ADAMS & ASSOCIATES

VE Study Report

I-25 Operational Improvements

Colorado Springs, CO

February 2022

FELSBURG HOLT & ULLEVIG
connecting & enhancing communities

COLORADO
Department of Transportation

ADAMS
& ASSOCIATES

COLORADO • OREGON • WASHINGTON

Ginger Adams, Managing Partner
ginger@aallcfacilitators.com

Telephone (970) 266-2696 Office
(970) 222-9505 Mobile

February 24, 2022

Mr. Kevan Kuhnel
Project Manager
Felsburg Holt & Ullevig
3 South Tejon Street, Suite 300
Colorado Springs, CO 80903

Sent via email to kevan.kuhnesl@fhueng.com and Mitchell.holck@state.co.us

Subject: I-25 Operational Improvements, Fillmore to Garden of the Gods
Colorado Springs, CO
VE Study Report

Dear Kevan:

Adams & Associates, LLC is pleased to submit the VE report for the referenced study, conducted 15-18 February 2022 via the WebEx online platform.

We very much appreciate the assistance and cooperation of the design team, customers, and stakeholders who participated in the study, and look forward to the future implementation meeting after the appropriate parties have completed their review of the report.

Should you have any questions, please contact me.

Sincerely,

Ginger Adams

Ginger Adams, IAF™ CPF, CVS®
VE Study Facilitator

cc: Mitch Holck, CDOT Project Manager

Special Notice
I-25 Operational Improvements VE Report
Colorado Springs, CO—February 2022

The contents of this report represent findings by a multidisciplinary team representing bridge, traffic, and construction engineering, water quality, and cost estimating during a 3-1/2–day VE study undertaken from February 15th through 18th via the WebEx online platform.

Decisions related to action taken on any of the VE Proposals or Design Suggestions presented herein are the responsibility of the Colorado Department of Transportation, their stakeholder partners, and their designers, who are ultimately responsible for the contract documents.

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

VE Study Facilitated by

Ginger Adams

Ginger Adams, IAF™-CPF, CVS®
Adams & Associates, LLC

Table of Contents

I-25 Operational Improvements VE Report
Colorado Springs, CO—February 2022

Acronym	Term
CDOT	Colorado Department of Transportation
CPF™	Certified Professional Facilitator
CVS®	Certified Value Specialist®
DS	Design Suggestion
EA	Environmental Assessment
EOPA	Engineer's Opinion of Probable Cost
FAST	Function Analysis System Technique
FHU	Fellsburg Holt & Ullevig
FHWA	Federal Highway Administration
FIR	Field Inspection Review
FS	Further Study
GOG	Garden of the Gods
HDPE	High Density Poly Ethylene
HMA	Hot Mix Asphalt
ITS	Intelligent Transportation Systems
LCC	Life Cycle Cost
MP	Milepost (aka Mile Marker)
NB	Northbound
PPC	Polyester Polymer Concrete
PW	Present Worth
ROW	Right of Way
RTA	Ready to Advertise
SB	Southbound
SHPO	State Historic Preservation Office
TSS	Total Suspended Solids
VE	Value Engineering
VMS	Variable Message Sign

Project Summary

The I-25 Operational Improvements, Fillmore to Garden of the Gods (GOG) is being designed for Colorado Department of Transportation (CDOT) by Fellsburg Holt and Ullevig (FHU) in Colorado Springs. This VE study focused on the Field Inspection Review (FIR) document set, representing approximately 30% design.

I-25, between exits 145 and 146 in Colorado Springs, is currently a 3-lane (6 total) interstate with standard length acceleration and deceleration ramps at each exit. The ultimate design for I-25 in this section of the corridor is 4 through lanes + 1 continuous auxiliary merge lane between exits, in each direction.

This operational improvements project will add continuous auxiliary lanes on both the northbound and southbound sides of I-25 between Fillmore Street and Garden of the Gods Road. It includes reconstruction of the Ellston Street Bridge, replacement of the Intelligent Transportation Systems (ITS) infrastructure, and correction of the superelevation of the curve on I-25.

Additionally, the project will improve various drainage components, bring the roadway and bridge up to current standards, and perform resurfacing and minor rehabilitation (joint replacement) of the GOG Bridge.

This project will accommodate the future ultimate widening of I-25 so that additional work will not be required when that widening occurs.

VE Study Process

The VE study was conducted in accordance with the Value Methodology Job Plan described in the Supplemental VE Information section of this report. The process includes:

- Information Phase – pre-study meeting, gathering and reviewing project documents, and first half day of the VE study
- Function Analysis Phase – defining the project scope in function terms
- Creative Phase – generating ideas without judgment or discussion of their viability
- Evaluation Phase – using project-specific criteria to evaluate the ideas generated in the previous phase
- Development Phase – writing, and estimating as appropriate, the VE proposals and Design Suggestions in sufficient detail to enable informed decisions relative to implementation
- Presentation Phase – presenting the preliminary results of the VE study to stakeholders and decision-makers, followed by this written report containing all the details of the VE study

- Implementation Phase – once the owners, designers, and stakeholders have reviewed this VE report, a meeting will be held to record the decisions related to implementing the VE concepts proposed

More detailed information about each of the above phases may be found in the VE Process section of this report.

An attendance list reflecting all participants throughout the pre-study and study is included in this report. Full time VE team members represented CDOT, the City of Colorado Springs, FHU, and Stanley Consultants.

VE Study Outcomes

The VE team generated 26 creative ideas, of which eight were developed into VE proposals (VEP) or Design Suggestions (DS). VEPs include cost impacts, DSs do not. It is important to note that six of the eight developed concepts would shorten construction time. The financial impact of this reduced construction duration was not quantified in the VE study, but the VE team recommends those impacts be quantified and considered when deciding on what, if any, VE concepts might be incorporated into the project.

As shown on the VEP Implementation Matrix that follows, the net cost impact of the VEPs developed is a cost increase of approximately $90,000.

ADAMS & ASSOCIATES

VE Proposal Implementation Matrix

I-25 Operational Improvements VE Report
Colorado Springs, CO—February 2022

No.	Description	Initial Cost Impact	Present Worth Life Cycle Cost Impact	Total Life Cycle Cost Impact	Implement. Decision	Verified Cost Impact	Comments
Function Name (Copy and paste as needed throughout the matrix.)							
IM-05	Use Polyester Concrete Overlay on the Ellston Bridge	($330,682)	$304,559	($26,123)			Reduces construction time
PC-01	Perform the Joint Replacement on the GOG Bridge Over a Weekend	($65,000)					Reduces construction time
PC-02	Split the Traffic and Put Construction Zone Between Travel Lanes	DS					Reduces construction time
PC-03	Include the Option for a Bridge Launch or Slide for Phasing the Ellston Bridges	DS					Reduces construction time
PC-04	Drive Pile Before the Existing Bridge is Removed	DS					
PC-07	Increase Horizontal Separation Between the Bridges	DS					
PC-09	Increase Longitudinal Joint Thickness and Lift Thickness to Reduce Phasing for Superelevation Correction	DS					Reduces construction time

ADAMS & ASSOCIATES

VE Proposal Implementation Matrix

I-25 Operational Improvements VE Report
Colorado Springs, CO—February 2022

No.	Description	Initial Cost Impact	Present Worth Life Cycle Cost Impact	Total Life Cycle Cost Impact	Implement. Decision	Verified Cost Impact	Comments
PC-11	Close the NB Fillmore On-Ramp Temporarily During Construction	DS					Reduces construction time
	Initial Cost Avoidance		**$304,559**	**$304,559**			
	Initial Cost Increase	**($395,682)**		**($395,682)**			
	Net Initial Cost Impact	**($395,682)**	**$304,559**	**($91,123)**			

Description

Use Polyester Concrete Overlay on the Ellston Bridge

Functions Addressed

Improve Maintainability

Baseline Design Concept

The planned approach is to use a deck overlay material.

VE Proposed Concept

Use Polyester Polymer Concrete (PPC) in lieu of waterproofing membrane and Hot Mix Asphalt (HMA).

Benefits

- Fewer maintenance cycles over life of bridge
- Reduced impact to traveling public for maintenance
- Faster construction
- PPC service life is 30 years

Challenges

- Requires specialized equipment for placement
- Requires specialized contractor qualifications
- Roadways to north and south of bridge would still require HMA maintenance

Cost Summary	Initial Cost	Present Worth LCC Cost	Total Life Cycle Cost
Baseline Design Assumption	$95,459	$639,518	$734,977
Proposed Change	$426,142	$334,959	$761,101
Total (Baseline Less Proposed)	**($330,682)**	**$304,559**	**($26,124)**
			COST INCREASE

Discussion/Justification

The current design has utilized a traditional 3 inches of HMA over a waterproofing membrane. This requires repaving every 5 years, and complete removal and replacement of the waterproofing membrane every 20 years.

A typical design life of a bridge is 100 years. In that time, the bridge would be milled and repaved 15 times, and complete replacement of membrane and all 3 inches of asphalt would occur 4 times before the bridge is replaced.

The PPC overlay does not need replacement for 30 years. This design requires more up-front costs and requires specialized equipment to place. It can only be placed by qualified personnel and a manufacturer's representative is required to be present.

With a 100-year design life, the PPC would only need to be replaced 3 times before the bridge would be replaced.

For the baseline deck overlay, cyclical maintenance would average 4 full days of one-lane closures every 5 years, and 2 weeks of half-bridge closures every 20 years. For the proposed PPC option, only 4 one-night closures would be required every 30 years.

This would significantly reduce "construction fatigue" on the part of the traveling public. For comparison, the baseline would require 116 total days of closure over 100 years and the proposed PPC would require 6 days over 100 years.

Although this maintenance analysis applies to the bridge itself, the HMA roadways to the north and south of the bridge will still require the same type of maintenance as the baseline approach. Thus, the benefits are negligible.

Sketch of Baseline—Membrane Placement

Sketch of Baseline—HMA Placement

Sketch of Proposed—PPC Placement

Estimator Assistance

PPC costs

519-03035 Place Thin Bond Overlay (Polyester Concrete)	$55 /SY
519-03055 Furnish Thin Bond Overlay (Polyester Concrete)	$145 /SY
Total / SY	$200 /SY
Replaced 3 times over life of Bridge	

Total cost of PPC over life of bridge = $800 / SY

Traditional HMA overlay costs

403-34871 HMA (Grading SX) (100) (PG 76-28)	$120 /ton
3” of HMA is 0.164 tons/sq yd	(~$20 /SY)
515-00120 Waterproofing Membrane	$25 /SY
Total initial cost / SY	$45 /SY
202-00246 removal of Asphalt Mat	$25 /SY
403-34871 HMA (Gradinf SX) (100) (PG 76-28)	$120 /ton
2” of HMA is 0.109 tons/sq yd	(~$13/SY)
Total repaving cost / SY	$38 /SY
Repaved 15 times over life of Bridge	
202-00246 removal of Asphalt Mat	$25 /SY
403-34871 HMA (Gradinf SX) (100) (PG 76-28)	$120 /ton
3” of HMA is 0.164 tons/sq yd	(~$20 /SY)
515-00120 Waterproofing Membrane	$25 /SY
Total membrane replacement cost / SY	$70 /SY
Replaced 4 times over life of Bridge	

Total cost of HMA over life of bridge = $895 / SY

ALL TOTALS ASSUME 100 YEAR LIFE CYCLE

ADAMS & ASSOCIATES

VE Proposal IM-05—Initial Cost Impacts

Use Polyester Concrete Overlay on the Ellston Bridge

I-25 Operational Improvements VE Report

Colorado Springs, CO—February 2022

		Baseline Design Concept			VE Proposed Concept		
Description	**Unit**	**Qty.**	**Cost Per Unit**	**Total**	**Qty.**	**Cost Per Unit**	**Total**
STONE MATRIX ASPHALT (ASPHALT) (POLYMER MODIFIED)	TON	233	$120.00	$27,960			
WATERPROOFING (MEMBRANE)	SY	1,412	$25.00	$35,300			
PLACE THIN BONDED OVERLAY (POLYESTER CONCRETE)	SY				1,412	$55.00	$77,660
FURNISH THIN BONDED OVERLAY (POLYESTER CONCRETE)	SY				1,412	$145.00	$204,740
Subtotal				$63,260			$282,400
Composite Mark-Up	50.9%			$32,199			$143,742
TOTAL				$95,459			$426,142
				Cost Increase			-$330,682

	Facility Service Life (Yrs)	100	Discount Rate	1.70%	**Baseline**	**Proposed**
A. Initial Cost					$95,459	$426,142
	Service Life—Baseline	20		**Baseline Less Proposed**		**($330,683)**
	Service Life—Proposed	30				**Initial Cost Increase**

B. Recurrent Cost *(Annual Expenditures; Operations and Maintenance Cost)*

	Expenditure Description	Notes and/or Calculations	Baseline	Proposed
1				
		Total Annual Cost	$0	$0
		Present Worth Annuity (PWA) Factor	47.9228	16.8349
		Present Worth of Recurrent Cost	**$0**	**$0**

C. Single Expenditures *(Replacement Cost)*

B	P	←	Expenditure Description	Year	Cost	PW Factor	Baseline Present Worth	Proposed Present Worth
			Place "x" in appropriate box below (**B**=Baseline, **P**=Proposed).					
x		1	Stone Matrix Asphalt (Polymer Modified)	5	$27,960	0.9192	$25,700	$0
x		5	Asphalt Milling	5	$35,300	0.9192	$32,447	$0
x		3	Stone Matrix Asphalt (Polymer Modified)	10	$27,960	0.8449	$23,623	$0
x		5	Asphalt Milling	10	$35,300	0.8449	$29,824	$0
x		5	Stone Matrix Asphalt (Polymer Modified)	15	$27,960	0.7766	$21,713	$0
x		5	Asphalt Milling	15	$35,300	0.7766	$27,413	$0
x		7	Stone Matrix Asphalt (Polymer Modified)	20	$27,960	0.7138	$19,958	$0
x		5	Asphalt Milling	20	$35,300	0.7138	$25,197	$0
x		8	Waterproofing Membrane	20	$35,300	0.7138	$25,197	$0
x		9	Stone Matrix Asphalt (Polymer Modified)	25	$27,960	0.6561	$18,345	$0
x		5	Asphalt Milling	25	$35,300	0.6561	$23,161	$0

			Facility Service Life (Yrs)	100	Discount Rate	1.70%	Baseline	Proposed
x		11	Stone Matrix Asphalt (Polymer Modified)	30	$27,960	0.6031	$16,862	$0
x		5	Asphalt Milling	30	$35,300	0.6031	$21,289	$0
x		13	Stone Matrix Asphalt (Polymer Modified)	35	$27,960	0.5543	$15,499	$0
x		5	Asphalt Milling	35	$35,300	0.5543	$19,568	$0
x		15	Stone Matrix Asphalt (Polymer Modified)	40	$27,960	0.5095	$14,246	$0
x		5	Asphalt Milling	40	$35,300	0.5095	$17,986	$0
x		16	Waterproofing Membrane	40	$35,300	0.5095	$17,986	$0
x		17	Stone Matrix Asphalt (Polymer Modified)	45	$27,960	0.4683	$13,095	$0
x		5	Asphalt Milling	45	$35,300	0.4683	$16,532	$0
x		19	Stone Matrix Asphalt (Polymer Modified)	50	$27,960	0.4305	$12,036	$0
x		5	Asphalt Milling	50	$35,300	0.4305	$15,196	$0
x		21	Stone Matrix Asphalt (Polymer Modified)	55	$27,960	0.3957	$11,063	$0
x		5	Asphalt Milling	55	$35,300	0.3957	$13,968	$0
x		23	Stone Matrix Asphalt (Polymer Modified)	60	$27,960	0.3637	$10,169	$0
x		5	Asphalt Milling	60	$35,300	0.3637	$12,839	$0
x		24	Waterproofing Membrane	60	$35,300	0.3637	$12,839	$0
x		25	Stone Matrix Asphalt (Polymer Modified)	65	$27,960	0.3343	$9,347	$0
x		5	Asphalt Milling	65	$35,300	0.3343	$11,801	$0

