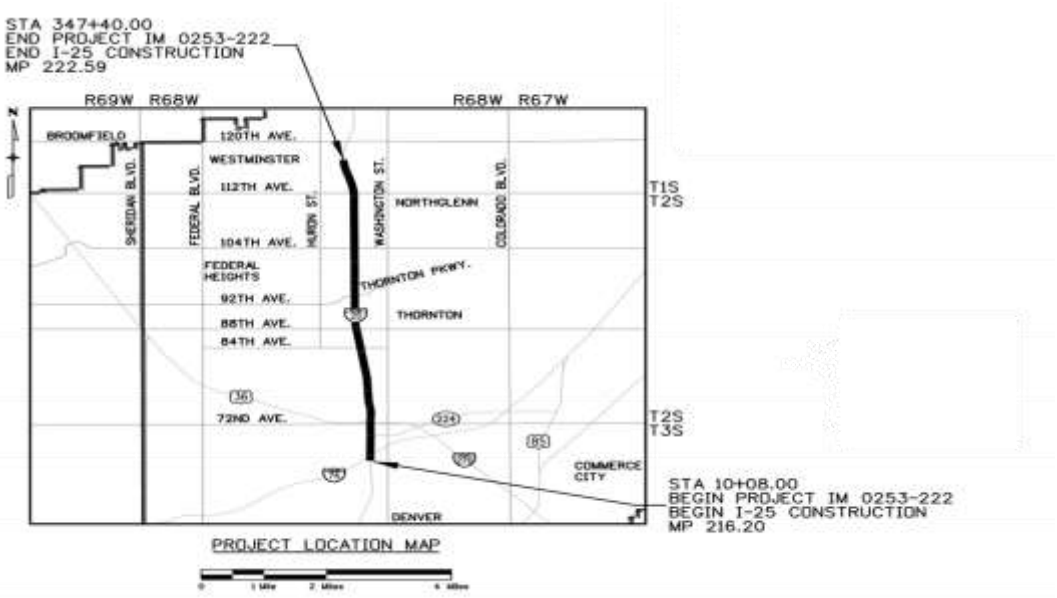
VALUE ENGINEERING STUDY REPORT

State of Colorado
Department of Transportation

Interstate 25 – Managed Lanes
US 36 to 120th Avenue

Federal Aid Project No. IM 0253-222
State Construction Project Code No. 18695



Value Engineering Study
14 – 17 January 2013

DESIGN TEAM

ATKINS PARSONS BRINCKERHOFF apexdesign

ATKINS

Atkins North America, Inc.
4601 DTC Boulevard, Suite 700
Denver, Colorado 80237

Telephone: +1.303.221.7275
Fax: +1.303.221.7276

www.atkinsglobal.com/northamerica

January 25, 2013

Mr. Andy Stratton, P.E.
Colorado Department of Transportation
Region 6 North Engineering
4670 Holly Street, Unit D
Denver, CO 80216

RE: Value Engineering Study Report
I-25 Managed Lanes: US 36 to 120th Avenue
Colorado DOT Project Code No. 18695

Dear Mr. Stratton:

Please find enclosed four (4) hard copies and two (2) CDs of our Value Engineering Report for the proposed I-25 Managed Lanes Project. Using the Value Engineering "Job Plan" – Information, Function Analysis, Creative, Evaluation & Development, the VE Team identified alternatives and design suggestions that offer potential opportunities for reducing construction cost, expediting project delivery and improving the flow of work during construction. All this was done without reducing the functionality of the finished project or encroaching on key understandings with the stakeholders and funding agencies.

We trust that you will find this report to be in proper order. It should be noted that the results of this workshop are volatile in that they can be overcome by the events that accompany the expeditious continuance of the design process. Accordingly, we encourage an equally expeditious implementation meeting to determine the disposition of the contents of this report.

Please contact me at (919) 576-4017 should you have any questions regarding this submittal.

On behalf of our VE Team, we thank you very much for the opportunity to work with you and the hard working staff members of the Colorado Department of Transportation and your design consultants.

Yours truly,

Charles R. McDuff, P.E., CVS-Life, CCE, LEED AP
VE Team Leader
SAVE International CVS No. 820102

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report is intended to recount the events and findings of the Value Engineering workshop that took place at the North Holly office of the Colorado Department of Transportation (CDOT) in Denver, during the period 14 – 17 January 2013. The subject of the VE workshop was the I-25 Managed Lanes Project on the north side of Denver. The project is being designed by the team of Parsons Brinckerhoff, Atkins, and APEX Design PC, out of the Denver offices of those three firms. At the time of the workshop, the plans had just recently been through their Field Inspection Review (FIR) on 10 December 2012. The plans and supporting documentation used by the VE Team for this study were in a state of transition, since the design team was in the process of incorporating the comments from the FIR.

1.2 PROJECT DESCRIPTION

The North I-25 Managed lanes extension project involves the creation of managed lanes along I-25 from US 36 to 120th Avenue by repurposing the existing inside shoulders of the roadway, both north and southbound. CDOT will be responsible for the design and construction of the new facility as well as maintenance of the facility and ITS infrastructure while the High-Performance Transportation Enterprise (HPTE) will be responsible for the management and operation of the managed lanes including the tolling system. It is planned that the E-470 Public Highway Authority will provide back office support to process and issue tolls, as well as collect payment.

The project would provide meaningful relief for the most congested corridor in the Denver Metropolitan area, currently traveled by 175,000 vehicles and 4,300 bus transit riders every day. Implementation of the managed lanes will result in a more efficient use of available roadway capacity to improve traffic flow and reduce travel times in the corridor. In addition, the managed lanes will support Bus Rapid Transit (BRT) along the corridor and provide more consistent transit travel times for the many express transit routes that currently serve the corridor.

Under the new managed lanes configuration all eligible user (HOVs, registered hybrid vehicles, motorcycles, buses and toll-paying POVs) will be able to access the managed lanes at designated ingress/egress points.

1.3 CONCERNS AND OBJECTIVES

The proposed North I-25 managed lane system will offer more choices to commuters and make the best use of available freeway capacity. The project has several key goals that include:

- Utilize managed lanes to improve flow in the general purpose lanes and thereby improve travel along the corridor for roadway users;
- Provide a means for public transit to achieve better on-time performance by removing them from the congestion in the general purpose lanes; and,
- Encourage carpooling and alternative modes of travel by offering free use of the managed lanes for public transit and HOV users;
- Encourage the further economic growth in the corridor by providing a more efficient transportation system.

All the usual concerns go along with this project. These concerns include:

- Meeting the objectives and requirements of the very important federal Tiger Grant. These are stringent and have a performance time frame which calls for the obligation of the funds by June of 2013.
- There are numerous stakeholders and fund sources involved in the execution of this project. The various agreements and the EIS/ROD requirements weave together a strict route that must be followed to deliver this project.
- Among the stakeholders are the owners of the irrigation ditches that cross under the existing right-of-way. Every effort has been made to make certain that the proposed project does not impact these ditches.
- There is also an important goal that calls for building all improvements within the existing footprint of I-25. Negotiations are currently underway to obtain the temporary construction easements necessary to construct the improvements.
- Repairs to the existing noise walls and the inclusion of Noise Wall No. 2 in the project has been a carefully tracked part of the negotiations with the local interest groups.

1.4 FINDINGS

During the course of the VE workshop the team developed 14 Alternatives and 16 Design Suggestions. Following this page is the table entitled, "VALUE ENGINEERING STUDY – SUMMARY OF RESULTS". The cost results may not be added together as some of the alternatives are mutually exclusive. One of the goals of the VE Team was to identify ways in which cost savings might be realized while, on the other hand, indicating ways in which the resulting savings might be invested back into the project to realize added value. A rough impression to be had from reviewing the Summary of Results is that between $5 and $7 million in cost savings might be reasonable to expect from the implementation of these alternatives. The team has also illustrated how nearly $800,000 could be put back into the project, in the form of added acceleration, deceleration and auxiliary lanes; in order to improve the operational performance of the proposed improvements.

The reader is encouraged to read over the summary table then look at the tabbed section of this report entitled, "STUDY RESULTS", for a detailed accounting as to how these alternatives were documented.

The Design Suggestions can also be as important as the fully developed Alternatives.

1.4.1 TABLE – SUMMARY OF RESULTS

		Cost Original Design	Cost Alternative	Initial Cost Reduction	Life Cycle Cost Impact	Net Cost Reduction Including LCC
	ITS/TOLLING (IT)					
IT-1	Don't use lane control for the general purpose lanes	$4,039,200	$571,200	$3,468,000	$3,119,769	$6,587,769
IT-2	Eliminate lane control for Northbound Traffic	$9,506,400	$3,481,600	$6,024,800	$5,419,833	$11,444,633
IT-3	Minimize signs and devices	$8,527,200	$571,200	$7,956,000		$7,956,000
IT-4	Do not add extra fiber optic cable	$301,376	$0	$301,376		$301,376
IT-5	Use standard VMS in lieu of full color matrix signs	$2,448,000	$2,284,800	$163,200		$163,200
IT-6	Eliminate proposed CCTV cameras	$13,600	$0	$13,600		$13,600
IT-7	Combine detection devices	**DESIGN SUGGESTION**				
IT-8	Provide for coordination of traffic management assets	**DESIGN SUGGESTION**				
IT-9	Maximize use of existing sign structures	**DESIGN SUGGESTION**				
IT-11	Set objective to integrate this project into area wide master plan for ATM	**DESIGN SUGGESTION**				
IT-14	Define enforcement concept	**DESIGN SUGGESTION**				
IT-15	Implement incident management concept	**DESIGN SUGGESTION**				
IT-16	Implement ramp metering for corridor	**DESIGN SUGGESTION**				
	PAVEMENT (PV)					
PV-4	Provide auxiliary lane between Thornton Parkway and 104th Avenue	$0	$512,088	($512,088)		($512,088)
PV-8	On southbound I-25, provide parallel acceleration lane from 104th Avenue	$32,849	$93,871	($61,022)		($61,022)
PV-9	Provide 1000 foot parallel deceleration lane for the approach to Thornton Parkway	$9,448	$171,516	($162,068)		($162,068)
PV-9A	Provide 500 foot parallel deceleration lane for the approach to Thornton Parkway	$9,448	$102,086	($92,638)		($92,638)
PV-10	Re-stripe Thornton Parkway southbound ramp	**DESIGN SUGGESTION**				

		Cost Original Design	Cost Alternative	Initial Cost Reduction	Life Cycle Cost Impact	Net Cost Reduction Including LCC
	TRAFFIC CONTROL DURING CONSTRUCTION (TC)					
TC-1	Re-Sequence construction phasing	**DESIGN SUGGESTION**				
TC-2	Reduce temporary Type 7 Barriers	$1,689,120	$478,725	$1,210,395		$1,210,395
TC-3	Reduce traffic control inspection (TCI) days	$72,216	$27,282	$44,934		$44,934
TC-6	Pay for mobile attenuators by days	**DESIGN SUGGESTION**				
	MISCELLANEOUS (MI)					
MI-1	Optimize conduit sizes	**DESIGN SUGGESTION**				
MI-2	Use shorter light standards	$1,629,484	$1,150,560	$478,924		$478,924
MI-3	Reduce lighting coverage	$2,479,416	$436,377	$2,043,039		$2,043,039
MI-4	Integrate lighting into barrier walls	**DESIGN SUGGESTION**				
MI-6	Consider use of LED fixtures for roadway lighting	**DESIGN SUGGESTION**				
MI-7	Revisit possibility of new bridge at 88th Avenue	**DESIGN SUGGESTION**				
MI-8 & 9	Replace in lieu of re-set the existing guardrail	**DESIGN SUGGESTION**				
MI-10	Enhance definition of project requirements	**DESIGN SUGGESTION**				

2 STUDY RESULTS

2.1 INTRODUCTION

The measurement of the success of Value Engineering study can be done in several important ways, mostly depending on the nature of the project under review. In the current instance it should be expected that the VE study would provide the I-25 Managed Lanes project delivery team from CDOT and their design firms with a selection of alternatives. These alternatives offer opportunities for initial and life cycle cost reductions, opportunities to reduce the project delivery time and a chance to enhance the effectiveness of the design before it goes to construction. The VE team used these objectives as they selected creative ideas to carry forward for development. The workshop resulted in full development of alternatives that offer opportunities for significant first cost savings. These alternatives were selected as being reasonable considerations for incorporation in the design. There were also Design Suggestions that offer measures to simplify construction, provide various means for reducing costs (in these cases these savings are hard to quantify), may help to improve the operational requirements for the finished facilities, and reduce the construction duration.

2.2 COST CALCULATIONS

The Value Engineering team members utilized the unit costs and quantities from the construction cost estimates provided by the Design Team, wherever possible. This was done to make sure that comparisons between original and alternative costs were handled consistently and fairly. When the VE team deviated from this practice by providing their own unit costs, mostly for alternative materials, it has been clearly noted in the cost calculations that accompany the developed alternatives. Likewise, if there was a problem with either unit costs or quantities in the supplied estimates, these deviations were clearly annotated in the VE Team's documentation.

The cost estimates provided by the VE Team in their documentation are intended to serve as general indicators of the cost results should the alternatives be accepted as they are written. Some of the alternatives are mutually exclusive so it is expected that the identified cost impacts cannot be added and taken as the final, total cost conclusion for the VE workshop.

With regard to Life Cycle Cost analyses (LCC), the conclusions reached are based on a 4.2% annual discount rate and zero percent inflation. This zero percent inflation is due to the use of "Constant Dollar" analytical practice recommended for use on federally funded projects. Life cycle cost analysis has impressive formulas that give the outward appearance of being very precise. However, many things affect the outcome of LCC decisions, not the least of which is the uncertainty of dealing with bank rates that may well be significantly different from that which was assumed, in a very short period of time. Accordingly, LCC decisions should only be supported when they signal a very clear benefit that will be experienced regardless of the ebb and flow of financial times.

