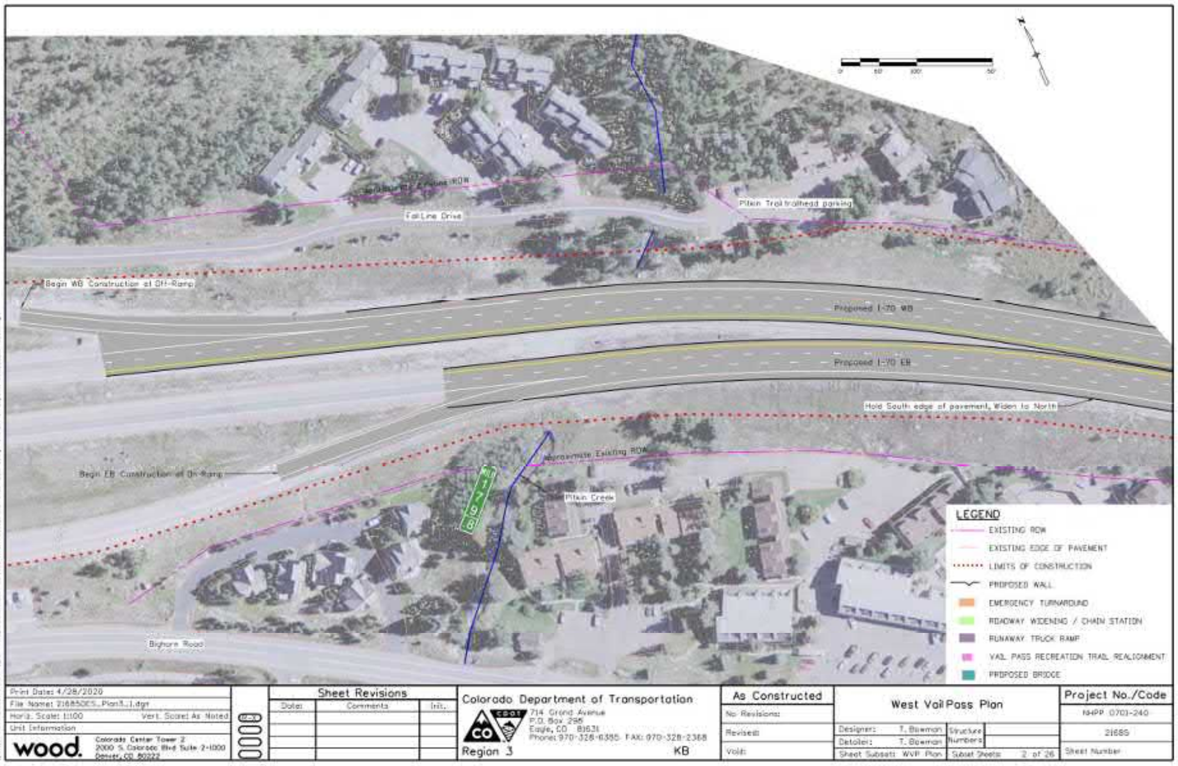
Obstacles

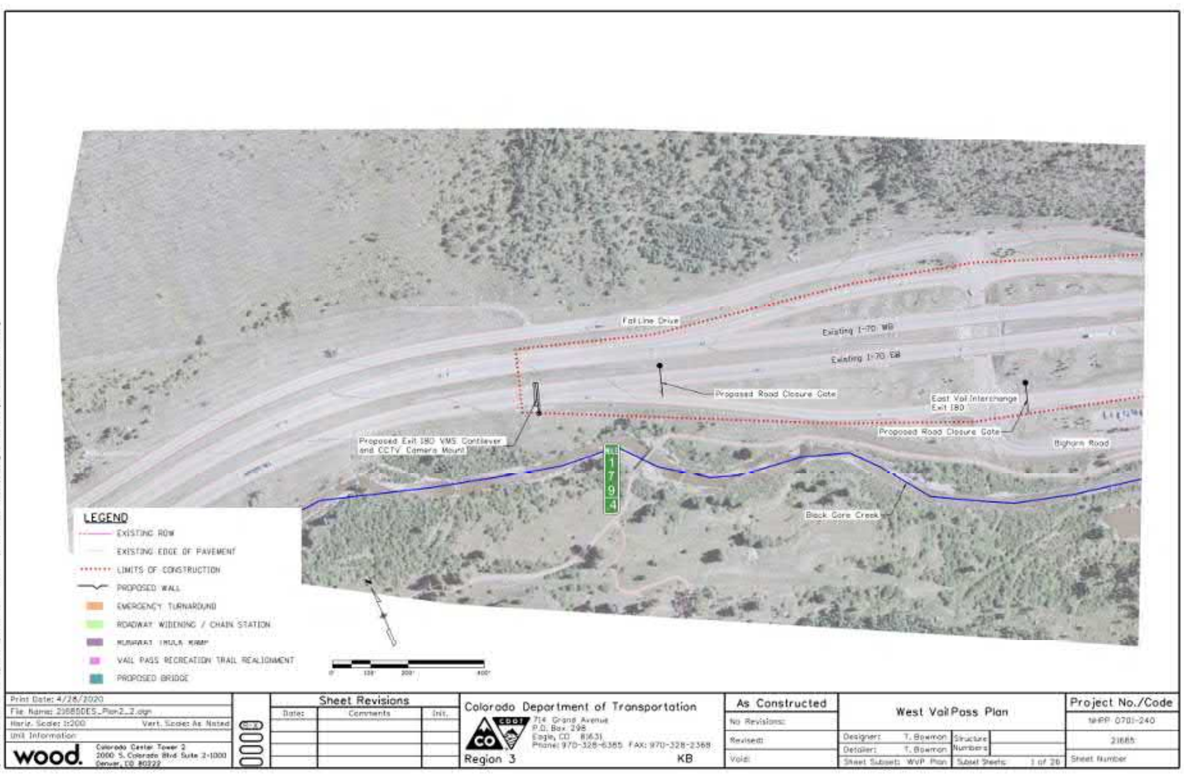
- Design Change
- Standards
- Schedule
- Funding Restrictions
- Public Perception
- Ownership
- Entitlement
- Politics

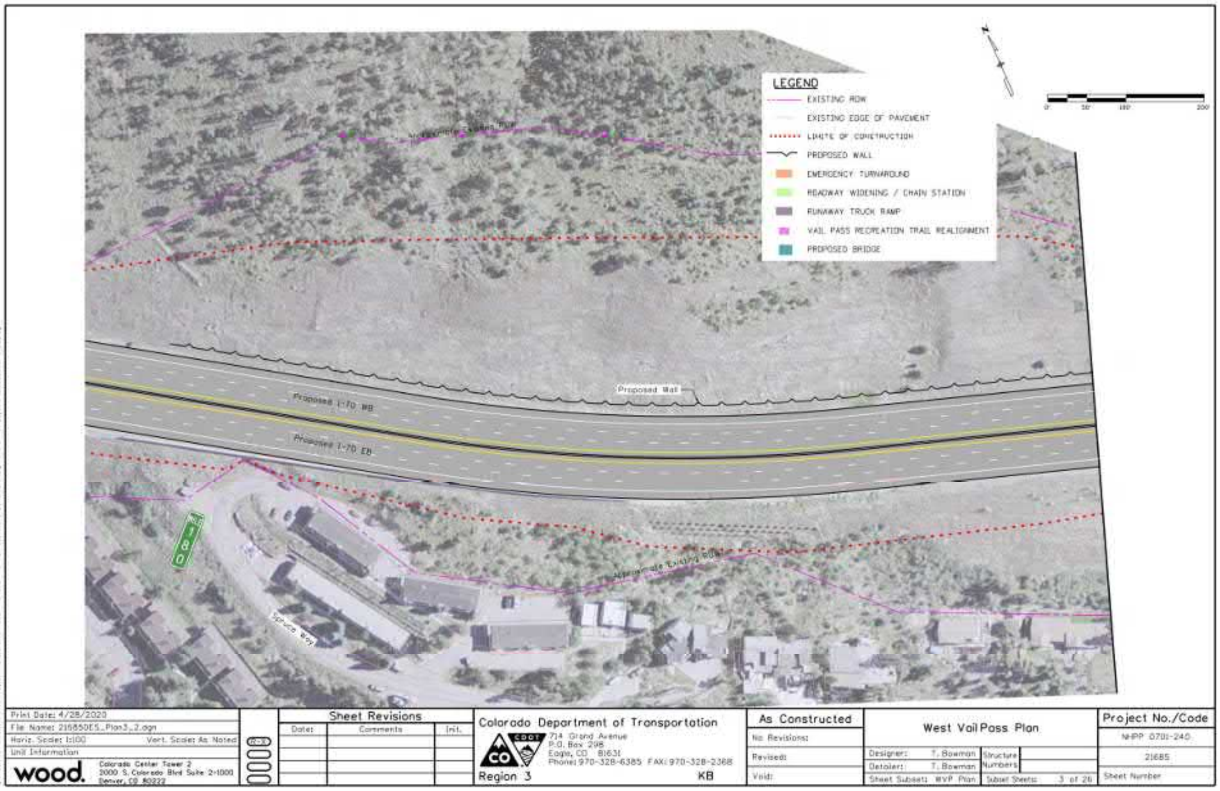

Myth: We have made so many it cannot be improved!
15 million ModelT's
Inspiration!
Evolution!
Everything has Changed!

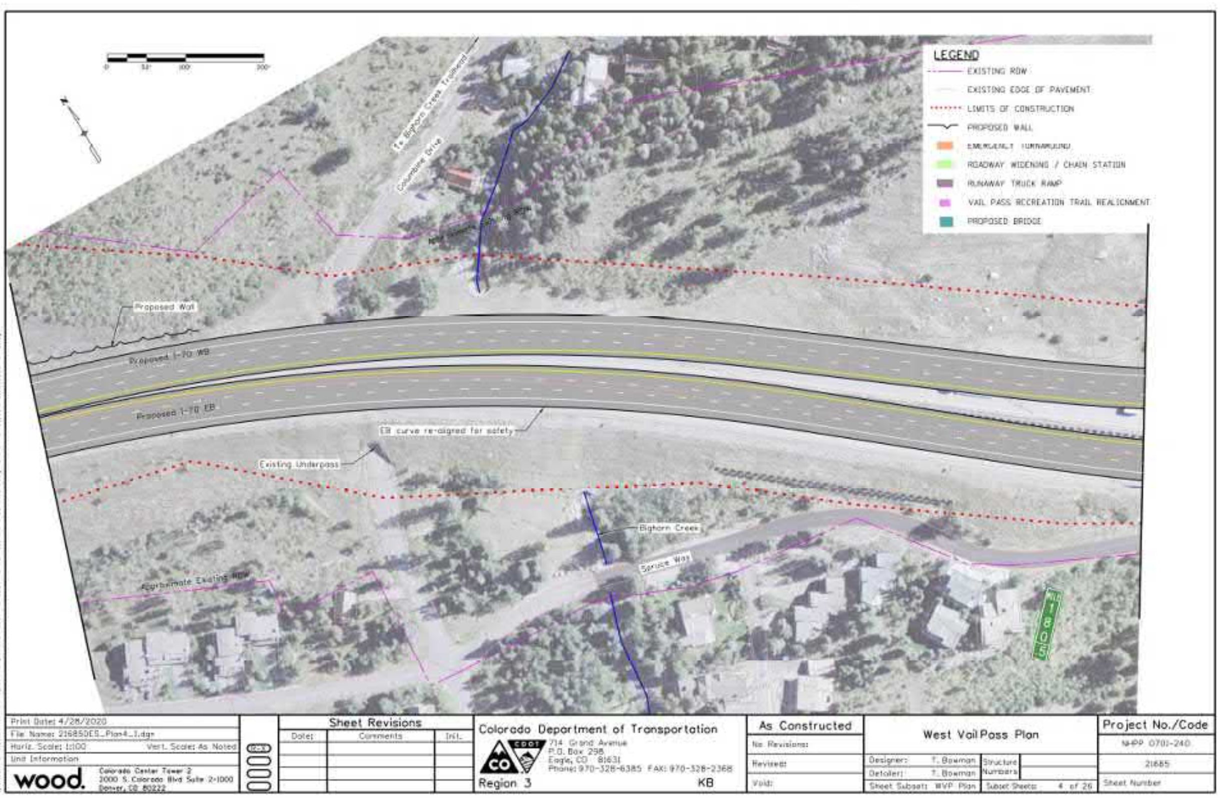
Questions?

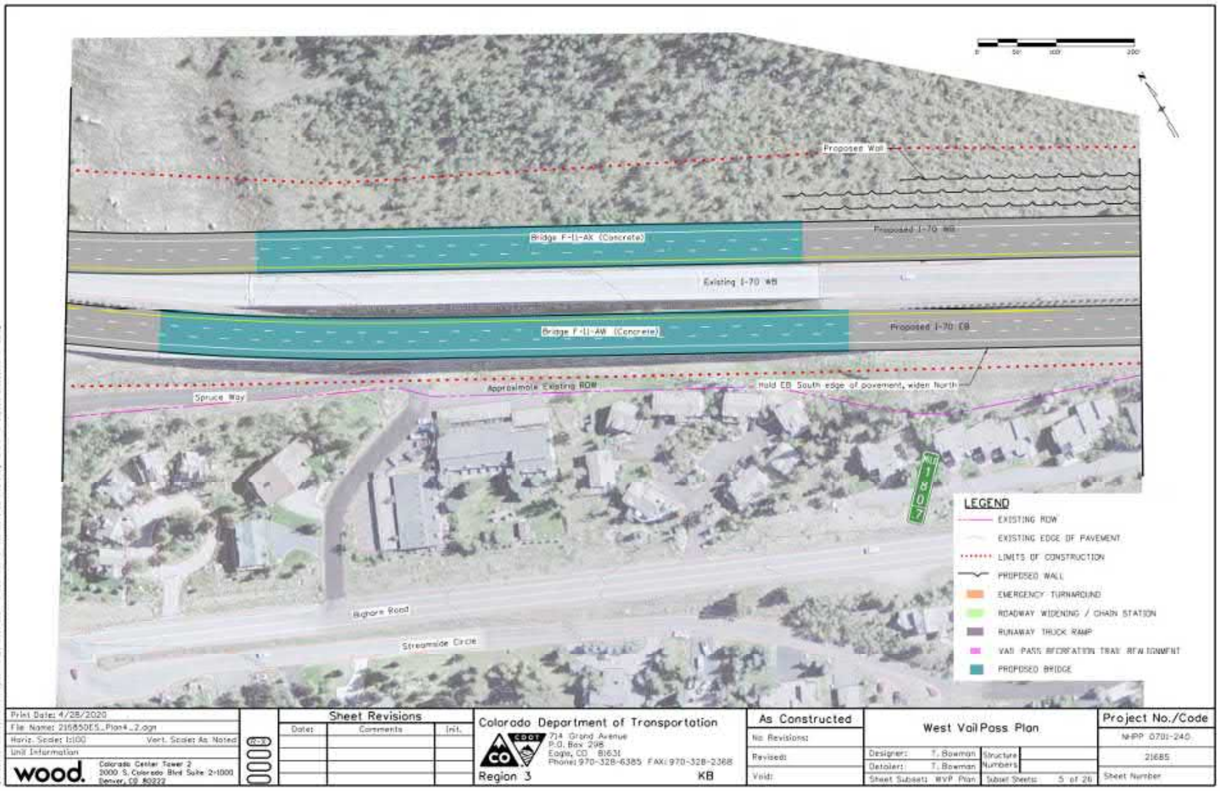
Appendix B. Proposed Action Alternative Preliminary Plans