			Facility Service Life (Yrs)	100	Discount Rate	1.70%	**Baseline**	**Proposed**
x		27	Stone Matrix Asphalt (Polymer Modified)	70	$27,960	0.3073	$8,592	$0
x		5	Asphalt Milling	70	$35,300	0.3073	$10,847	$0
x		29	Stone Matrix Asphalt (Polymer Modified)	75	$27,960	0.2824	$7,897	$0
x		5	Asphalt Milling	75	$35,300	0.2824	$9,970	$0
x		30	Stone Matrix Asphalt (Polymer Modified)	80	$27,960	0.2596	$7,259	$0
x		5	Asphalt Milling	80	$35,300	0.2596	$9,164	$0
x		31	Waterproofing Membrane	80	$35,300	0.2596	$9,164	$0
x		32	Stone Matrix Asphalt (Polymer Modified)	85	$27,960	0.2386	$6,672	$0
x		5	Asphalt Milling	85	$35,300	0.2386	$8,424	$0
x		32	Stone Matrix Asphalt (Polymer Modified)	90	$27,960	0.2193	$6,133	$0
x		5	Asphalt Milling	90	$35,300	0.2193	$7,743	$0
x		33	Stone Matrix Asphalt (Polymer Modified)	95	$27,960	0.2016	$5,637	$0
x		5	Asphalt Milling	95	$35,300	0.2016	$7,117	$0
	x	34	Place Thin Bonded Overlay (Polyester Concrete)	30	$77,660	0.6031	$0	$46,835
	x	35	Furnish Thin Bonded Overlay (Polyester Concrete)	30	$204,740	0.6031	$0	$123,474
	x	36	Place Thin Bonded Overlay (Polyester Concrete)	60	$77,660	0.3637	$0	$28,245
	x	37	Furnish Thin Bonded Overlay (Polyester Concrete)	60	$204,740	0.3637	$0	$74,464
	x	38	Place Thin Bonded Overlay (Polyester Concrete)	90	$77,660	0.2193	$0	$17,034

			Facility Service Life (Yrs)	100	Discount Rate	1.70%	**Baseline**	**Proposed**
	x	39	Furnish Thin Bonded Overlay (Polyester Concrete)	90	$204,740	0.2193	$0	$44,907
							$639,518	**$334,959**
E. Life-Cycle Cost (B+C+D)							**$639,518**	**$334,959**
							Baseline Less Proposed	**$304,559**
								LCC Cost Avoidance
Total Life-Cycle Cost (A+B+C+D)								
							$734,977	**$761,101**
							Baseline Less Proposed	**($26,124)**
								Total LCC Cost Increase

Description

Perform the Joint Replacement on the Garden of the Gods (GOG) Bridge Over a Weekend

Functions Addressed

Phase Construction

Baseline Design Concept

Remove 243 linear feet of the existing expansion device and replace it with 243 linear feet of bridge expansion device (0-4 Inch) at both northbound (NB) and southbound (SB) GOG Bridge on Interstate 25. This work (remove and replace) will be performed at night, one lane at a time.

VE Proposed Concept

Perform removal and replacement of bridge expansion joint for both NB and SB GOG Bridge over a weekend.

Benefits

- Increases quality of the work
- Allows for other work to be done concurrently
- Eliminates weekday night work and associated noise
- Reduces the construction duration
- Reduces maintenance

Challenges

- Requires lane closure variation from the Region Traffic Engineer
- Requires major public Information outreach effort

Cost Summary			Initial Cost
Baseline Design Assumption			$95,459
Proposed Change			$426,142
Total (Baseline Less Proposed)			**($330,682)**
			COST INCREASE

Discussion/Justification

The current design is based on building one lane at a time for expansion device removal and replacement for both NB and SB I-25 at GOG Bridge. The contractor needs to coordinate and prepare for removal and installation of this work on both the south and north ends of each lane, since the bridge has two expansion joints. This work would typically be done Sunday through Thursday nights, requiring that the lanes must be opened to traffic every morning, and three though lanes in each direction must be open.

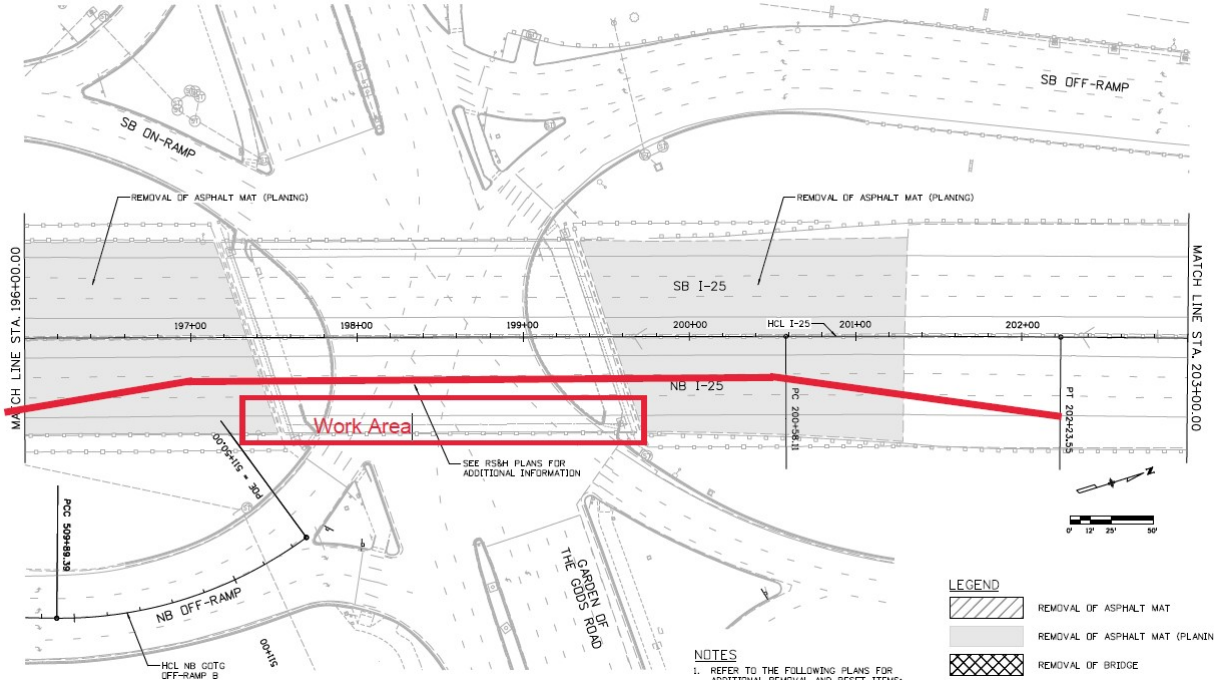
The coordination and preparation include removing the concrete header and expansion joint itself, placing half-inch expansion joint materials, installing new expansion joint, and placing high early strength concrete at the header. This process must be repeated until the entire length of the expansion joints are done. Since there are three through lanes and inside and outside shoulders, this portion of the work will take a minimum of 10 days. There are possibilities for compromised quality. For example, there will be several construction joints in the header and welding joints of expansion joints where they can break off.

Performing removal and replacement of expansion joints over a weekend makes good sense. With placement of both NB and SB traffic on either NB or SB, depending on which side the contractor is working, the contactor can pull all their resources to complete the work over the weekend. This method would reduce the maintenance cycle of header and the expansion joint itself, reduce the construction duration by more than 20 days, and more likely result in smoother transitions from the roadway to the bridge.

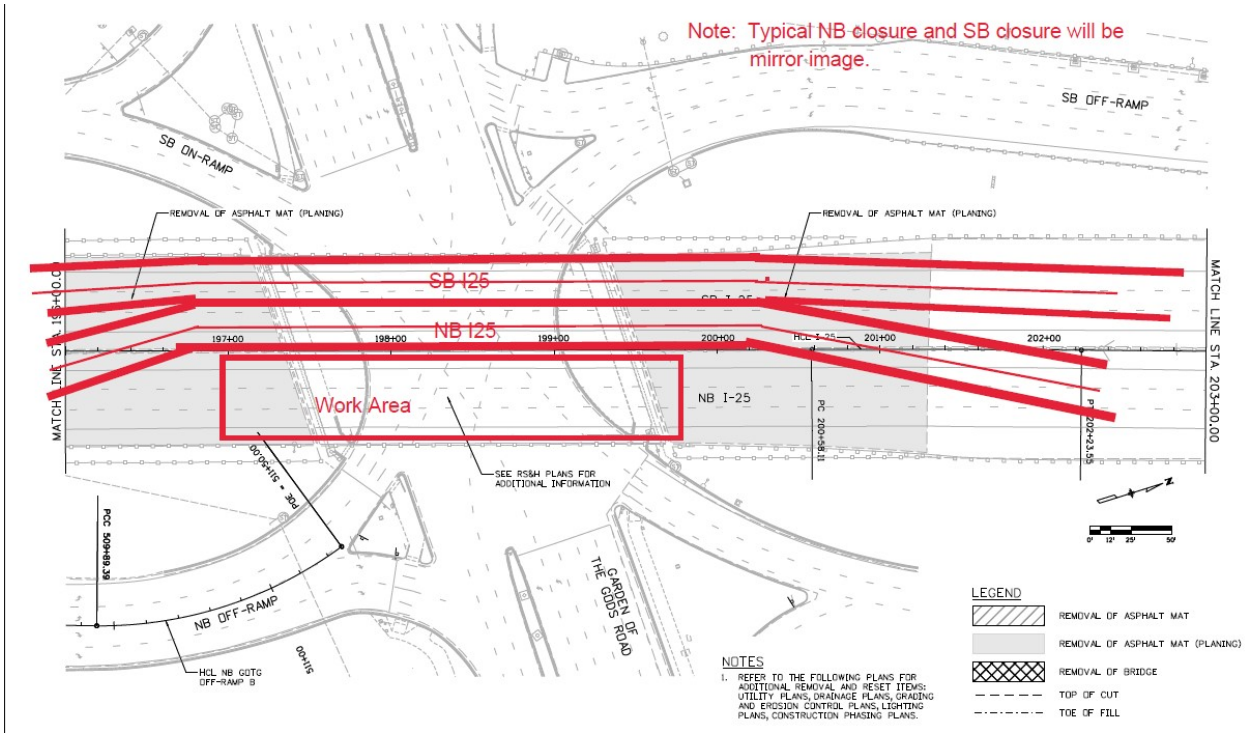
This type of roadway closure has been used at US 24 Rockfall Mitigation Project where both directions of traffic were placed on either eastbound (EB) or westbound (WB) while the work occurred. There were no accidents, and the method reduced the construction duration by 20%. Since this work occurs on each end of the bridge, the contractor can also perform removal of hot mix asphalt (HMA), waterproofing membrane, and placement of new HMA concurrently. This would save even more time.

This proposed approach would take place over two weekends and is highly recommended by the VE team.

Sketch of Baseline—Typical Single Lane Closure



Sketch of Proposed Change—Typical Crossover for Bridge Work



Estimator Assistance

Extra Items or increase in qty:

Removal of Median Barrier: $50/LF

Removal of Tensioned Cable Barrier: $20/LF

HMA or HMA (Patching): $175/Tons, needed south side of the bridge

Removal of Pavement Marking: $2/SF

Pavement Marking Paint (High Build): $50/Gal

Removal of Asphalt Mat: $10/SY, after work is done

Impact Attenuator (Temporary): $5000/EACH

Barricade (Type 3 M-B) (Temporary): $400/EACH

Guardrail Type 7 (Style CA?): $300/LF

*Note: There will be misc. items that need to be used. Such as construction signs, drums, VMS, arrow boards, and etc.

VE Proposal PC-01—Initial Cost Impacts

Perform the Joint Replacement on the GOG Bridge Over a Weekend

I-25 Operational Improvements VE Report
Colorado Springs, CO—February 2022

		Baseline Design Concept			VE Proposed Concept		
Description	**Unit**	**Qty.**	**Cost Per Unit**	**Total**	**Qty.**	**Cost Per Unit**	**Total**
REMOVAL OF ASPHALT MAT	SY				100	$5.00	$500
REMOVAL OF PAVEMENT MARKING	SF				2,000	$2.00	$4,000
REMOVAL OF MEDIAN BARRIER	LF				80	$50.00	$4,000
REMOVAL OF TENSIONED CABLE BARRIER	LF				80	$20.00	$1,600
HOT MIX ASPHALT (PATCHING) (ASPHALT)	TON				25	$175.00	$4,375
GUARDRAIL TYPE 7 (STYLE CA)	LF				80	$200.00	$16,000
PAVEMENT MARKING PAINT (HIGH BUILD)	GAL				20	$50.00	$1,000
BARRICADE (TYPE 3 M-B) (TEMPORARY)	EACH				4	$400.00	$1,600
IMPACT ATTENUATOR (TEMPORARY)	EACH				2	$5,000.00	$10,000
Subtotal							$43,075
Composite Mark-Up	50.9%						$21,925
TOTAL							$65,000
				Cost Increase			-$65,000

Description

Split the Traffic and Put Construction Zone Between Travel Lanes

Functions Addressed

Phase Construction

Baseline Design Concept

Construction phasing and construction traffic control are currently based on set-up and take-down of traffic control devices between day and night work, limiting the time actual work may be performed.

VE Proposed Concept

Split traffic lanes in the same flow direction (northbound [NB] or southbound [SB]) to allow for work zones that can be left open for multiple days or weeks. This may include staying on the current side of the roadway or splitting a lane off into the opposing travel direction side of the highway, for example, pulling one SB lane into the western edge of the NB direction and separating by barrier.

Benefits

- Increases productivity
- Reduces construction duration

Challenges

- Frequent lane shifts reduce driver expectancy

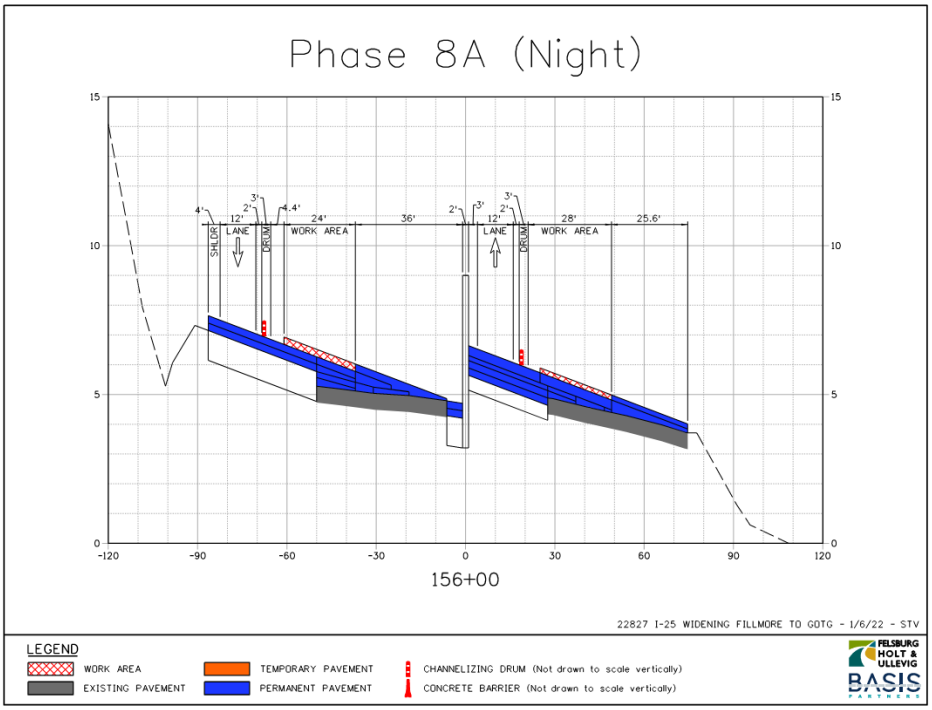
DESIGN SUGGESTION

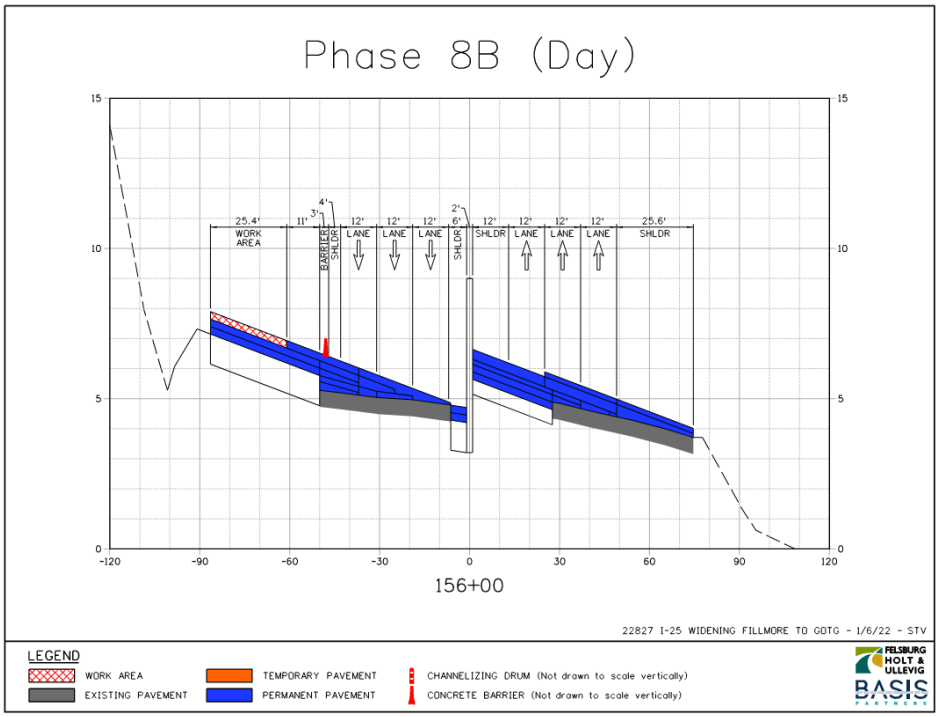
Discussion/Justification

The current approach for the superelevation correction in the FIR Plan Set Construction Phasing Plans requires challenging and time-consuming shifts in the traffic control devices between day and night work. The night shift is controlled by CDOT's lane closure policy and will be limited to approximately 10:00 p.m. to 5:00 a.m. Productivity during night work will be limited to the small window after devices are set up and before they need to be taken down to reopen for morning traffic. As a result, we are proposing to split the traffic lanes to open work areas for extended periods of time and minimize the resetting of traffic control devices.