VALUE ANALYSIS DESIGN ALTERNATIVE

ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-1**

IM 0253-222 PCN 18695

DESCRIPTION: SHEET NO.: 1 of 3

DON'T USE LANE CONTROL FOR GENERAL PURPOSE LANES

Original Design:

The design calls for 99 lane control signs including locations on the managed and general purpose lanes.

Alternative:

The lane controls will be placed on the managed lanes only. This would reduce the number of signs down to 14 for the managed lanes.

Opportunities:

- Initial cost savings
- Will reduce driver distraction
- Maintenance and energy cost savings

Risks:

- Some redesign will be required.

Technical Discussion:

This approach would provide the needed information for the drivers to navigate through the managed lanes and fulfill the requirements of the project. The cost savings would be the result of reducing the number of signs, sign structures, and utility services. This amounts to approximately $30,000 per sign. The savings from this alternative could be used to add more pavement in the form of Acceleration and Deceleration, and Auxiliary lanes to further support the efforts to reduce traffic incidents and enhance traffic operations.

The ATM deployment might be better served by deploying it south of US 36 from downtown to the northern terminus of this project.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 4,039,200	$ 3,633,613	$ 7,672,813
ALTERNATIVE	$ 571,200	$ 513,844	$ 1,085,044
SAVINGS	$ 3,468,000	$ 3,119,769	$ 6,587,769

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **IT-1** SHEET NO.: 2 of 3

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Lane Control Signage	EA	99	$ 30,000.00	$2,970,000	14	$ 30,000.00	$ 420,000
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$2,970,000			$ 420,000
Mark-up at 36.00%				$1,069,200			$ 151,200
TOTAL				**$4,039,200**			**$ 571,200**
Estimated Savings:							$3,468,000

LIFE COST ANALYSIS

PROJECT:	**Reduction in Number of Lane Control Signs Based on Eliminating Lane Control for GP Lanes**					ALTERNATIVE NO. **IT-1** SHEET NO. 3 of 3	
LIFE CYCLE PERIOD:	20 **years**					**99 Signs**	**14 Signs**
INTEREST RATE:	4.20%	**ESCALATION RATE:**	0.00%			**ORIGINAL**	**ROPOSED**
A.	**INITIAL COST**	**(Note - escalation shown as 0.0% since using**				4,039,200	571,200
	Useful Life (Years)	**constant dollar LCC analysis)**				10	10
					INITIAL COST SAVINGS		3,468,000
B.	**RECURRENT COSTS (Annual Expenditures)**						
	1. **Maintenance**	5 % of First Cost during each year				201,960	28,560
	2. **Maintenance**						
	3. **Energy**						
					Total Annual Costs	201,960	28,560
					Present Worth Factor	13.3528	13.3528
					Present Worth of RECURRENT COSTS	2,696,728	381,355
C.	**SINGLE EXPENDITURES**		**Year**	**Amount**	**PW factor**	**Present Worth**	**Present Worth**
ORIG	PROP	**< Put "x" in appropriate box (original design or proposed design)**					
x		**1.** **Refurbish Signs (99)**	10	1,413,720	0.6627	936,885	-
	x	**2.** **Refurbish Signs (14)**	10	199,920	0.6627	-	132,489
		3. Cost based on 35% of			1.0000	-	-
		4. first cost			1.0000	-	-
D.	**SALVAGE VALUE**		**Year**	**Amount**	**PW factor**	**Present Worth**	**Present Worth**
					Present Worth of SINGLE EXPENDITURES	936,885	132,489
E.	**Total Recurrent Costs & Single Expenditures (B + C + D)**					3,633,613	513,844
					RECURRENT COSTS & SINGLE EXPENDITURES SAVINGS		3,119,769
					TOTAL PRESENT WORTH COST (A + E)	7,672,813	1,085,044
					TOTAL LIFE CYCLE SAVINGS		**6,587,769**

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-2**
IM 0253-222 PCN 18695

DESCRIPTION: **ELIMINATE LANE CONTROL FOR NORTHBOUND TRAFFIC** SHEET NO.: 1 of 3

Original Design:

The design calls for a high density of devices along the northbound and southbound travel routes in order to develop the ATM system. The overhead supports for the devices are located at one half mile intervals.

Alternative:

The current design would be modified by eliminating that portion of the ATM system not necessarily required for the current operational plan. This is more adequately described as follows:

- Eliminate the northbound overhead supports and devices except for those at stations 65+00 and 117+00.
- Eliminate all side-mounted signs (VMS)
- Reduce southbound locations to approximately one-mile intervals, to meet obvious needs such as exit locations.

Opportunities:

- Initial cost savings
- Significant Maintenance and energy cost savings
- Reduces driver distraction

Risks:

- Significant redesign will be required.

Technical Discussion:

ATM is probably not needed as the northbound traffic is significantly lighter than the southbound traffic. Side mounted signs can be installed once the need and purpose have been identified through day-to-day use. Having the structures on one-half mile intervals, along with the proposed signage, may be more than is required for the moment and will likely distract drivers from their attention to driving.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH
ORIGINAL DESIGN	$ 9,506,400	$ 8,551,837	$ 18,058,237
ALTERNATIVE	$ 3,481,600	$ 3,132,004	$ 6,613,604
SAVINGS	$ 6,024,800	$ 5,419,833	$ 11,444,633

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **IT-2** SHEET NO.: 2 of 3

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Lane Control Signage	EA	99	$ 30,000.00	$2,970,000	48	$ 30,000.00	$ 1,440,000
				$ -			$ -
Side-mount VMS	EA	24	$ 50,000.00	$1,200,000	0	$ 50,000.00	$ -
				$ -			$ -
ATM structures (ATM)	EA	24	$ 80,000.00	$1,920,000	8	$ 80,000.00	$ 640,000
				$ -			$ -
Butterfly (for managed lanes)	EA			$ -	6	$ 30,000.00	$ 180,000
				$ -			$ -
Appurtenances, wiring, etc.	LS	1	$900,000.00	$ 900,000	1	$300,000.00	$ 300,000
				$ -			$ -
Unit costs are primarily VE Team Approximations				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$6,990,000			$ 2,560,000
Mark-up at 36.00%				$2,516,400			$ 921,600
TOTAL				**$9,506,400**			**$ 3,481,600**
Estimated Savings:							$6,024,800

LIFE CYCLE COST WORKSHEET

PROJECT:	**Reduction in Number of Lane Control Signs Based on Eliminating Lane Control for GP Lanes**						ALTERNATIVE NO.	**IT-2**
							SHEET NO.	3 of 3
LIFE CYCLE PERIOD:			20	**years**				
INTEREST RATE:			4.20%	**ESCALATION RATE:**	0.00%		**ORIGINAL**	**PROPOSED**
A.	**INITIAL COST**			**(Note - escalation shown as 0.0% since using**			9,506,400	3,481,600
	Useful Life (Years)			**constant dollar LCC analysis)**			10	10
						INITIAL COST SAVINGS	**INITIAL COST SAVINGS**	6,024,800
B.	**RECURRENT COSTS (Annual Expenditures)**							
	1.	**Maintenance**	5 % of First Cost during each year				475,320	174,080
	2.	**Maintenance**						
	3.	**Energy**	Not identified					
						Total Annual Costs	475,320	174,080
						Present Worth Factor	13.3528	13.3528
						Present Worth of RECURRENT COSTS	6,346,845	2,324,453
C.	**SINGLE EXPENDITURES**			**Year**	**Amount**	**PW factor**	**Present Worth**	**Present Worth**
ORIG	PROP	**< Put "x" in appropriate box (original design or proposed design)**						
x		**1.**	**Refurbish system**	10	3,327,240	0.6627	2,204,992	-
	x	**2.**	**Refurbish system**	10	1,218,560	0.6627	-	807,551
		3.	Cost based on 35% of			1.0000	-	-
		4.	first cost			1.0000		-
D.	**SALVAGE VALUE**			**Year**	**Amount**	**PW factor**	**Present Worth**	**Present Worth**
						Present Worth of SINGLE EXPENDITURES	2,204,992	807,551
E.	**Total Recurrent Costs & Single Expenditures (B + C + D)**						8,551,837	3,132,004
						RECURRENT COSTS & SINGLE EXPENDITURES SAVINGS		5,419,833
						TOTAL PRESENT WORTH COST (A + E)	18,058,237	6,613,604
						TOTAL LIFE CYCLE SAVINGS		**11,444,633**

VALUE ANALYSIS DESIGN ALTERNATIVE

ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave**
IM 0253-222 PCN 18695

IT-3

DESCRIPTION: **MINIMIZE SIGNS AND DEVICES**

SHEET NO.: 1 of 2

Original Design:

The design calls for 91 ITS signs for the six-mile corridor. This may represent a very high information density from a driver's perspective.

Alternative:

The intent of the project is to construct managed lanes that help to move the traffic through the corridor. Consideration might be made to reducing the management and driver information density by affecting the following changes:

- Use eight existing cameras but do not install the four new cameras
- Use the existing variable message signs but eliminate the VMSs and supplemental VMSs for ATM
- Use the minimum signs and devices necessary to meet the project intent

Opportunities:

- Initial cost savings
- Will reduce driver distraction
- Maintenance and energy cost savings
- Streamlines the design

Risks:

- Very significant redesign
- Must make sure this approach is consistent with the project design requirements

Technical Discussion:

This approach would provide the needed information for the drivers to navigate through the managed lanes and fulfill the requirements of the project. The cost savings would be the result of reducing the number of signs, sign structures, and utility services. Savings from this alternative could be used to add more pavement in the form of acceleration and deceleration, and auxiliary lanes to further support the efforts to reduce traffic incidents and enhance traffic operations. There would be additional life cycle cost savings that have not been calculated.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 8,527,200	$	$ 8,527,200
ALTERNATIVE	$ 571,200	$	$ 571,200
SAVINGS	$ 7,956,000	$	$ 7,956,000

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **IT-3** SHEET NO.: 2 of 2

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Variable Message Signs(Apex)	EA	2	$140,000.00	$ 280,000	0	$ -	$ -
Variable Message Signs(PB)	EA	12	$150,000.00	$1,800,000			$ -
VMS-sopp(PB)	EA	24	$ 50,000.00	$1,200,000	0	$ 50,000.00	$ -
Lane Control Signs	EA	99	$ 30,000.00	$2,970,000	14	$ 30,000.00	$ 420,000
CCTV Cameras	EA	4	$ 5,000.00	$ 20,000		$ -	$ -
				$ -			$ -
				$ -		$ -	$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$6,270,000			$ 420,000
Mark-up at 36.00%				$2,257,200			$ 151,200
TOTAL				**$8,527,200**			**$ 571,200**
Estimated Savings:							$7,956,000

VALUE ANALYSIS DESIGN ALTERNATIVE

ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave**
IM 0253-222 PCN 18695

IT-4

DESCRIPTION: **DO NOT ADD EXTRA FIBER OPTIC CABLE**

SHEET NO.: 1 of 2

Original Design:

Install new fiber optics line. 34,320 LF Northbound and 10,000 LF Southbound.

Alternative:

Do not place extra fiber line. Utilize what is already in place.

Opportunities:

- Initial cost savings
- May expedite construction

Risks:

- In the future, may not have enough lines available

Technical Discussion:

There is an opportunity to utilize the remaining capacity with of the existing fiber optic facilities. The adequacy of this capacity must be confirmed. If needed, can always add fiber optic cabling to meet needs of that time.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	**$ 301,376**	**$**	**$ 301,376**
ALTERNATIVE	**$ 0**	**$**	**$ 0**
SAVINGS	**$ 301,376**	**$**	**$ 301,376**

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **IT-4** SHEET NO.: 2 of 2

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Install fiber optics	LF	44,320	$5.00	$221,600	0	$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
						$ -	
Sub-total				$221,600			$ 0
Mark-up at 36.00%				$79,776			$ 0
TOTAL				**$301,376**			**$ 0**
Estimated Savings:							$301,376

VALUE ANALYSIS DESIGN ALTERNATIVES

ALTERNATIVE NO.: **IT-5**

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave**
IM 0253-222 PCN 18695

DESCRIPTION: **USE STANDARD VARIABLE MESSAGE SIGNS (VMS) IN LIEU OF FULL COLOR MATRIX SIGNS**

SHEET NO.: 1 of 2

Original Design:

The current design calls for the use of 12 each full matrix, full color, 20 mm pitch, overhead variable message signs. There are to be six in the northbound and six in the southbound traffic lanes.

Alternative:

Standard variable message signs would be used in place of the full color matrix signs.

Opportunities:

- Initial cost savings by reducing IT cost for driver/sign integration
- Will reduce driver distractions

Risks:

- There would be no color options
- Some redesign required

Technical Discussion:

The same messages can be communicated by the standard message signs as with the full color matrix signs.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 2,448,000	$	$ 2,448,000
ALTERNATIVE	$ 2,284,800	$	$ 2,284,800
SAVINGS	$ 163,200	$	$ 163,200

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **IT-5** SHEET NO.: 2 of 2

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
VMS Full Color (Overhead)	EA	12	$ 150,000.00	$ 1,800,000		$ -	$ -
VMS LED (Overhead)	EA		$ -	$ -	12	$ 140,000.00	$ 1,680,000
			$ -	$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$,800,000			$ 1,680,000
Mark-up at 36.00%				$ 648,000			$ 604,800
TOTAL				**$ 2,448,000**			**$ 2,284,800**
Estimated Savings:							$163,200

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-6**
IM 0253-222 PCN 18695

DESCRIPTION: **ELIMINATE PROPOSED CCTV CAMERAS** SHEET NO.: 1 of 1

Original Design:

The design calls for CCTV cameras to monitor VMSs. There are two of them located at Stations 149+00 and 254+00.

Alternative:

The design would be modified to rely on the internal diagnostic devices to monitor the proposed equipment.

Opportunities:

- Initial cost savings
- Minimal Maintenance and energy cost savings

Risks:

- Some redesign will be required

Technical Discussion:

The internal diagnostic devices that come with the proposed system equipment should be adequate to monitor the system. Each of the cameras cost $5,000. The resulting cost savings would be $10,000 plus $3,600 in project mark-ups.