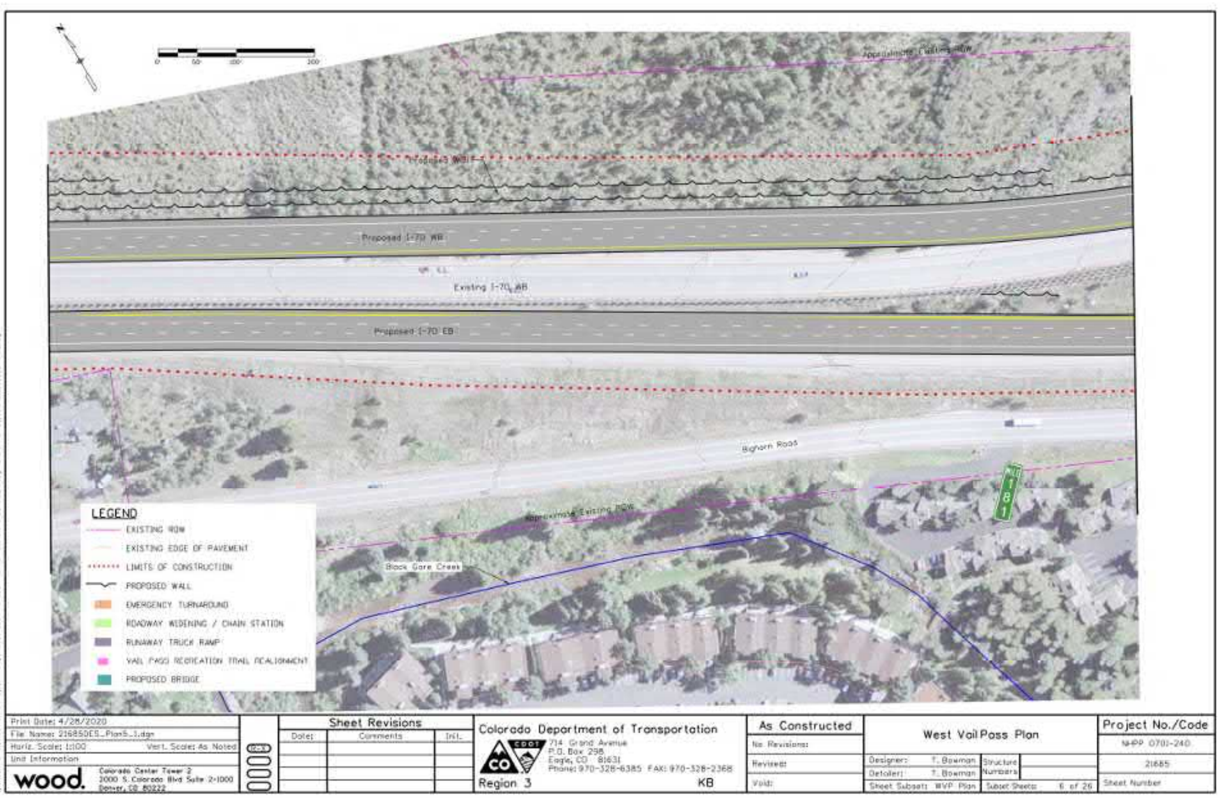


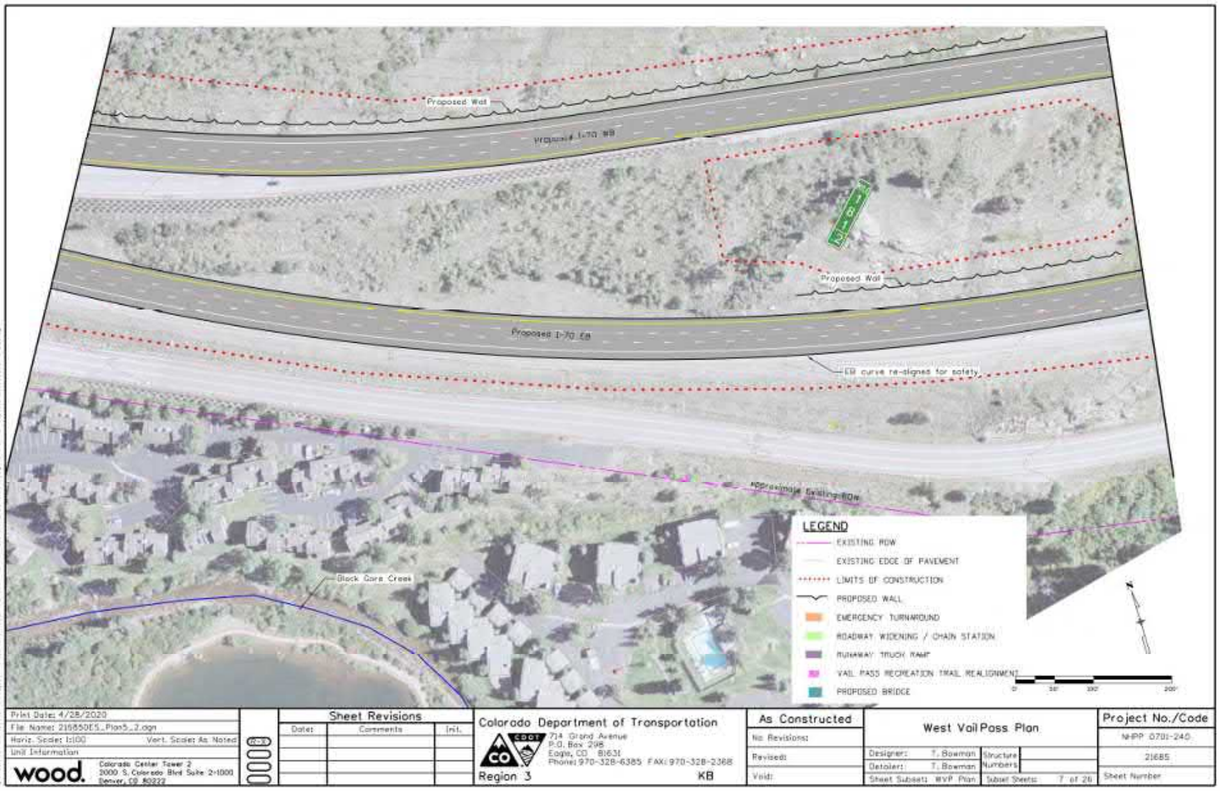


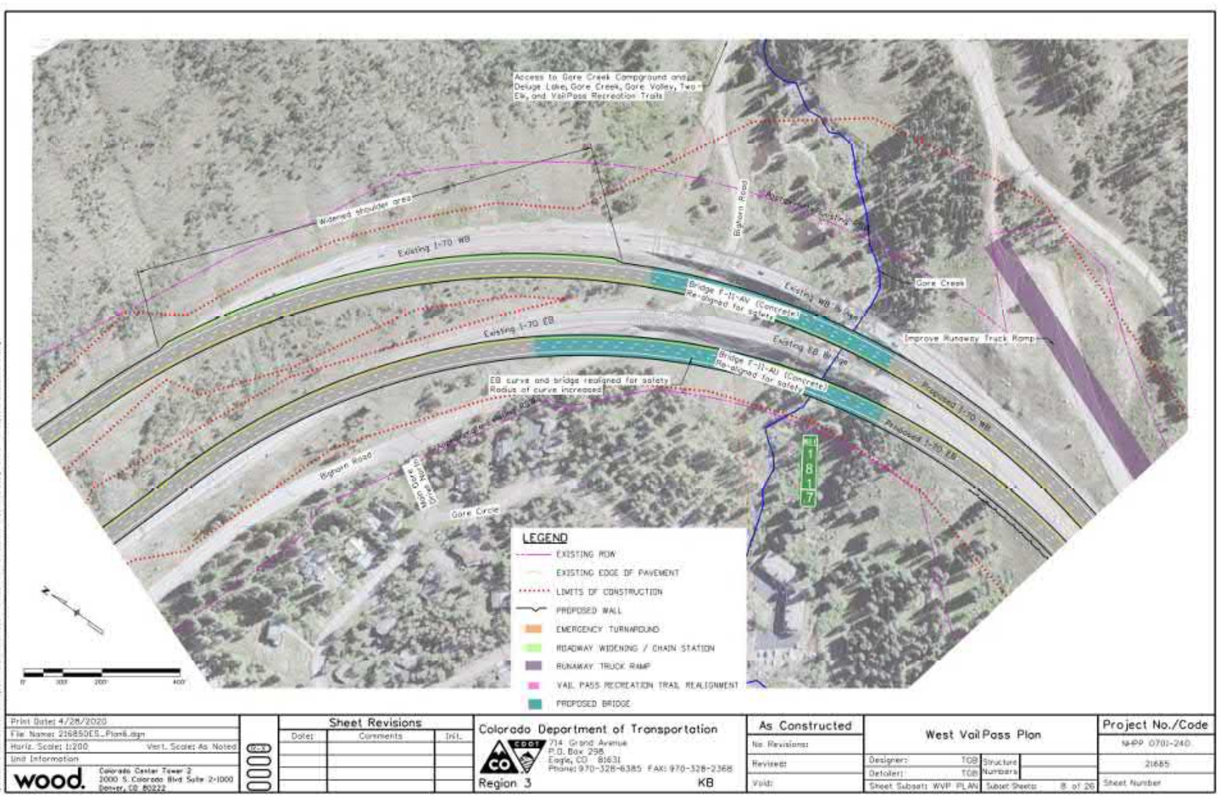

LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Proposed Wall
Proposed I-70 WB
Proposed I-70 EB
Spruce Way
Print Date: 4/28/2020
Sheet Revisions
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Region 3
As Constructed
West Vail Pass Plan
Project No./Code
NHPP 0701-240
21685
wood.

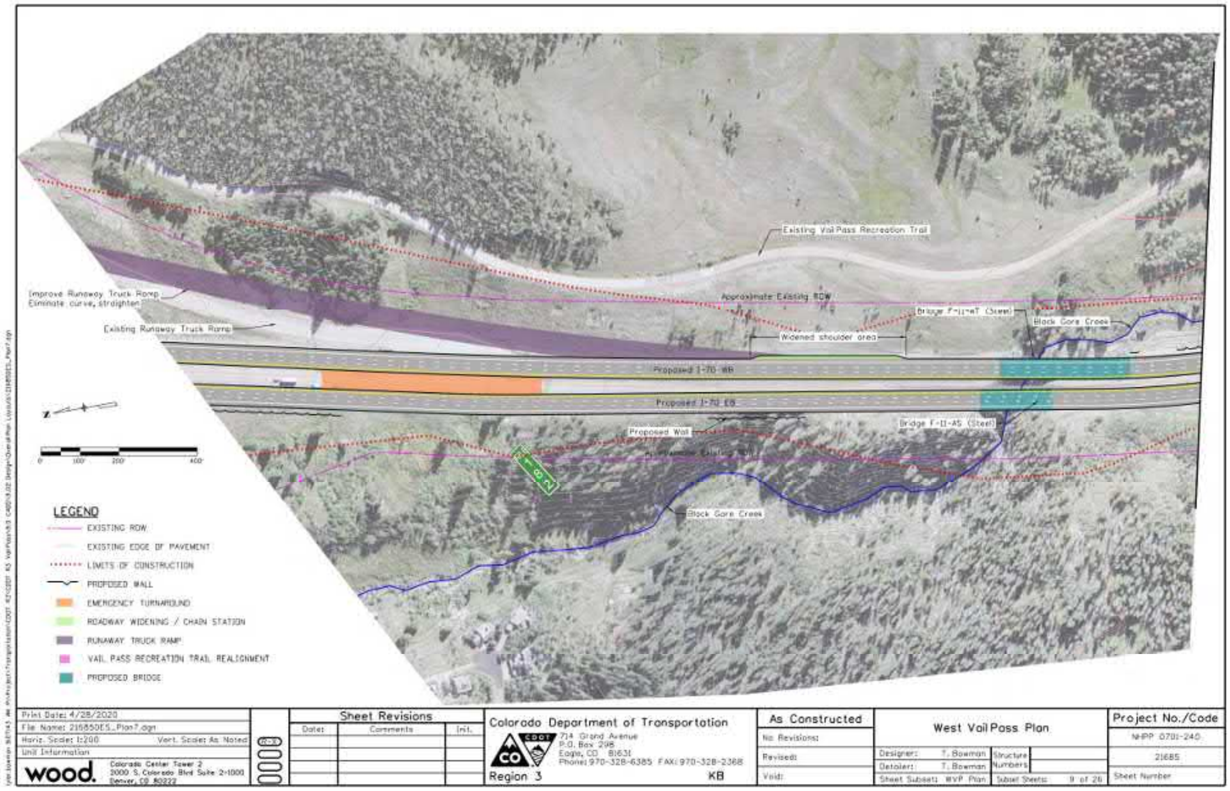

LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Proposed Wall
Proposed I-70 WB
Proposed I-70 EB
EB curve re-aligned for safety
Existing Underpass
Bighorn Creek
Spruce Way
Print Date: 4/28/2020
Sheet Revisions
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Region 3
As Constructed
West Vail Pass Plan
Project No./Code
NHPP 0701-240
21685
wood.

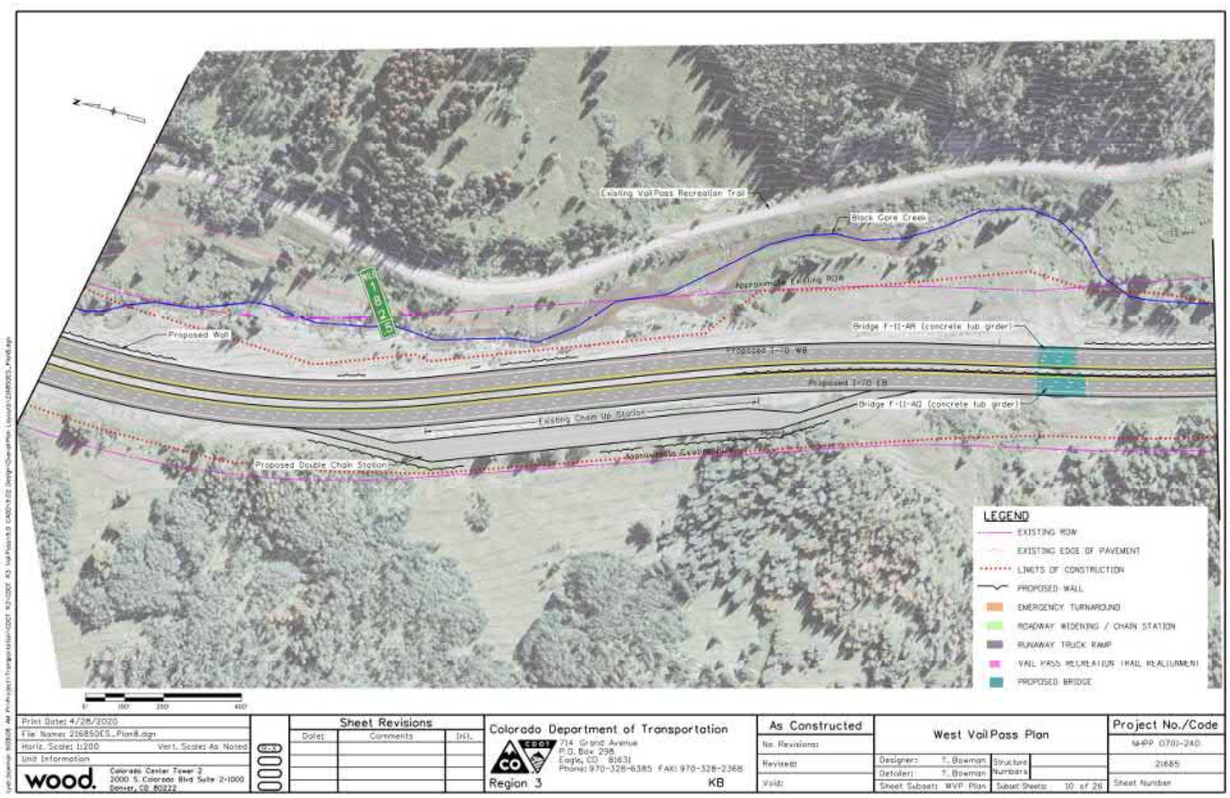

Proposed Wall
Bridge F-11-AX (Concrete)
Proposed I-70 WB
Existing I-70 WB
Bridge F-11-AW (Concrete)
Proposed I-70 EB
Approximate Existing ROW
Hold EB South edge of pavement, widen North
Spruce Way
Bighorn Road
Streamside Circle
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 21685DES_Plan4_2.dgn
Horiz. Scale: 1:100
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 5 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number

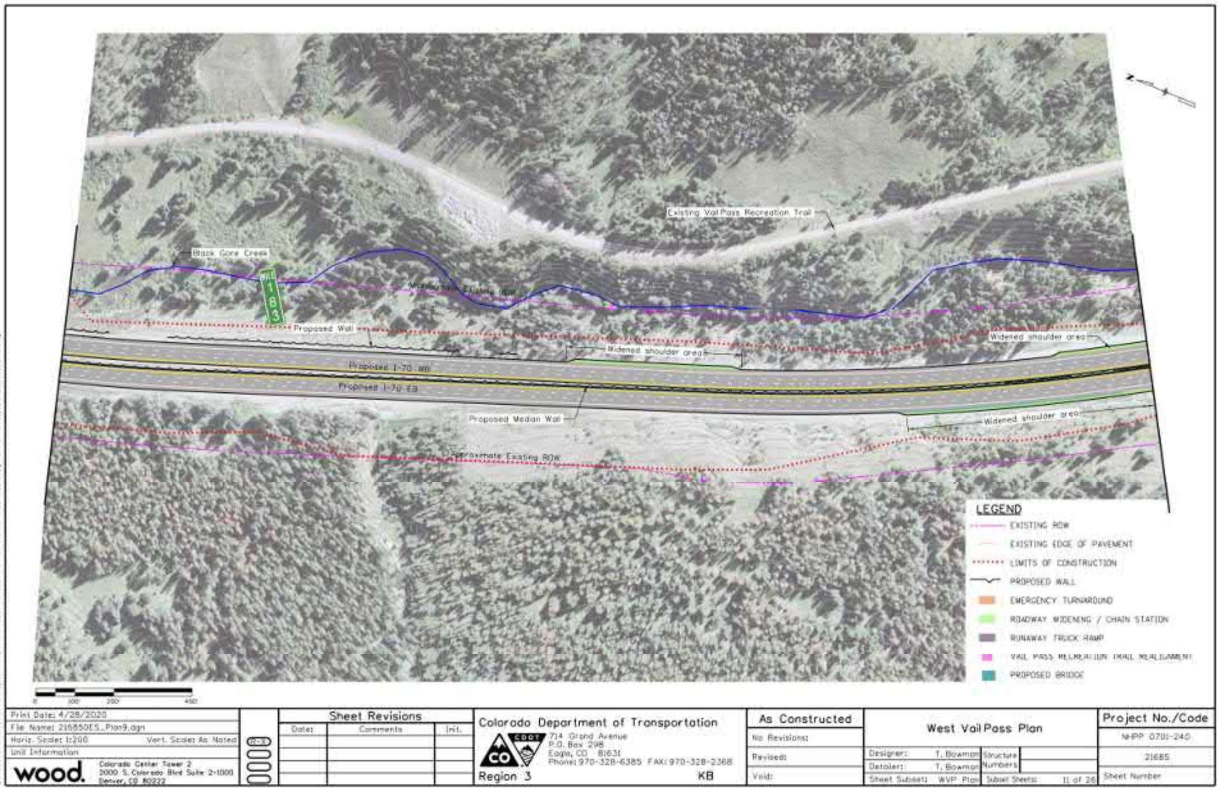

Approximate Existing ROW
Proposed Wall
Proposed I-70 WB
Existing I-70 WB
Proposed I-70 EB
Bighorn Road
Approximate Existing ROW
Black Gore Creek
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 21685DES_Plan5_1.dgn
Horiz. Scale: 1:100
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 6 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Proposed Wall
Proposed I-70 WB
Proposed Wall
Proposed I-70 EB
EB curve re-aligned for safety
Approximate Existing ROW
Black Gore Creek
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
Sheet Revisions
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Region 3
KB
As Constructed
West Vail Pass Plan
Project No./Code
NHPP 0701-240
21685
Sheet Number
wood.


Access to Gore Creek Campground and Deluge Lake, Gore Creek, Gore Valley, Two Elk, and Vail Pass Recreation Trails
Widened shoulder area
Existing I-70 WB
Bighorn Road
Existing I-70 EB
Bridge F-11-AV (Concrete) Re-aligned for safety
Existing WB Bridge
Gore Creek
Existing EB Bridge
Improve Runaway Truck Ramp
Bridge F-11-AU (Concrete) Re-aligned for safety
EB curve and bridge realigned for safety Radius of curve increased
Proposed I-70 WB
Proposed I-70 EB
Bighorn Road
Gore Circle
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
Sheet Revisions
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Region 3
KB
As Constructed
West Vail Pass Plan
Project No./Code
NHPP 0701-240
21685
Sheet Number
wood.