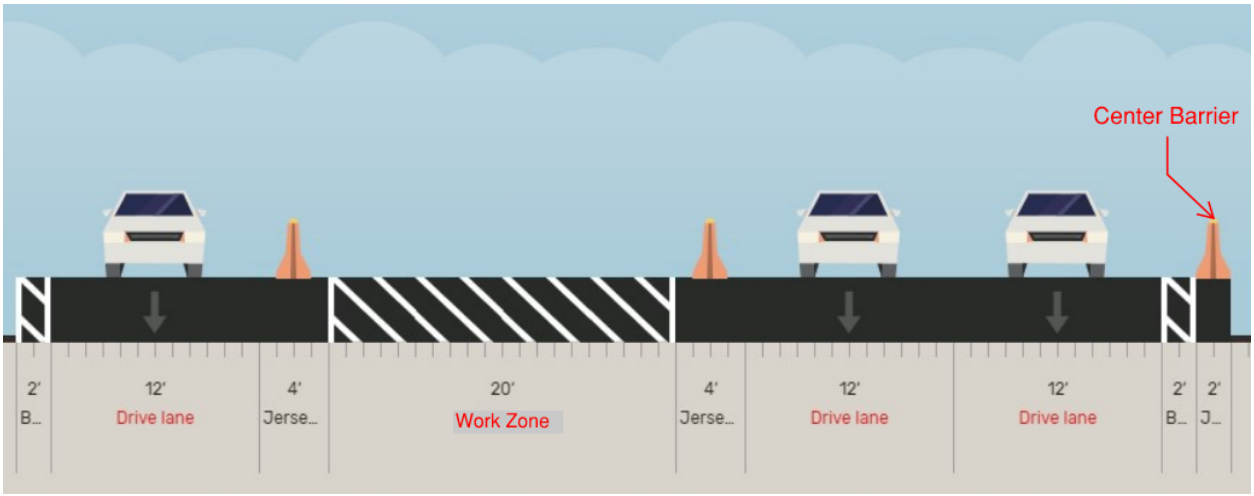
The proposed approach is frequently used on projects and would be beneficial in areas requiring a superelevation correction, specifically the full-depth replacement areas. Full-depth pavement replacement isn't feasible to accomplish in a single overnight operation and open the next day to traffic. Allowing the contractor to keep a work area open for multiple days or weeks will enable them to spend less time shifting traffic patterns and associated traffic control devices, thereby increasing productivity and reducing the construction duration.

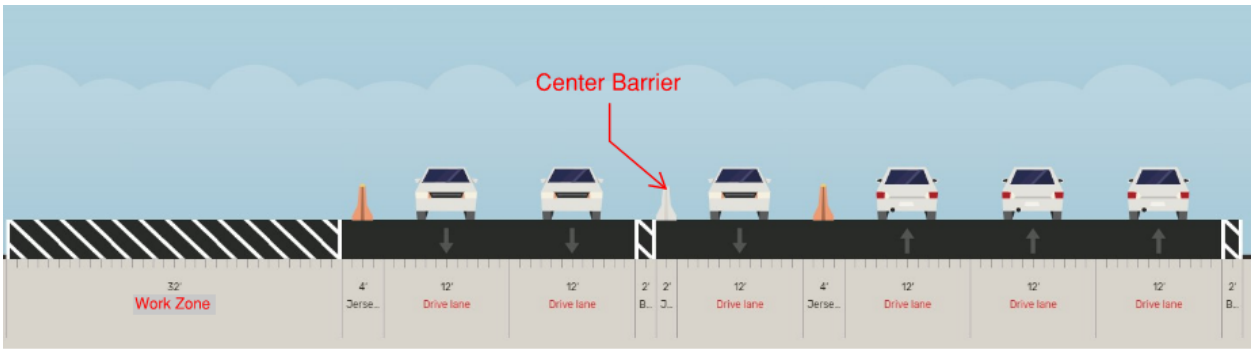
Sketch of Baseline—Current Super Correction Phase 8 (Night and Day)





Sketch of Proposed Change—Cross Section Examples





Description

Include the Option for a Bridge Launch or Slide for Phasing the Ellston Bridges

Functions Addressed

Phase Construction

Baseline Design Concept

The planned approach is to use phased construction for the construction of the Ellston Bridges.

VE Proposed Concept

Allow the contractor to use a bridge slide or other form of offsite bridge construction by encouraging innovation in the advertisement for construction.

Benefits

- Improves the constructability of the site
- Reduces project duration
- Separates worksite from traffic

Challenges

- Space for off-alignment construction is limited
- Increases bridge complexity
- Requires temporary foundations
- Accelerated methods of roadway construction may limit feasibility

DESIGN SUGGESTION

Discussion/Justification

Slide-in bridge construction consists of building a new bridge on temporary supports, equipped with rails, parallel to the proposed finished location of the existing bridge. Once the new bridge is entirely constructed, and the existing bridge is demolished, the new bridge slides into its proposed final position. The slide-in process has been completed within two days or, in some cases, within twelve hours. In some cases, the bridge is slid multiple times to accommodate different phases of roadway construction. Bridges can even be lifted for grade changes in later phases.

Using a conventional bridge construction technique requires removing the west ten feet of the existing structure. Using a slide-in method, this step can be eliminated. Slide-in bridge construction allows traffic flow by keeping the existing bridge open to users, while the new bridge-building occurs. Allowing traffic flow is the most significant advantage compared to conventional bridge construction. Slide-in bridge construction builds the replacement bridge on a temporary support structure. Some replacement bridges are built off-site and shipped to the temporary support location. The contractor builds the substructure and the new superstructure simultaneously. In some cases, the abutment is also built under the existing bridge.

Typically, the demolition and removal are strategically planned during times of lesser traffic volume. For example, projects have used slide-in bridge construction over a night on the weekend. After placement of the new bridge, the superstructure is ready to be connected with the roadway by installing waterproofing membranes, approach slabs, and paving the surface. The bridge is opened to traffic once the connection is complete. Slide-in bridge construction is a solution to site conditions that have limited alternative routes, and high traffic or freight volumes.

Slide-in bridge construction could reduce interaction between travelers and workers, reducing the potential for work zone accidents.

One of the differences between conventional bridge construction and slide-in bridge construction is temporary supports, which could increase project cost. The temporary structure also requires sufficient space and right-of-way (ROW) to construct the replacement bridge.

This option was considered previously and discarded since the design team could not find an appropriate use of this technique. The VE team agrees with the initial findings, but also believes it is important that the construction contract not preclude the contractor from proposing a bridge launch/slide. We recommend including language in the advertisement that encourages innovation.

Sketch of Baseline—Conventional Construction Example

Sketch of Proposed Change—Bridge Slide Example

Description

Drive Pile Before the Existing Bridge is Removed

Functions Addressed

Phase Construction

Baseline Design Concept

The proposed FIR design depicts the existing bridges over Ellston Street being razed prior to driving pile for new abutments.

VE Proposed Concept

Allow the contractor to drive pile for the proposed bridges adjacent to and under the existing bridge, prior to removal.

Benefits

- Allows the contractor greater latitude in scheduling
- Work can be completed independent of other items
- Would not disrupt flow of traffic on I-25

Challenges

- Requires specialty equipment
- Increases risk
- Necessitates work being performed in a “confined” space
- Actual pile driving will take longer
- Not a normal construction practice

DESIGN SUGGESTION

Discussion/Justification

To minimize the impact on traffic and allow the contractor greater flexibility in scheduling, it may be desirable to consider driving piles prior to the demolition of the existing I-25 bridges over Ellston Street. Traditional pile-driving for a bridge replacement would take place after the roadway has been closed to traffic and the bridge deck removed. The piers of the existing bridge are 59 feet from center to center. The proposed abutments are 70 feet from center to center. Therefore, the proposed piles will be driven 5.5 feet behind each of the existing piers. ***Figure 1*** shows the existing bridge configuration with approximate location of the proposed abutment piles.

This project is recommending the use of H-piles, which are very common in Colorado for this type of construction. H-piles can be driven with one of three different types of drivers: hammer, hydraulic press, or vibratory. Since this proposal would allow driving piles under the existing active bridge, the contractor would need to use specialty equipment for use in a confined space. It is not likely that a hammer-type driver will work, so the necessary equipment that can fit under the existing bridge would need to be hydraulic or vibratory. Examples of each are depicted in ***Figures 2 and 3***.

Most DOTs require a minimum pile length of 40 feet or greater without a splice. CDOT Staff Bridge would need to work closely with the contractor to work out the details. After excavation behind the existing piers, the available headroom will be approximately 16 to 18 feet. This dictates that the pile driver must be small, and segments of pile will likely not be longer than 8 feet.

It is anticipated that bedrock is approximately 25 feet below Ellston, so the contractor will be required to make 3-4 splices. ***Figure 4*** shows an example of placing pile under an existing bridge.

Pile drivers are specialty subcontractors and are in very high demand. Allowing for the potential to drive piles at almost any time in a schedule provides the general contractor a great deal of flexibility. For this specific case, driving pile prior to shifting traffic and demolishing the existing bridges would provide added time to construct the proposed southbound lanes and bridge. It would also likely eliminate the need for mobilizing the pile-driving crew more than one time.

This method of construction has been used successfully in the past for CDOT on the Bronco Bridge in Denver. Although there are many risks and challenges inherent to this proposed construction method, the benefit of limiting mobilizations and greater flexibility is a tool that many contractors would likely entertain.

The cost implications to this proposal are much more intangible than quantifiable. There will likely be cost increases to drive pile adjacent to and under a bridge with live traffic. This will be due to the need for specialized equipment, working in tight locations, risk associated with working adjacent to live traffic, and risks of working under a bridge with live traffic.

Benefits to the project cost will primarily be derived from allowing the contractor a greater window for pile driving, and the potential for only one mobilization.

Figure 1: Existing I-25 Bridge Over Ellston

Figure 2: Vibratory Hammer

Figure 3: Hydraulic Press

Figure 4: Under-Bridge Construction

Description

Increase Horizontal Separation Between the Bridges

Functions Addressed

Phase Construction

Baseline Design Concept

Reconstruct the northbound (NB) and southbound (SB) I-25 bridges over Ellston Street, maintaining approximately 2 feet of separation between them.

VE Proposed Concept

Modify the design to create a greater separation between the proposed NB and SB bridges.

Benefits

- Allows the contractor greater space in which to work
- Provides greater separation of workspace from traveling public
- Adds ambient light under the bridges
- Improves maintenance access

Challenges

- May impact other design features such as drainage or right-of-way (ROW)
- Will require changes to the alignment and/or profile
- May impact construction phasing

Discussion/Justification

The current design plans show a two-foot separation between the proposed I-25 bridges over Ellston Street. It has been discussed that this minimal clearance will make it difficult to construct the bridges in phases, which is needed to stage construction for this project. ***Figure 1*** on the following page depicts a portion of the proposed typical section for the bridges.

The construction phasing of this project dictates that the SB I-25 bridge must be constructed prior to the NB bridge. This will allow for the placement of all traffic lanes on the SB bridge while the northbound lanes and bridge are constructed. During this phase of construction, the outside northbound lane will only be two feet away from the bridge rail. From the temporary northbound edge line to the edge of the proposed northbound bridge, there is only 5.5 feet.

There are several inherent concerns associated with the proposed construction of the bridges as proposed. Most bridge decks are placed through the use of a Bid-Well or similar paving machine (see ***Figure 2***). Depending on the orientation of the paver, the machine needs from 18” to six feet of overhang. Either way, it will be scraping the southbound bridge rail or overhanging it into the traffic lane.

The contractor will typically utilize one of two methods for constructing the concrete bridge rail: a slip-form paver or setting forms. Using a slip-form paver, as shown in ***Figure 3***, will be tight, but does not allow for any wiggle room. Setting forms would be all but impossible with only a two-foot clearance (***Figure 4***).

Upon completion of casting the bridge rails, a mortar wash and finish must be applied to the concrete. This will prove very difficult, even if one lane of traffic is closed on the adjacent bridge.

Only 2 feet of separation would make it difficult to maintain the bridge rails. A 5-foot clearance will allow for much easier access from below.

An added benefit of greater separation is extra ambient lighting under the bridge for pedestrians and drivers. Even an extra three feet will allow for a great deal of additional light.

The only drawbacks to creating greater separation between the proposed bridges are all related to design. Since the design is still in the preliminary phase, making the modifications now should have minimal impact.

Ultimately, the benefits to separating the bridges to at least a five-foot separation greatly outweigh the design changes necessary.

The cost implications to this proposal are much more intangible than quantifiable. There could be minor cost increases related to design, but there will be savings on the contractor side by allowing for greater ease of construction.

Figure 1: Baseline Bridge Separation

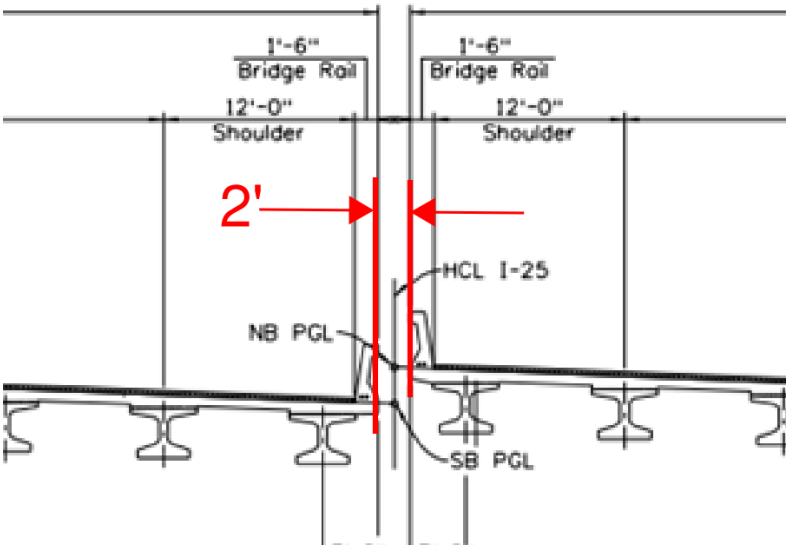


Figure 2: Bid-Well Paving Machine

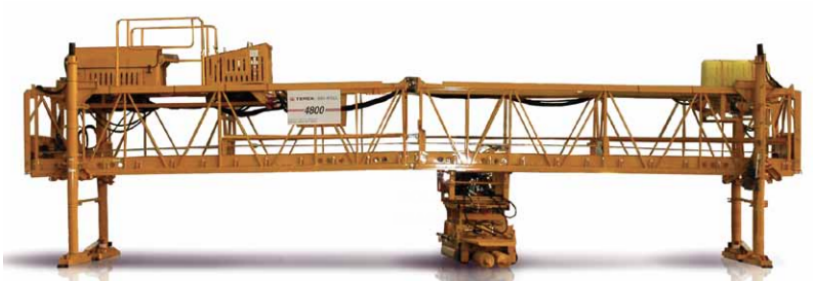


Figure 3: Slip Form Paver

Figure 4: Setting Forms

Description

Increase Longitudinal Joint Thickness and Lift Thickness to Reduce Phasing for Superelevation Correction

Functions Addressed

Phase Construction

Baseline Design Concept

The superelevation correction on the major curve in the project requires significant addition of pavement thickness to the existing roadway. This additional thickness will be paved in adjacent runs along the length of the curve and must be constructed in lifts to achieve proper compaction.