There would some additional cost savings related to wiring and power provision. This is not included in the numbers below as this is a fairly minimal cost.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 13,600	$	$ 13,600
ALTERNATIVE	$ 0	$	$ 0
SAVINGS	$ 13,600	$	$ 13,600

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-7**
IM 0253-222 PCN 18695

DESCRIPTION: **COMBINE DETECTION DEVICES** SHEET NO.: 1 of 1

Original Design:

Throughout the project there are devices (RTMS, Doppler and others) deployed to measure speed/occupancy, etc., for different CDOT user groups (DTS, ITS/TOLLS). These devices collect similar or the same information.

Alternative:

There may be an opportunity to streamline and combine these devices. Perhaps the various groups could get together and determine their various data needs and see how they overlap and find opportunities for consolidation of devices to reduce the cost of construction and simplify data acquisition.

Opportunities:

- Cost savings for initial capital outlay
- Reduce future maintenance and replacement costs

Risks:

- It will take time to provide for the communications between the various stakeholders
- Significant redesign may be required

Technical Discussion:

There is a potential for construction cost savings and simplification of the systems that must be serviced over the years to come.

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	VALUE ANALYSIS DESIGN SUGGESTION	ALTERNATIVE NO.:
PROJECT:	**I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	**IT-8**
DESCRIPTION:	**PROVIDE FOR COORDINATION OF TRAFFIC MANAGEMENT ASSETS**	SHEET NO.: 1 of 1

Original Design:

Similar to IT-7, there are redundant devices for traffic data collection.

Alternative:

Opportunities should be sought for consolidation of devices and the sharing of their data flow.

Opportunities:

- Cost savings for initial and maintenance capital outlay
- Operations enhancements

Risks:

- Time will be required to orchestrate this effort
- Some redesign may be required

Technical Discussion:

There is a need for a standard data collection protocol to aid in the collection and dissemination of data.

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VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-9**
IM 0253-222 PCN 18695

DESCRIPTION: **MAXIMIZE USE OF EXISTING SIGN STRUCTURES** SHEET NO.: 1 of 1

Original Design:

The ATM/Tolling project has almost 40 new structures for devices and signage.

Alternative:

Consideration might be given to seeking opportunities to reuse some of the existing structures for mounting these devices and signs.

Opportunities:

- Reducing structures in the clear zone should help improve traffic safety
- Initial cost savings

Risks:

- Some redesign may be required

Technical Discussion:

If this is possible, there could be significant benefits in terms of initial cost savings and in the expedition of construction.

This design suggestion is a part of several design suggestions and alternatives that encourage simplification of the data fed to drivers passing through this corridor. Spacing structures out along the way would give the drivers time to digest the information provided to them from the last sign array.

	VALUE ANALYSIS DESIGN SUGGESTION	ALTERNATIVE NO.:
PROJECT:	**I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	**IT-11**
DESCRIPTION:	**SET OBJECTIVE TO INTEGRATE THIS PROJECT INTO AREA WIDE MASTER PLAN FOR ATM**	SHEET NO.: 1 of 1

Original Design:

ATM is employed for this six-mile project. It is being used to reduce congestion and improve safety.

Alternative:

As this project is being deployed, it would be a good time to evaluate how the project is to be deployed and to be sure that it is a part of the area wide master plan.

Opportunities:

- Will likely add to the effectiveness of future deployments

Risks:

- None apparent

Technical Discussion:

Much of the ATM deployment is geared toward queue detection and management. Based on the quick analysis, the cost for this system is about $8 million. One of the questions about deployment and implementation of this queue detection is what mechanism will be used to manage queues. Will this be based on CDOT research of spaced harmonization or other technical approach? Based on past studies/projects, the ATM could have significant impact on this corridor if deployed from downtown to the northern limits of this project.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-14**
IM 0253-222 PCN 18695

DESCRIPTION: **DEFINE ENFORCEMENT CONCEPT** SHEET NO.: 1 of 1

Technical Discussion:

The design calls for a buffered, separated configuration for managed lanes throughout the corridor. This type of configuration raises enforcement questions. Is there an enforcement plan and has it been worked out so that appropriate enforcement assets will be available when needed?

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VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-15**
IM 0253-222 PCN 18695

DESCRIPTION: **IMPLEMENT INCIDENT MANAGEMENT CONCEPT** SHEET NO.: 1 of 1

Technical Discussion:

A "quick clearance program" should be developed as part of the existing incident management plan. Establishing best practices for first responders and CDOT to deal with incidents will add significant value to the current Incident Management Plan of detour/diversion. The quick clearance of incidents should help minimize the impact on traffic.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **IT-16**
IM 0253-222 PCN 18695

DESCRIPTION: **IMPLEMENT RAMP METERNG FOR CORRIDOR CONSISTENCY** SHEET NO.: 1 of 1

Original Design:

The design now calls for ramp metering at some locations.

Alternative:

Consideration might be given to deploying ramp metering for all ramps in the project.

Opportunities:

- Will improve traffic flow
- Better coordination

Risks:

- Some redesign may be required
- Added costs

Technical Discussion:

Some locations may not have the necessary volume to warrant metering. However, from a corridor perspective, it will allow for better coordination if the entire project has ramp metering on all ramps. An important consideration for this suggestion is whether or not the existing operations system is capable of accommodating the use of metering at the ramp locations not already metered.

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **PV-4**
IM 0253-222 PCN 18695

DESCRIPTION: **PROVIDE AUXILIARY LANE BETWEEN THORNTON PARKWAY AND 104TH AVENUE** SHEET NO.: 1 of 3

Original Design:

There is no auxiliary lane planned in the original design.

Alternative:

The alternative would provide a full auxiliary lane between Thornton Parkway and 104th Avenue.

Opportunities:

- Improved safety
- Added capacity

Risks:

- Significant redesign will be required
- Additional construction cost
- Added vehicular movements
- Project delivery schedule may not afford time to do this

Technical Discussion:

The existing on-ramp from Thornton Parkway merges onto Northbound I-25 then, as one approaches the 104th off-ramp, an exit ramp with two lanes is present for two vehicles to exit. The alternative would then call for extending an auxiliary lane as noted.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 0	$	$ 0
ALTERNATIVE	$ 512,088	$	$ 512,088
SAVINGS	$ (512,088)	$	$ (512,088)

CALCULATIONS

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-4**
DESCRIPTION:	**PROVIDE FULL AUXILIARY LANE BETWEEN THORNTON PKWY & 104TH AVE**	SHEET NO.: 2 of 3

UNCLASSIFIED EXCAVATION: $3200' \times 12' \times 21.5'' / 27 = 2,548.14$ → 2,548 CY

RECONDITIONED EXISTING EMBANKMENT: $3200' \times 12' \times 2' / 27 = 2,844.44$ → 2,844 CY

AGGREGATE BASE COURSE (CL 6): $\frac{3200' \times 12' \times 1' \times 133}{2000} = 2,553.6$ TON → 2,554 TON

HOT MIX ASPHALT (GR S): $\frac{3200' \times 12' \times 11.5'' \times 110}{9\ (2000)} = 2,698.67$ → 2,699 TON

STONE MATRIX ASPHALT: $\frac{3200' \times 12' \times 2'' \times 110}{9\ (2000)} = 469.33$ → 469 TON

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **PV-4** SHEET NO.: 3 of 3

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Unclassified Excavation	CY	0	$ -	$ -	2,548	$ 25.00	$ 63,700
EMB. Mat'l (CIP)(Special)	CY	0		$ -	2844	$ 20.00	$ 56,880
Aggregate Base Course	Ton	0		$ -	2554	$ 15.00	$ 38,310
HMA (GR 5) (100)(PG64-22)	Ton	0		$ -	2699	$ 65.00	$ 175,435
SMA (Fibers)(Asphalt)	Tone	0		$ -	469	$ 90.00	$ 42,210
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$ -			$ 376,535
Mark-up at 36.00%				$ -			$ 135,553
TOTAL				**$ -**			**$ 512,088**
Estimated Savings:							($512,088)

	VALUE ANALYSIS DESIGN ALTERNATIVE	ALTERNATIVE NO.:
PROJECT:	**I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	**PV-8**
DESCRIPTION:	**ON SB I-25, PROVIDE PARALLEL ACCELERATION LANE FROM 104TH AVE**	SHEET NO.: 1 of 5

Original Design:

Uniform 35:1 taper merge for two lanes coming onto mainline SB I-25 from 104 Ave. Length of taper = 855ft for two lanes.

Alternative:

Provide a 50:1 (620ft) taper to merge two on-ramp lanes onto one, then provide a 600ft parallel acceleration lane, terminating with a 300ft lane termination taper.

Opportunities:

- Allows for safer operation
- Reduces vehicle conflict

Risks:

- Additional cost to project
- May conflict with ROD

Technical Discussion:

The taper and parallel accelerations lengths are regularly used in the metro area and are consistent with AASHTO guidance.

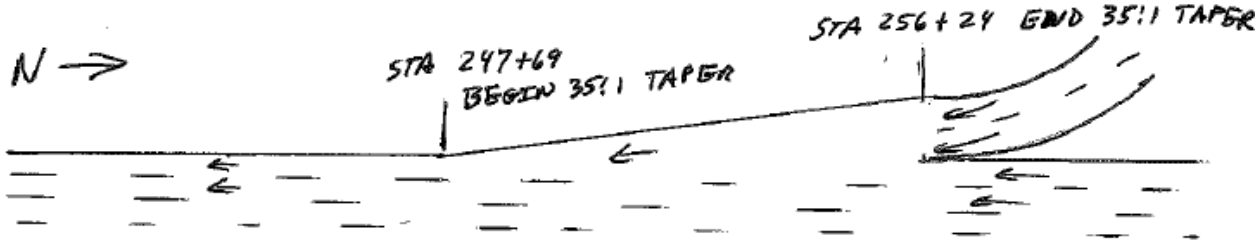
COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 32,849	$	$ 32,849
ALTERNATIVE	$ 93,871	$	$ 93,871
SAVINGS	$ (61,022)	$	$ (61,022)

ILLUSTRATION

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-8**
DESCRIPTION:	**ON SB I-25, PROVIDE PARALLEL ACCELERATION LANE FROM 104TH AVE**	SHEET NO.: 2 of 5

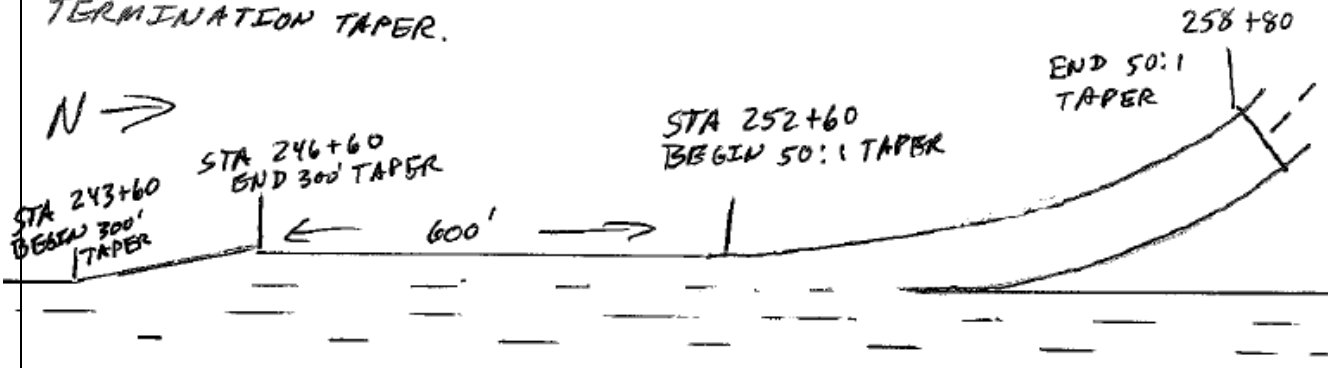
ORIGINAL DESIGN:

SIMPLE TAPER 35:1 (855') TO MERGE TWO ON-RAMP LANES ONTO I-25



ALTERNATIVE DESIGN

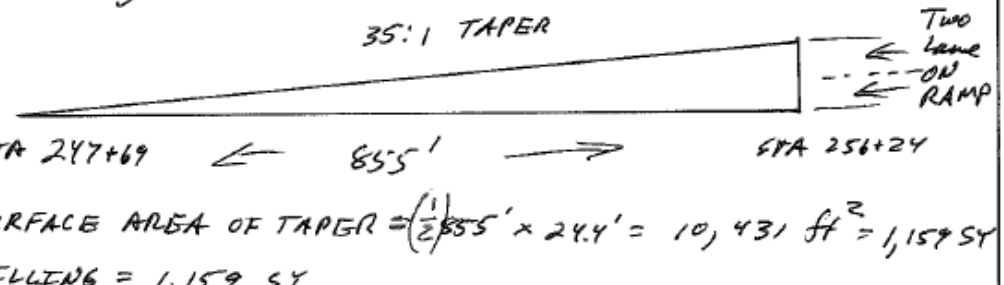
STARTING AT RAMP METER, @ ~ STA 258+80, USE 50:1 (620') TAPER TO MERGE TWO ON-RAMP LANES TO ONE LANE. THEN, PROVIDE 600' PARALLEL ACCEL LANE, FOLLOWED BY 300' TERMINATION TAPER.