Existing Vail Pass Recreation Trail
Improve Runaway Truck Ramp
Eliminate curve, straighten
Existing Runaway Truck Ramp
Approximate Existing ROW
Bridge F-11-AT (Steel)
Black Gore Creek
Widened shoulder area
Proposed I-70 WB
Proposed I-70 EB
Bridge F-11-AS (Steel)
Proposed Wall
Black Gore Creek
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 216850ES_Plan7.dgn
Horiz. Scale: 1:200
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 9 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Existing Vail Pass Recreation Trail
Black Gore Creek
Approximate Existing ROW
Proposed Wall
Bridge F-11-AR (concrete tub girder)
Proposed I-70 WB
Proposed I-70 EB
Bridge F-11-AQ (concrete tub girder)
Existing Chain Up Station
Proposed Double Chain Station
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 216850ES_Plan8.dgn
Horiz. Scale: 1:200
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 10 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Existing Vail Pass Recreation Trail
Black Gore Creek
183
Proposed Wall
Widened shoulder area
Proposed I-70 WB
Proposed I-70 EB
Proposed Median Wall
Approximate Existing ROW
Widened shoulder area
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 21685DES_Plan9.dgn
Horiz. Scale: 1:200
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
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Region 3
KB
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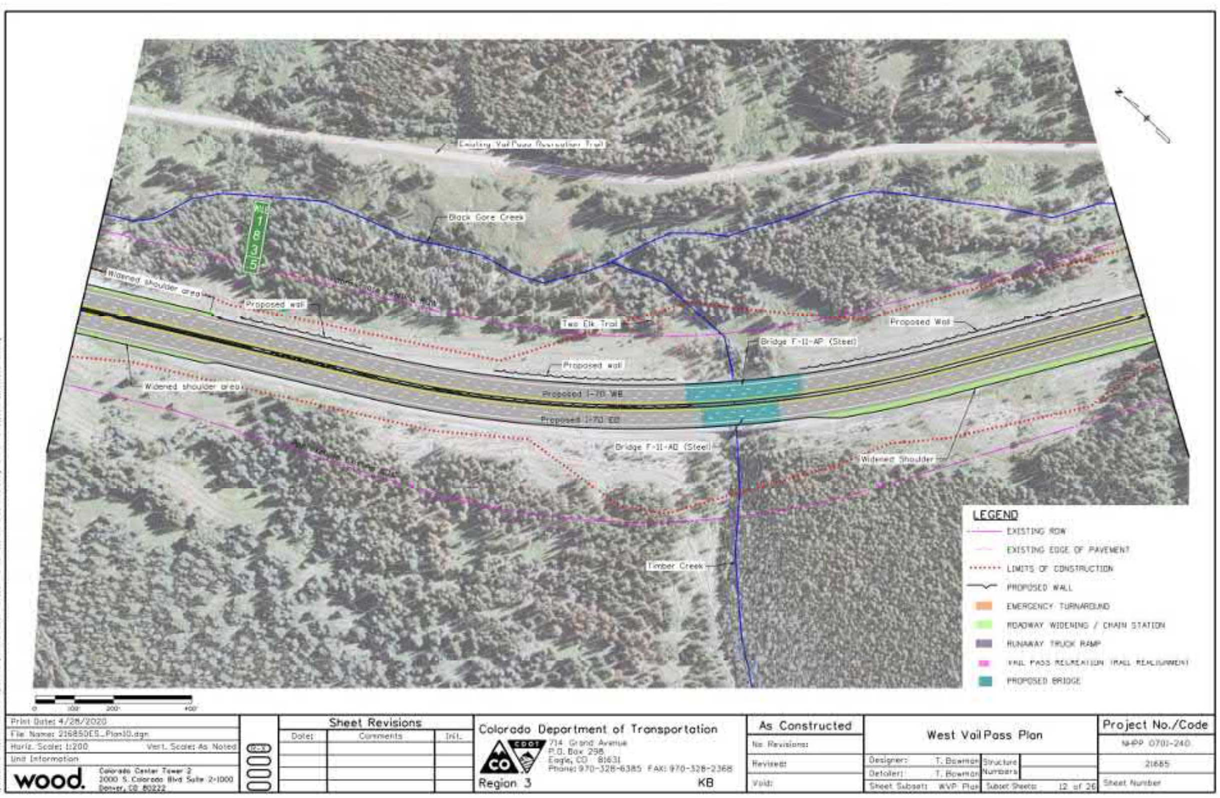
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 11 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Existing Vail Pass Recreation Trail
Black Gore Creek
183.5
Widened shoulder area
Proposed wall
Two Elk Trail
Proposed Wall
Bridge F-11-AP (Steel)
Proposed wall
Widened shoulder area
Proposed I-70 WB
Proposed I-70 EB
Bridge F-11-AQ (Steel)
Widened Shoulder
Timber Creek
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 21685DES_Plan10.dgn
Horiz. Scale: 1:200
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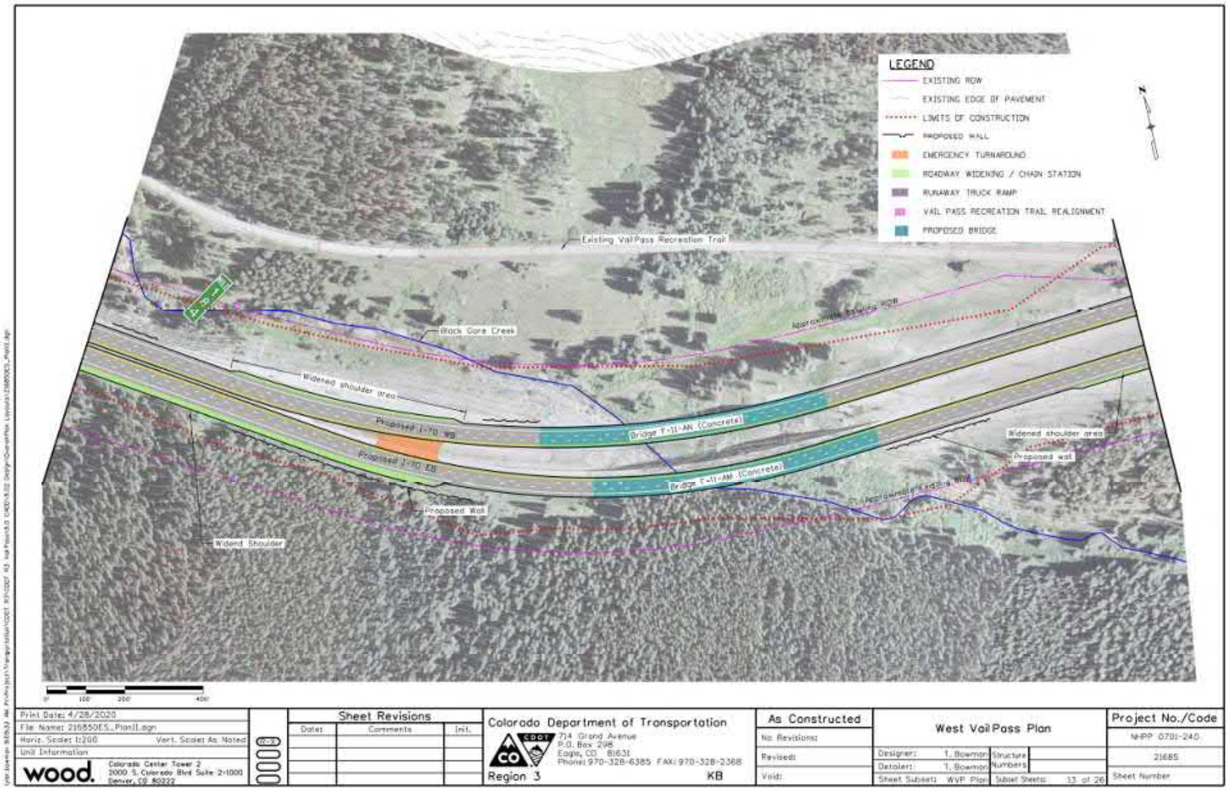
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 12 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Existing Vail Pass Recreation Trail
Black Gore Creek
Widened shoulder area
Proposed I-70 WB
Proposed I-70 EB
Bridge F-11-AN (Concrete)
Bridge F-11-AM (Concrete)
Widened shoulder area
Proposed wall
Proposed Wall
Widend Shoulder
Print Date: 4/28/2020
File Name: 216850ES_Plan11.dgn
Horiz. Scale: 1:200
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
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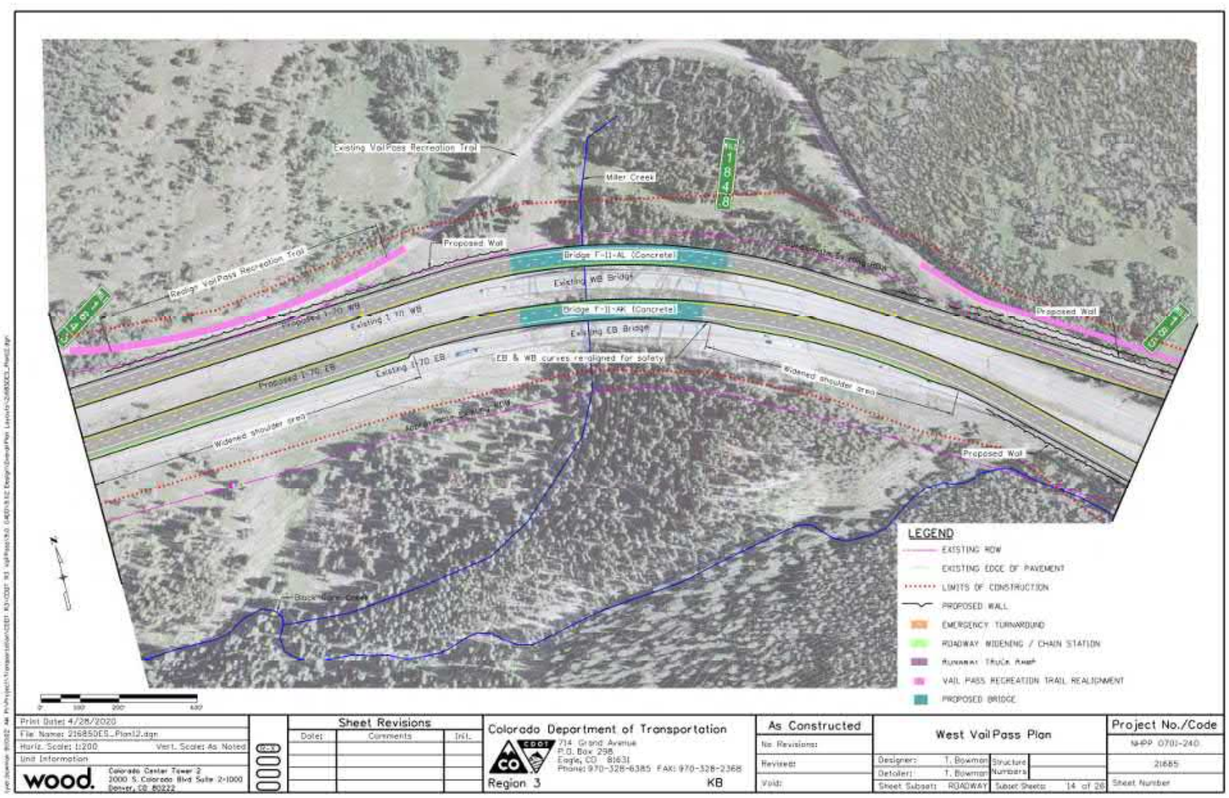
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 13 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Existing VailPass Recreation Trail
Miller Creek
Proposed Wall
Bridge F-11-AL (Concrete)
Existing WB Bridge
Bridge F-11-AK (Concrete)
Existing EB Bridge
EB & WB curves re-aligned for safety
Realign VailPass Recreation Trail
Proposed I-70 WB
Existing I-70 WB
Proposed I-70 EB
Existing I-70 EB
Widened shoulder area
Widened shoulder area
Proposed Wall
Proposed Wall
Black Gore Creek
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
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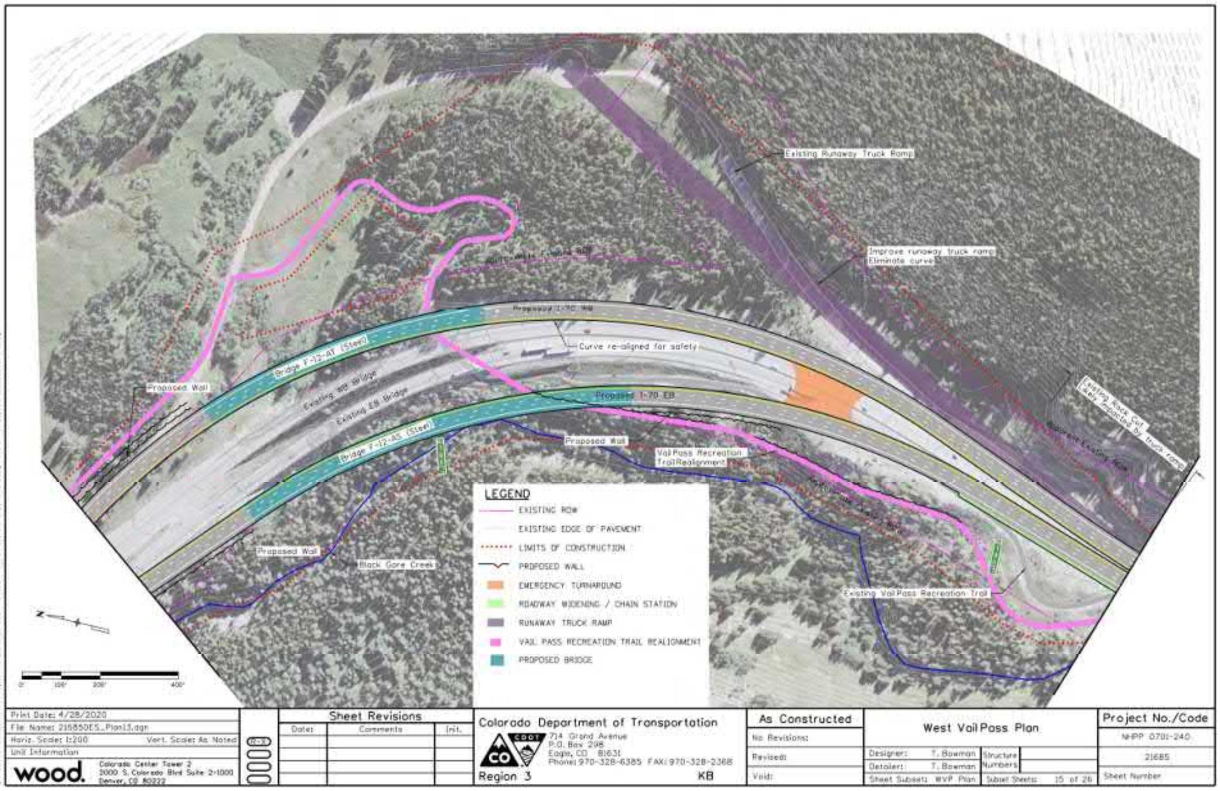
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: ROADWAY
Subset Sheets: 14 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Existing Runaway Truck Ramp
Improve runaway truck ramp Eliminate curve
Proposed I-70 WB
Curve re-aligned for safety
Bridge F-12-AT (Steel)
Existing WB Bridge
Existing EB Bridge
Proposed I-70 EB
Bridge F-12-AS (Steel)
Proposed Wall
Vail Pass Recreation Trail Realignment
Black Gore Creek
Existing Vail Pass Recreation Trail
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
File Name: 21685DES_Plan15.dgn
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Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
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Colorado Department of Transportation
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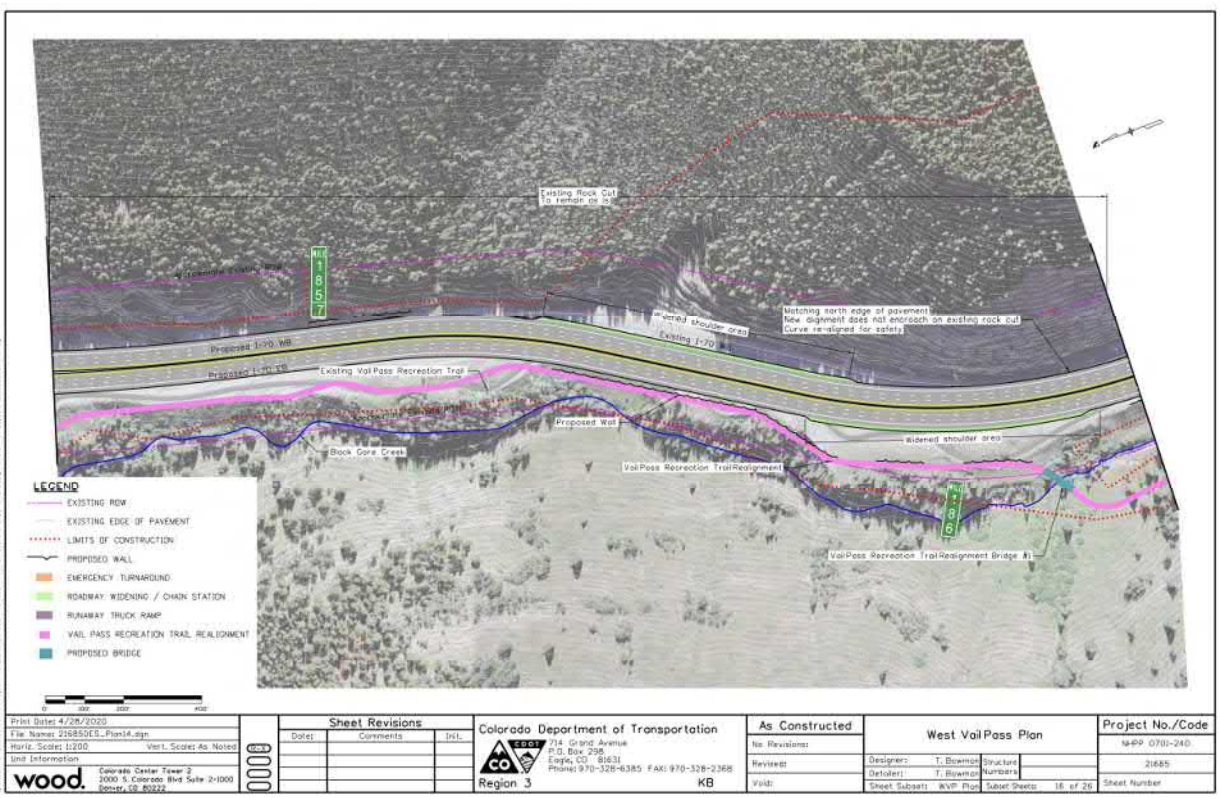
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 15 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Existing Rock Cut To remain as is
Matching north edge of pavement
New alignment does not encroach on existing rock cut
Curve re-aligned for safety
Paved shoulder area
Existing I-70 WB
Proposed I-70 WB
Proposed I-70 EB
Existing Vail Pass Recreation Trail
Proposed Wall
Black Gore Creek
Widened shoulder area
Vail Pass Recreation Trail Realignment
Vail Pass Recreation Trail Realignment Bridge #1
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
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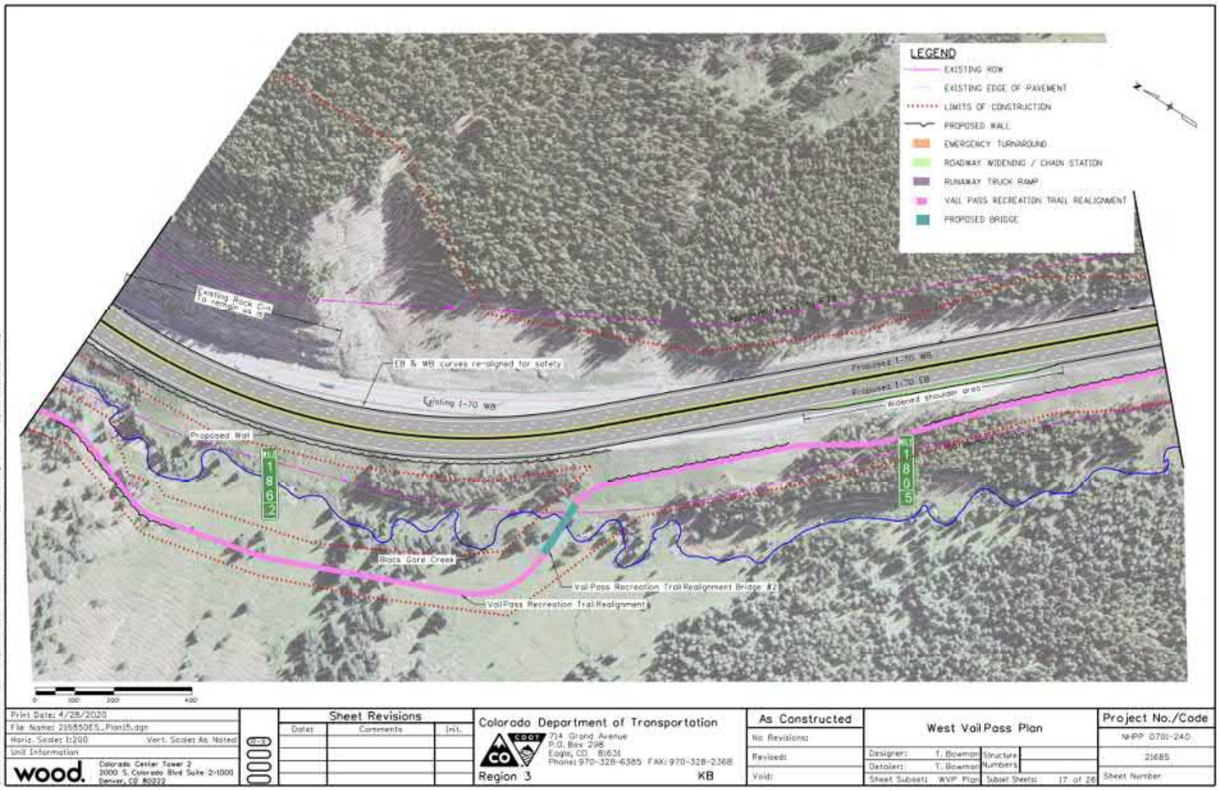
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date: Comments Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 16 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
EB & WB curves re-aligned for safety
Existing I-70 WB
Proposed I-70 WB
Proposed I-70 EB
Widened shoulder area
Proposed Wall
Black Gore Creek
Vail Pass Recreation Trail Realignment Bridge #2
Vail Pass Recreation Trail Realignment
Print Date: 4/28/2020
Sheet Revisions
Colorado Department of Transportation
714 Grand Avenue
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Eagle, CO 81631
Region 3
KB
As Constructed
West Vail Pass Plan
Project No./Code
NHPP 0701-240
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17 of 26
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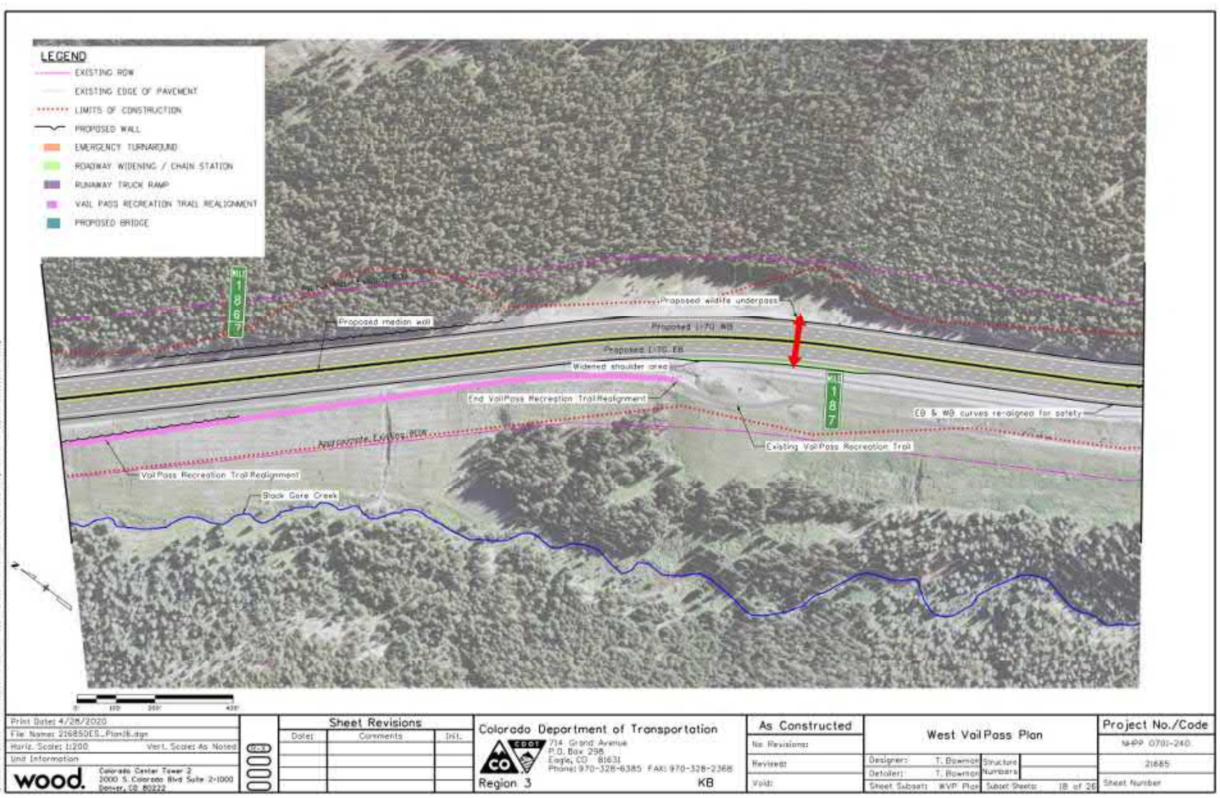
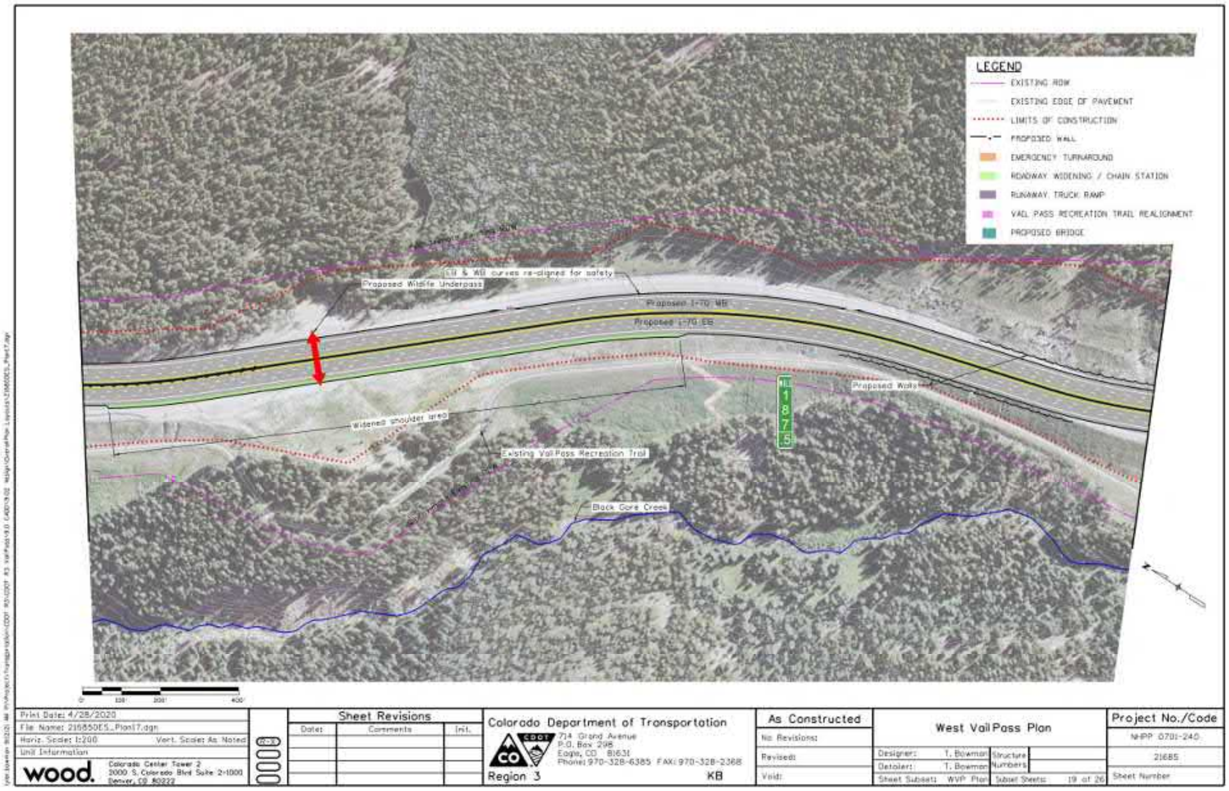

LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Proposed wildlife underpass
Proposed median wall
Proposed I-70 WB
Proposed I-70 EB
Widened shoulder area
End Vail Pass Recreation Trail Realignment
EB & WB curves re-aligned for safety
Existing Vail Pass Recreation Trail
Approximate Existing ROW
Vail Pass Recreation Trail Realignment
Black Gore Creek
Print Date: 4/28/2020
Sheet Revisions
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Region 3
KB
As Constructed
West Vail Pass Plan
Project No./Code
NHPP 0701-240
21685
18 of 26
wood.


LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
EB & WB curves re-aligned for safety
Proposed Wildlife Underpass
Proposed I-70 WB
Proposed I-70 EB
Proposed Walls
Widened shoulder area
Existing Vail Pass Recreation Trail
Black Gore Creek
Print Date: 4/28/2020
File Name: 216850ES_Plan17.dgn
Horiz. Scale: 1:200
Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
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Denver, CO 80222
Sheet Revisions
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Colorado Department of Transportation
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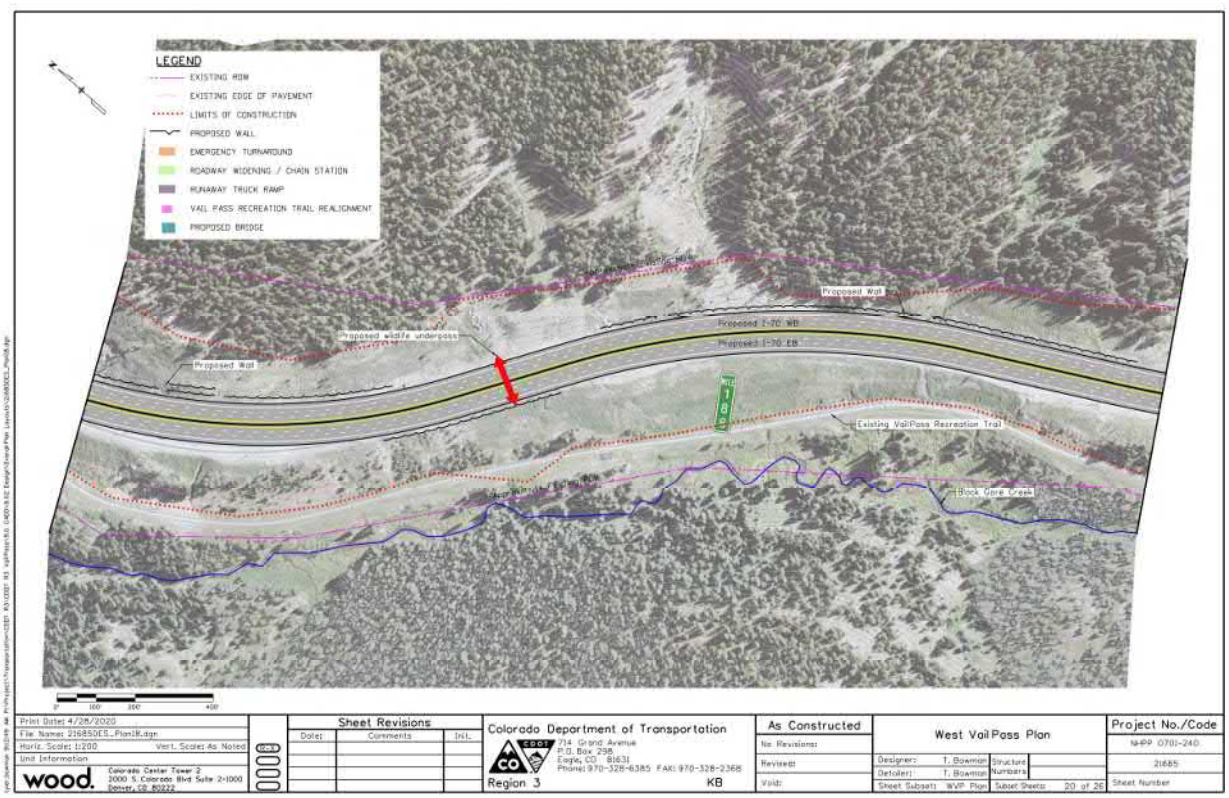
Phone: 970-328-6385 FAX: 970-328-2368
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 19 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Proposed Wall
Proposed wildlife underpass
Proposed I-70 WB
Proposed I-70 EB
Existing Vail Pass Recreation Trail
Black Gore Creek
Print Date: 4/28/2020
File Name: 216850ES_Plan18.dgn
Horiz. Scale: 1:200
Vert. Scale: As Noted
Unit Information
wood.
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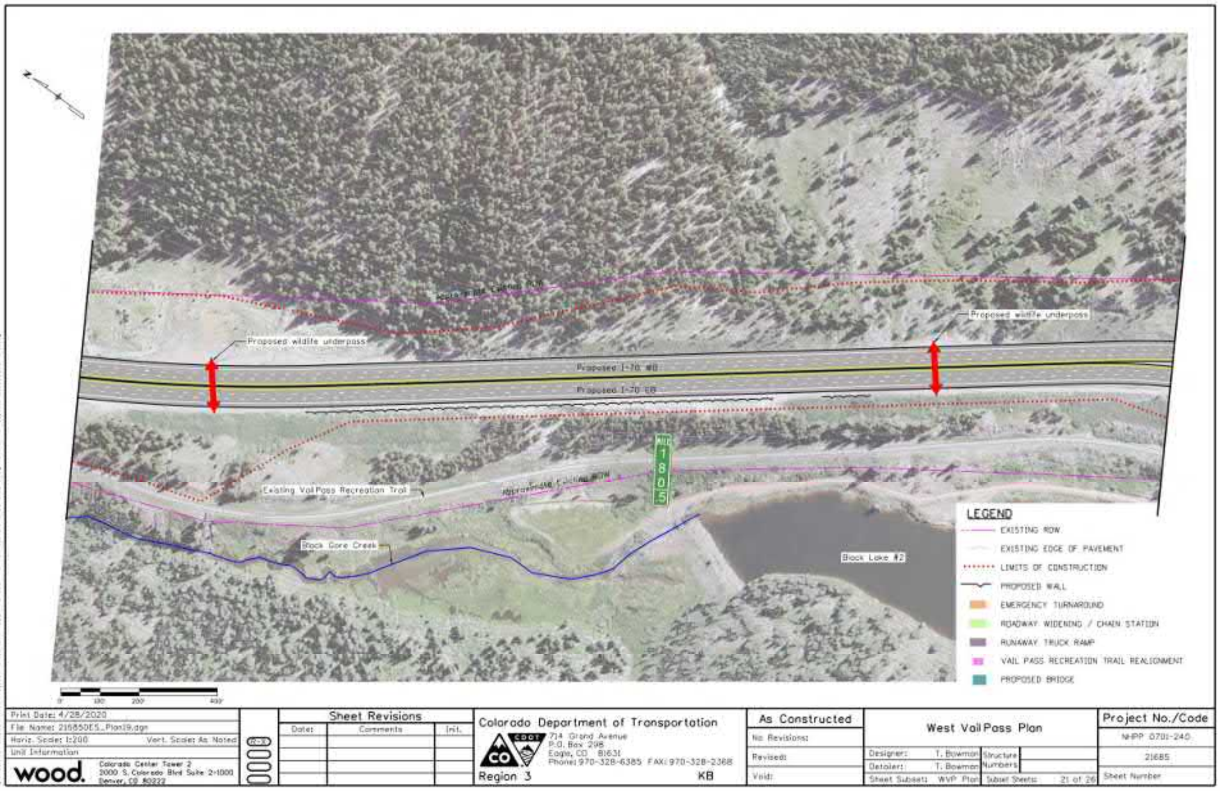
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 20 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Proposed wildlife underpass
Proposed wildlife underpass
Proposed I-70 WB
Proposed I-70 EB
Existing Vail Pass Recreation Trail
Approximate Existing ROW
Black Gore Creek
Black Lake #2
1
8
0
5
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
0' 100' 200' 400'
Print Date: 4/28/2020
File Name: 216850ES_Plan19.dgn
Horiz. Scale: 1:200 Vert. Scale: As Noted
Unit Information
wood.
Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date: Comments Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3 KB
As Constructed
No Revisions:
Revised:
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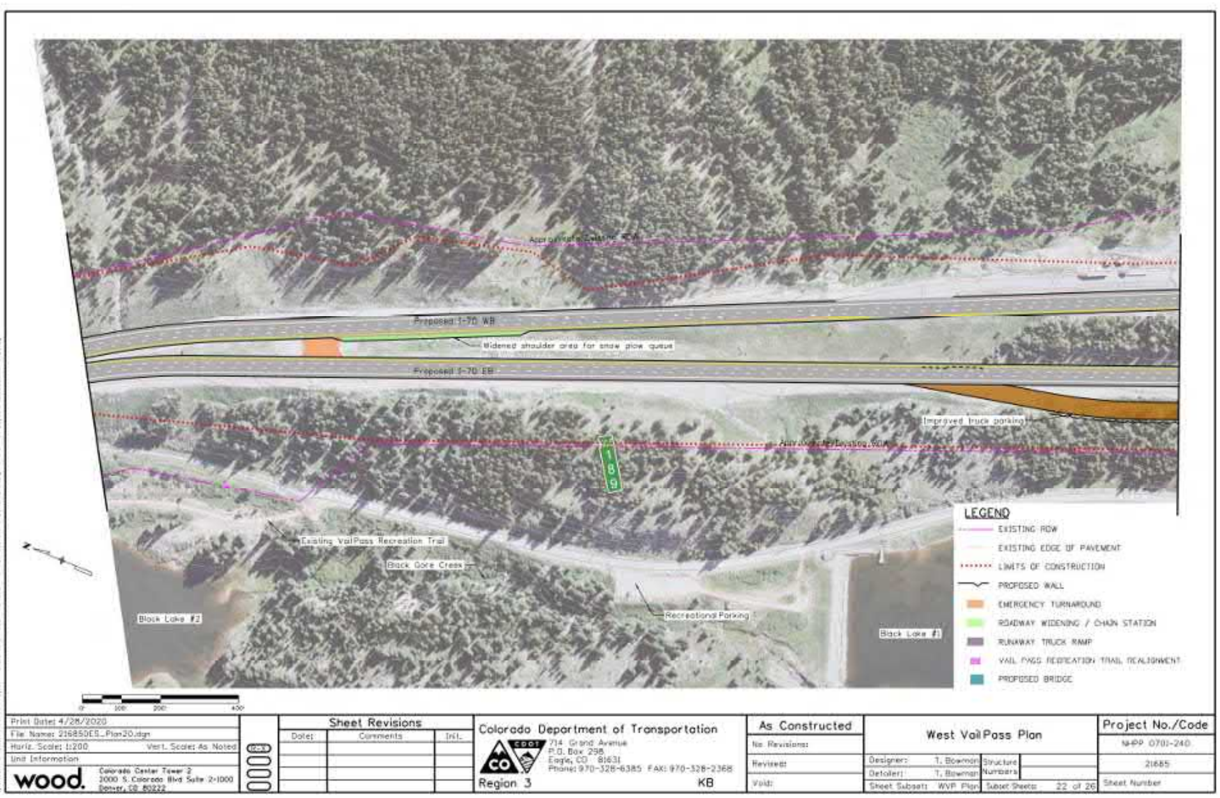
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 21 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