VE Proposed Concept

Increase the design thickness of both the pavement lifts and the temporary longitudinal joints during construction within the superelevation correction area.

Benefits

- Reduces number of phases and traffic pattern reconfigurations
- Adds contractor flexibility
- Reduces construction duration
- Results in more consistent cross slopes
- Fewer pavement joints could increase quality
- Improves durability

Challenges

- Maintaining a reasonable limit to the thickness of the longitudinal pavement joint
- Thicker pavement lifts can cause compaction issues and should be carefully engineered prior to implementation
- Adding extra thickness may not increase overall volumetric production rates, and the daily length of paving runs may actually shorten due to the additional thickness

DESIGN SUGGESTION

Discussion/Justification

Parts of the work zone on this project must be reopened to traffic on designated through lanes during daytime hours. As a result, in areas where the superelevation is being corrected, there will be longitudinal joints between pavement runs and lifts, running parallel to and within 1 foot of temporary lane lines. The current (30% design) phasing proposal is to limit the thickness of longitudinal joints to the proposed pavement lift thickness of 3 inches. To reach the proposed pavement depth for superelevation correction could require at least 12 traffic reconfigurations/phases.

This project should benefit from a minimum increase to 4 inches for temporary longitudinal pavement joints *and* lift thicknesses, as this would be a theoretical 33% increase for thickness installed per lift and between traffic reconfigurations. This could eliminate extra paving phases and reduce the number of joints in the pavement structure, thereby improving the durability of the roadway.

CDOT Standard Specifications (401.16) allow for temporary longitudinal pavement joints during construction under the following two conditions (and at the approval of the Engineer):

(1) When the thickness of the pavement course being placed is 1.5 inches or less a vertical exposed longitudinal joint may be constructed.

(2) When the thickness of the pavement course being placed is greater than 1.5 inches the joint shall be constructed according to one of the following:

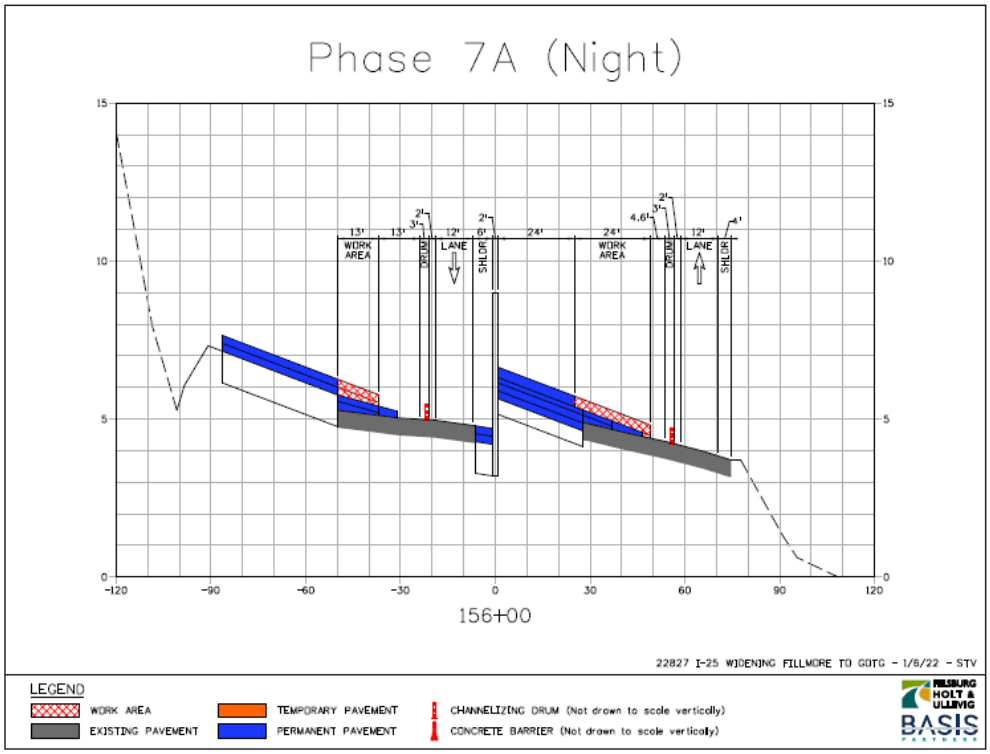
1. *The entire joint shall be tapered 3:1 or flatter. A Taper steeper than 3:1 shall be considered vertical.*
2. *The top portion of the longitudinal joint may be vertical. The vertical portion shall be a maximum of 1.5 vertical inches. The remainder of the joint, below the vertical portion, shall be tapered 3:1 or flatter.*

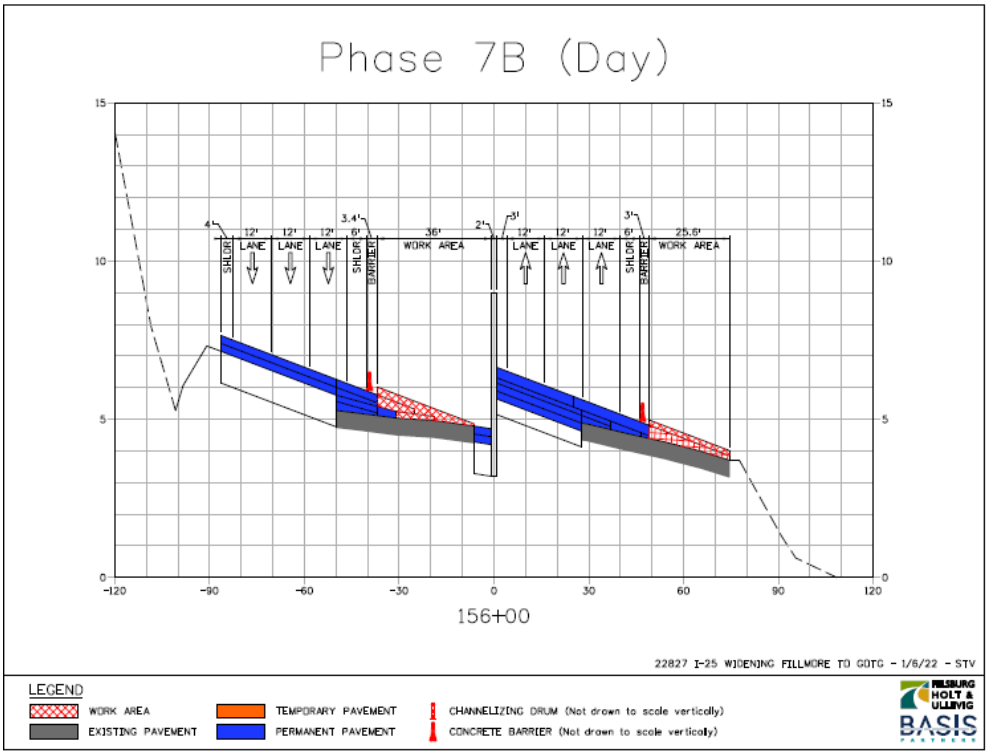
Obviously, there is a reasonable limit to the height of a temporary longitudinal joint, and for every extra inch of thickness beyond 1.5 inches, the joint width must also increase by 3 inches in taper – so there is a point where this becomes prohibitive, simply due to the amount of width required for the taper.

The current paving plan calls for longitudinal joint thickness of 3 inches and other projects have gone further. It would be ideal for the proposed joint thickness to align with the design lift thickness (1x or 2x), so either a 4-inch (1x4” lift) or 6-inch (2x3” lift) joint thickness seem reasonable. Going beyond a 6-inch joint thickness may cause the taper width of the longitudinal joint to encroach too far into adjacent lane space and would potentially create a non-traversable joint.

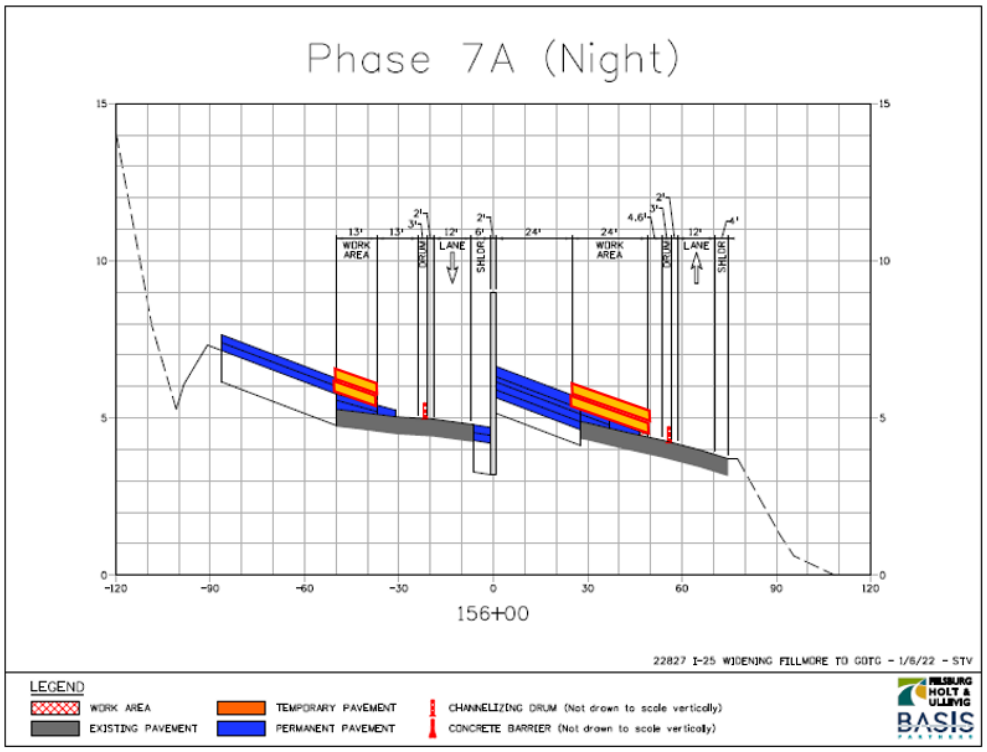
Four-inch pavement lifts are used on other CDOT projects, and the project team is already evaluating the HMA mix design for the superelevation correction. Modifications to lift thickness could be reviewed in tandem with that work. Production rates are calculated in total daily tonnage depending on the paving layout. While extra thickness may potentially shorten daily paving runs, it is also possible that the section of superelevation is already short enough that each longitudinal run can be done in a single day regardless of the thickness increase.

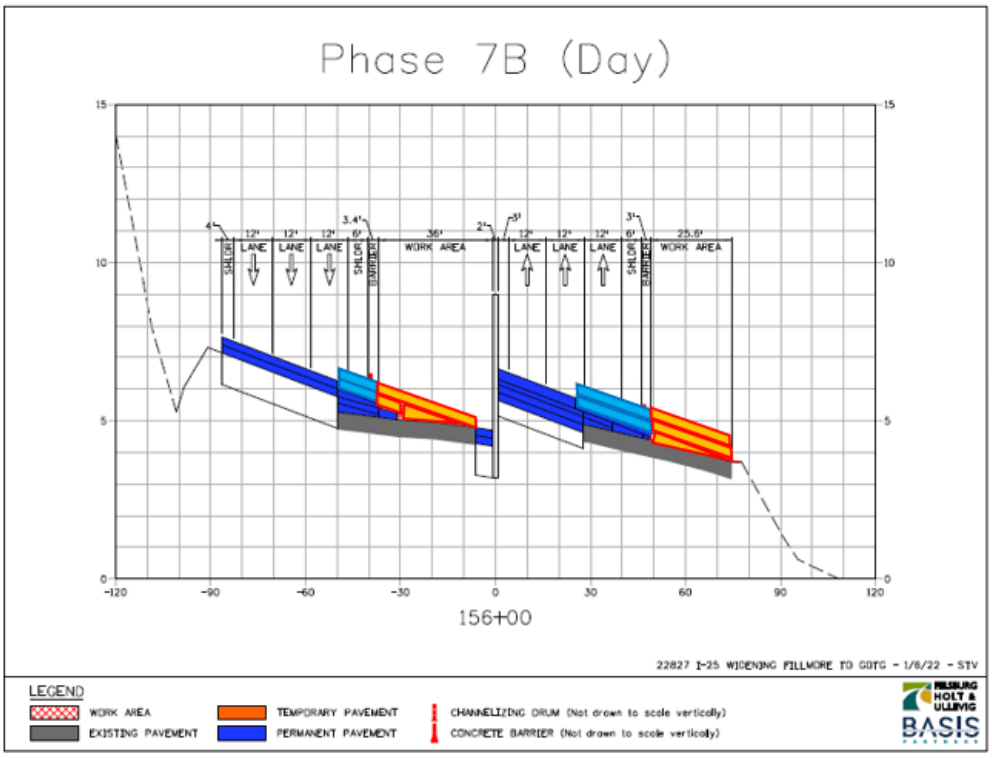
Sketch of Baseline





Sketch of Proposed Change





Description

Close the Northbound (NB) Fillmore On-Ramp Temporarily During Construction

Functions Addressed

Phase Construction

Baseline Design Concept

Maintain the NB on-ramp at Fillmore with a crossover placed at the appropriate distance to allow for a safe merge condition.

VE Proposed Concept

Close the NB on-ramp and place the crossover further south.

Benefits

- Reduces number of construction phases
- Simplifies the superelevation correction for NB I-25
- Improves construction quality

Challenges

- Requires adequate detours
- Requires significant public messaging

DESIGN SUGGESTION

Discussion/Justification

Moving the crossover further south would open the full width of I-25 North for superelevation correction, pipe crossings, and other construction activities. One of the primary constraints to the proposed crossover location is accommodating the merging traffic from the NB Fillmore on-ramp prior to the crossover. Closing the ramp would eliminate this constraint and allow the contactor flexibility in construction phasing.

Being able to construct the full width of NB I-25 without traffic would improve the quality and production rate and reduce the overall project schedule. Additionally, the widening of the NB Fillmore on-ramp and relocation of the ramp metering signals could be completed during the ramp closure. This would eliminate work occurring adjacent to moving traffic on the ramp and shorten the duration of time it would take to complete ramp construction.

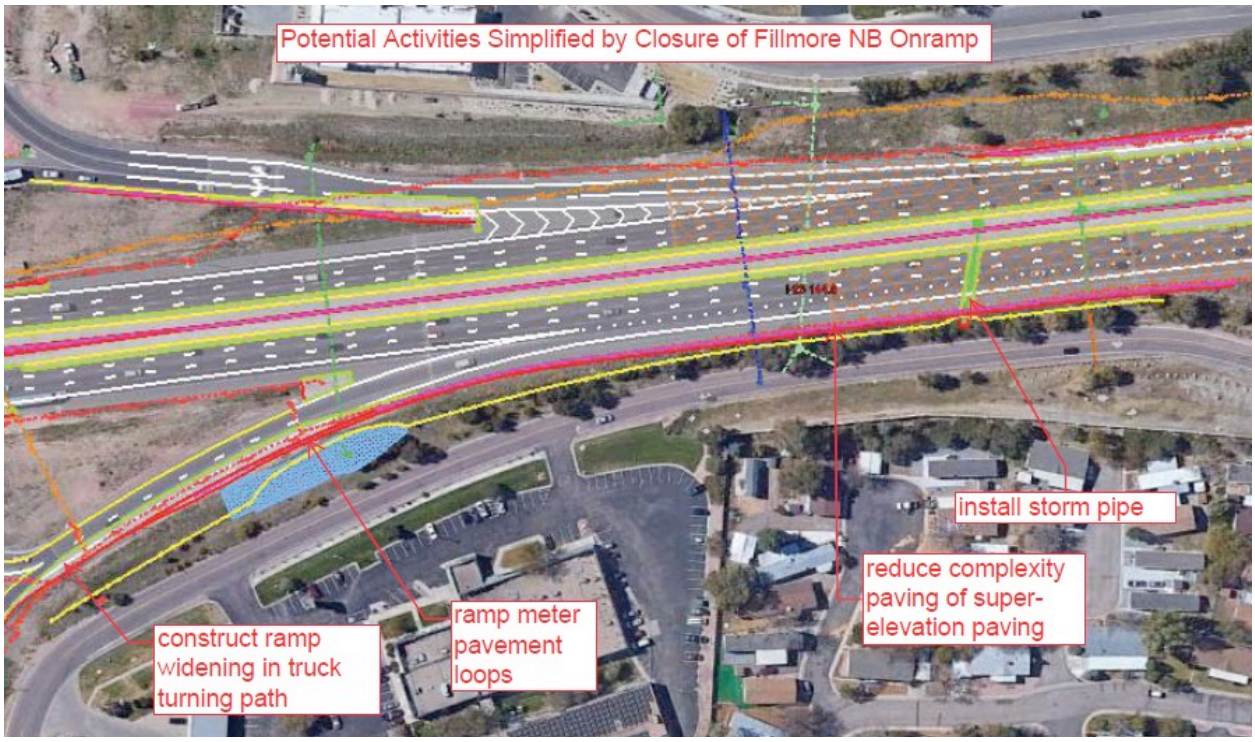
The detours required by the ramp closure could include North Nevada Avenue to the east and Centennial Blvd. to the west. See sketches on the following page. Variable message signs will be needed to inform the public of the closure several weeks in advance and throughout the closure.