CALCULATIONS

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-8**
DESCRIPTION:	**ON SB I-25, PROVIDE PARALLEL ACCELERATION LANE FROM 104TH AVE**	SHEET NO.: 3 of 5

Original Design:



SURFACE AREA OF TAPER = $(\frac{1}{2} \times 855' \times 24.4' = 10,431\ ft^2 = 1,159\ SY$

MILLING = 1,159 SY

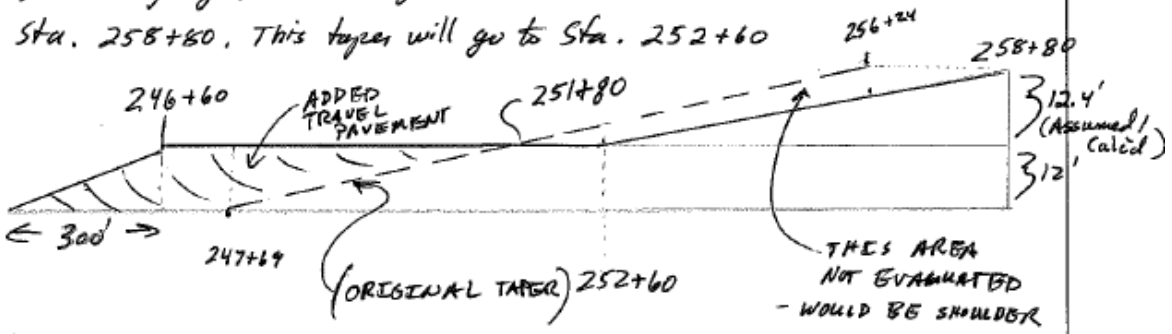
PAVING = 1,159 SY × 110 lbs/SY/inch × 4.5 inches = 286.9 tons HMA

SMA 2 inches = 127.5 tons

HMA 2.5 inches = 159.4 tons

Alternative Design:

Start Merging Two On-Ramp lanes @ Ramp Meter Stop-Bar @ Sta. 258+80. This taper will go to Sta. 252+60



ADDITIONAL TRAVEL PAVEMENT REQ'D

$\frac{1}{2}(300' \times 12') + (24769 - 24660)(12') + \frac{1}{2}(25190 - 24769)(12')$

$= 1800\ ft^2 + 1,308\ ft^2 + 2,526\ ft^2 = 5,634\ ft^2$

$= 626\ SY$

SMA: 626 SY × 110 lbs/SY/IN × 2 INCH = 68.9 Tons

HMA: 626 SY × 110 × 11.5 inch = 395.9 Tons

ABC: 5,634 ft² × 1 ft × 133 lbs/ft³ = 374.66 tons

SUBEX: 626 SY × (2/3) YD = 417.33

CALCULATIONS

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-8**
DESCRIPTION:	**ON SB I-25, PROVIDE PARALLEL ACCELERATION LANE FROM 104TH AVE**	SHEET NO.: 4 of 5

ALTERNATIVE DESIGN CONT'D

AREA TO BE MILLED / OVERLAID

- Assume Limits Are Within 247+69 to 256+25

$$\text{Area} = \tfrac{1}{2}(12)(251+80 - 247+69) + (12)(25260 - 25180)$$

$$+(12)(25624 - 25260) + \tfrac{1}{2}(12.4)\left[(25624-25260)/(25880-25260)\right] * (25624-25260)$$

$$\Rightarrow \text{Area} = 2,466\ ft^2 + 960\ ft^2 + 4,368\ ft^2 + 1,325\ ft^2$$

$$\Rightarrow \text{Area} = 9,119\ ft^2 = 1,013\ SY$$

TONS SMA OVERLAY = 2" x 110 lbs/SY/in x 1,013 SY / 2000 lbs/ton

= 111.4 Tons

TONS HMA OVERLAY = 2.5" x 110 lbs/SY/in x 1,013 SY ÷ 2000 lbs/

= 139.3 Tons

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **PV-8** SHEET NO.: 5 of 5

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Milling	SY	1,159	$2.00	$2,318	1,013	$2.00	$2,026
Overlay – 2" SMA	Tons	127.5	$90.00	$11,475	111.4	$90.00	$10,026
Overlay – 2.5" HMA	Tons	159.4	$65.00	$10,361	139.3	$65.00	$9,055
Paving SMA 2"	Tons			$	68.9	$90.00	$6,201
Paving HMA 11.5"	Tons			$ -	395.9	$65.00	$25,734
ABC	Tons			$ -	374.7	$15.00	$5,621
SUBEX	CY			$ -	417.3	$25.00	$10,433
				$ -			$ -
				$ -			$ -
Sub-total				$24,154			$69,096
Mark-up at 36.00%				$8,695			$24,875
TOTAL				**$32,849**			**$93,871**
Estimated Savings:							($61,022)

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **PV-9**
IM 0253-222 PCN 18695

DESCRIPTION: **PROVIDE PARALLEL DECELERATION LANE – 1000' APPROACH TO THORNTON PARKWAY** SHEET NO.: 1 of 4

Original Design:

The Thornton Parkway southbound off ramp starts at Station 215+50 with no deceleration lane. The ramp is where deceleration is expected to occur. (See attached illustration)

Alternative:

The alternative would provide a 1000' deceleration lane prior to the off-ramp entrance. (See attached illustration)

Opportunities:

- Improved safety
- Reduces the impedance of mainline traffic

Risks:

- Moderate redesign will be required
- Additional construction cost

Technical Discussion:

There would be some significant advantages realized from adding this highly beneficial deceleration lane. First, the vehicles exiting the mainline to take the Thornton Road off-ramp will be able to more safely execute the maneuver. Since they will be able to move out of the mainline flow of traffic in order to decelerate, this added lane should assist in maintaining the flow of traffic on the mainline.

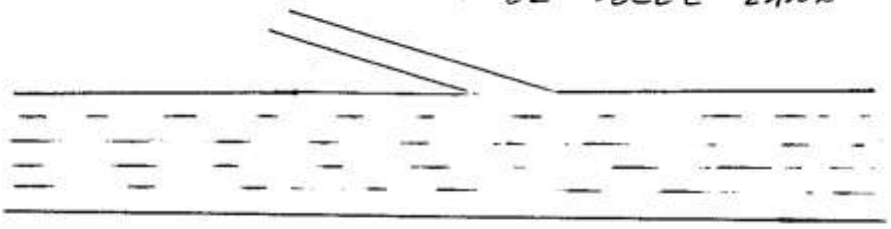
COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 4,039,200	$ 2,671,774	$ 5,641,774
ALTERNATIVE	$ 1,069,200	$ 377,826	$ 797,826
SAVINGS	$ 3,468,000	$ 2,293,948	$ 4,843,948

ILLUSTRATION

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-9**
DESCRIPTION:	**PROVIDE PARALLEL DECELERATION LANE – 1000' APPROACH TO THORNTON PARKWAY**	SHEET NO.: 2 of 4

ORIGINAL DESIGN:

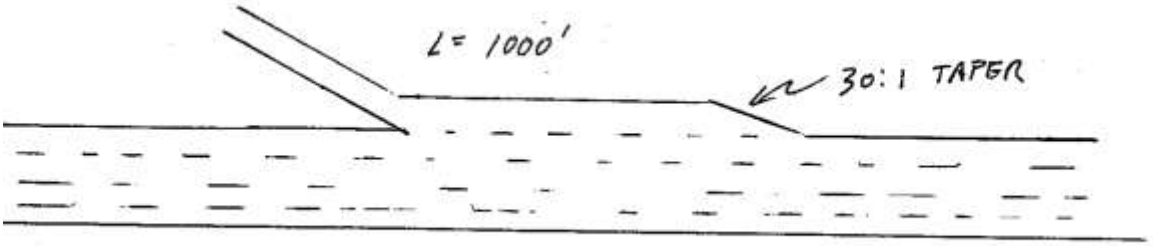
SB OFF RAMP TO THORNTON PKWY STARTS @ STA 215+50, AND IS A SIMPLE TAPER WITH NO PARALLEL DECEL LANE



ALTERNATIVE DESIGN:

CONSTRUCT PARALLEL DECELLERATION LANE 500' MIN, 1000' PREFERRED

THE DECEL LANE COULD HELP WITH OVERALL OPERATION OF FACILITY.



CALCULATIONS

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-9**
DESCRIPTION:	**PROVIDE PARALLEL DECELERATION LANE – 1000' APPROACH TO THORNTON PARKWAY**	SHEET NO.: 3 of 4

ORIGINAL DESIGN!

PLANS SHOW APPROXIMATELY 200' x 12' wide + $\frac{1}{2}$ (12')(100') OF TAPERED OFF-RAMP TO BE MILLED & OVERLAID.

$[(200' \times 12') + \frac{1}{2}(12')(100')] = 3000\ SF = 333.3\ SY$

MILLING = 333.3 SY

2" SMA OVERLAY = $(110\ lbs/SY/in)\left(\frac{1\ ton}{2000\ lbs}\right)(333.3)(2\ in) = 36.7$ TONS

2.5" HMA OVERLAY = $(" \quad " \quad " \quad (2.5\ in) = 45.8$ TONS

ALTERNAIVE DESIGN

30:1 TAPER = 360' ; Area of TAPER = $(\frac{1}{2})(360)(12) = 2{,}160\ ft^2$ = 240 SY

PARALLEL LANE = 1000' x 12' = 12,000 ft² = 1,333 SY

(MINIMUM DES) 500' x 12' = 6,000 ft² = 667 SY

ASSUME THIS WOULD TIE INTO EXISTING RAMP @ GORE

SO, MILL + OVERLAY NEEDED FOR 200'x12' = 2,400 ft² = 267 SY

FOR 100' Design:

MILLING QNTY = 267 SY

2" SMA QNTY = (240 SY) + (1,333 SY) + (267 SY) = 1,840 SY

$(1840\ SY)(110\ lbs/SY/in)(2\ in)\left(\frac{1}{2000}\right) = 202$ Tons

2.5" HMA QNTY = $(267\ SY)(110)(2.5)\frac{1}{2000} = 36.7$ Tons

ABC = $1{,}573\ SY \times \frac{9\ ft^2}{SY} \times 133\ \frac{lb}{ft^2} \times \frac{1}{2000} = 941$ Tons

SUBEX = $\left(1{,}573\ SY \times \frac{2\ ft}{3\ ft}\right) = 1{,}049$ CY

11.5" HMA = $(240\ SY + 1{,}333\ SY)(11.5)(110)\left(\frac{1}{2000}\right) = 995$ Tons

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **PV-9** SHEET NO.: 4 of 4

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
MILLING	SY	333	$ 2.00	$ 667	267	$ 2.00	$ 534
2 INCH SMA	TONS	37	$ 90.00	$ 3,303	202	$ 90.00	$ 18,180
2.5 INCH HMA	TONS	46	$ 65.00	$ 2,977	36.7	$ 65.00	$ 2,386
11.5" HMA	TONS			$ -	995	$ 65.00	$ 64,675
ABC	TONS			$ -	941	$ 15.00	$ 14,115
SUBEX	CY			$ -	1049	$ 25.00	$ 26,225
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$ 6,947			$ 126,115
Mark-up at 36.00%				$ 2,501			$ 45,401
TOTAL				**$ 9,447**			**$ 171,516**
Estimated Savings:							($162,068)

	VALUE ANALYSIS DESIGN ALTERNATIVE	ALTERNATIVE NO.:
PROJECT:	**I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	**PV-9A**
DESCRIPTION:	**PROVIDE 500 FOOT PARALLEL DECELERATION LANE FOR THE APPROACH TO THORNTON PARKWAY**	SHEET NO.: 1 of 4

Original Design:

The Thornton Parkway southbound off ramp starts at Station 215+50 with no deceleration lane. The ramp is where deceleration is expected to occur. (See attached illustration)

Alternative:

The alternative would provide a 500' (preferred design length) deceleration lane prior to the off-ramp entrance. (See attached illustration)

Opportunities:

- Improved safety
- Reduces the impedance of mainline traffic

Risks:

- Moderate redesign will be required
- Additional construction cost

Technical Discussion:

There would be some significant advantages realized from adding this highly beneficial deceleration lane. First, the vehicles exiting the mainline to take the Thornton Road off-ramp will be able to more safely execute the maneuver. Since they will be able to move out of the mainline flow of traffic in order to decelerate, this added lane should assist in maintaining the flow of traffic on the mainline.

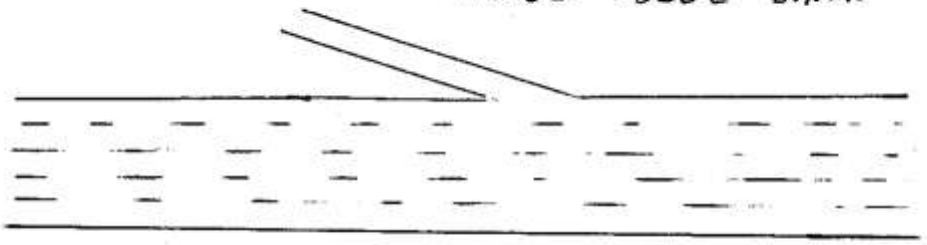
COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 9,448	$	$ 9,448
ALTERNATIVE	$ 102,086	$	$ 102,086
SAVINGS	$ (92,638)	$	$ (92,638)

ILLUSTRATION

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-9A**
DESCRIPTION:	**PROVIDE 500 FOOT PARALLEL DECELERATION LANE FOR THE APPROACH TO THORNTON PARKWAY**	SHEET NO.: 2 of 4

ORIGINAL DESIGN:

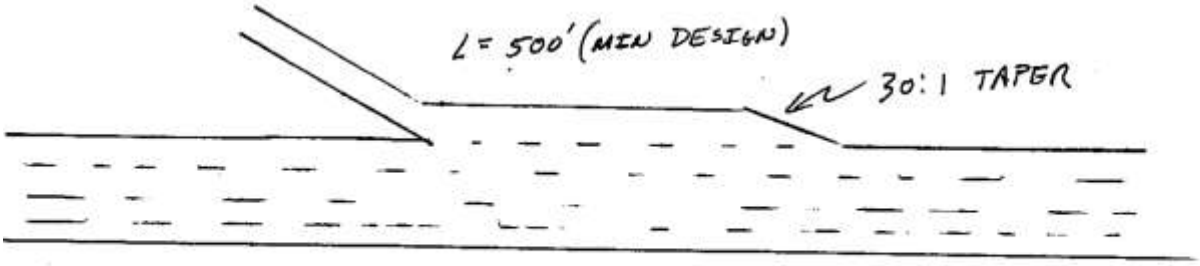
SB OFF RAMP TO THORNTON PKWY STARTS @ STA 215+50, AND IS A SIMPLE TAPER WITH NO PARALLEL DECEL LANE



ALTERNATIVE DESIGN:

CONSTRUCT PARALLEL DECELLERATION LANE 500' MIN, 1000' PREFERRED

THE DECEL LANE COULD HELP WITH OVERALL OPERATION OF FACILITY.