Approximate Existing ROW
Proposed I-70 WB
Widened shoulder area for snow plow queue
Proposed I-70 EB
Improved truck parking
Approximate Existing ROW
1
8
9
Existing Vail Pass Recreation Trail
Black Gore Creek
Recreational Parking
Black Lake #2
Black Lake #1
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
0' 100' 200' 400'
Print Date: 4/28/2020
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Horiz. Scale: 1:200 Vert. Scale: As Noted
Unit Information
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Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date: Comments Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
Phone: 970-328-6385 FAX: 970-328-2368
Region 3 KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
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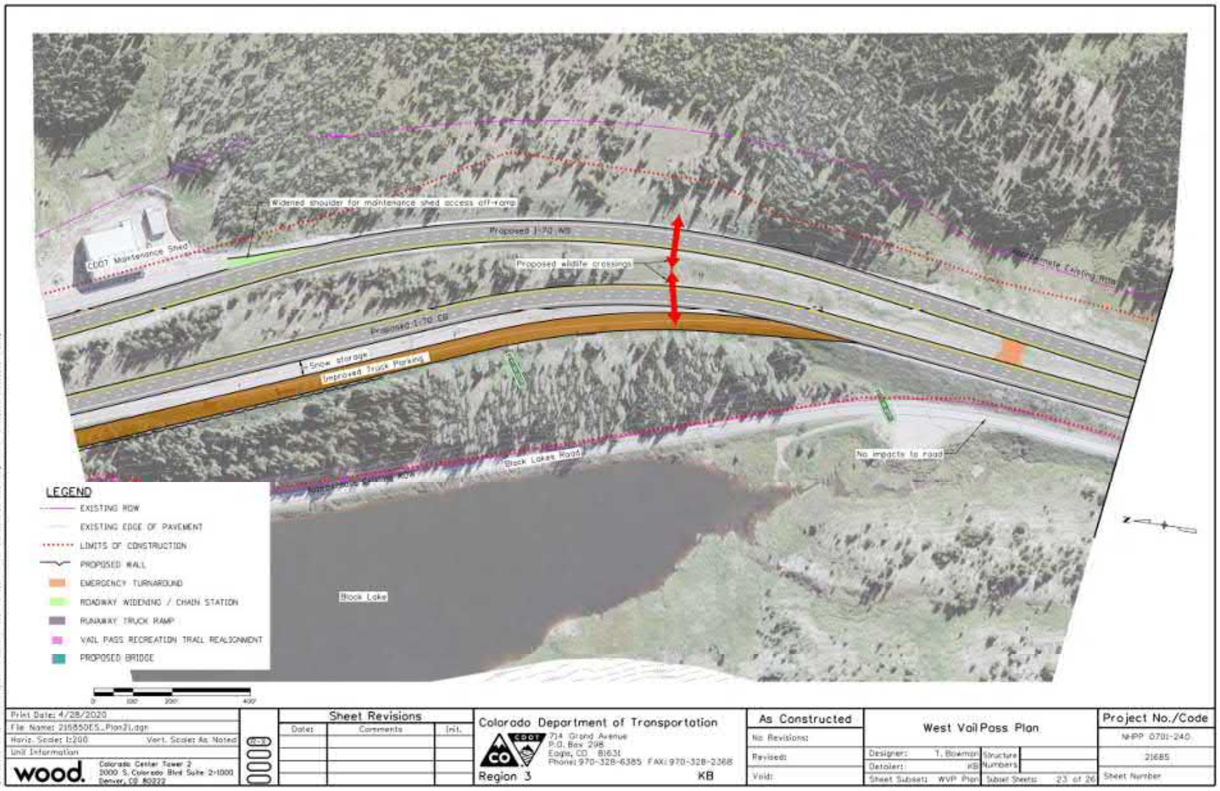
NHPP 0701-240
21685
Sheet Number


Widened shoulder for maintenance shed access off-ramp
CDOT Maintenance Shed
Proposed I-70 WB
Proposed wildlife crossings
Proposed I-70 EB
Snow storage
Improved Truck Parking
Black Lakes Road
No impacts to road
Black Lake
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
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Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
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Region 3
KB
As Constructed
No Revisions:
Revised:
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West Vail Pass Plan
Designer: T. Bowman
Detailer: KB
Structure Numbers
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Project No./Code
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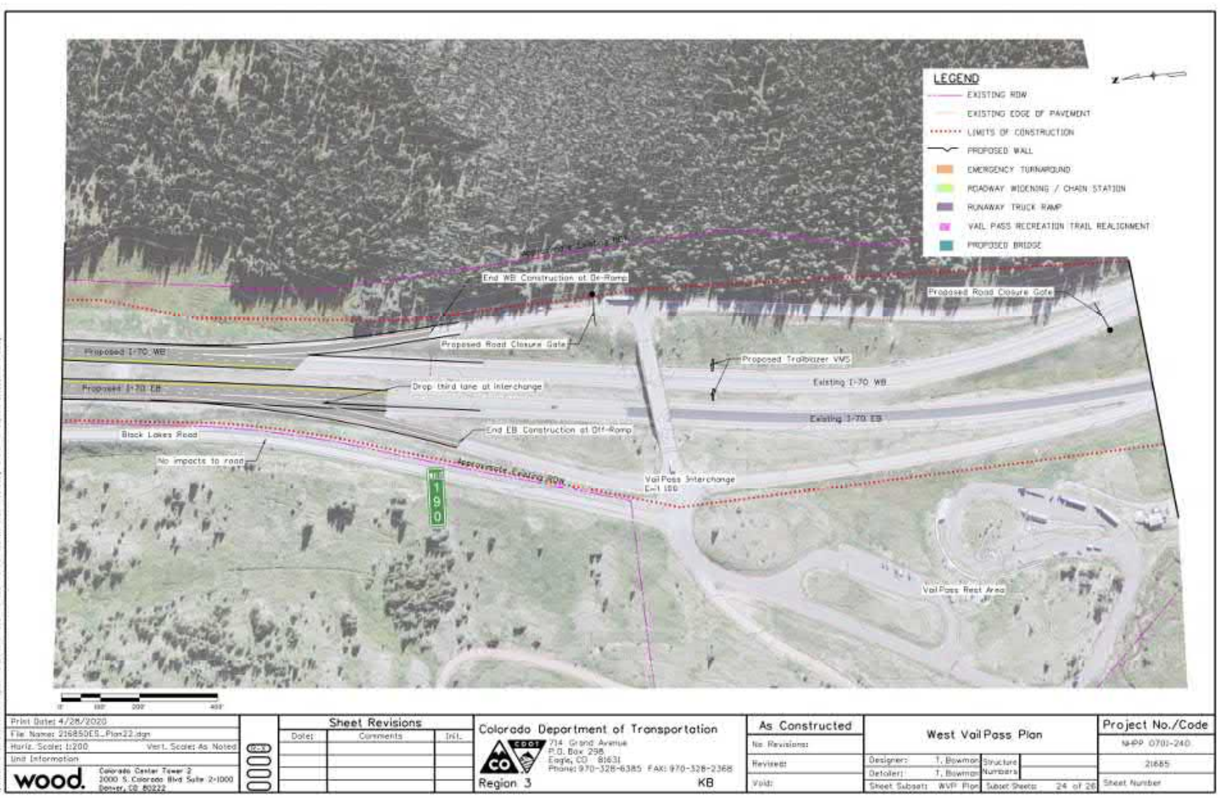
21685
Sheet Number


LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
End WB Construction at On-Ramp
Proposed Road Closure Gate
Proposed I-70 WB
Proposed I-70 EB
Drop third lane at interchange
Proposed Trailblazer VMS
Existing I-70 WB
Existing I-70 EB
End EB Construction at Off-Ramp
Black Lakes Road
No impacts to road
Approximate Existing ROW
Vail Pass Interchange
Vail Pass Rest Area
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Colorado Center Tower 2
2000 S. Colorado Blvd Suite 2-1000
Denver, CO 80222
Sheet Revisions
Date:
Comments
Init.
Colorado Department of Transportation
714 Grand Avenue
P.O. Box 298
Eagle, CO 81631
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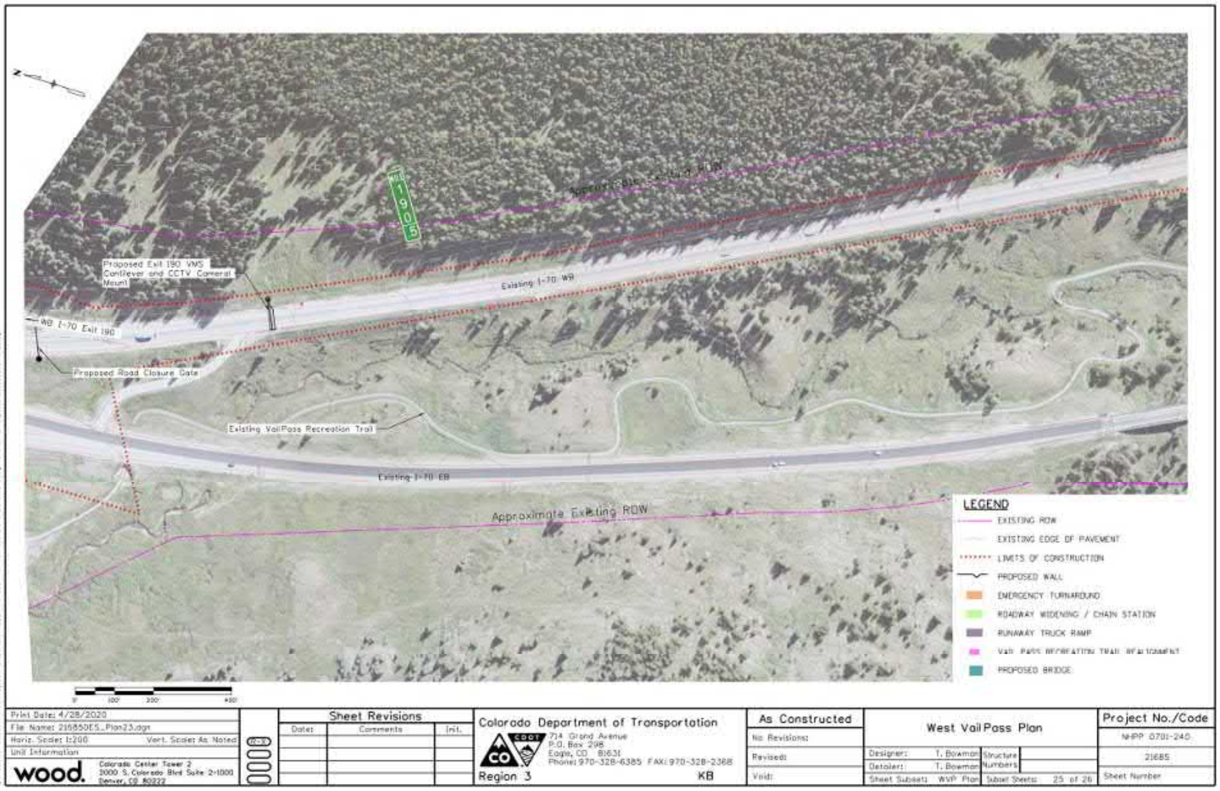
Region 3
KB
As Constructed
No Revisions:
Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
Structure Numbers
Sheet Subset: WVP Plan
Subset Sheets: 24 of 26
Project No./Code
NHPP 0701-240
21685
Sheet Number


MILE 190.5
Proposed Exit 190 VMS Cantilever and CCTV Camera Mount
WB I-70 Exit 190
Existing I-70 WB
Proposed Road Closure Gate
Existing Vail Pass Recreation Trail
Existing I-70 EB
Approximate Existing ROW
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
RUNAWAY TRUCK RAMP
PROPOSED BRIDGE
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Colorado Center Tower 2
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CDOT
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Eagle, CO 81631
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KB
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Revised:
Void:
West Vail Pass Plan
Designer: T. Bowman
Detailer: T. Bowman
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Subset Sheets: 25 of 26
Project No./Code
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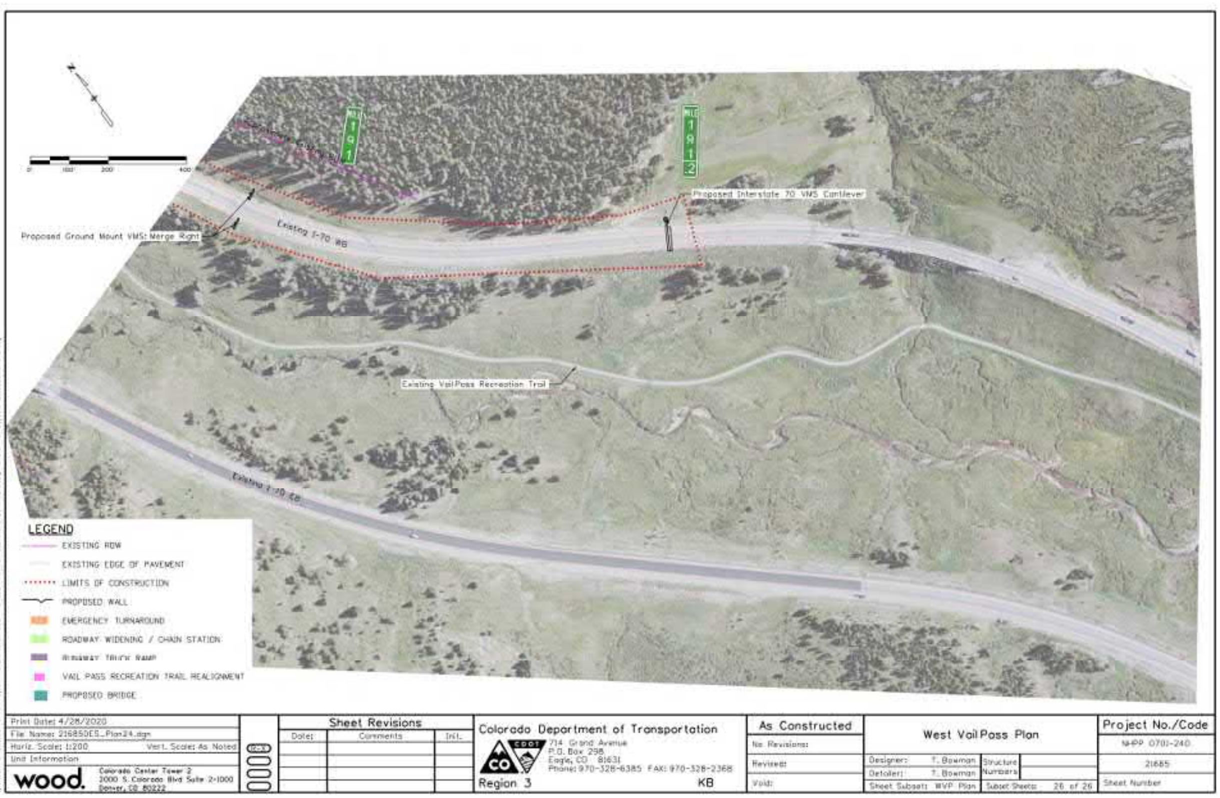
21685
Sheet Number


MILE 191
MILE 191.2
Proposed Interstate 70 VMS Cantilever
Proposed Ground Mount VMS: Merge Right
Existing I-70 WB
Existing Vail Pass Recreation Trail
Existing I-70 EB
LEGEND
EXISTING ROW
EXISTING EDGE OF PAVEMENT
LIMITS OF CONSTRUCTION
PROPOSED WALL
EMERGENCY TURNAROUND
ROADWAY WIDENING / CHAIN STATION
VAIL PASS RECREATION TRAIL REALIGNMENT
PROPOSED BRIDGE
Print Date: 4/28/2020
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21685
Sheet Number

Appendix C. VE Study Presentation Power Point Slideshow

Colorado Department of Transportation
Region 3

I-70 West Vail Pass Auxiliary Lanes
Eagle County, CO

VE Study Presentation
April 9, 2021

Value Engineering Team:

Jacobs
John Corcoran
Craig Broadhead
Tim Siedlecki

RS&H
Mark Talvitie
Greg Grant
Ben Sterling

Kiewit
Ted Rutledge

Apex
Ken DePinto

CDOT
Neil Ogden
Craig Wieden

FHWA
Jeff Bellen
Armando Henriquez

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I-70 West Vail Pass Auxiliary Lanes

Regional Project Location – Aerial Photo

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I-70 West Vail Pass Auxiliary Lanes

Project Description and Scope

- Project Escape Ramp at Milepost 182.2 – FIR/FOR
- Infra-Grant MP 185 – MP 190 (mostly eastbound)
- West Vail Pass Mileposts 180 to 191 – Environmental Assessment

Project Goals

- Improve Operations
- Improve Safety

Existing Conditions

- Steep slopes
- Inadequate cross section width, limited pull-off and breakdown area
- Substandard geometry
- Heavy tractor trailer congestion
- Poor interaction between faster and slower vehicles
- Extremely high crash rate
- Pass closed frequently due to traffic and weather incidents

Proposed Construction Scope

- 12' wide auxiliary lanes in each direction
- Address substandard geometry
- Modify curves for design and posted speed limits
- Widen inside shoulders from 4' to 6'
- Widen outside shoulders to 8'
- Additional shoulder widening for truck pullouts
- Increase commercial truck passing
- Replace bridges
- Replace failing retaining walls
- Incorporate remote lane closure system to allow for fast closure
- Install avalanche protection
- Relocate recreation trail
- Match existing aesthetic and historical character
- Kiewit – CMGC Contractor – Phase 1

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I-70 West Vail Pass Auxiliary Lanes

Study conducted in accordance with SAVE International Standards.