Duration of the ramp closure would need to be submitted by the contractor to the City and CDOT for approval. The anticipated duration would be around two weeks.

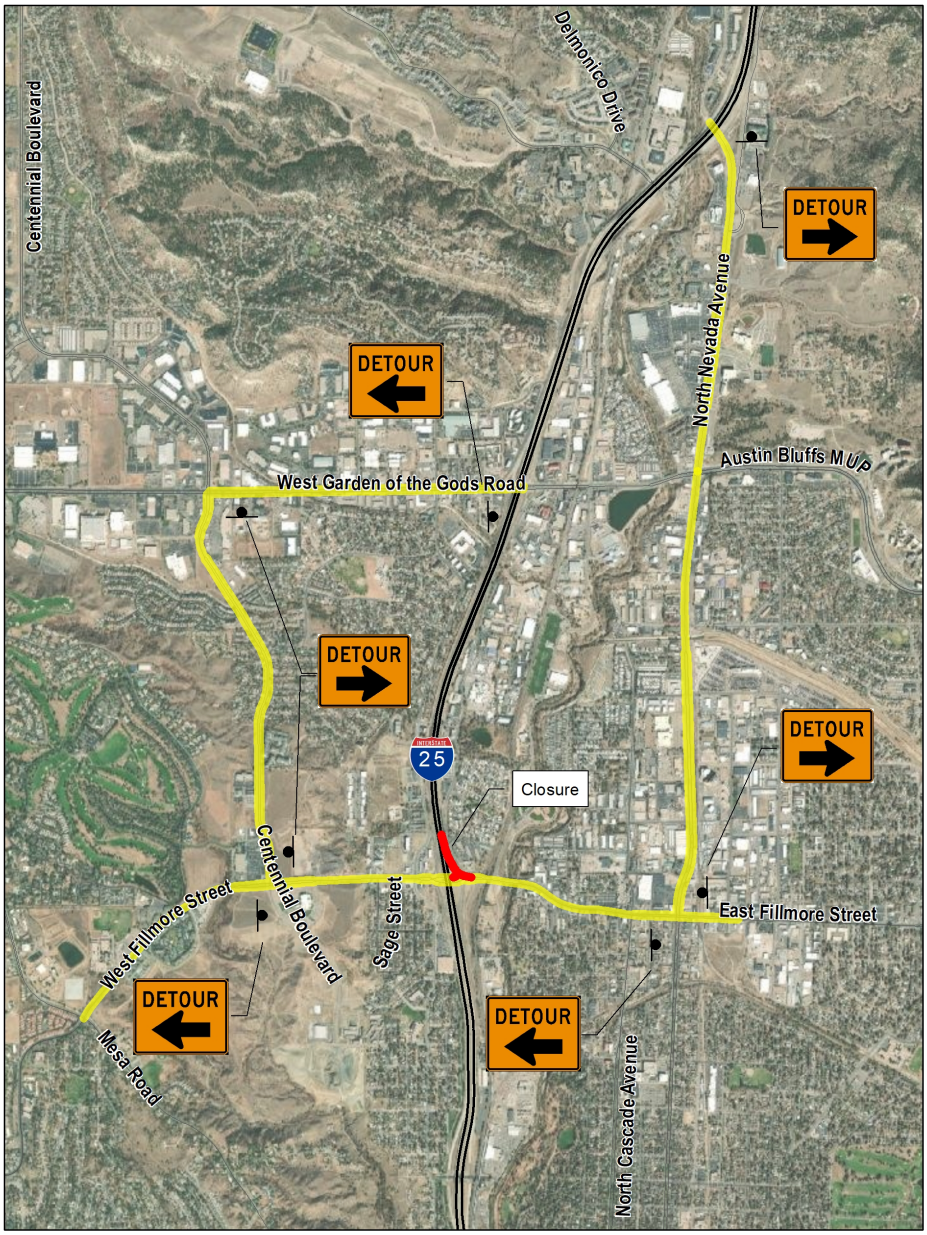
We have seen similar closures utilized between CDOT and the City if the design team or contractor can prove the benefits. An example would be the Powers and Research Interchange.

It is assumed a two-week closure of the NB Fillmore on-ramp could save approximately 1.5 months of construction time for the project.

Sketch of Activities Simplified by Proposal



Sketch of Proposed Detours



Project Description

Background

I-25, between exits 145 and 146 in Colorado Springs, is currently a 3-lane (6 total) interstate with standard length acceleration and deceleration ramps at each exit. The ultimate design for I-25 in this section of the corridor is 4 through lanes + 1 continuous auxiliary merge lane between exits, in each direction.

Project Description

Current traffic volumes and patterns indicate the need for the addition of the continuous auxiliary merge lane in order to ease congestion, however the final 4-lane through-traffic configuration is not yet required. The existing overpass structure at Ellston St. (MP 145.2) will need to be fully reconstructed, including expansion to the full width of the ultimate design for the corridor in order to avoid an additional expansion when the ultimate design is eventually constructed. The Intelligent Transportation Systems (ITS) infrastructure will be replaced within the project area. Additional scope items include, but are not necessarily limited to:

- Correcting the superelevation of the curve on I-25
- Expanding capacity of the Fillmore northbound on-ramp
- Bringing the roadway and Ellston Bridge up to standards
- Various drainage improvements
- Bringing the roadway and bridge up to current standards
- Resurfacing and minor rehabilitation (joint replacement) of the Garden of the Gods (GOG) Bridge

Project Goals, Objectives, and Key Drivers

VE Study Goals and Objectives

The VE study employs the Value Methodology Job Plan to optimize the overall value of the project and to ensure that the functional requirements of the stakeholders are appropriately addressed. Significant project elements to be addressed, as presented by CDOT, included improved safety, higher level of service (LOS), bridge replacement, and resurfacing, restoration, and rehabilitation of the roadway.

Constraints

Constraints identified included:

- Superelevation correction is fixed, non-negotiable
- Method of widening has been decided
- Environmental implications – Environmental Assessment (EA) reevaluation has progressed; we can't do anything that would restart the process
- Must maintain 3 lanes of traffic in each direction during construction

Risks

Risks identified included:

- Impacts to the biking community
- Design schedule has been reduced to 14 months
- Right of Way impacts
- Environmental Impacts — there are two warehouses on the east side of I-25 subject to State Historic Preservation Office (SHPO) review; they're not designated historical, but they do qualify
- Construction Phasing/Project Schedule

Critical Assumptions

- Project will be in construction by end of 2022
- PS&E due in August, Ready to Advertise (RTA) Sept. 20, 2022
- Funding is allocated, but not budgeted

Key Observations

During the review of project documents and the inbrief meeting on the first morning of the VE study, the team members made the following observations:

- There are a high number of wildlife strikes on this part of I-25. There is an incidental wildlife crossing at Ellston, and this project is taking steps to make it more intentional. Ellston is low volume and deer use the trail, so funneling them to the underpass should work. Deer trail will not be seeded. Construction can not create a camping space under the bridge.

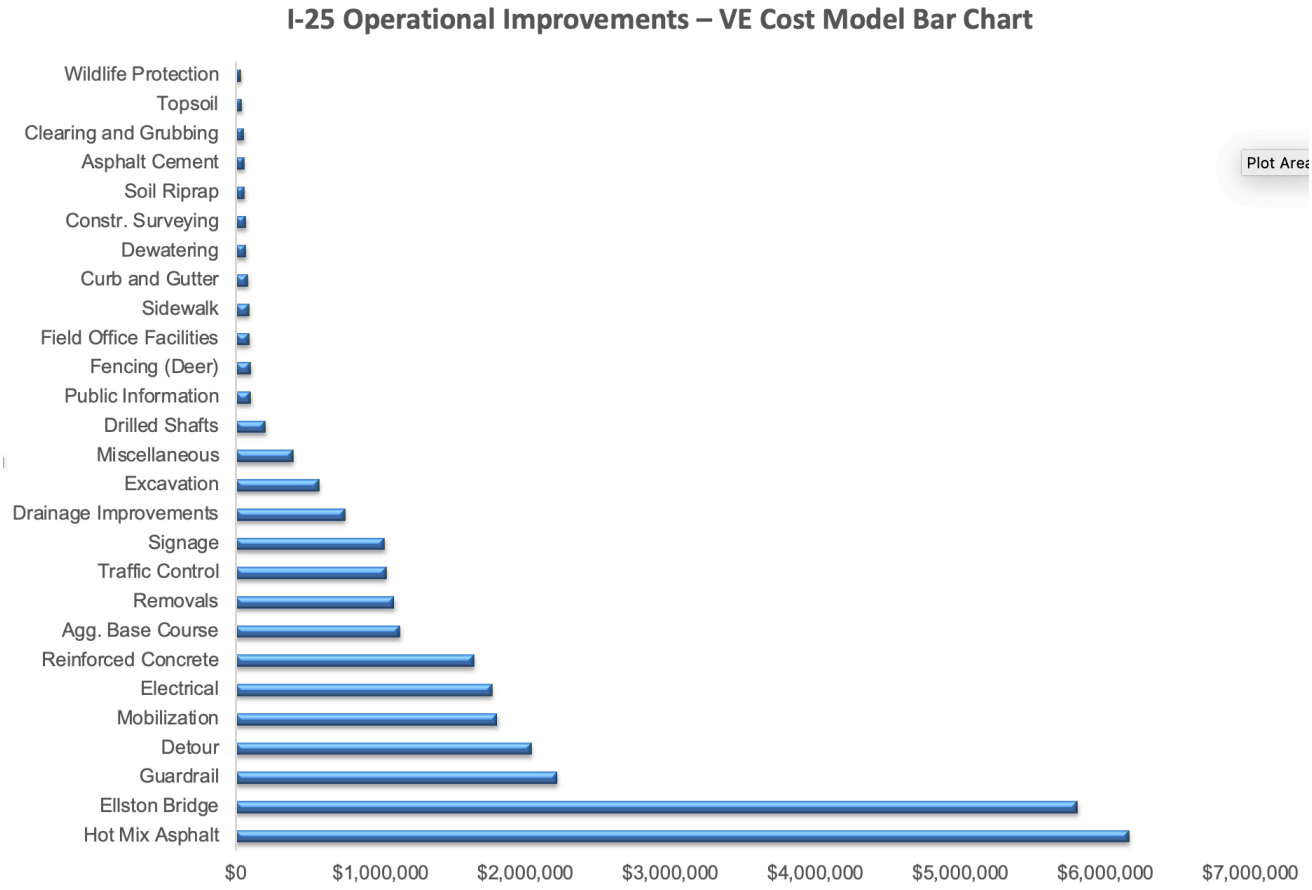
- Filmore northbound onramp: don't want to do a throwaway, but try to find ways to make it better. Will need further improvement in future I-25 widening.
- Filmore southbound onramp: new ponds will better manage total suspended solids (TSS). When retrofitted, a micro pool will exist just before the outlet, such that the trash rack prevents water from entering the system.
- GOG bridge is a single bridge for both northbound and southbound; will require phasing
- This is a congested corridor, even throughout the day, making daytime work a challenge—need construction phasing. It is congested with commercial traffic at night.
- Planning to use steel barrier, which is easily moved during phasing, allowing moving in and out of construction zones overnight. Also allows phasing in lane takes. This gets into means and methods, as contractor will own/lease them. If contractor has a more creative phasing strategy, that's also an option. Current CDOT spec requires a temporary barrier, either Jersey type or steel
- Added GOG scope impact on phasing hasn't been evaluated as yet

Summary of Cost Estimate, Cost Model

The 30% Engineer's Opinion of Probable Cost (EOPC) provided by FHU is summarized below. A VE cost model following the estimate summary reflects how the costs within the estimate break down.

Category	Amount
Clearing and Grubbing	$50,000
Removals (Asphalt, Pavement, Drainage Devices, ITS Infrastructure, Lighting)	$1,089,251
Excavation	$571,344
Topsoil	$37,200
Dewatering	$65,000
Wildlife Protection (Migratory Birds)	$28,320
Agg. Base Course	$1,127,725
Hot Mix Asphalt	$6,156,335
Asphalt Cement	$53,445
Drilled Shafts	$200,950
Soil Riprap	$55,695
Reinforced Concrete	$1,639,655

Category	Amount
Drainage Improvements	$749,100
Guardrail	$2,213,667
Fencing (Deer)	$98,355
Sidewalk	$86,850
Curb and Gutter	$81,196
Delineator (Fiber Optic)	$1,200
Electrical	$1,764,066
Signage	$1,021,950
Field Office Facilities	$91,000
Detour	$2,035,000
Constr. Surveying	$65,000
Mobilization	$1,800,000
Public Information	$100,000
Traffic Control	$1,035,000
Ellston Bridge	$5,801,354
Miscellaneous	$392,533
TOTAL CONSTRUCTION BID ITEMS	**$28,411,191**