CALCULATIONS

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **PV-9A**
DESCRIPTION:	**PROVIDE 500 FOOT PARALLEL DECELERATION LANE FOR THE APPROACH TO THORNTON PARKWAY**	SHEET NO.: 3 of 4

For 500' Design – See PV9 For Base Area Calc.s.

MILLING = 267 SY

2" SMA = 240 SY + 667 SY + 267 SY = 1,174 SY

$1{,}174\ SY \times 110\ \frac{lb}{SY/in} \times \frac{1}{2000} \times 2\ inches = 129\ TONS$

2.5" HMA = $(267\ SY)(110)(2.5)\left(\frac{1}{2000}\right) = 36.7\ Tons$

11.5" HMA = $(667\ SY + 240\ SY)(110)(11.5)\left(\frac{1}{2000}\right) = 573.7\ Tons$

ABC = $(667+240)\left(9\ \frac{ft^2}{SY}\right)(1ft)\left(133\ \frac{lb}{ft^2}\right)\frac{1}{2000} = 542.8\ TONS$

SUBGR = $(667+240)\left(\frac{2}{3}\right) = 604\ CY$

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.:	**PV-9A**
		SHEET NO.:	4 of 4

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
MILLING	SY	333	$ 2.00	$ 667	267	$ 2.00	$ 534
2" SMA	Tons	37	$ 90.00	$ 3,303	129	$ 90.00	$ 11,610
2.5" HMA	Tons	46	$ 65.00	$ 2,977	36.7	$ 65.00	$ 2,386
11.5" HMA	Tons			$ -	573.7	$ 65.00	$ 37,291
ABC	Tons			$ -	542.8	$ 15.00	$ 8,142
SUBEX	CY			$ -	604	$ 25.00	$ 15,100
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$ 6,947			$ 75,063
Mark-up at 36.00%				$ 2,501			$ 27,023
TOTAL				**$ 9,448**			**$ 102,086**
Estimated Savings:							($92,638)

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **PV-10**
IM 0253-222 PCN 18695

DESCRIPTION: **RE-STRIPE THORNTON PARKWAY SOUTHBOUND RAMP** SHEET NO.: 1 of 1

Original Design:

Currently, the on-ramp is striped as a tapered acceleration lane.

Alternative:

Re-stripe ramp as a parallel acceleration lane.

Opportunities:

- Should improve safety
- Should improve traffic operations

Risks:

- Some minimal re-design

Technical Discussion:

This re-striping can be done without adding any pavement. So, the result is a more effective acceleration lane at very little extra cost, if any.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **TC-1**
IM 0253-222 PCN 18695

DESCRIPTION: **RE-SEQUENCE CONSTRUCTION PHASING** SHEET NO.: 1 of 2

Original Design:

Phasing has median work being completed first, with milling and paving being completed in Phases 3a and 3b.

Alternative:

Re-sequence phasing so milling and paving are the final items to be completed along with tie-ins.

Opportunities:

- Less traffic shifting
- Better finished product. No pavement scarring from lane shifts.

Risks:

- None apparent.

Technical Discussion:

Phasing seems out of sequence. Milling and final paving should be the last item to be performed. Try to reduce number of shifts. Avoid scarring on new pavement.

ILLUSTRATION

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **TC-1**
DESCRIPTION:	**RE-SEQUENCE CONSTRUCTION PHASING**	SHEET NO.: 2 of 2

Phase 1a – Install drainage across I-25 (night work, lane closures as per Region 6 lane closure strategy)

Phase 1b – Reconstruct outside shoulders (original Phase 2)

Phase 2 – Place traffic in final configuration. Construct median… (original Phase 1)

Phase 3a – Complete all construction outside of the existing pavement. (original Phase 4a)

Phase 3b – Complete all remaining construction to complete the HOV/HOT lane connections. (original 4b)

Phase 4 – Remove barrier and place drums in HOV/HOT lanes.

- Mill and overlay with traffic in final configuration
- Place hot mix asphalt (2" – 2.5" lift) for entire project
- Place SMA for entire project

Phase 5 – Open HOV/HOT lanes

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **TC-2**
IM 0253-222 PCN 18695

DESCRIPTION: **REDUCE TEMPORARY TYPE 7 BARRIERS** SHEET NO.: 1 of 2

Original Design:

The estimate quantity of concrete barrier (temp) to be used on the project is 46,000 LF.

Alternative:

Reduce the amount of barrier needed by constructing the shoulder in segments. Also construct the median drainage improvements, sign structures and guardrail type 7 in segments.

Opportunities:

- Impact to traffic

Risks:

- Extra moves to reset barrier

Technical Discussion:

Build in segments to lessen the impact on traffic. Build approximately 1 ½ miles at a time. Reduce concrete barrier to 16,000 LF.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 1,689,120	$	$ 1,689,120
ALTERNATIVE	$ 478,725	$	$ 478,725
SAVINGS	$ 1,210,395	$	$ 1,210,395

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **TC-2** SHEET NO.: 2 of 2

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Concrete Barrier (temp)	LF	46,000	$ 27.00	$ 1,242,000	16,000	$ 22.00	$ 352,000
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$ 1,242,000			$ 352,000
Mark-up at 36.00%				$ 447,120			$ 126,720
TOTAL				**$ 1,689,120**			**$ 478,725**
Estimated Savings:							($1,210,395)

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **TC-3**
IM 0253-222 PCN 18695

DESCRIPTION: **REDUCE TRAFFIC CONTROL INSPECTION (TCI) DAYS** SHEET NO.: 1 of 2

Original Design:

It is estimated that that there will be 450 TCI days associated with the duration of the project.

Alternative:

Reduce the TCI days to reflect the days needed for the project duration of 268 days (working days).

Opportunities:

- Quantity adjustment will better fit expected and necessary TCI days

Risks:

- Need to make sure that there are enough TCI days to service the length of the project

Technical Discussion:

This alternative calls for reducing the quantity of TCI days actually needed based on 268 working days. The current quantity is too high, based on project duration. The quantity will reflect the TCI days needed for weekends, holidays and potential non-chargeable weather days.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 72,216	$	$ 72,216
ALTERNATIVE	$ 27,282	$	$ 27,282
SAVINGS	$ 44,934	$	$ 44,934

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **TC-3** SHEET NO.: 2 of 2

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
Traffic Control Inspection	Days	450	$ 118.00	$ 53,100	170	$ 118.00	$ 20,060
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$ 53,100			$ 20,060
Mark-up at 36.00%				$ 19,116			$ 7,222
TOTAL				**$ 72,216**			**$ 27,282**
Estimated Savings:							$44,934

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **TC-6**
IM 0253-222 PCN 18695

DESCRIPTION: **PAY FOR MOBILE ATTENUATORS BY DAYS** SHEET NO.: 1 of 1

Original Design:

The design identifies the cost of the mobile attenuators by cost unit "each".

Alternative:

The pay item for the mobile attenuators should "days" (pay for each of the attenuators by day when they are being used on the job site).

Opportunities:

- More flexibility as to how the attenuators can be used and their costs tracked
- More accurate cost estimate

Risks:

- Cost tracking by engineer is more complicated

Technical Discussion:

Even if this was not a CDOT standard to pay by day per attenuator as it is used on the job site, it is more accurate to use this cost approach in the design and the construction phases.

It should be noted that the VE team feels that the cost for the attenuators will actually be significantly higher than what is currently reflected in the estimate. Suggest that this be checked as the design and estimate move to the next level.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **MI-1**
IM 0253-222 PCN 18695

DESCRIPTION: **OPTIMIZE CONDUIT SIZES** SHEET NO.: 1 of 1

Original Design:

Place 3" conduit (plastic) for mainline lighting.

Alternative:

Use approximately sized lighting conduit. (2" conduit may satisfy requirements).

Opportunities:

- Smaller conduit is easier to work with
- Save cost with smaller size

Risks:

- Will not be able to add more wiring in future

Technical Discussion:

Is 3" plastic conduit needed? A smaller size may be more appropriate. Some of the conduit may need to be bored, resulting in different pricing. The sizing may result in a cost savings. This will likely be more apparent as the design progresses.

VALUE ANALYSIS DESIGN ALTERNATIVE ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **MI-2**
IM 0253-222 PCN 18695

DESCRIPTION: **USE SHORTER LIGHT STANDARDS** SHEET NO.: 1 of 3

Original Design:

The current design calls for 77 each, 70 foot high light standards with triple headed, 1000 W fixtures.

Alternative:

The alternative would call for the use of 134 each, 40 foot high light standards with double-headed, 400 W fixtures.

Opportunities:

- Initial cost savings
- Significant Maintenance and energy cost savings
- Reduced light pollution

Risks:

- Significant redesign will be required

Technical Discussion:

The use of the 70 foot high standards would require heavy foundations that will difficult to accommodate in the median. The 40 foot high standards will go up quickly and not require significant measures to accommodate and protect in the median.

The VE team assumptions include going from three heads for 70 foot standards to two heads for 40 foot standards. Also, it will take twice as many 40 foot standards to replace the 70 foot standards (must be confirmed). Also, assumed that the caisson savings would offset the additional cost for the alternative conduits.

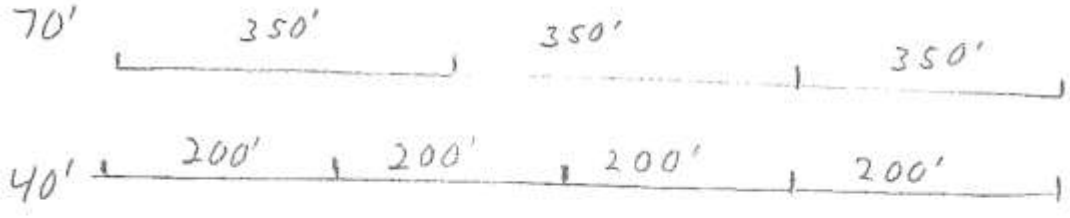
COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 1,629,484	$	$ 1,629,484
ALTERNATIVE	$ 1,150,560	$	$ 1,150,560
SAVINGS	$ 478,924	$	$ 478,924

ILLUSTRATION

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	ALTERNATIVE NO.: **MI-2**
DESCRIPTION:	**USE SHORTER LIGHT STANDARDS**	SHEET NO.: 2 of 3

spacing 70' x 5 = 350'

350' x 77(ea) = 26,950'



spacing 40' x 5 = 200'

26,920 / 200 = 134(ea)

based on CDOT's height x 5 = spacing

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **MI-2** SHEET NO.: 3 of 3

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
70 foot high standards	EA	77	$ 9,000.00	$ 93,000			$ -
40 foot high standards	EA			$ -	134	$ 3,000.00	$ 402,000
Luminaire Heads	EA	211	$ 1,500.00	$ 316,500	278	$ 850.00	$ 236,300
Pull Boxes	EA	77	$ 650.00	$ 50,050	134	$ 650.00	$ 87,100
Caisson	LF	924	$ 150.00	$ 138,600			$ -
Foundation	EA			$ -	134	$ 900.00	$ 120,600
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$1,198,150			$ 846,000
Mark-up at 36.00%				$ 431,334			$ 304,560
TOTAL				**$1,629,484**			**$1,150,560**
Estimated Savings:							$478,924

	VALUE ANALYSIS DESIGN ALTERNATIVE	ALTERNATIVE NO.:
PROJECT:	**I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	**MI-3**
DESCRIPTION:	**REDUCE LIGHTING COVERAGE**	SHEET NO.: 1 of 2

Original Design:

The current design calls for 77 each, 70 foot high light standards with 1000 Watt light fixtures. The project site is in a transition area from dense urban to light urban land use, with interchange spacing at approximately one mile.

Alternative:

The VE came upon the question – does the project require roadway lighting to supplement high mast lighting at interchanges? Is this a requirement from the EIS? Could the focus of the lighting on this project be on the area one mile north of U.S. 36 only, or specific areas where lighting needs have been identified. The documentation says, "proposed project is to reduce roadway lighting one mile north of U.S. 36".
It appears that it might be possible to reduce the lighting requirement from 30,000 LF of lighting to 5,280 LF.

Opportunities:

- Initial cost savings
- Significant Maintenance and energy cost savings
- Reduced light pollution

Risks:

- Pavement will not be lit as well
- Moderate redesign required.
- Need to reconstruct median barrier if median roadway lighting is needed in the future

Technical Discussion:
Taken to its conclusion, the obvious question is whether or not the intent is to illuminate the entire corridor. Perhaps, the noted reduction in lighting deployment could be a good place to stop for this time.

COST SUMMARY	INITIAL COST	PRESENT WORTH RECURRING COSTS	PRESENT WORTH LIFE-CYCLE COST
ORIGINAL DESIGN	$ 2,479,416	$	$ 2,479,416
ALTERNATIVE	$ 436,377	$	$ 436,377
SAVINGS	$ 2,043,039	$	$ 2,043,039

COST WORKSHEET

PROJECT:	**Colorado Department of Transportation** **I-25 Managed Lanes: US 36 to 120th Avenue** **Federal Aid Project Number - IM 0253-222** **Project Code No. 18695**	ALTERNATIVE NO.: **MI-3** SHEET NO.: 2 of 2

CONSTRUCTION ITEM		ORIGINAL ESTIMATE			PROPOSED ESTIMATE		
ITEM	UNITS	NO. OF UNITS	COST/ UNIT	TOTAL	NO. OF UNITS	COST/ UNIT	TOTAL
			$ -	$ -		$ -	$ -
Lighting from estimate	LF	30,000	$ 60.77	$1,823,100			$ -
				$ -			$ -
Lighting for reduced run	LF			$ -	5280	$ 60.77	$ 320,866
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
				$ -			$ -
Sub-total				$ 1,823,100			$ 320,866
Mark-up at 36.00 %				$ 656,316			$ 115,512
TOTAL				**$ 2,479,416**			**$ 436,377**
Estimated Savings:							$2,043,039

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **MI-4**
IM 0253-222 PCN 18695

DESCRIPTION: **INTEGRATE LIGHTING INTO BARRIER WALLS** SHEET NO.: 1 of 1

Original Design:

The existing design calls for concrete barrier walls in the medians.