1. Preparation
2. Information
3. Function Analysis
4. Idea Generation
5. Evaluation
6. Development
7. Presentation
8. Implementation

- What is Value?
  - Preserving project Basic Functions
  - Cost savings
  - Life-Cycle
  - Schedule
  - Constructability
  - Safety
  - Risk

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I-70 West Vail Pass Auxiliary Lanes

Function Analysis Summary

Verb	Noun	Category: Basic / Secondary / Higher Order
improve	safety	B
improve	operations	B
maintain	aesthetics	B
collaborate	w/ stakeholders	HO

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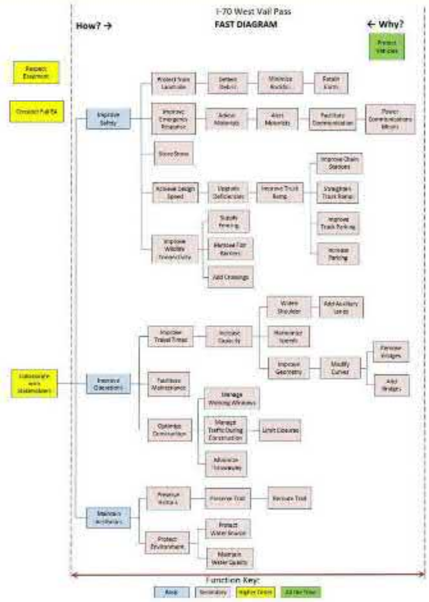
I-70 West Vail Pass Auxiliary Lanes

FAST Diagram



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I-70 West Vail Pass Auxiliary Lanes

Project Cost Estimate Summary

WORK CATEGORY	DIRECT COST	PERCENTAGE	CUMULATIVE PERCENTAGE
Bridge Deck Area	$12,788,600	16.8%	16.8%
Unclassified Excavation (Complete in Place)-ROADWAY	$8,945,460	11.7%	28.5%
Fill Walls - MSE	$8,595,048	11.3%	39.8%
Hot Mix Asphalt (Grading SX) (100) (PG 76-28)-ROADWAY	$8,482,584	11.1%	50.9%
Cut Walls - Soil Nail/Ground Anchor	$7,222,345	9.5%	60.4%
2 underpasses @ 55' wide, 14' tall, 150' long	$4,879,305	6.4%	66.8%
Structure Excavation	$2,876,010	3.8%	70.5%
Guardrail Type 9 (Style CG)	$1,796,520	2.4%	72.9%
Shoring (Walls)	$1,500,000	2.0%	74.8%
Guardrail Type 9 (Style CA)	$1,382,490	1.8%	76.7%
Bridge Deck Area - Trail	$1,305,000	1.7%	78.4%
4 underpasses at 8' wide, 8' tall and 150' long	$1,261,600	1.7%	80.0%
Project Office/Lab	$1,220,000	1.6%	81.6%
Construction Surveying	$1,200,000	1.6%	83.2%
59 other items	$12,818,213	16.8%	100.0%
Total	$76,273,175		

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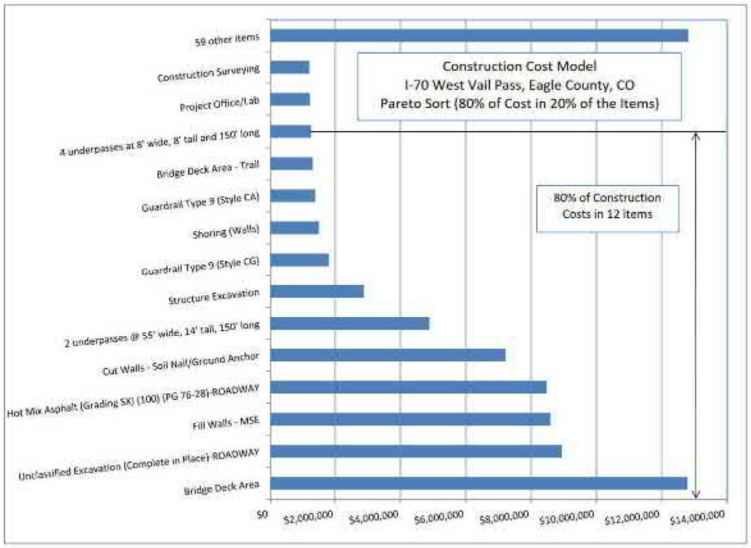
I-70 West Vail Pass Auxiliary Lanes

Cost Model



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I-70 West Vail Pass Auxiliary Lanes

Study Findings:

56 Ideas

41 Proposals:

- Highway / Bridge Alignment
- Retaining Walls / MSE Walls / Earthwork
- Barriers
- Shoulders
- Wildlife Crossings
- Guardrail
- Asphalt Mix
- Electric / Power
- Grading / Reforestation
- Implementation

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I-70 West Vail Pass Auxiliary Lanes

Proposal 1: Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area.

Advantages

- Saves cost
- Possible reuse of onsite spoils

Disadvantages

- Requires realignment of Big Horn Road
- Changes aesthetics of long span bridge
- Impacts a small grove of trees along Big Horn Road

Cost Savings: $5,994,862

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I-70 West Vail Pass Auxiliary Lanes

Proposal 1: Shift Big Horn Road alignment to the east and shorten I-70 mainline bridges in EA area.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 2: Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.

Advantages

- Increase mainline curve radii and design speed
- Shortens EB bridge

Disadvantages

- May impact ROW to the north
- May impact truck ramp
- Increased excavation requirements
- May have to lower Big Horn

Proposal Eliminated

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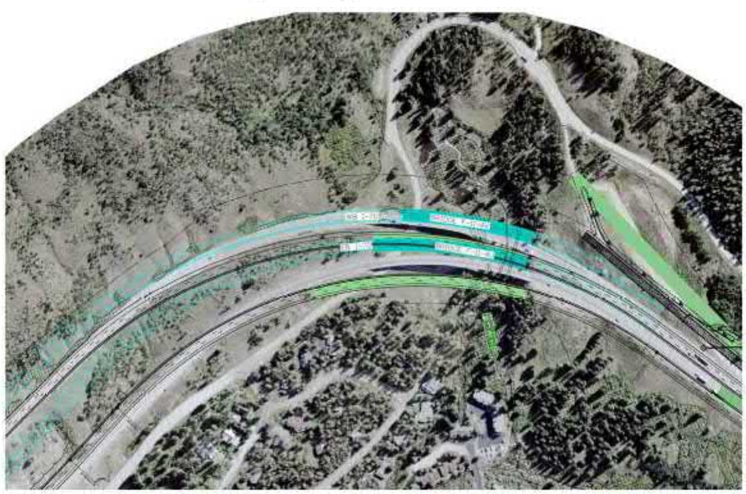
I-70 West Vail Pass Auxiliary Lanes

Proposal 2: Construct both bridges to the north of existing bridges at I-70 crossing of Big Horn and Gore Creek in EA area.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 3: At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.

Advantages
- Improves operation
- Adds recovery capability

Disadvantages
- Adds cost for more pavement to this phase

Added Cost: $86,846

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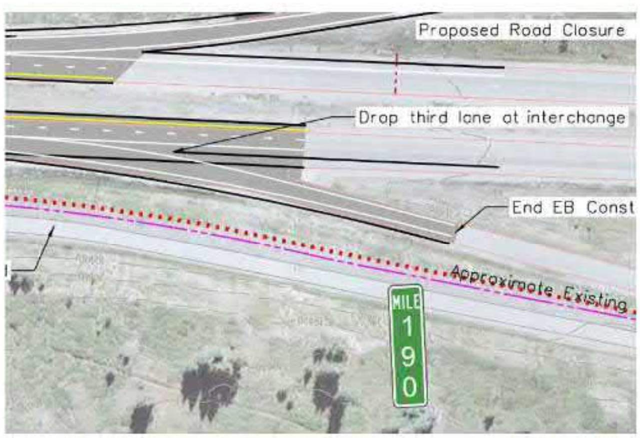
I-70 West Vail Pass Auxiliary Lanes

Proposal 3: At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.



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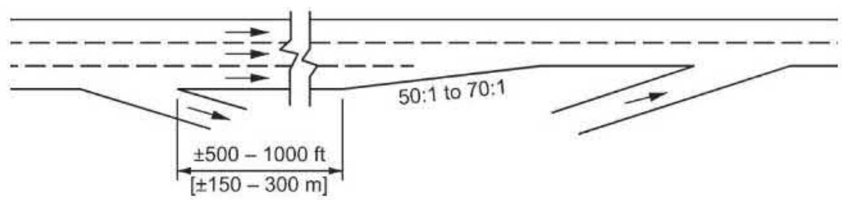
I-70 West Vail Pass Auxiliary Lanes

Proposal 3: At the east end of the project, Exit 190 EB, provide a recovery lane beyond the exit to improve operations, especially with trucks merging.



Auxiliary Lane Dropped within an Interchange

– C –

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I-70 West Vail Pass Auxiliary Lanes

Proposal 4: Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.

Advantages
- Saves demolition cost in current contract
- Less environmental disturbance during demolition
- Better sustainability as opposed to landfill alternative
- Potential functional benefit to CDOT and road users

Disadvantages
- Continued maintenance responsibility
- Remains on bridge inventory
- Potential aesthetic issues

Design Suggestion

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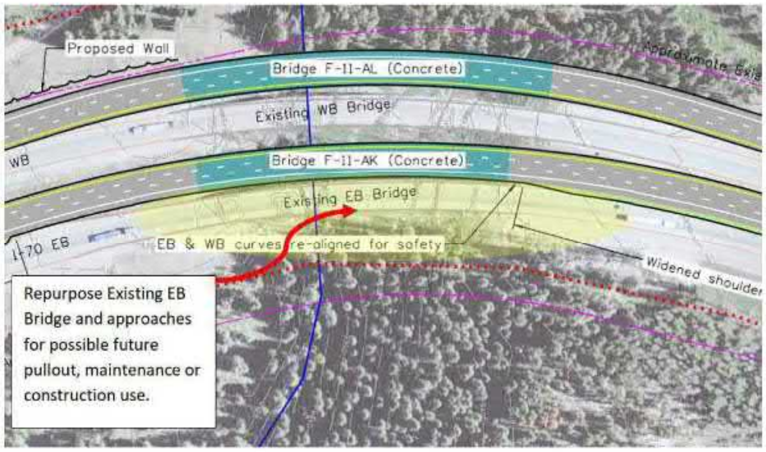
I-70 West Vail Pass Auxiliary Lanes

Proposal 4: Preserve some bridges scheduled to be demolished for repair operations, emergency crossovers or temporary storage areas.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 5: Consider historic tub shape using alternate structural concrete members.

Advantages

- Potential cost savings
- Reduces maintenance
- More concrete availability
- Utilizes more readily available material

Disadvantages

- More difficult erection
- Concrete beams are more difficult to frame

Design Suggestion

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I-70 West Vail Pass Auxiliary Lanes

Proposal 5: Consider historic tub shape using alternate structural concrete members.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 6: Look for opportunities to shift WB alignment south and replace structure F11AX.

Advantages
- Eliminates Bridge
- Reduction of north side cut walls
- Potential to stabilize landslide
- Provides opportunity to use site material

Disadvantages
- Adds large retaining wall
- Potential political fatal flaw
- Drainage considerations
- Aesthetic concerns

Proposal Eliminated

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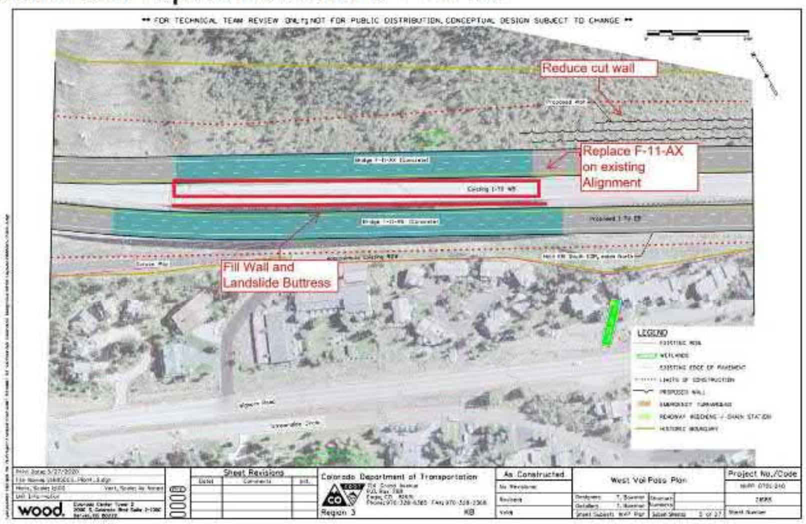
I-70 West Vail Pass Auxiliary Lanes

Proposal 6: Look for opportunities to shift WB alignment south and replace structure F11AX.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 7: Incorporate a public turnaround point halfway up the pass.

Advantages

- Improves operations
- Clears traffic jams
- Adds mobility
- Facilitates traffic turnaround

Disadvantages

- Adds cost
- May need acceleration lane or police control
- May need FHWA approval
- Adds maintenance
- Promotes illegal parking
- Environmental impacts

Added Cost: $2,864,809

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I-70 West Vail Pass Auxiliary Lanes

Proposal 7: Incorporate a public turnaround point halfway up the pass.

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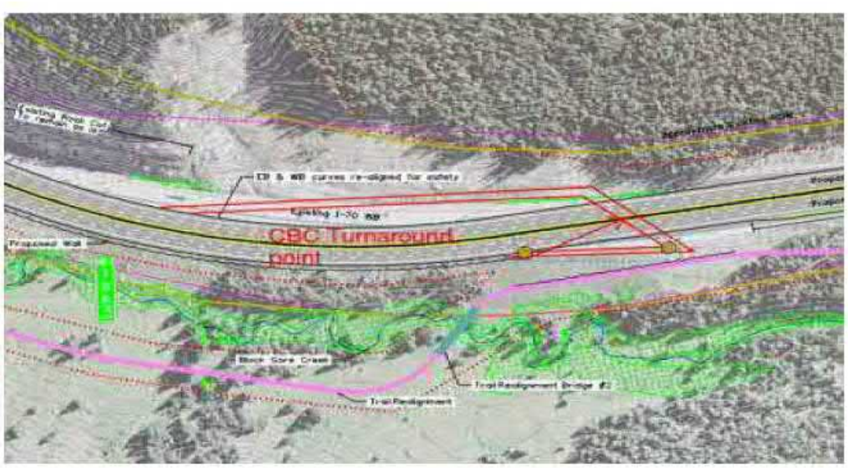
Proposal 7: Incorporate a public turnaround point halfway up the pass.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 8: Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.

Advantages

- Improve EB radius
- Saves cost
- Maintain or improve geometry
- Less environmental impact

Disadvantages

- Increases construction time
- Loss of emergency turnaround

Cost Savings: $7,333,093

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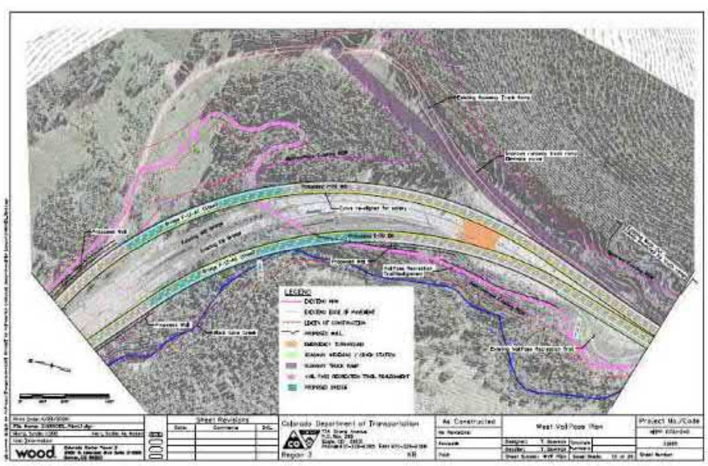
I-70 West Vail Pass Auxiliary Lanes

Proposal 8: Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.



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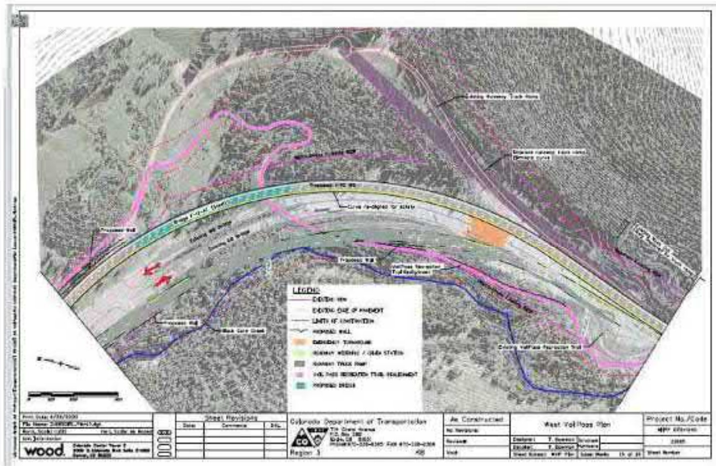

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I-70 West Vail Pass Auxiliary Lanes

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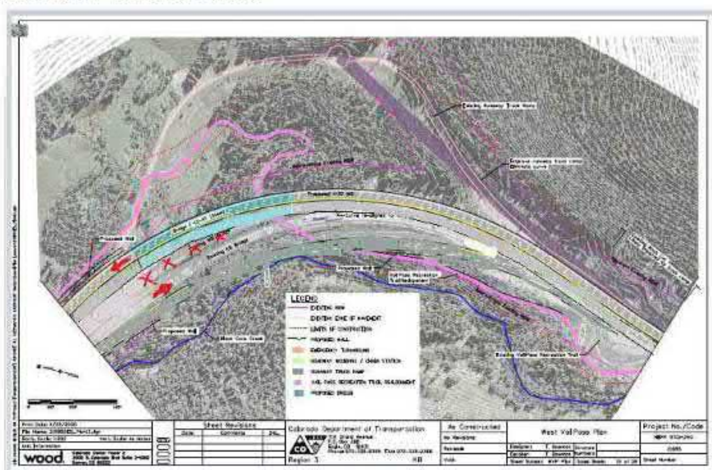

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I-70 West Vail Pass Auxiliary Lanes

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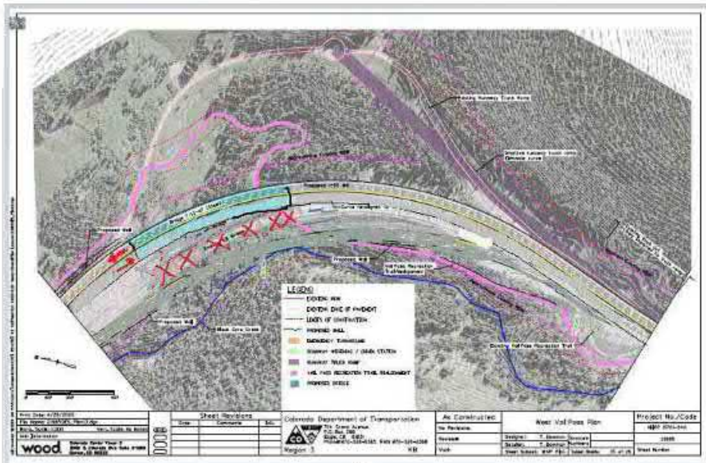

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I-70 West Vail Pass Auxiliary Lanes

Proposal 8: Build new WB bridge where designed, demo existing WB bridge and construct EB bridge in the same location at Polk Creek.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 9: Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.

Advantages

- Improve EB radius
- Saves cost
- Maintain or improve geometry

Disadvantages

- Increases construction time

Proposal Eliminated

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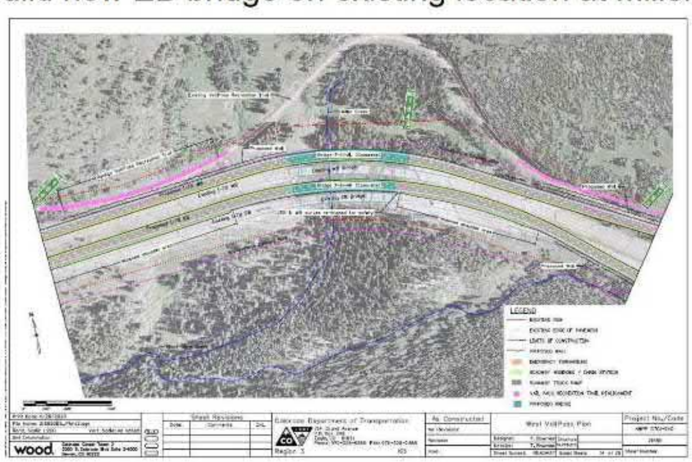
I-70 West Vail Pass Auxiliary Lanes

Proposal 9: Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 9: Build new WB bridge where designed and put WB traffic on it, then use existing WB bridge for EB traffic and build new EB bridge on existing location at Miller Creek.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 10: Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.