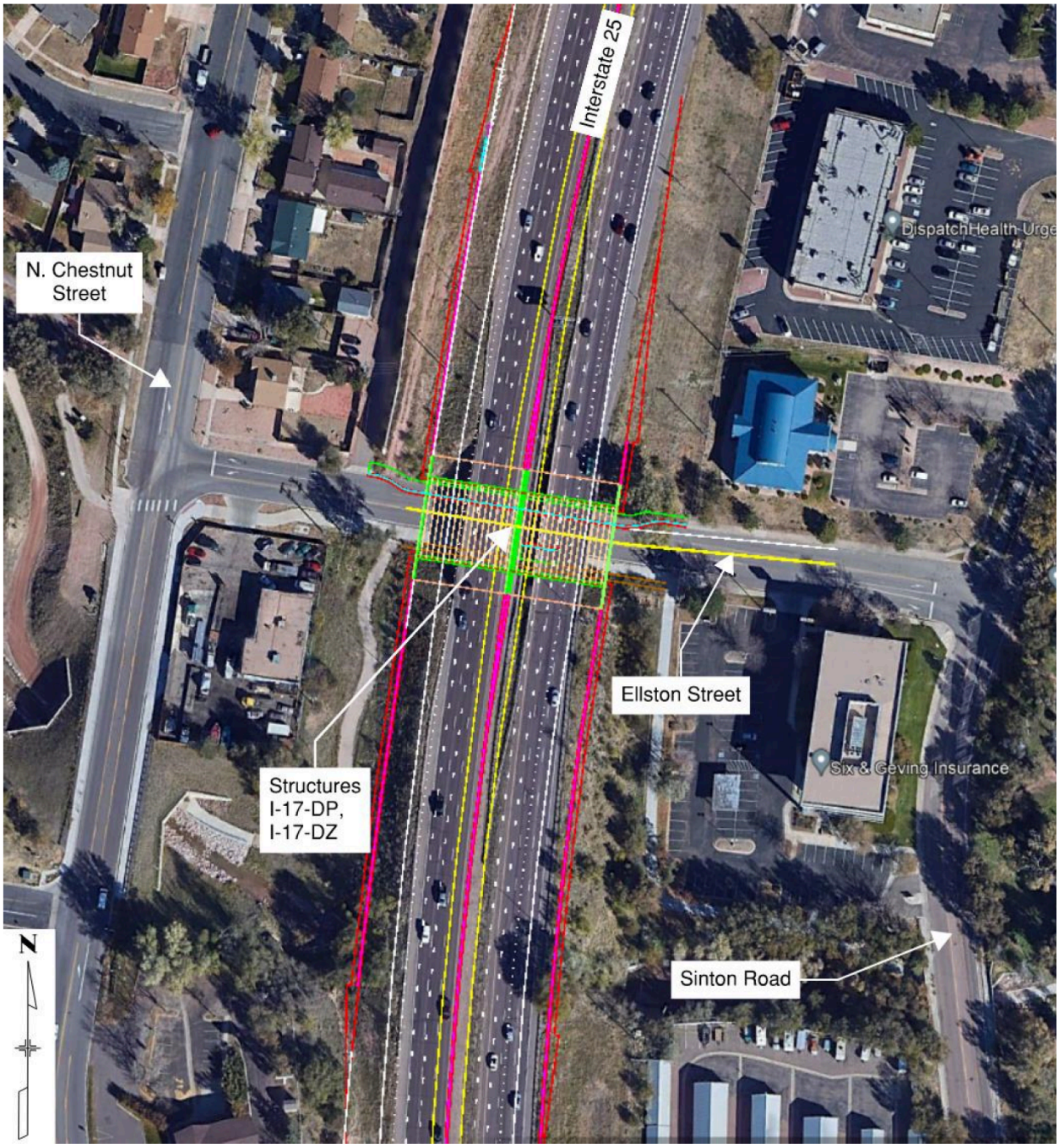


Key Project Drawings and Site Imagery

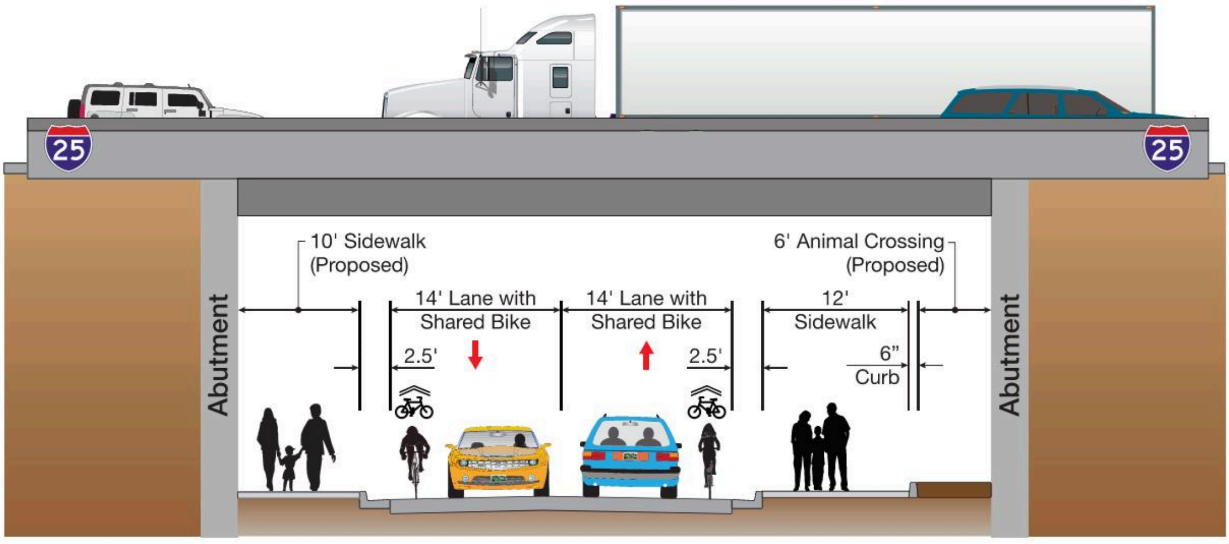
The following pages include the aerial plan, vicinity map, proposed Ellston Street section, and the typical roadway sections (existing and proposed) used as a basis for the VE study efforts.

Aerial View of Project Area

Vicinity Map of Project Area

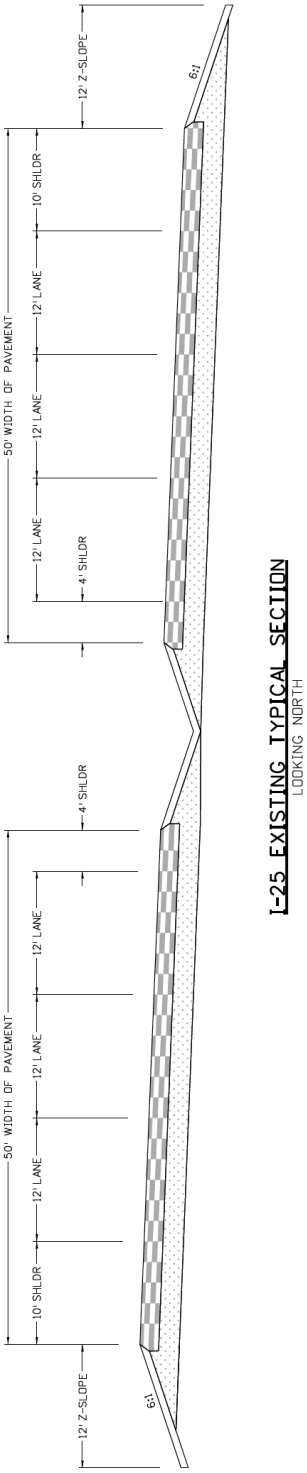


Proposed Ellston Street Section



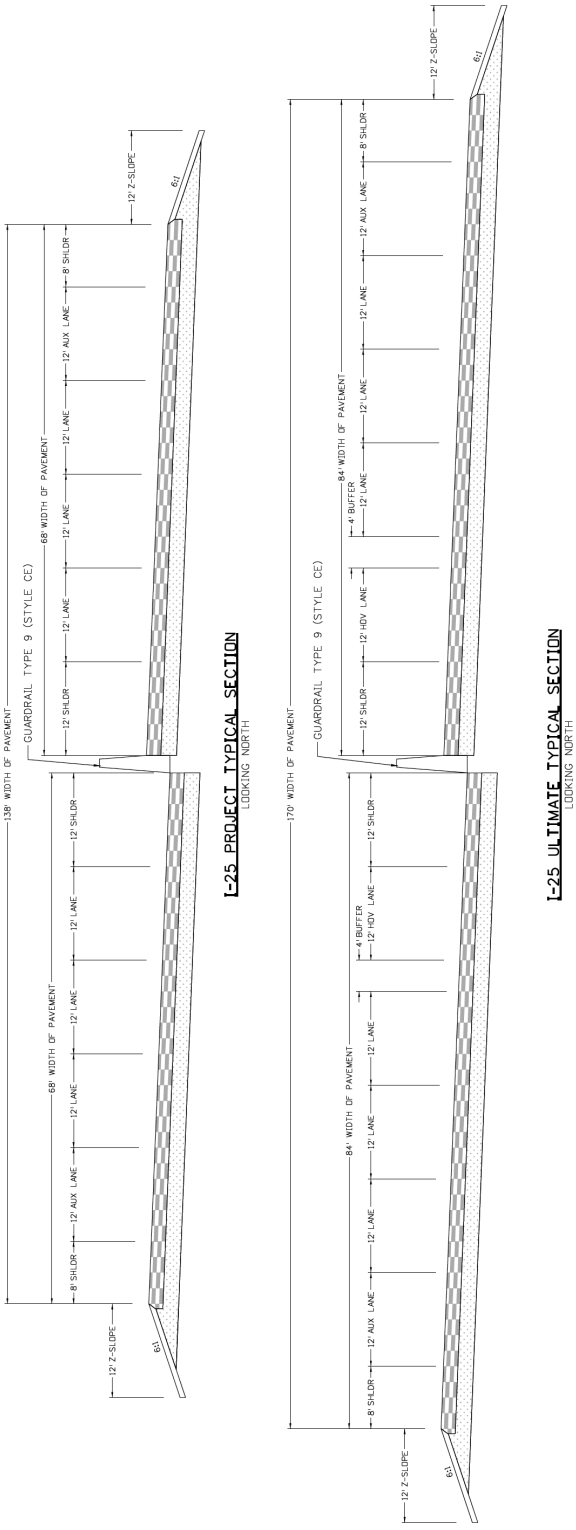
Ellston Street

I-25 Typical Roadway Sections – Existing



I-25 EXISTING TYPICAL SECTION
LOOKING NORTH

I-25 Typical Roadway Sections – Proposed



Value Engineering Process

The value engineering (VE) process comprises a series of steps, shown below, that are performed in sequential order before, during, and after a workshop.

1	Pre-Workshop	▪ Identify team members ▪ Gather project data ▪ Prepare for workshop
2	Information Phase *Understand project, goals, objectives, and issues*	▪ Gather, organize, analyze data ▪ Define costs, develop cost models ▪ Define problem – purpose/scope of VE workshop ▪ Determine customer needs/value metrics
3	Function Analysis *Understand the purpose of the project*	▪ Define functions ▪ Classify functions ▪ Select functions for further analysis ▪ Develop FAST diagram, if appropriate
4	Creativity *Generate ideas to improve the value of the project*	▪ Blast and create ▪ What else will perform the function? ▪ Innovative ideas
5	Evaluation *Select best ideas to improve value*	▪ Analyze, evaluate, rank ideas ▪ Select and refine best ideas
6	Development *Expand on selected ideas and include rationale for proposed change*	▪ Develop best ideas into VE proposals or design suggestions ▪ Develop support data
7	Presentation *Sell VE proposals*	▪ Present results of VE workshop
8	Implementation/Post Workshop	▪ Prepare and issue VE report ▪ Implement changes ▪ Monitor status

Function analysis is the heart of the value methodology. It is the primary activity that separates the Value Methodology from all other "improvement" methods. The objective of function analysis is to solidify the VE team's understanding and consensus regarding the project scope—including purpose, need, and associated impacts, such as time, cost, complexity, or sustainability—so they are better able, as a team, to identify the most beneficial elements for improvement.

The VE team randomly identified the functions of the project using active verbs and measurable nouns. Once the functions were discussed, the team classified them as higher order, basic, essential secondary, secondary, lower order, all-the-time, or one-time functions (e.g., during construction) or design objectives, as shown below.

Function Identification and Classification

Function	Classification
Phase Construction	One-Time
Reduce Delay	**Secondary**
Improve Connections	Secondary
Improve Sufficiency Ratings	Design Objective
Meet Standards	Design Objective
Reduce Flooding	Secondary
Convey Drainage	Secondary
Upgrade Infrastructure	Secondary
Protect Utilities	One-Time
Reduce Conflicts	Secondary
Reduce Congestion	Secondary
Accommodate Future	Higher Order
Accommodate Wildlife	All-the-Time
Improve Maintainability	Secondary
Satisfy Cyclists	All-the-Time
Improve Quality	Secondary
Improve Visibility	Design Objective
Improve Operations	Basic
Reduce Queuing	Secondary

Function	Classification
Accommodate Traveling Public	Higher Order
Satisfy Stakeholders	All-the-Time

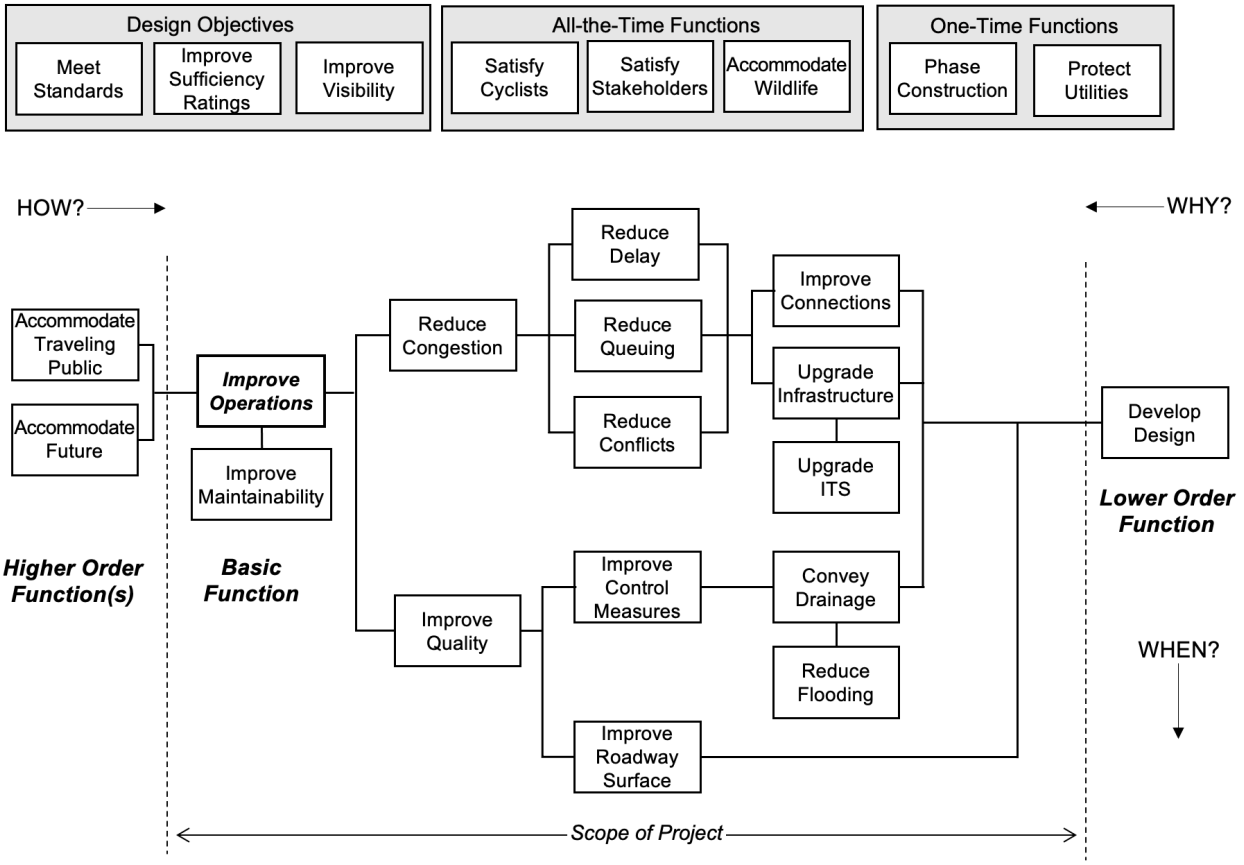
Functions Organized via FAST Diagram

Subsequent to identifying and classifying the functions, the VE team developed a Function Analysis System Technique (FAST) diagram, shown on the following page, to illustrate the scope of the project in function terms.

The diagram arranges some of the functions in logical order so that they answer the question “How?” when reading from left to right, and “Why?” when reading from right to left.

Functions connected by a vertical line (“When?” relationship) are those that happen at the same time as, or are caused by, the function at the top of the connection. Some functions, shown detached and above the FAST diagrams, represent design objectives, all-the-time functions, or one-time functions (e.g., during construction).

FAST Diagram



Creativity Phase

The VE team brainstormed alternative ways to perform some of the key functions associated with the project. The ideas were coded according to the function or project element being considered, and are identified as follows:

IM = Improve Maintainability

PC = Phase Construction

RC = Reduce Congestion

SC = Satisfy Cyclists

Evaluation Phase

Evaluation Criteria

The criteria identified for the project are used by the VE team to evaluate creative ideas. The objectives selected include:

- Constructability
- Maintainability
- Future Compatibility
- Stakeholder Impacts
- Minimize Impacts
  - Utilities
  - Environmental
  - Right of Way

Using the above criteria, in combination with an assessment of cost impacts and what functions are addressed, the team discussed the ideas with respect to how the overall project would be affected. Functionality was defined as how well the proposed concept will satisfy the goals, objectives, and requirements of the project without compromising the quality or criteria listed above. Cost included implications related to capital, operating, and maintenance costs.

During the review of the creative ideas, each idea was rated as follows to be prioritized for further development and documentation:

Y – Develop VEP

N – No Further Action

DS – Design Suggestion

ABD – Already Being Done

OS – Outside Scope

Creative Idea List

The list of creative ideas generated for the project is on the following pages. It includes the functions under which the ideas were brainstormed, the idea title, and the evaluation score received.

Note that some ideas ranked 5 during the Evaluation Phase were deemed, after additional investigation, inappropriate to develop into a VE proposal. The original idea list is not revised to reflect those changes; it represents the decisions reached by the team at the point in time that they were initially evaluating ideas.