Alternative:

The alternative would call for down lighting to be integrated into the barrier walls.

Opportunities:

- Entrance efficacy of lighting

Risks:

- Moderate redesign cost
- Initial cost increase

Technical Discussion:

LED lighting may be a good candidate for providing this integrated lighting.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **MI-6**
IM 0253-222 PCN 18695

DESCRIPTION: **CONSIDER USE OF LED FIXTURES FOR ROADWAY LIGHTING** SHEET NO.: 1 of 1

Original Design:

The current design calls for High Pressure Sodium (HPS) type light fixtures to illuminate the roadway.

Alternative:

Consideration might be given to the use of LED light fixtures.

Opportunities:

- Reduced maintenance costs
- Minimizes maintenance crew time in high traffic areas
- Life cycle energy cost savings

Risks:

- There will be an initial cost increase since LED lights are much more expensive than HPS lights

Technical Discussion:

The current trend is to move toward greater utilization of LED light fixtures in most industries. For each application contemplated one must research the availability of appropriate LED fixtures and determine their unit costs. It is understood that roadway lighting with LED fixtures is in its infancy and is not immediately reassuring. Attached the reader will find a brochure that should help in deciding whether the alternative should be implemented. The usual conclusions should be that a more natural light color rendition results for LED vs. HPS lighting. The life of the LED bulbs exceeds that for HPS lighting. Since the bulbs do not need replacement as often, the maintenance crews do not have to get out into high traffic areas so often. This is a real plus. LED lights are more expensive but, due to their longer life, they generally prove out on a life cycle cost basis.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **MI-7**
IM 0253-222 PCN 18695

DESCRIPTION: **REVISIT POSSIBILTIY OF NEW BRIDGE AT 88TH AVENUE** SHEET NO.: 1 of 1

Original Design:

Currently, 88th Avenue passes over the existing I-25 Mainline. This situation has been studied carefully and, due to cost considerations, it was decided to lower I-25 mainline in order to get the required overhead clearance between the mainline pavement and the bottom chord of the bridge.

Alternative:

Re-stripe ramp as a parallel acceleration lane.

Opportunities:

- Should improve safety
- Should improve traffic operations

Risks:

- Some minimal re-design

Technical Discussion:

This re-striping can be done without adding any pavement. So, the result is a more effective acceleration lane at very little extra cost, if any.

VALUE ANALYSIS DESIGN SUGGESTION ALTERNATIVE NO.:

PROJECT: **I-25 Managed Lanes: US 36 to 120th Ave** **MI-8 & 9**
IM 0253-222 PCN 18695

DESCRIPTION: **REPLACE IN LIEU OF RESET EXISTING GUARDRAIL** SHEET NO.: 1 of 1

Original Design:

The design calls for resetting approximately 13,000 LF of Type 3 Guardrail.

Alternative:

Consideration should be given to replacing the existing Type 3 with new Type 3 or cable rail where possible.

Opportunities:

- This will enhance safety aspects of project
- Will reduce maintenance cost

Risks:

- Significant redesign required

Technical Discussion:

The cost to reset guardrail can actually be more than if new guardrail is used. In addition, resetting Type 3 guardrail can much more labor intensive and difficult than using the new.

Cable rail is an efficient barrier. When impacted, it minimizes the damage to people and property. Although cable rail cannot be used throughout much of the project, due its deflection during an incident, but should be considered for isolated areas of application. Some of the deflection can be dealt with during the design stage.

	VALUE ANALYSIS DESIGN SUGGESTION	ALTERNATIVE NO.:
PROJECT:	**I-25 Managed Lanes: US 36 to 120th Ave** **IM 0253-222 PCN 18695**	**MI-10**
DESCRIPTION:	**ENHANCE DEFINIITION OF PROJECT REQUIREMENTS**	SHEET NO.: 1 of 1

Technical Discussion:

When the Value Engineering team was working their way through the Function Analysis Phase, they arrived at the conclusion that this interesting project is not easily pigeonholed like many projects. The popular title of the project, "I-25 Managed Lanes", tells only part of the story. The project is also a pilot program to test the application of some intensive Active Traffic Management, Tolling and other sophisticated tools on a critical corridor. It is a corridor that has some of the heaviest traffic congestion in the State. Accordingly, many eyes will be observing the rollout of this project and its resulting benefits as measured in the near future.

It is suggested that CDOT capitalize on the knowledge to be gained from this project by establishing a well-defined series of measures for its operational parameters. The following might be asked in developing the success measures for the different elements of this project:

- What is this project supposed to do?
- How do we measure success on this project?
- One of our known goals is to reduce congestion. How do we define our goals so that we can measure our success or failure?
- One of our goals is to increase capacity, how do we measure this?
- Will we develop an idea of the optimal density of information that we can pass on to the driving public without becoming a potentially dangerous distraction?
- Are we going to be able to correlate safety results within the project boundaries with other similar corridors that might serve as a control group for this pilot project?

In short, there is an opportunity here to provide the basis for new lessons learned in the future. These observations could provide insights that will be beneficial for years to come.

3 PROJECT DESCRIPTION

3.1 NEED AND PURPOSE FOR PROJECT

The North I-25 Managed lanes extension project involves the creation of managed lanes along I-25 from US 36 to 120th Avenue by repurposing the existing inside shoulders of the roadway, both north and southbound. CDOT will be responsible for the design and construction of the new facility as well as maintenance of the facility and ITS infrastructure while the High-Performance Transportation Enterprise (HPTE) will be responsible for the management and operation of the managed lanes including the tolling system. It is planned that the E-470 Public Highway Authority will provide back office support to process and issue tolls, as well as collect payment.

The project would provide meaningful relief for the most congested corridor in the Denver Metropolitan area, currently traveled by 175,000 vehicles and 4,300 bus transit riders every day. Implementation of the managed lanes will result in a more efficient use of available roadway capacity to improve traffic flow and reduce travel times in the corridor. In addition, the managed lanes will support Bus Rapid Transit (BRT) along the corridor and provide more consistent transit travel times for the many express transit routes that currently serve the corridor.

Under the new managed lanes configuration all eligible user (HOVs, registered hybrid vehicles, motorcycles, buses and toll-paying POVs) will be able to access the managed lanes at designated ingress/egress points.

3.2 GENERAL SCOPE DESCRIPTION

The proposed North I-25 managed lane system will offer more choices to commuters and make the best use of available freeway capacity. The project has several key goals that include:

- Utilize managed lanes to improve flow in the general purpose lanes and thereby improve travel along the corridor for a roadway users;
- Provide a means for public transit to achieve better on-time performance by removing them from the congestion in the general purpose lanes; and,
- Encourage carpooling and alternative modes of travel by offering free use of the managed lanes for public transit and HOV users;
- Encourage the further economic growth in the corridor by providing a more efficient transportation system.

All the usual concerns go along with this project. These concerns include:

- Meeting the objectives and requirements of the very important federal Tiger Grant. These are stringent and have a performance timeframe that calls for the obligation of the funds by June of 2013.
- There are numerous stakeholders and fund sources involved in the execution of this project. The various agreements and the EIS/ROD requirements weave together a strict route that must be followed to deliver this project.
- Among the stakeholders are the owners of the irrigation ditches that cross under the existing right-of-way. Every effort has been made to make certain that the proposed project does not impact these ditches.
- There is also an important goal that calls for building all improvements within the existing footprint of I-25. Negotiations are currently underway to obtain the temporary construction easements necessary to construct the improvements.
- Repairs to the existing noise walls and the inclusion of Noise Wall No. 2 in the project has been a carefully tracked and rehearsed part of the negotiations with the local interest groups.
- Maximizing use of available roadway capacity
- Match driver expectancy
- Minimize delays to the RTD bus operations
- Minimize toll revenue losses
- Maximize enforcement efficiency; and,
- Integrate seamlessly with the reversible lane segment

In order to do this it will be necessary to deploy key components that are subjects of carefully orchestrated protocols developed between the operating agencies. Some of the key components in tolling facilities, ITS and tolling integration, HOV lane management, courtesy patrol and snow plow operations, incident management capabilities, managed lane enforcement, enhanced Active Traffic Management (ATM) elements, Variable Message Signs (VMS), CCTV, Microwave Vehicle Radar Detectors (MVRD), Travel Time Indicators (TTI), Ramp Meter Stations (RMS) and Automatic Traffic Recorders (ATR). All of these, coupled with integrating communications make this a very complex project.

Part 3.4 of this narrative includes some drawings that will give the reader some understanding of the extent and detail of this important project.

3.3 NOTES FROM THE KICK-OFF SESSION PRESENTATIONS BY CDOT AND PROJECT DESIGN TEAM

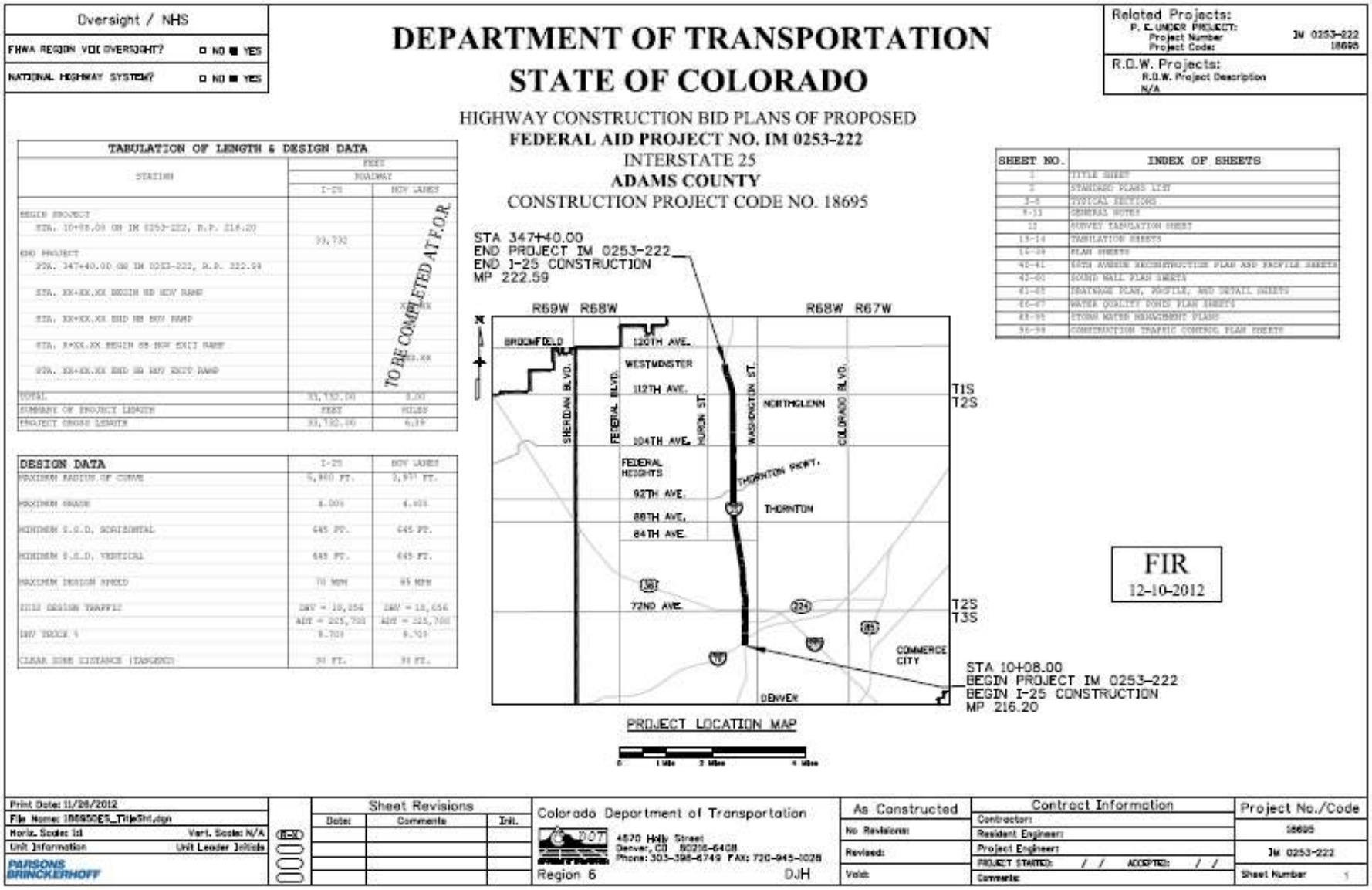
Andy Stratton - CDOT

- In the corridor there is a lot of congestion. Basically, traffic is at a standstill during heavy use hours.
- North 25 EIS -- approximately 2003 -- ROD was signed in 2009. The record of decision sealed a lot of the decision making process and set the pace for the rest of the project.
- Idea was to use some unused space on the typical section by inserting one new managed lane each way on the inside shoulder. This was a very direct way of making use of an existing asset to minimize cost and provide additional required traffic capacity.
- A federal Tiger Grant was applied for and the resulting funds have made it possible to expedite this project. Originally, this project was not seen as possible for years to come. With the added financial assets, this served to energize the other stakeholders to step up to the plate and help to fund this project. As a result, there are a lot of stakeholders (eight or nine) that are providing funds to make this happen. The Tiger Grant requires obligation of the funds by June of this year. CDOT expects to have this done by May.
- Must re-stripe lanes -- got design exceptions to go to 11.5 foot lanes and 4 foot inside shoulders. The outer two lanes are kept at 12 feet to accommodate truck traffic.
- This project will expedite bus traffic.
- Some new noise wall, pavement repair and tolling/ATM facilities have been made an integral part of the project.
- Safety was a big part of the Federal Tiger Grant.
- FIR meeting was held in December. FOR is due in March.
- Budget $44.3 million. Now at $60 million. Major elements, including ATM, tolling, etc. affect the bottom line dramatically. It appears that current funding commitments could be stretched to cover the $60 million. Could not accept a bottom line that is higher than this.
- Project will be design-bid-build.
- Concern was raised by FHWA about the status of the integration of the technology deployment and having a cradle-to-grave plan that must be approved by FHWA before the project can be approved to go forward. This will be addressed in part during the VE workshop.