Advantages

- Saves cost
- Possibly less impact to environmentally sensitive area
- Reduce wildlife crossing width
- Snow storage area not needed
- Eliminates retaining wall

Disadvantages

- Less chain down area for trucks

Cost Savings: $3,259,997

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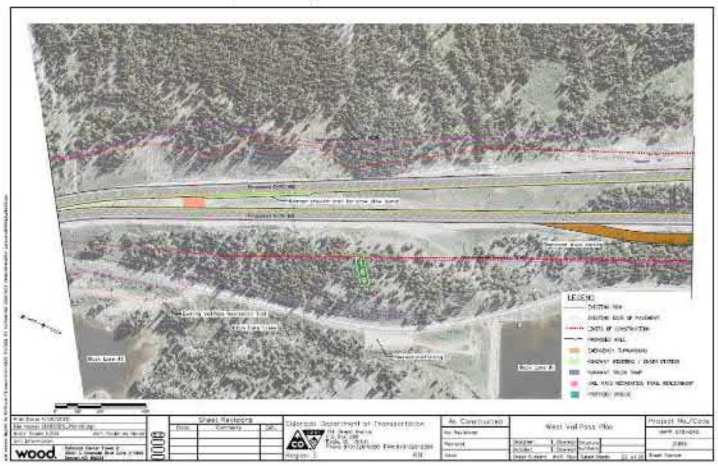
I-70 West Vail Pass Auxiliary Lanes

Proposal 10: Consider relocating improved truck parking to eliminate a retaining wall at the top of the hill near MP 190 or eliminate completely.



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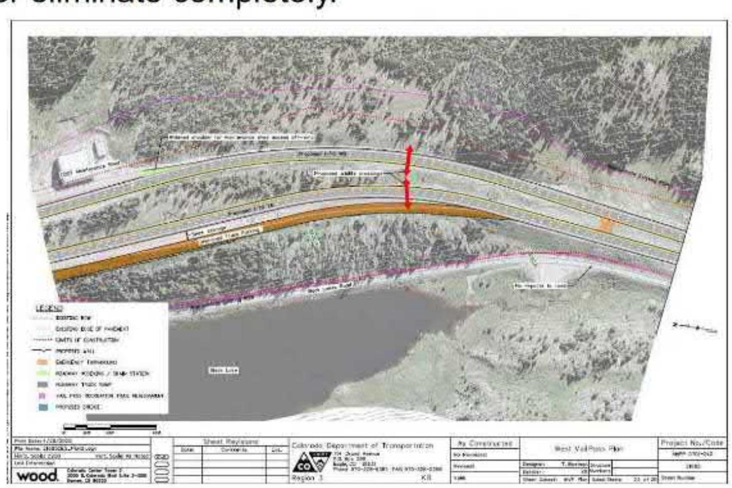

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I-70 West Vail Pass Auxiliary Lanes

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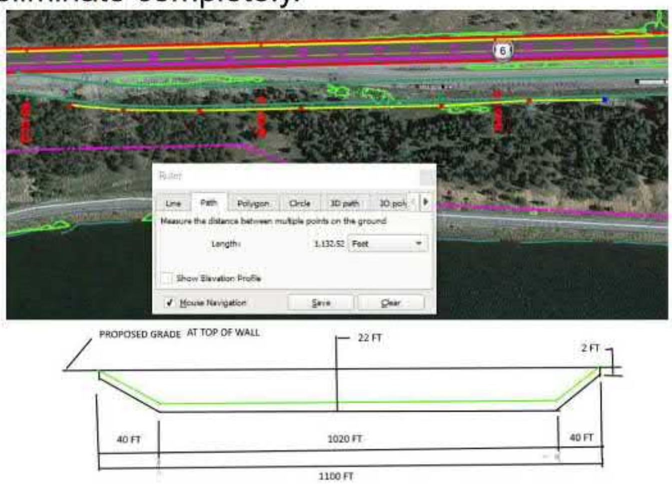

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I-70 West Vail Pass Auxiliary Lanes

Proposal 11: Shorten north end of bridge over Polk Creek and convert to MSE wall.

Advantages
- Saves cost
- Reduces bridge cost
- Reduces long-term bridge maintenance
- Faster construction

Disadvantages
- Aesthetic impact
- Trail needs to be rerouted around MSE wall abutment
- Additional MSE wall requirements

Cost Savings: $4,801,402

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I-70 West Vail Pass Auxiliary Lanes

Proposal 11: Shorten north end of bridge over Polk Creek and convert to MSE wall.

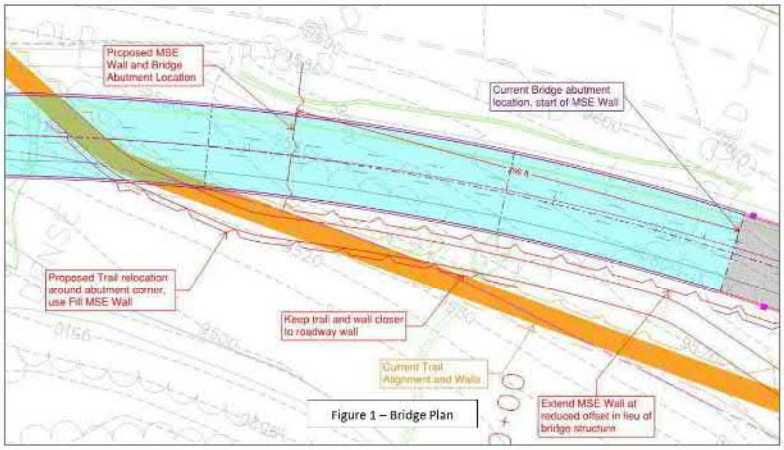


Figure 1 – Bridge Plan

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 11: Shorten north end of bridge over Polk Creek and convert to MSE wall.

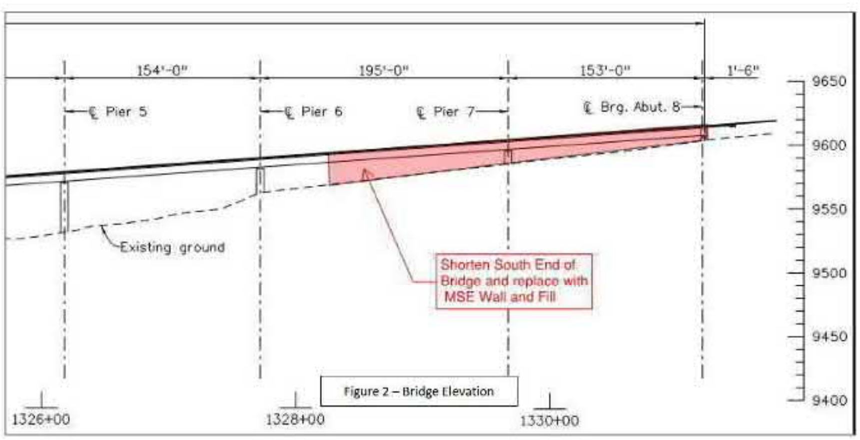


Figure 2 – Bridge Elevation

COLORADO Department of Transportation — I-70 West Vail Pass Auxiliary Lanes

Proposal 11: Shorten north end of bridge over Polk Creek and convert to MSE wall.

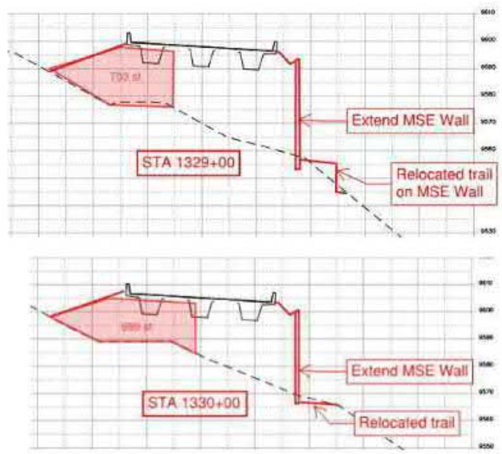


Figure 3 – Cross Sections

COLORADO Department of Transportation — I-70 West Vail Pass Auxiliary Lanes

Proposal 12: Consider Anchor Slab on Top of Walls.

Advantages
- Reduces footprint
- Reduces wall height
- Potential to save cost

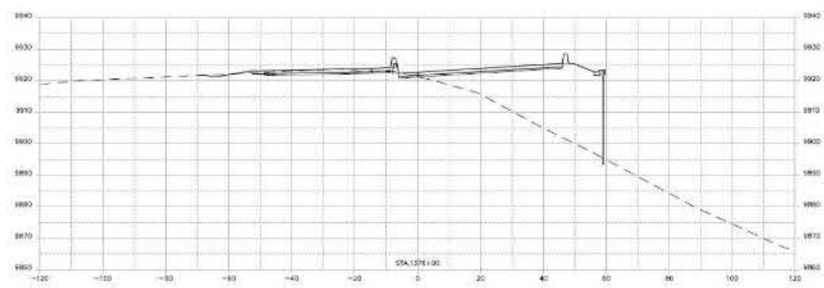
Disadvantages
- Potentially more difficult to construct next to travel lanes
- Access for future repairs

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 12: Consider Anchor Slab on Top of Walls.



Project Cross Section

COLORADO
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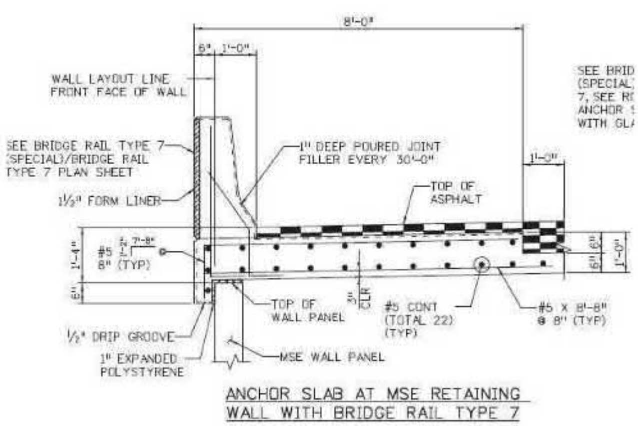
I-70 West Vail Pass Auxiliary Lanes

Proposal 12: Consider Anchor Slab on Top of Walls.



Example Anchor Slab Detail

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 13: Consider anchor slabs for short walls.

Advantages

- May save cost
- Potential to improve aesthetics in constrained visible areas

Disadvantages

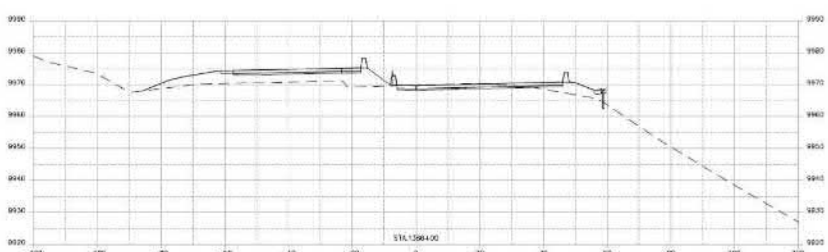
- Potentially more difficult to construct next to travel lanes

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 13: Consider anchor slabs for short walls.



Project Cross Section and Potential Application Locations

COLORADO
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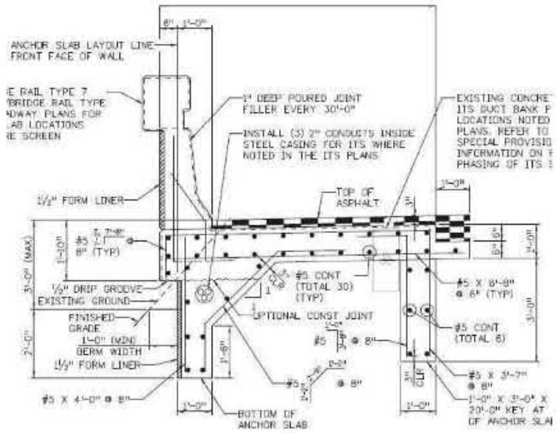
I-70 West Vail Pass Auxiliary Lanes

Proposal 13: Consider anchor slabs for short walls.



Example Anchor Slab Detail

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 13: Consider anchor slabs for short walls.

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 14: Reduce offset of MSE walls from shoulder to reduce height.

Advantages
- Reduces MSE wall height and overall earthwork
- Reduces project footprint
- Saves cost

Disadvantages
- Reduces maintenance access
- May impact SCAP conveyance / collection behind wall

Cost Savings: $2,506,614

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 14: Reduce offset of MSE walls from shoulder to reduce height.

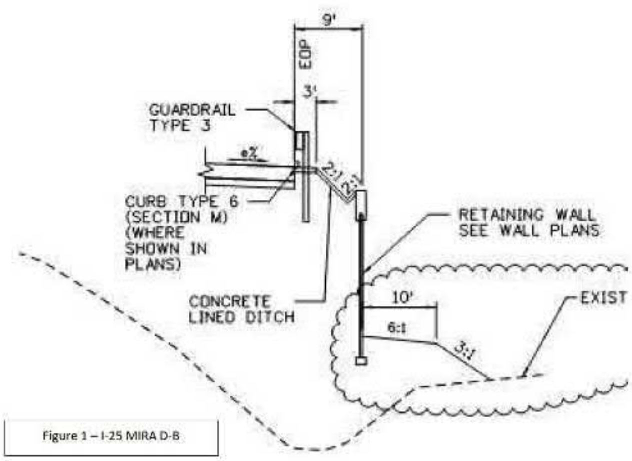


Figure 1 – I-25 MIRA D-8

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I-70 West Vail Pass Auxiliary Lanes

Proposal 14: Reduce offset of MSE walls from shoulder to reduce height.

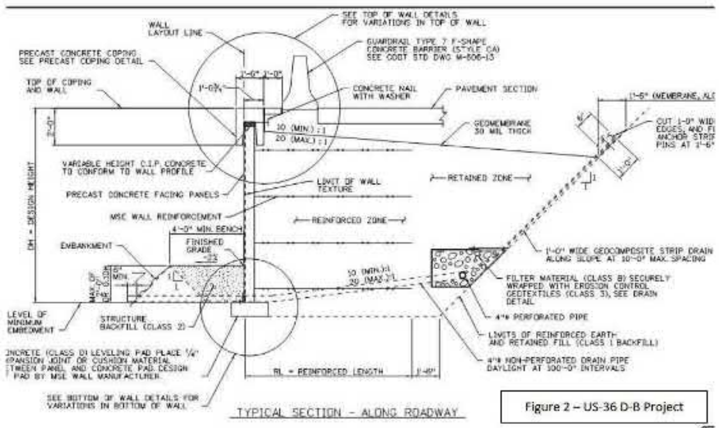

Figure 2 – US-36 D-B Project

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Proposal 14: Reduce offset of MSE walls from shoulder to reduce height.

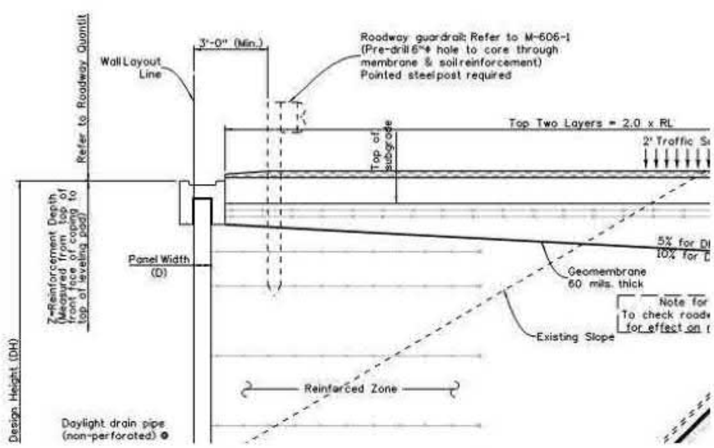

Figure 3 – CDOT Wall Worksheet

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I-70 West Vail Pass Auxiliary Lanes

Proposal 15: Consider use of reinforced soil slope in lieu of retaining walls.

Advantages

- Saves cost over conventional MSE wall
- More natural appearance
- Potential to use existing soil for backfill
- Less vulnerable to differential deflection

Disadvantages

- Requires a larger footprint
- May take more construction time
- More susceptible to erosion

Design Suggestion

COLORADO Department of Transportation
I-70 West Vail Pass Auxiliary Lanes

Proposal 16: Eliminate additional 3' offset to higher cut walls in trail section.

Advantages

- Reduced outside wall height
- Reduced section width
- Reduced footprint and impacts

Disadvantages

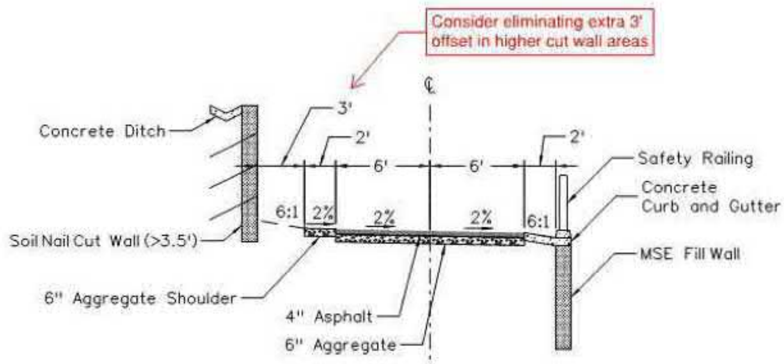
- Possibly less snow storage for trail
- More closed-in feeling to users

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 16: Eliminate additional 3' offset to higher cut walls in trail section.



WVP Rec Path Typical Section
Cut and Fill Walls

COLORADO
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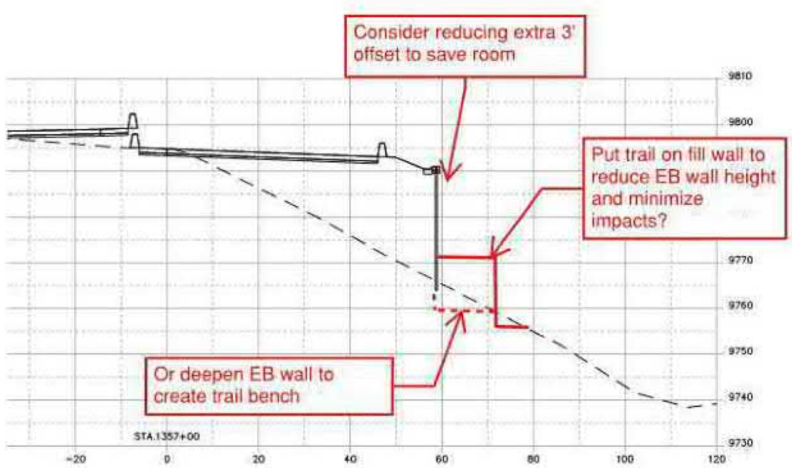
I-70 West Vail Pass Auxiliary Lanes

Proposal 16: Eliminate additional 3' offset to higher cut walls in trail section.



Proposal 17: Look for opportunities to balance earthwork.

Advantages
- Saves cost
- Reduce material haul off

Disadvantages
- May result in modified profiles
- May complicate construction phasing

Design Suggestion

COLORADO
Department of Transportation
I-70 West Vail Pass Auxiliary Lanes

Proposal 18: Keep eastbound and westbound grades consistent to minimize median retaining walls.