Idea No.	Function/Title	Team Discussion	Idea Rank
Improve Maintainability			
IM-01	Remove the GOG Bridge Deck and Use Polyester Concrete Overlay	▪ Lasts much longer ▪ More expensive ▪ Requires zero maintenance ▪ Requires removal of HMA ▪ This bridge will be a major bottleneck when ultimate widening occurs (10-20 years?); will have to be widened or replaced ▪ Requires lowering the roadway by 2-1/4”	N
IM-02	Use Concrete Pavement in lieu of Hot Mix Asphalt (HMA)	▪ Requires full depth reconstruction which would likely not be feasible with maintaining 3 lanes of traffic each direction ▪ Would increase construction time ▪ Would match roadways to north and south that are already concrete ▪ Significantly increases scope of work and project costs (current surface treatment is minimal)	N
IM-03	Allow Contractors to Bid on Different Pavement Sections Based on the Geotech Report	▪ This project is more overlay than widening – limited applicability	N
IM-04	Use HDPE in lieu of Concrete for Pipes	▪	ABD
IM-05	Use Polyester Concrete Overlay on the Ellston Bridge	▪ Lasts much longer ▪ More expensive ▪ Requires zero maintenance	Y

Idea No.	Function/Title	Team Discussion	Idea Rank
Phase Construction			
PC-01	Perform the Joint Replacement on the GOG Bridge Over a Weekend	▪ Requires closing one direction of freeway at a time ▪ Can work if benefits warrant ▪ Increases quality of the work ▪ Could be combined with other work on the project ▪ Would reduce construction duration ▪ Requires a variance on lane closure policy on I-25	Y
PC-02	Split the Traffic and Put Construction Zone Between Lanes Going the Same Direction	▪ Has been done on other projects	Y
PC-03	Consider a Bridge Launch or Slide for Phasing the Ellston Bridges	▪ Time savings ▪ Increases construction cost, but reduces time ▪ Might help phasing if used in tandem with lane closure variance	DS
PC-04	Drive Pile Before the Existing Bridge is Removed	▪ Contractors like the flexibility this offers ▪ Tall piles sticking up adjacent to active traffic can be unsettling	DS
PC-05	Construct Ellston as One Bridge in lieu of Two	▪ Complicated due to superelevation change ▪ Would have to raise the roadway 4' which could create environmental (noise) impacts ▪ Eliminates tight space between bridges that limits contractors' work area	N
PC-06	Expand the Crossover Detours for Superelevation Work	▪	ABD
PC-07	Increase Horizontal Separation Between the Bridges	▪ Need to watch the footprint to avoid ROW impacts	Y

Idea No.	Function/Title	Team Discussion	Idea Rank
PC-08	Minimize Phases to the Extent Possible	▪	ABD
PC-09	Use Thicker Lifts to Correct the Superelevation	▪ Fewer construction phases ▪ Reduces construction duration ▪ There is a limit to thickness for safety reasons	Y
PC-10	Build Temporary Additional Width to Permit Half and Half Construction	▪	w/PC-06
PC-11	Close the NB Fillmore On-Ramp During Construction	▪ Enables pushing crossover further south ▪ Creates a difficult detour ▪ Sinton Road is not CDOT's road ▪ May require intergovernmental agreement	Y
PC-12	Utilize Full Depth Construction	▪ Would speed up the project immensely ▪ Requires detours	w/PC-06
PC-13	Close I-25 Overnight, as Needed, During Construction	▪ May require intergovernmental agreement ▪ Will require a variance ▪ Will require significant public information effort	N
PC-14	Allow 2 Lanes in lieu of 3 in Each Direction During Daytime Construction in Certain Areas	▪ Would require variance to lane closure policy ▪ Could reduce construction time ▪ Would require revisions to existing stakeholder expectations	N
Reduce Congestion			
RC-01	After Project is Complete, Remove Ramp Metering at NB Fillmore and SB GOG	▪ Meters are intended to be used with continuous merge lanes	OS

Idea No.	Function/Title	Team Discussion	Idea Rank
RC-02	Modify Turning Radius at Fillmore Ramp Terminals to Accommodate Large Vehicles	▪ Would require a minor interchange variance ▪ Would improve overall operations ▪ Adds scope to the project	N
RC-03	Allow Left Turns on Red on Fillmore Off-Ramps	▪	OS
RC-04	Use Variable Speed Limits in the Corridor During Construction	▪ Contractors usually bring this up	N
RC-05	Use Variable Speed Limits in the Corridor in the Permanent Condition	▪ ITS is being revamped throughout the corridor as part of the project	ABD
Satisfy Cyclists			
SC-01	Validate the Project Approach Related to Cyclists' Needs	▪ Appears cyclists are being well accommodated	N
SC-02	Close Ellston to all Roadway Traffic to Enable Day and Night Construction	▪ Cyclists commute through that route during the day ▪ Trying to minimize daytime closures ▪ Construction Engineer will have to be at bridge every morning to confirm whether people can safely walk/cycle under it (expensive)	N

Virtual VE Workshop Agenda

I-25 Fillmore to GOG Operational Improvements
Colorado Springs, CO
February 15–18, 2022

Logistics

Workshop Location	Webex Platform
Facilitator	Ginger Adams, IAF-CPF™, CVS®-Life, (970) 222-9505 Phone or Text
Participant Key	Agenda items with a check (✓) below indicate participation of project sponsors, customers, stakeholders, and the VE Team.

Agenda

Tuesday, February 15			
8:00a	✓	***Please join via computer with webcam to view/share documents.*** **INTRODUCTION BRIEF** Welcome and Introductory Remarks Purpose of Workshop and Agenda Overview, Virtual VE Workshop Process	Facilitator
		Information Phase	
8:15a	✓	Project Sponsor's and Stakeholders' Statements ▪ Project Goals ▪ VE Study Expectations ▪ Q&A	Facilitator w/All
8:30a	✓	Design Presentation ▪ Introduction and Project Background ▪ Site Photos / Google Earth tour / Videos ▪ Project Cost—PA and CWE ▪ Challenges Anticipated ▪ Facility Users/Operators Input ▪ Q&A	FHU, CDOT
9:30a	✓	Discussion of ▪ Critical Constraints ▪ Critical Assumptions ▪ Risk ▪ Evaluation Criteria	Facilitator w/All
10:00a	✓	Review of Information Requests	
10:15a		Break	

Tuesday, February 15			
10:30a		**RECONVENE ONLINE** Discussion of VE Team Observations from Morning Session	Facilitator w/VE Team
		Function Analysis Phase	
10:45a		Function Analysis ▪ Online group to brainstorm functions of project ▪ Facilitator to show example of previously completed FAST diagram from another project to illustrate structure/composition of the diagram ▪ Group to define basic function(s) for this project ▪ Facilitated group development of FAST diagram	Facilitator w/VE Team
11:45a		Lunch Break	
1:00p		**RECONVENE ONLINE** Function Analysis continued ▪ Finalize FAST diagram ▪ Prioritize/select functions for brainstorming	
2:15p		Break	
		Creative Phase	
2:45p		**RECONVENE ONLINE** Brainstorm to Generate Ideas	
4:45p		"Virtual Dots" Exercise	
5:00p		Adjourn Online Meeting	
Wednesday, February 16			
		Evaluation Phase	
8:00a		**RECONVENE ONLINE** ***Please join via computer with webcam to view/share documents.***	Facilitator w/VE Team
		Evaluate Ideas	Facilitator w/VE Team
10:30a		Break	

Wednesday, February 16			
10:45a		**RECONVENE ONLINE** Evaluate Ideas (continued)	
11:30a		Assignment of VE Proposals, Instructions for Forms and Formats	Facilitator w/VE Team
12:00p		Lunch Break	
1:30p	✓	**MIDPOINT REVIEW OF IDEAS**	Facilitator w/VE Team
2:15p		Recap Midpoint Review meeting outcomes with VE team; finalize VE assignments	Facilitator w/VE Team
		Development Phase	
2:45p		VE Proposal Development	VE Team
5:00p		Adjourn Online Meeting	

Thursday, February 17			
8:00a		**RECONVENE ONLINE** ***Please join via computer with webcam to view/share documents.*** VE Proposal Development	VE Team – Independent individual work offline
10:30a		Check-in on proposals and design suggestions under development: ▪ Discussion among team members relative to specific details within concepts ▪ Status of each item assigned	Facilitator w/VE Team
12:00p		Lunch Break	
1:00p		**RECONVENE ONLINE** ***Please join via computer with webcam to view/share documents.*** VE Proposal Development	Facilitator w/VE Team
3:00p		Check-in on proposals and design suggestions under development: ▪ Discussion among team members relative to specific details within concepts ▪ Status of each item assigned	Facilitator w/VE Team
4:45p		**All VE Proposals Due to Facilitator**	
5:00p		Adjourn Online Meeting	

Friday, February 18			
		Presentation Phase	
8:00a		**RECONVENE ONLINE** ***Please join via computer with webcam to view/share documents.*** Review and Discussion of VE Proposals Presentation Preparation ▪ Discussion of Key Alternatives and/or Combinations Thereof ▪ Presentation Format, Presenters	Facilitator w/VE Team
9:30a		Break	
10:00a	✓	**RECONVENE ONLINE** ***Please join via computer with webcam to view/share documents.*** **Presentation of Preliminary VE Study Results**	Facilitator w/all
12:00p		Adjourn Meeting	

ADAMS
& ASSOCIATES

VE Study Attendance List

I-25 Operational Improvements Project
Colorado Springs, CO—February 2022

Jan	February				Name	Affiliation Role	Phone	Email
31	15	16	17	18				
	X	X	X	X	Anna Bremmer	Adams & Associates, LLC Asst. VE Study Facilitator	206-605-6657	anna@aallcfacilitators.com
X	X	X		X	Armando Henriquez	FHWA Area Engineer, FHWA Colorado Division		armando.henriquez@dot.gov
X	X	X	X	X	Colleen Guillotte	City of Colorado Springs Traffic Engineer	719-385-7627 O 719-491-6085 M	colleen.guillotte@coloradosprings.gov
X	X	X	X	X	Ginger Adams	Adams & Associates, LLC VE Study Facilitator	970-266-2696 O 970-222-9505 M	ginger@aallcfacilitators.com
X	X	X	X	X	James Biren	CDOT Traffic Engineer	719-546-5404 O 719-248-8315 M	james.biren@state.co.us
X	X	X	X	X	Joel Johnson	CDOT Bridge Engineer	303-512-5989 O 720-425-3429 M	joel.johnson@state.co.us
X		X		X	John Hall	CDOT Resident Engineer, Bridges	719-227-3205 O 729-321-8748 M	john.hall@state.co.us
X	X	X	X	X	Kevan Kuhnel	FHU Project Manager	719-424-4785 O 729-290-2338 M	kevan.kuhnel@fhueng.com
X	X	X	X	X	Mitch Holck	CDOT Project Manager	719-565-9272 M	mitchell.holck@state.co.us
X	X	X	X	X	Rob Pratt	Stanley Consultants Construction Specialist	719-237-9850 M	prattrob@stanleygroup.com

ADAMS & ASSOCIATES

VE Study Attendance List

I-25 Operational Improvements Project
Colorado Springs, CO—February 2022

Jan	February				Name	Affiliation Role	Phone	Email
31	15	16	17	18				
		X			Shane Ferguson	CDOT North Program Engineer		shane.ferguson@state.co.us
X					Steve Murray	FHU Principal in Charge		steve.murray@fhueng.com
	X	X		X	Todd Frisbie	City of Colorado Springs City Traffic Engineer		todd.frisbie@coloradosprings.gov
X	X	X	X	X	Wesley Boggs	FHU Deputy Project Manager		wes.boggs@fhueng.com
X	X	X	X	X	Yunsu Han	CDOT Resident Engineer	719-227-3200 O 729-659-7459 M	yunsu.han@state.co.us

Value Engineering Study Presentation of Preliminary Results

I-25 Fillmore to Garden of the Gods Operational Improvements Colorado Springs, Colorado

February 18, 2022

ADAMS & ASSOCIATES

FELSBURG HOLT & ULLEVIG
connecting & enhancing communities

COLORADO
Department of Transportation

Purpose of Meeting

- Information Briefing
- Review of VE Team Activities
- Preview of VE Report
- Path Forward

Clarifications,
Not Decisions

Full Time VE Team and Roles

- Ginger Adams, CVS, Adams & Associates, Facilitator
- Anna Bremmer, CVS, Adams & Associates, Asst. Facilitator
- Jimmy Biren, CDOT, Traffic Engineer
- Wes Boggs, Felsburg Holt & Ullevig, Deputy Project Manager
- Colleen Guillotte, City of Colorado Springs, Traffic Engineer
- Yunsu Han, CDOT, Construction
- Mitch Holck, CDOT, Project Manager
- Joel Johnson, CDOT, Bridge Engineer
- Kevan Kuhnel, Felsburg Holt & Ullevig, Project Manager
- Rob Pratt, Stanley Consultants, Construction Specialist

VE Team Support

- Shane Ferguson, CDOT, North Program Engineer
- Todd Frisbie, City of Colorado Springs, City Traffic Engineer
- John Hall, CDOT, Resident Engineer
- Armando Henriquez, Area Engineer, FHWA Colorado Division

Project Overview

- Add Auxiliary Lanes on I-25 between Garden of the Gods Road and Fillmore Street
- Construct new twin bridges over Ellston Street
- Replace ITS within project limits
- Bridge rehabilitation on Garden of the Gods overpass
- Correct superelevation on curve of I-25 within project limits
- Accommodate future ultimate widening of I-25
- Upgrade water quality features

VE Job Plan Overview
Workshop Phases

Preparation	Evaluation
Information	Development
Function Analysis	Presentation
Creativity	*Implementation*

Information

ADAMS & ASSOCIATES

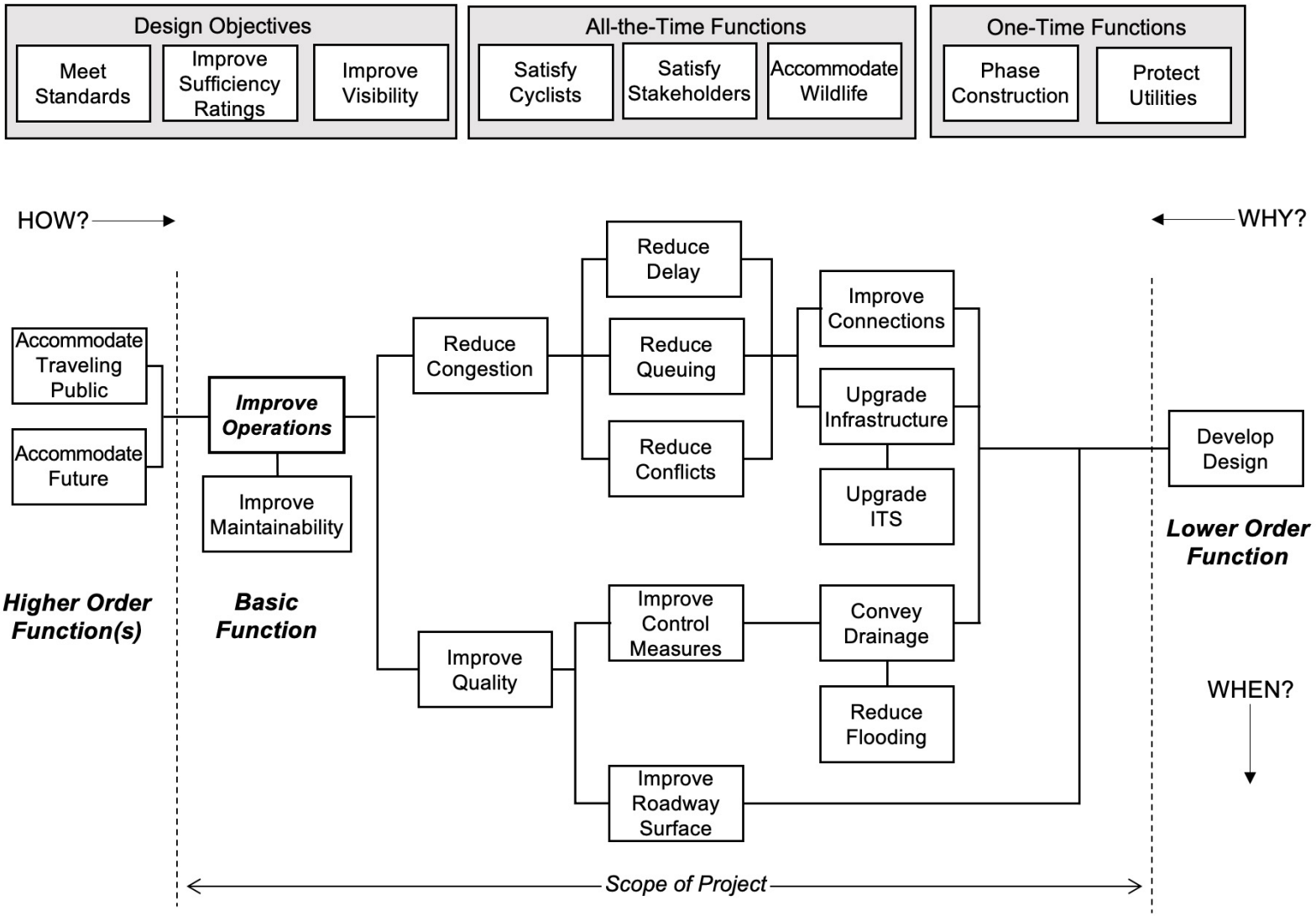
Identified

- Challenges
- Constraints
- Assumptions
- Risks
- Evaluation Criteria

Information: Evaluation Criteria

- Constructability
- Maintainability
- Future Compatibility
- Stakeholder Impacts
- Minimizing Impacts to:
  - Utilities
  - Environmental
  - Right of Way