Jim Bumanglag - Larry Nechanicky - Parsons Brinckerhoff

- Noise Wall No. 2 is a work in progress. The plans for this Noise Wall is separate from the current plans because it was in the project, taken out, and is now back in the project. The details are being worked out.
- Other documentation includes the comments on the FIR plan set which was covered on 10 December 2012.
- May 18, 2013 -- advertising date for bids. Construction is expected to begin in the fall and is believed to last for about 22 months.
- Action Items from the FIR meeting:
- Couple of options on the south side with regard to how the managed lanes would be connected.
- Ditches -- had to adjust by concurrences with owners of the ditches.
- Noise Walls -- currently proceeding with all noise walls as shown on the plans.
- Working within the confines of what is currently in the field -- i.e., staying within the current footprint/Right-of-way.
- Currently dealing with the need to define construction easements. Results of this research is expected shortly.
- Environmental -- pulling together the noise wall, air quality, hazmat and other features that dictate the final compliance scheme for the project.
- Drainage is fairly well along. Got concurrence to break the grade at the shoulder to simplify the design and enhance the drainage away from the mainline, on the inside of the travelways.
- Pavement calls for reconstruction of the shoulders in order to be able to handle the traffic. This is a full-depth replacement.
- With regard to scope changes -- lowering I-25 at 88th Avenue -- requires some additional phasing/costs, adding some lighting in the median for the entire project.
- Some of the constraints that are seen as necessary:
- Noise walls -- needed
- At 88th Avenue -- elected to lower the interstate. Since the bridge has been hit a few times consideration was given to the use of new bridge. Rejected due to much greater costs to put in a new bridge.

3.4 REPRESENTATIVE CONSTRUCTION DRAWINGS



Oversight / NHS

FHWA REGION VOI OVERSIGHT? ☐ NO ■ YES

NATIONAL HIGHWAY SYSTEM? ☐ NO ■ YES

DEPARTMENT OF TRANSPORTATION
STATE OF COLORADO

HIGHWAY CONSTRUCTION BID PLANS OF PROPOSED
FEDERAL AID PROJECT NO. IM 0253-222
INTERSTATE 25
ADAMS COUNTY
CONSTRUCTION PROJECT CODE NO. 18695

Related Projects:
P. E. UNDER PROJECT:
Project Number IM 0253-222
Project Code: 18695

R.O.W. Projects:
R.O.W. Project Description
N/A

TABULATION OF LENGTH & DESIGN DATA

STATION	FEET ROADWAY I-25	FEET ROADWAY HOV LANES
BEGIN PROJECT STA. 10+08.00 ON IM 0253-222, M.P. 216.20		
	33,732	
END PROJECT STA. 347+40.00 ON IM 0253-222, M.P. 222.59		
STA. XX+XX.XX BEGIN HOV RAMP		TO BE COMPLETED AT F.O.R.
STA. XX+XX.XX END HOV RAMP		
STA. X+XX.XX BEGIN SB HOV EXIT RAMP		
STA. XX+XX.XX END SB HOV EXIT RAMP		
TOTAL	33,732.00	0.00
SUMMARY OF PROJECT LENGTH	FEET	MILES
PROJECT GROSS LENGTH	33,732.00	6.39

DESIGN DATA	I-25	HOV LANES
MINIMUM RADIUS OF CURVE	5,960 FT.	3,937 FT.
MAXIMUM GRADE	4.00%	4.00%
MINIMUM S.S.D. HORIZONTAL	645 FT.	645 FT.
MINIMUM S.S.D. VERTICAL	645 FT.	645 FT.
MAXIMUM DESIGN SPEED	70 MPH	65 MPH
2032 DESIGN TRAFFIC	DHV = 10,656 ADT = 225,700	DHV = 10,656 ADT = 225,700
DHV TRUCK %	5.70%	5.70%
CLEAR ZONE DISTANCE (TANGENT)	30 FT.	30 FT.

SHEET NO.	INDEX OF SHEETS
1	TITLE SHEET
2	STANDARD PLANS LIST
3-5	TYPICAL SECTIONS
6-11	GENERAL NOTES
12	SURVEY TABULATION SHEET
13-14	TABULATION SHEETS
15-39	PLAN SHEETS
40-41	80TH AVENUE RECONSTRUCTION PLAN AND PROFILE SHEETS
42-60	SOUND WALL PLAN SHEETS
61-65	BRIDGE PLAN, PROFILE, AND DETAIL SHEETS
66-87	WATER QUALITY POND PLAN SHEETS
88-95	STORM WATER MANAGEMENT PLANS
96-99	CONSTRUCTION TRAFFIC CONTROL PLAN SHEETS

STA 347+40.00
END PROJECT IM 0253-222
END I-25 CONSTRUCTION
MP 222.59

PROJECT LOCATION MAP

STA 10+08.00
BEGIN PROJECT IM 0253-222
BEGIN I-25 CONSTRUCTION
MP 216.20

FIR
12-10-2012

Print Date: 11/28/2012
File Name: IM0253DES_TitleSht.dgn
Horiz. Scale: 1:1 Vert. Scale: N/A
Unit Information Unit Leader Initials
PARSONS BRINCKERHOFF

Sheet Revisions

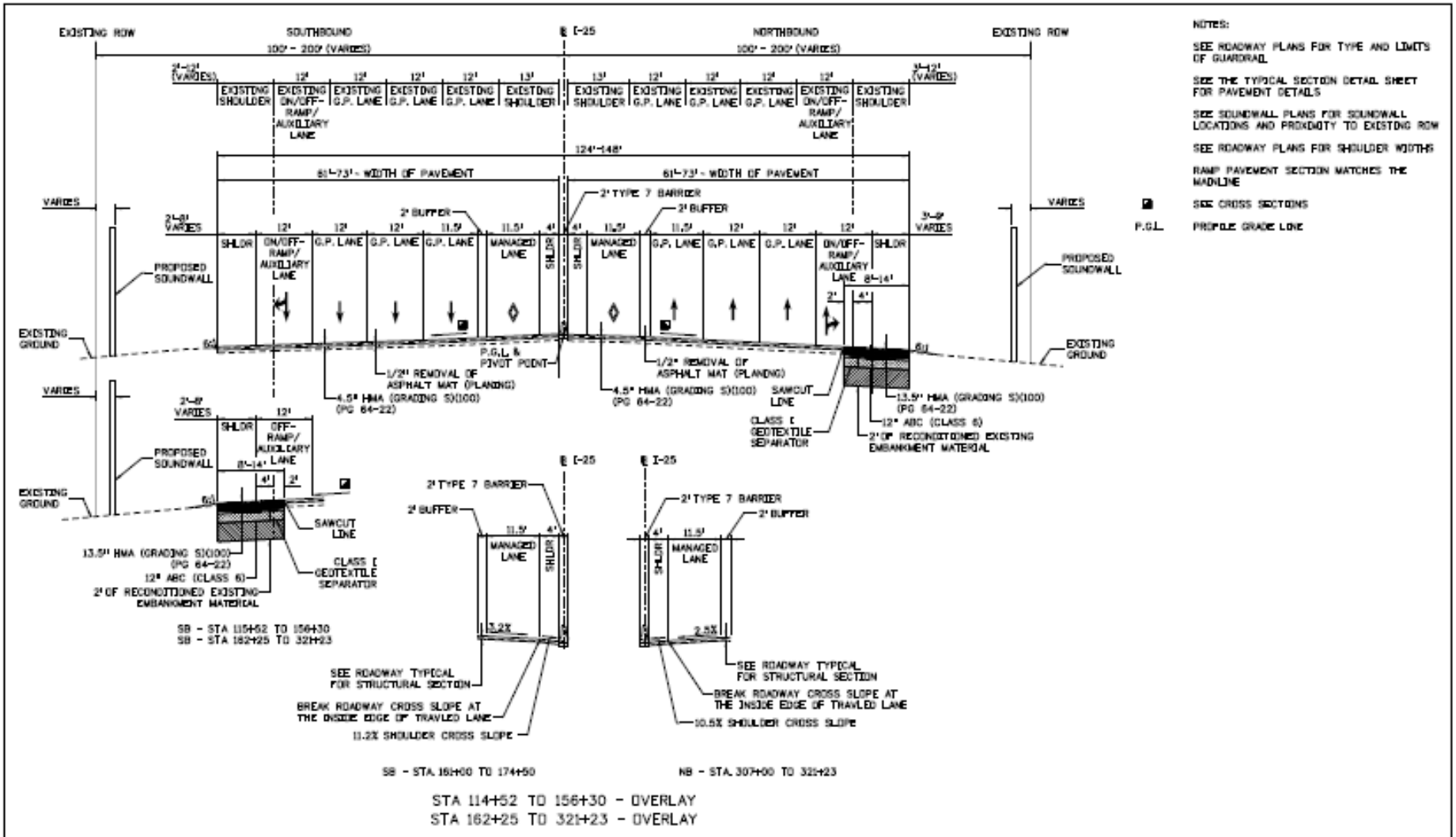
Date:	Comments	Init.

Colorado Department of Transportation
DOT 4670 Holly Street
Denver, CO 80216-6408
Phone: 303-398-6749 FAX: 720-945-1028
Region 6 DJH

As Constructed
No Revisions:
Revised:
Void:

Contract Information
Contractor:
Resident Engineer:
Project Engineer:
PROJECT STARTED: / / ACCEPTED: / /
Comments:

Project No./Code
18695
IM 0253-222
Sheet Number 1



Print Date: 11/26/2012	Sheet Revisions	Colorado Department of Transportation	As Constructed	I-25 US 36 TO 120TH AVENUE TYPICAL SECTION		Project No./Code
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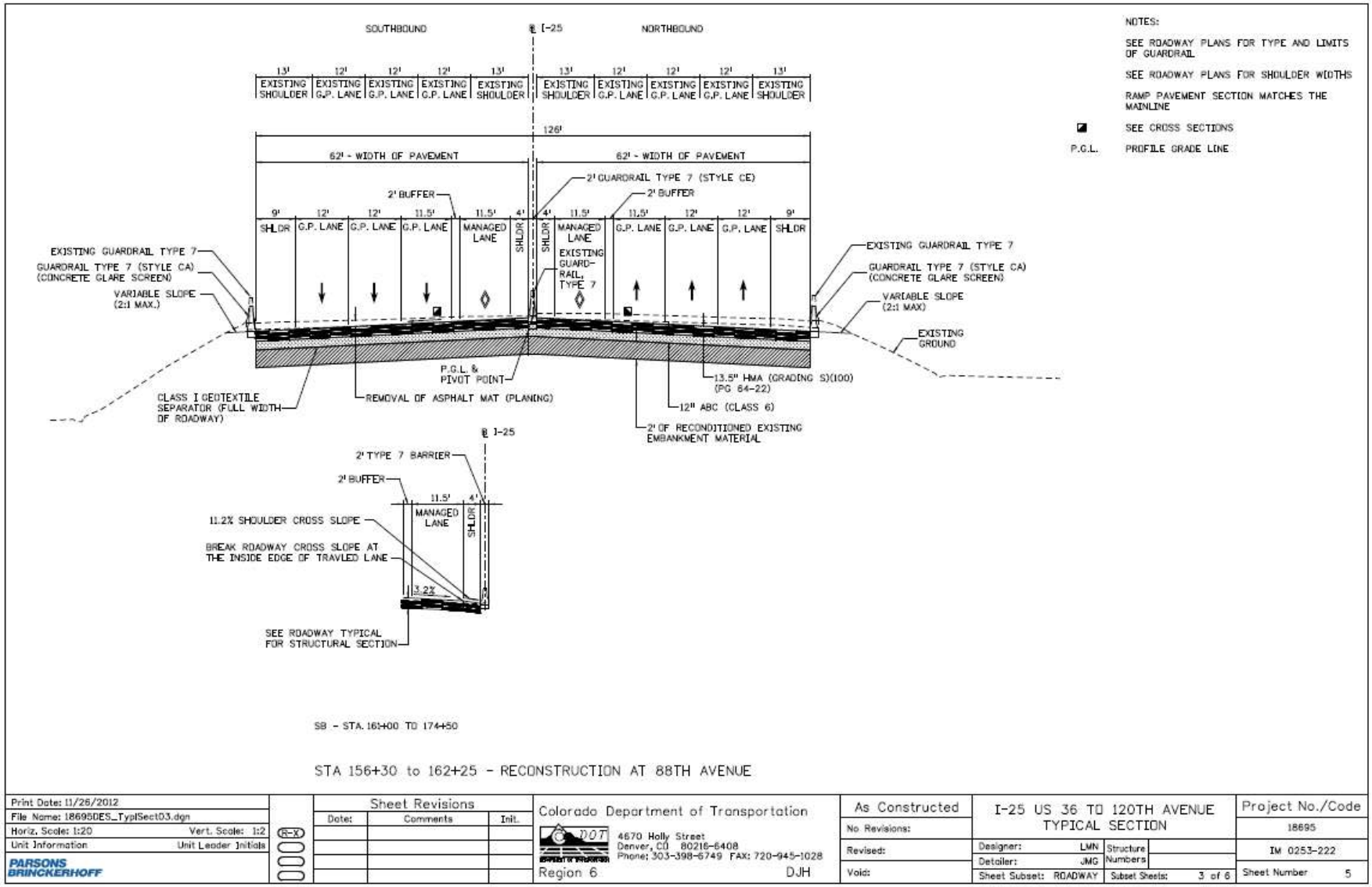
Horiz. Scale: 1:20 Vert. Scale: 1:2		Region 6 DJH	Revised:	Designer: LMN Structure Numbers		IM 0253-222
Unit Information: Unit Leader Initials			Void:	Detailer: JMG		
PARSONS BRINCKERHOFF				Sheet Subset: ROADWAY Subset Sheets: 2 of 5		Sheet Number 4