Advantages
- Saves median retaining wall cost
- Minimize need for median scalloped walls
- Reduces interior median wall maintenance
- Reduce throwaway by using spoil material

Disadvantages
- Possible cut and fill cost increase
- May complicate phasing
- Impacts median aesthetics if scalloped walls are eliminated

Cost Savings: $672,476

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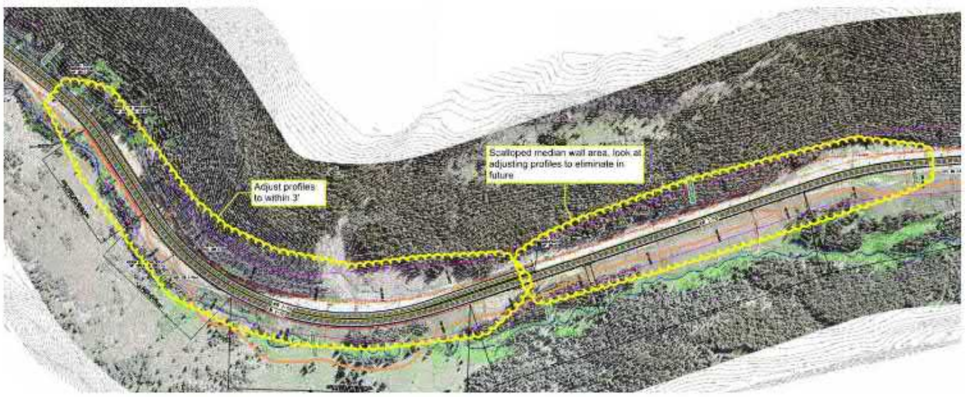
I-70 West Vail Pass Auxiliary Lanes

Proposal 18: Keep eastbound and westbound grades consistent to minimize median retaining walls.



COLORADO
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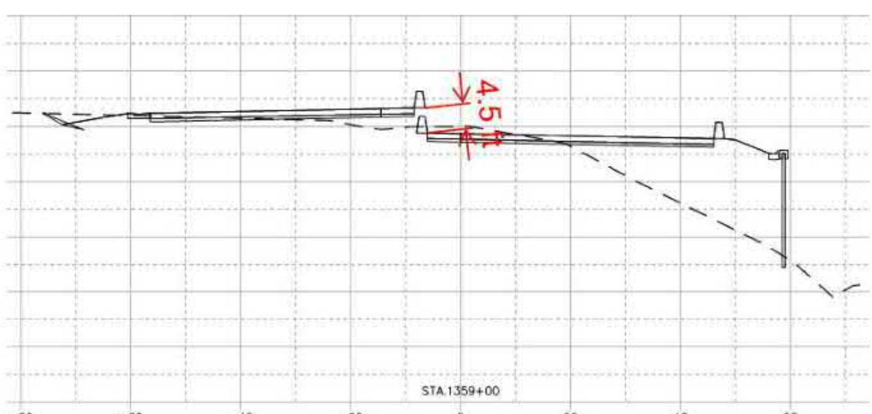
I-70 West Vail Pass Auxiliary Lanes

Proposal 18: Keep eastbound and westbound grades consistent to minimize median retaining walls.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 18: Keep eastbound and westbound grades consistent to minimize median retaining walls.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 19: Incorporate excess excavation as MSE backfill.

Advantages

- Reduces material import and export
- Saves backfill material cost

Disadvantages

- May need more conservative retaining wall design
- Material may not meet backfill requirements

Design Suggestion

Proposal 20: Incorporate additional height into Type 9 barrier .

Advantages

- Accommodates future overlays

Disadvantages

- Adds cost
- Bottom width may increase

Added Cost: $813,112

COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 21: Incorporate type 9 barrier with glare screen.

Advantages

- Reduces glare
- Improves safety
- Incidental noise reduction

Disadvantages

- Adds cost
- Reduces viewshed

Added Cost: $307,581

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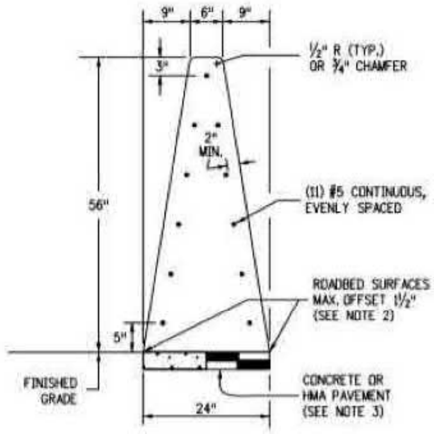
I-70 West Vail Pass Auxiliary Lanes

Proposal 21: Incorporate type 9 barrier with glare screen.



CONCRETE BARRIER STYLE CG (56")

MONOLITHIC CONCRETE GLARE SCREEN/BARRIER

COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 22: Consider a typical construction section wider than minimum required with temporary shoulders.

Advantages

- Improves operations
- Better facilitates emergency response
- Easier transition back to winter season
- Additional shoulder width might be more economical than barrier
- Improves quick response times for injured parties

Disadvantages

- Adds cost
- Potential increase in cuts and fills

Added Cost: $3,765,678

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I-70 West Vail Pass Auxiliary Lanes

Proposal 22: Consider a typical construction section wider than minimum required with temporary shoulders.

Figure 1

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Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 22: Consider a typical construction section wider than minimum required with temporary shoulders.

Figure 2

Proposal 23: Expand interior shoulder from 4' wide to 10' wide (instead of 6') to store disabled vehicle where there is head-to-head traffic with median barrier.

Advantages

- Better disabled vehicle storage
- Frees up another through-lane for emergency response
- Complies with AASHTO guidance

Disadvantages

- Wider roadway section
- Additional cost

Added Cost: $21,476,029

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I-70 West Vail Pass Auxiliary Lanes

Proposal 24: Reduce left shoulder to 4' wide.

Advantages

- Reduces highway footprint and overall project impacts
- Reduces project cost

Disadvantages

- Potential to decrease safety
- Potential loss of snow storage area
- May not meet INFRA Grant typical section

Cost Savings: $10,470,600

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I-70 West Vail Pass Auxiliary Lanes

Proposal 24: Reduce left shoulder to 4' wide.

Expected Safety Performance for CO 6 - Lane Mountainous Freeway with 26,000 AADT*		
Inside Shoulder Width	Total Crashes/mile/year	Fatal and Injury Crashes/mile/year
4 ft	11.67	3
6 ft	11.32	2.9
10 ft	10.65	2.71

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 25: Consider Contech concrete arch-type structures versus concrete box or metal arch.

Advantages
- May satisfy wildlife crossing design
- May reduce cost

Disadvantages
- May change roadway profile

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 25: Consider Contech concrete arch-type structures versus concrete box or metal arch.

CONTECH
ENGINEERED SOLUTIONS

PLATE	PRODUCT	SPAN RANGE
	MULTI-PLATE® & Aluminum Structural Plate (MP & ALSP)	5' to 26'

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 25: Consider Contech concrete arch-type structures versus concrete box or metal arch.

PRECAST		
	CON/SPAN® Bridge Systems O-Series® & B-Series	12' to 65'
	BEBO® Arch Systems	12' to 102'

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 26: Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.

Advantages

- Saves cost

Disadvantages

- May not be appropriately sized
- May require very specific retrofitting measures

Design Suggestion

COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 26: Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 26: Evaluate existing crossings for retrofitting to incorporate wildlife use and or serve multiple purposes.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 27: Reduce size of wildlife crossing structures.

Advantages
- Saves cost
- Reduces roadway icing impacts
- Adds flexibility to maintain roadway profile

Disadvantages
- Commitments already made to sizes
- May reduce wildlife use

Cost Savings: $1,935,019

Proposal 28: Consider lynx in-lieu fee mitigation program.

Advantages
- May reduce need for or number of wildlife crossings
- Reduces construction time
- May provide funding opportunity

Disadvantages
- Requirements of using the in-lieu fee program may not be met
- Cost-benefit to be determined

Design Suggestion

COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 29: Monitor crossing effectiveness and wildlife collisions before committing to fencing as part of Phase 1.

Advantages
- Saves cost
- May be able to shift funding and installation to a future phase or allow for additional Phase 1 construction with saved costs
- Preserves corridor aesthetics

Disadvantages
- Commitment already made to fencing
- Reduced use of crossing structures
- Would not eliminate AVCs

Cost Savings: $1,512,575

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I-70 West Vail Pass Auxiliary Lanes

Proposal 30: Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.

Advantages
- Reduce number of inlets
- Reduce closed storm system quantity
- Saves cost

Disadvantages
- Additional guardrail maintenance
- Additional drainage and sand removal methods may be needed

Cost Savings: $208,070

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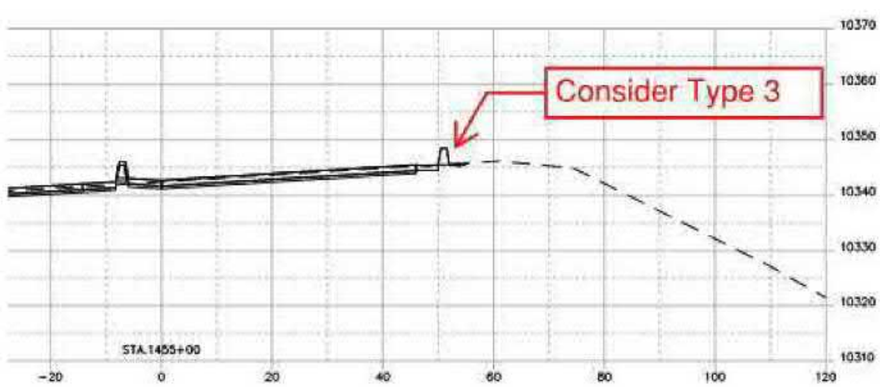
I-70 West Vail Pass Auxiliary Lanes

Proposal 30: Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.



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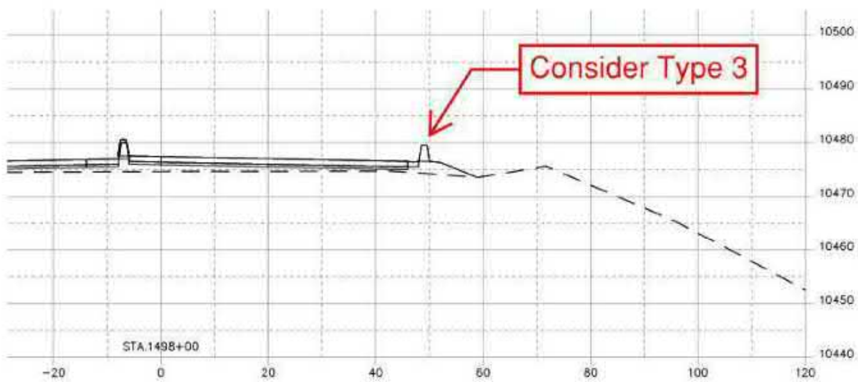
I-70 West Vail Pass Auxiliary Lanes

Proposal 30: Consider using Type 3 metal guardrail in lieu of Type 9 concrete barrier at selected locations.



COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 31: Incorporate alternative bridge de-icing system into design.

Advantages
- Improves safety
- May reduce maintenance

Disadvantages
- Adds cost
- Effectiveness not known

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 32: Consider warm mix asphalt due to remote location.

Advantages

- Increases workability for cooler temperatures
- Expands paving window in terms of temperature
- May enhance compaction leading to better quality

Disadvantages

- Adds cost

Added Cost: $275,097

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 33: Use stone matrix (mastic) asphalt for wearing course.

Advantages

- May be more durable
- Potentially more resistance to tire chain wear
- Has been used in Colorado
- Reduces maintenance

Disadvantages

- Adds cost
- More difficult paving

Added Cost: $761,035

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I-70 West Vail Pass Auxiliary Lanes

Proposal 34: Use unmodified mix in lieu of modified HMA on the trail.

Advantages

- Eliminate more expensive modified binder currently shown
- Modified high-temp binder not needed for light trail traffic
- Can be same asphalt mix proposed for lower paving lifts on roadway

Disadvantages

- None apparent

Cost Savings: $299,795

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I-70 West Vail Pass Auxiliary Lanes

Proposal 35: Propose smart lighting where lighting is needed, i.e. chain up, parking areas, and runaway truck ramp.

Advantages

- Turn on only for chain station operations
- Can be turned on remotely
- Reduces light pollution
- Can turn on by vehicle sensor
- Energy savings
- Lighting levels are adjustable
- Reduces maintenance

Disadvantages

- Requires fiber optic cable to locations for control
- Technology glitches

Design Suggestion

COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 36: Incorporate Smart Work Zone technology for construction.

Advantages

- Improves safety
- Speed limits can be changed and displayed instantly
- Improves traveler information
- Allows for encroachment warning devices
- Scalable per season and other needs

Disadvantages

- Adds cost
- Adds maintenance

Added Cost: $72,372 / month

COLORADO
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I-70 West Vail Pass Auxiliary Lanes

Proposal 36: Incorporate Smart Work Zone technology for construction.

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Proposal 36: Incorporate Smart Work Zone technology for construction.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 36: Incorporate Smart Work Zone technology for construction.

COLORADO
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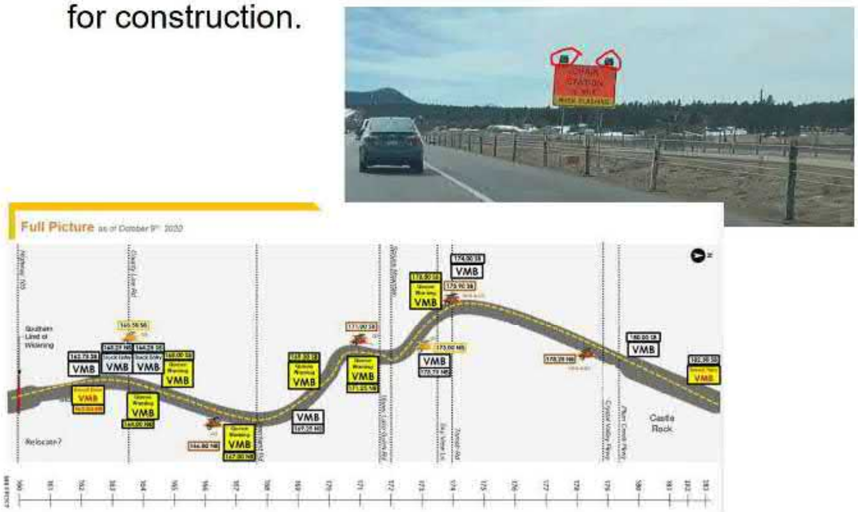
Proposal 36: Incorporate Smart Work Zone technology for construction.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 37: Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.

Advantages

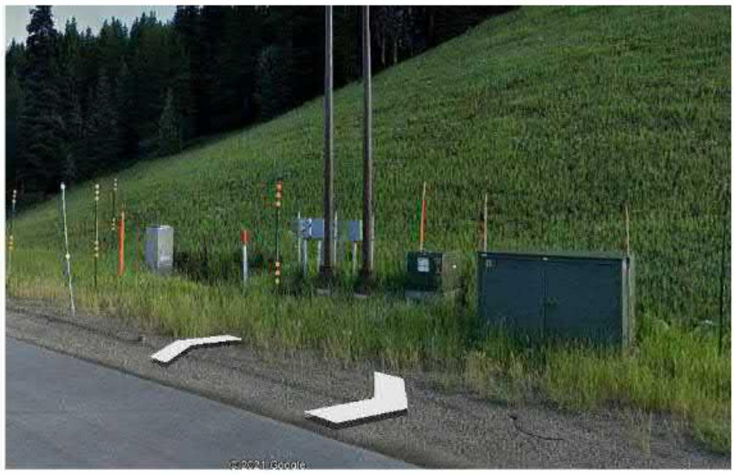
- Improved power reliability for the town and CDOT
- May replace outdated services
- May not increase cost by using the public private partnership CDOT guidelines

Disadvantages

- Additional utility coordination
- Added construction complexity

Design Suggestion

Proposal 37: Incorporate Continuous High Voltage connecting the Top of Vail Pass to the town.



Proposal 38: Incorporate Electronic / Automated powered road closure gates.

Advantages
- Railroads have this technology
- This technology is used in HOV lanes in Denver metro on I-25
- Can be incorporated into smart technology

Disadvantages
- Adds cost
- Potential technology failure
- May need manual override

Added Cost: $1,257,102

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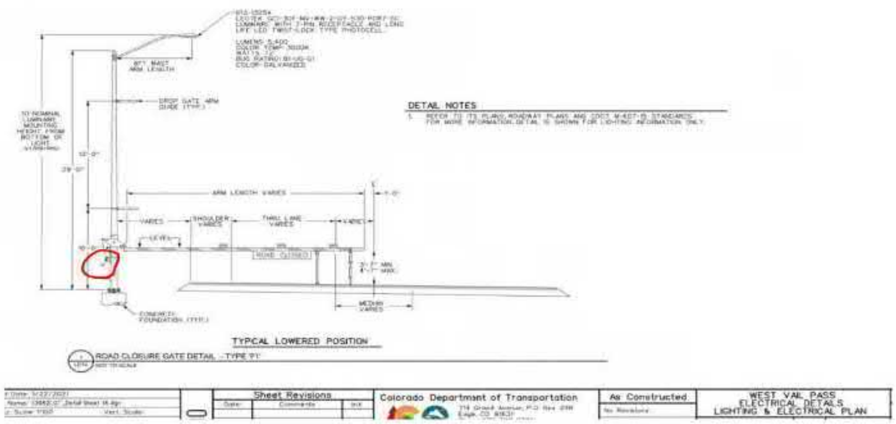
I-70 West Vail Pass Auxiliary Lanes

Proposal 38: Incorporate Electronic / Automated powered road closure gates.



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I-70 West Vail Pass Auxiliary Lanes

Proposal 38: Incorporate Electronic / Automated powered road closure gates.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 38: Incorporate Electronic / Automated powered road closure gates.

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 39: Dispose haul off material in interchange infield areas and grade aesthetically.

Advantages

- Saves cost
- Can be used to enhance aesthetics
- Convenient waste site

Disadvantages

- Wetlands impact
- Could change drainage and grading patterns
- Adds landscape cost
- Could impact sight distance

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 39: Dispose haul off material in interchange infield areas and grade aesthetically.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 39: Dispose haul off material in interchange infield areas and grade aesthetically.

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I-70 West Vail Pass Auxiliary Lanes

Proposal 40: Explore federal or state reforestation grants to offset cost.

Advantages

- May provide additional project funding

Disadvantages

- Application process
- Funding qualifications

Design Suggestion

COLORADO
Department of Transportation

I-70 West Vail Pass Auxiliary Lanes

Proposal 41: Incorporate Programmatic permitting and mitigation strategies.

Advantages

- Saves cost
- Removes environmental from critical path on future phases
- Better mitigation ratios

Disadvantages

- None apparent

Design Suggestion

Maximum Coincident Savings:
Maximum Coincident Cost Added:

The maximum coincidental savings is based upon the sum of the proposals which could be simultaneously implemented.

Not all potential cost increases / savings are additive. Some only apply for a specific alternative.

Example: There are two opposing alternatives proposed related to shoulder width. Only one of the two could be implemented.

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I-70 West Vail Pass Auxiliary Lanes

Implementation Decisions by CDOT:

- Accept
- Accept with Modifications
- Reject
- Hold for Further Consideration

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I-70 West Vail Pass Auxiliary Lanes

Next Steps:

- Delivery of Power Point Slideshow at the conclusion of the presentation
- Delivery of Preliminary Report by Friday, April 16th
- Project Design Team provides review comments and determines the disposition for each proposal
- Delivery of Final Report

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I-70 West Vail Pass Auxiliary Lanes

Questions?