Function Analysis: FAST



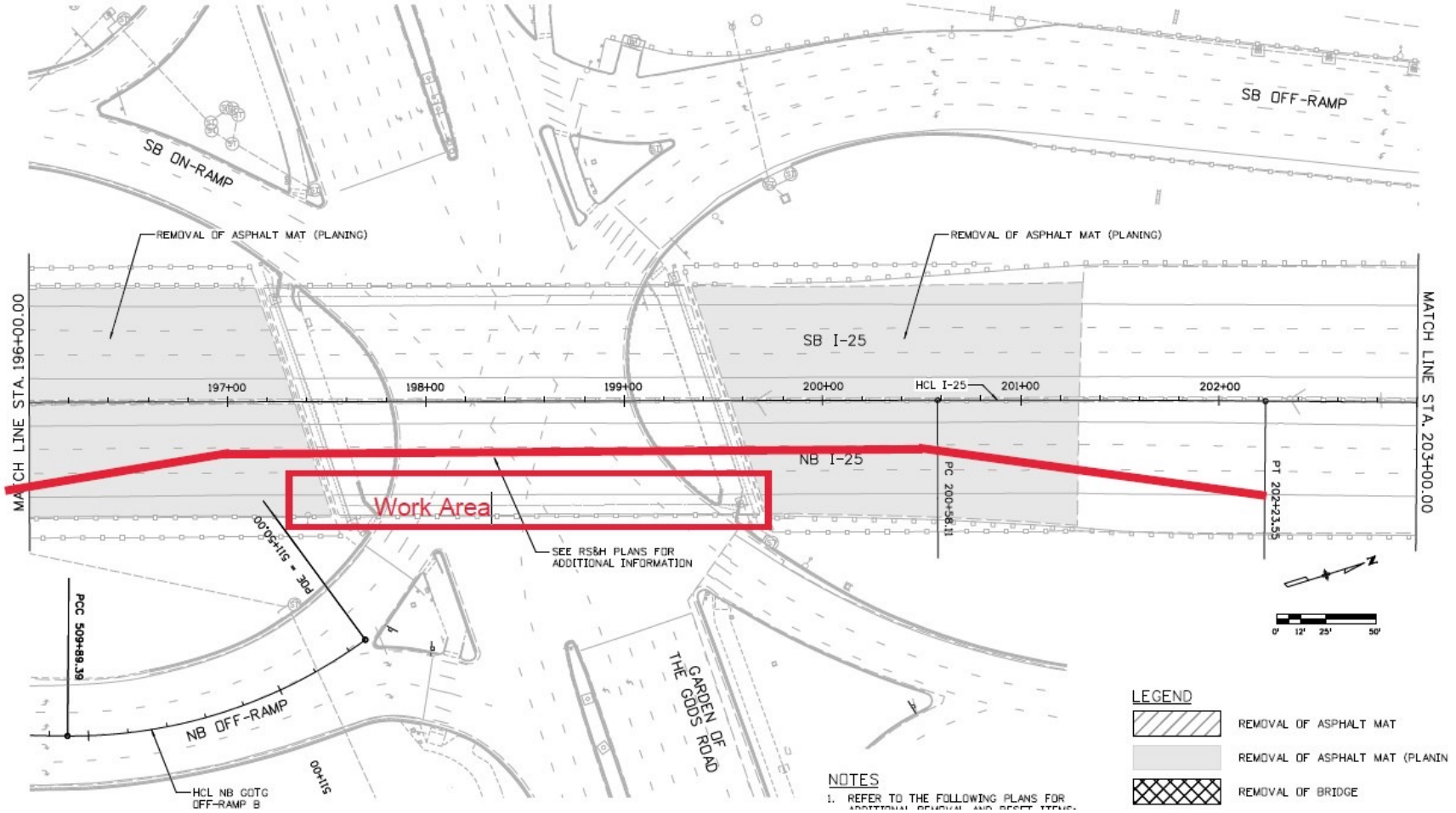
Function Analysis: Priority Functions

- Improve Maintainability (IM)
- Phase Construction (PC)
- Reduce Congestion (RC)
- Satisfy Cyclists (SC)

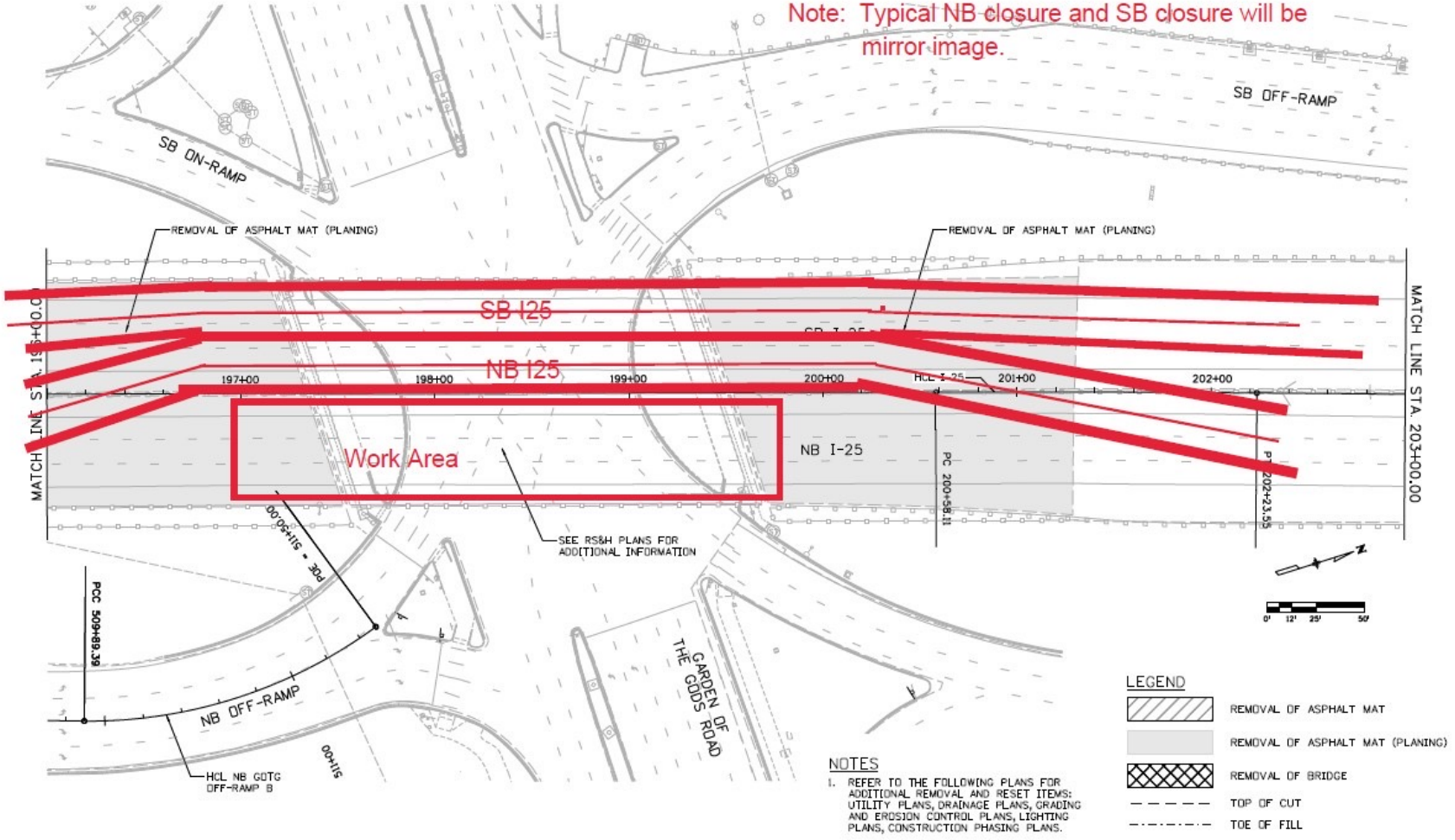
Creativity & Evaluation: Ideas

Number of Ideas Generated:	**26**
Improve Maintainability (IM)	5
Phase Construction (PC)	14
Reduce Congestion (RC)	5
Satisfy Cyclists (SC)	2
Number of Ideas Developed:	**8**

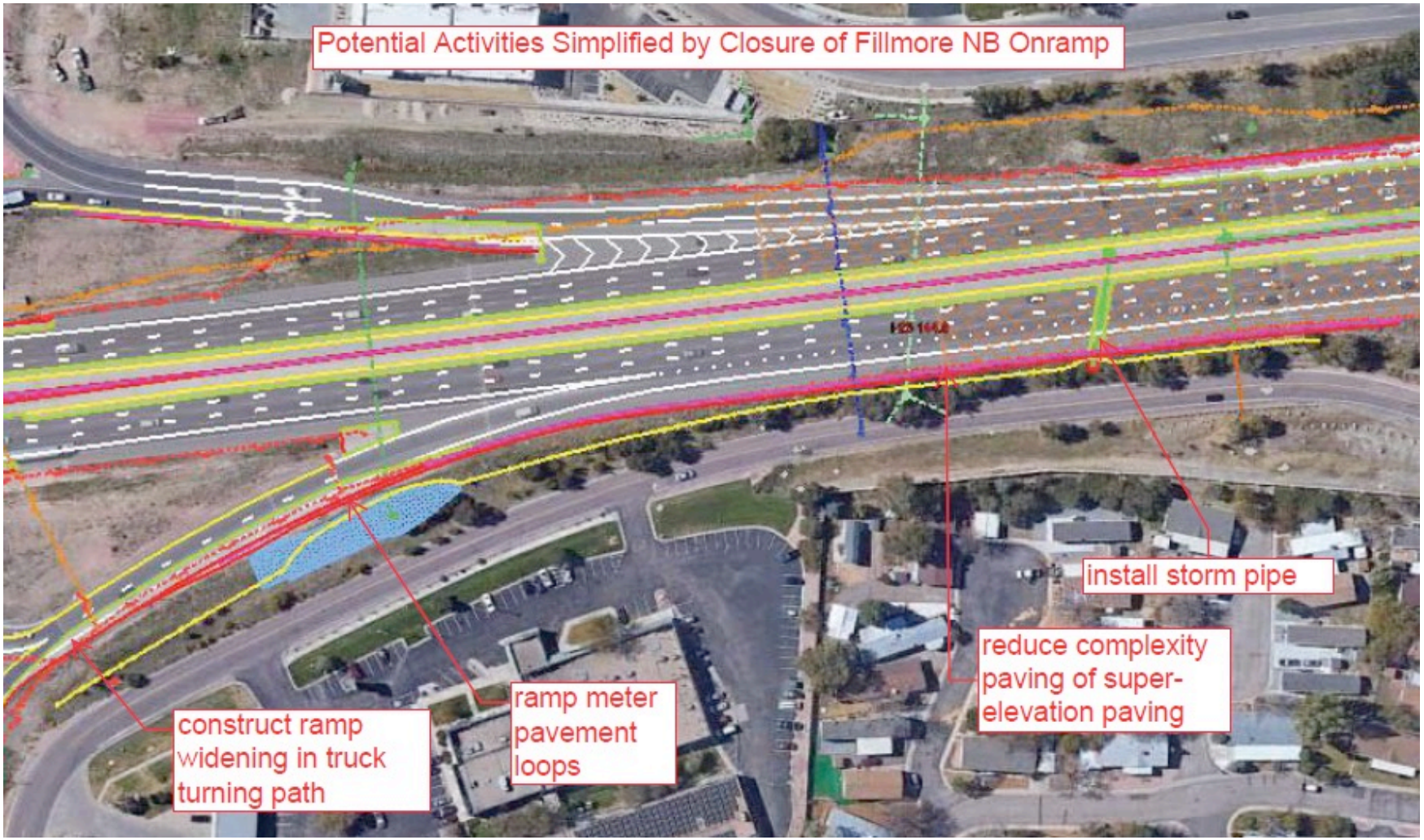
Development: VEP PC-01
Perform the Joint Replacement on the GOG Bridge Over a Weekend – Baseline



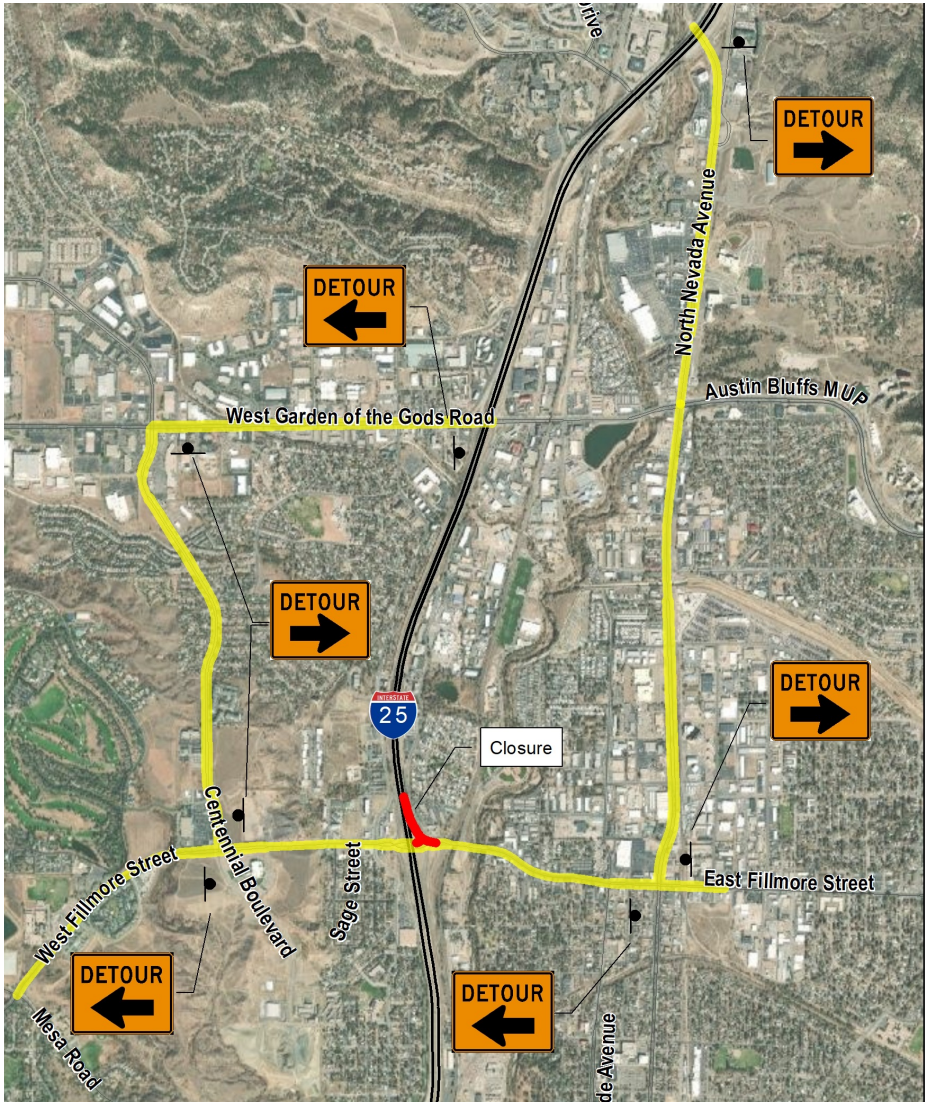
Development: VEP PC-01
Perform the Joint Replacement on the GOG Bridge Over a Weekend – Proposed



Development: VEP PC-11
Close NB Fillmore On-Ramp Intermittently – Potential Benefits



Development: VEP PC-11
Close NB Fillmore On-Ramp Temporarily – Proposed Detours



ADAMS
& ASSOCIATES

QUESTIONS?

Presentation & Implementation: Next Steps

- VE Report – February 25, 2022
- Close Out Meeting – TBD
- Document Decisions