SOUTHBOUND
℄ I-25
NORTHBOUND
13' EXISTING SHOULDER
12' EXISTING G.P. LANE
12' EXISTING G.P. LANE
12' EXISTING G.P. LANE
13' EXISTING SHOULDER
126'
62' - WIDTH OF PAVEMENT
62' - WIDTH OF PAVEMENT
2' BUFFER
2' GUARDRAIL TYPE 7 (STYLE CE)
2' BUFFER
9' SHLDR
12' G.P. LANE
12' G.P. LANE
11.5' G.P. LANE
11.5' MANAGED LANE
4' SHLDR
4' SHLDR
11.5' MANAGED LANE
11.5' G.P. LANE
12' G.P. LANE
12' G.P. LANE
9' SHLDR
EXISTING GUARDRAIL TYPE 7
GUARDRAIL TYPE 7 (STYLE CA) (CONCRETE GLARE SCREEN)
VARIABLE SLOPE (2:1 MAX.)
EXISTING GUARD-RAIL, TYPE 7
EXISTING GUARDRAIL TYPE 7
GUARDRAIL TYPE 7 (STYLE CA) (CONCRETE GLARE SCREEN)
VARIABLE SLOPE (2:1 MAX)
EXISTING GROUND
P.G.L. & PIVOT POINT
CLASS I GEOTEXTILE SEPARATOR (FULL WIDTH OF ROADWAY)
REMOVAL OF ASPHALT MAT (PLANING)
13.5" HMA (GRADING S)(100) (PG 64-22)
12" ABC (CLASS 6)
2' OF RECONDITIONED EXISTING EMBANKMENT MATERIAL
℄ I-25
2' TYPE 7 BARRIER
2' BUFFER
11.5' MANAGED LANE
4' SHLDR
11.2% SHOULDER CROSS SLOPE
BREAK ROADWAY CROSS SLOPE AT THE INSIDE EDGE OF TRAVLED LANE
3.2%
SEE ROADWAY TYPICAL FOR STRUCTURAL SECTION
NOTES:
SEE ROADWAY PLANS FOR TYPE AND LIMITS OF GUARDRAIL
SEE ROADWAY PLANS FOR SHOULDER WIDTHS
RAMP PAVEMENT SECTION MATCHES THE MAINLINE
SEE CROSS SECTIONS
P.G.L. PROFILE GRADE LINE
SB - STA. 161+00 TO 174+50
STA 156+30 to 162+25 - RECONSTRUCTION AT 88TH AVENUE
Print Date: 11/26/2012
File Name: 18695DES_TypISect03.dgn
Horiz. Scale: 1:20 Vert. Scale: 1:2
Unit Information Unit Leader Initials
PARSONS BRINCKERHOFF
Sheet Revisions
Date: Comments Init.
Colorado Department of Transportation
4670 Holly Street
Denver, CO 80216-6408
Phone: 303-398-6749 FAX: 720-945-1028
Region 6 DJH
As Constructed
No Revisions:
Revised:
Void:
I-25 US 36 TO 120TH AVENUE
TYPICAL SECTION
Designer: LMN
Detailer: JMG
Sheet Subset: ROADWAY
Structure Numbers
Subset Sheets: 3 of 6
Project No./Code
18695
IM 0253-222
Sheet Number 5

4 VALUE ENGINEERING PROCESS

4.1 WORKSHOP TEAM

Generally, the most important ingredient in the conduct of a Value Engineering workshop is to have the VE team composed of seasoned, highly knowledgeable personnel. The team members must be very skilled in the discipline they represent while serving on the team. In the instance of this VE study we had the privilege of support from the following key personnel from the Colorado Department of Transportation and the Federal Highway Administration:

Full-Time VE Team Members

Chung Tran	Tolling/Ops	Federal Highway Administration
Pablo Lopez	Construction	Colorado Department of Transportation
Guy Norris	Traffic Engineer	Colorado Department of Transportation
Richard Horstmann	Highway Design	Colorado Department of Transportation

On-Call VE Team Members

Mark Carillo	Highway Maintenance	Colorado Department of Transportation
Colin Haggerty	Hydraulics/Water Qual.	Colorado Department of Transportation
Materials	Materials	Colorado Department of Transportation
Ali Imansepahi	ATM	Colorado Department of Transportation

The Value Engineering team was led by Charles R. McDuff, PE, CVS-Life, CCE, LEED AP of Atkins. The team would also like to thank several of the key players in preparing for and lending support throughout the VE effort. These include:

Andy Stratton	Colorado Department of Transportation
David Poling	Parsons Brinckerhoff
Jeff Wilson	Parsons Brinckerhoff
Jim Daves	Parsons Brinckerhoff
Jeff Kullman	Atkins
Jim Hanson	Atkins
Praveen Ommi	Atkins
Monica Rosario	Atkins

4.2 THE SIX-STEP VALUE ENGINEERING JOB PLAN

The Value Engineering team followed the six-step Value Engineering job plan as promulgated by SAVE International. This six-step job plan includes the following:

- **Information Phase** – during this phase of the team's work, the team received a briefing from the design team and representatives of the Colorado Department of Transportation. This briefing included discussions of the design intent behind the project, the cost concerns, and was followed by a general discussion and Q & A session for all the participants. In the working session that followed, the VE team developed cost models from the cost data provided by the designers and familiarized themselves with the construction drawings and other data that was available to the team. An excerpt from the cost estimate and the included cost model are enclosed, immediately following this introductory narrative.

- **Function Analysis Phase** – during this phase the team reviewed the project from the simplest perspective by asking the questions of "What is the project supposed to do?" and "How is it supposed to accomplish this purpose?". In the Value Engineering vernacular, the answers to these questions are cast in the form of active verbs and measurable nouns. These verb/noun pairs form the basis of the function analysis that distinguishes a Value Engineering effort from a potentially damaging cost cutting exercise. The team developed a Function Analysis System Technique (FAST) diagram that depicts the flow of functions within this project. The FAST diagram is also enclosed.

- **Creative/Brainstorming Phase** – The VE team performed a brainstorming session to identify ideas that might help meet the team objectives:
    - Reduce construction and life cycle costs
    - Improve traffic operations
    - Reduce the time of construction
    - Respect environmental and other constraints
    - Clarify risks and opportunities associated with the project
    - Acts to mitigate risks and to act on opportunities.

  This brainstorming session initially identified numerous ideas that were then evaluated in the next phase. The reader will find the creative worksheets enclosed. These same work sheets were also used to record the results of the Judgment or Evaluation Phase.

- **Judgment or Evaluation Phase** – Once the team identified the various creative ideas, it was necessary to decide which alternatives should be carried forward. This is the work of the Judgment or Evaluation Phase. The team reflected back to the project constraints and objectives shared with the team by the owner's representatives, in the kick-off meeting on the first day of the workshop. From that guidance, the team settled on the following values as measures of whether or not an alternative had enough merit to be carried forward in the VE process:
    - Construction Cost Savings
    - Support for Environmental Objectives
    - Ability to Implement the Idea

- General Acceptability of the Alternatives
- Constructability
- Meeting the needs of the project delivery schedule

Based on these measurement sticks, the VE team evaluated the alternatives and graded them from 5 (Excellent) down to 1 (Poor). Other notes about the alternatives are annotated at the bottom of the enclosed creative and evaluation sheets, including the inclusion of two other ratings – Design Suggestion (DS) and Already Being Done (ABD)

- **Development Phase** – This is the section of the report in which the alternatives are explained, sketched, documented and put to cost and technical tests to determine their suitability for implementation and for their impact on the project.

- **Presentation Phase** – As noted earlier, the team made a final, informal out-briefing on the last day of the workshop, designed to inform the Owners and the Designers of the initial findings of the VE workshop. A copy of the summary table and the rough draft of the results section of the report were left with the project delivery team. This written report is intended to formalize those findings.

As noted earlier, this report section includes supportive narratives, cost data and cost models, and other useful information. In order of appearance this documentation consists of:

- (4.3)Value Engineering Workshop Agenda
- (4.4)Construction Cost Estimate
- (4.5)Pareto Chart
- (4.6)Function Analysis System Technique (FAST) Diagram
- (4.7) Creative/Evaluation Worksheets
- (4.8)Attendance Sheets
  - (4.8.1)Kick-off session Attendance Sheets
  - (4.8.2)Closing Presentation Attendance Sheets

4.3 VALUE ENGINEERING WORKSHOP AGENDA

Turnpike Conference Room located at 4670 North Holly Street Denver, CO 80216

Monday, January 14, 2013

9:00 – 9:20 Introduction
- Participant Introduction
- Review of Agenda

9:20 – 9:40 Owner Presentation
- Project Goals & Purpose
- Key Project Issues and Constraints for VE Team

9:40 - 10:10 Designer Presentation
- Overview
- Basis of Design and Rationale Behind Design Choices
- Description of Project Elements

10:10 – 12:00 VE Team Time for Reviewing Project Materials
12:00 –1:00 Lunch Break
1:00 – 2:30 Project Function Analysis
2:30 – 5:00 Creative Idea Generation

Tuesday, January 15, 2013

8:00 – 8:30 Creative Idea Generation (cont.)
8:30 – 10:00 Evaluation of Ideas
10:00 – 12:00 Development of Alternatives
12:00 – 1:00 Lunch Break
1:00 – 2:00 Owner/Client/Designer Review of Selected Ideas with Team Leader
2:00 – 5:00 Development of Alternatives

Wednesday, January 16, 2013

8:00 – 12:00 Development of Alternatives (cont.)
12:00 – 1:00 Lunch Break
1:00 – 5:00 Development of Alternatives (cont.)

Thursday, January 17, 2013

8:00 – 12:00 Development of Alternatives (cont.)
12:00 – 1:00 Lunch Break
1:00 – 2:30 Preparation for Presentation
2:30 – 4:30 Presentation of VE Results

4.4 CONSTRUCTION COST ESTIMATE

FIELD INSPECTION REVIEW (F.I.R.) MASTER COST ESTIMATE

I-25 Managed Lanes from US 36 to 120th Avenue

Prepared by Parson Brinckerhoff — Preparer: LMN — Checked by: DP — Date: 1/15/2013

ITEM NUMBERS	DESCRIPTIONS	UNITS	QUANTITY	UNIT COST (2012)	TOTAL COST
	MAINLINE EARTHWORK				
203-00000	Unclassified Excavation	CY	178,000	$25	$4,450,000
203-00062	Embankment Material (Complete In Place) (Special)	CY	13,400	$20	$268,000
	MAINLINE REMOVALS				
202-01130	Remove Guardrail Type 3	LF	12,710	$3	$31,800
202-01170	Remove Guardrail Type 7	LF	27,776	$8	$222,200
202-00210	Removal of Concrete Pavement	SY	11,000	$5	$55,000
202-00240	Removal of Asphalt Mat (Planing)	SY	464,958	$2	$929,900
	MAINLINE PAVEMENT				
304-06000	Aggregate Base Course (Class 6)	TON	38,229	$15	$573,400
412-01300	Concrete Pavement (13 inch)	SY	18,000	$35	$630,000
403-09221	Stone Matrix Asphalt (Fibers)(Asphalt) - Managed Lanes	TON	51,674	$90	$4,650,700
403-33842	Hot Mix Asphalt (Grading S) (100) (PG 64-22)	TON	86,299	$65	$5,609,400
411-10255	Emulsified Asphalt (Slow-Setting)	GAL	89,671	$2.5	$224,200
420-00132	Geotextile (Separator) (Class 1)	SY	63,875	$3	$159,700
	MAINLINE GUARDRAIL				
210-01130	Reset Guardrail Type 3	LF	12,710	$30	$381,300
210-01170	Reset Guardrail Type 7	LF	6,036	$20	$120,700
606-00715	Guardrail Type 7 (Style CA) (Concrete Glare Screen)	LF	27,776	$45	$1,249,900
606-00730	Guardrail Type 7 (Style CD)	LF	180	$62	$11,200
606-00745	Guardrail Type 7 (Style CE) (Concrete Glare Screen)	LF	3,000	$80	$240,000
606-00747	Guardrail Type 7 (Style CD-HOV) (Special)	LF	1,600	$100	$160,000
	MAINLINE RETAINING WALL				
504-XXXXX	Retaining Wall (12' Height) (I-25 & US 36) (Assuming 200' Wall Length)	SF	2,400	$75	$180,000
	MAINLINE DRAINAGE				
208-XXXXX	Erosion Control	L S	1	$250,000	$250,000
202-00019	Removal of Inlet	EACH	5	$500	$2,500
202-00037	Removal of End Section	EACH	3	$200	$600
507-00100	Concrete Slope and Ditch Paving (Reinforced)	CY	20	$500	$10,000
507-00550	Concrete Lined Ditch	LF	980	$20	$19,600
603-01185	18 Inch Reinforced Concrete Pipe (Complete In Place)	LF	1,444	$150	$216,600
603-01305	30 Inch Reinforced Concrete Pipe (Complete In Place)	LF	35	$200	$7,000
603-01485	48 Inch Reinforced Concrete Pipe (Complete In Place)	LF	106	$250	$26,500
603-05018	18 Inch Reinforced Concrete End Section	EACH	4	$900	$3,600
603-05048	48 Inch Reinforced Concrete End Section	EACH	1	$1,800	$1,800
604-20002	Outlet Structure (Special)	EACH	2	$13,000	$26,000
604-25005	Vane Grate (Single)	EACH	11	$4,000	$44,000
604-30010	Manhole Slab Base (10 Ft)	EACH	2	$4,000	$8,000
	MAINLINE LIGHTING				
503-00030	Drilled Caisson (30 Inch)	LF	924	$150	$138,600
613-01300	3 Inch Electrical Conduit (Plastic)	LF	30,000	$15	$450,000
613-07026	Pull Box (16"x24"x12")	EACH	77	$650	$50,050
613-10000	Wiring	L S	1	$100,000	$100,000
613-34700	Light standard Metal (70 Foot)	EACH	77	$9,000	$693,000
613-50100	Lighting Control Center	EACH	5	$12,000	$60,000
613-50355	Power Transformer	EACH	3	$5,000	$15,000
613-71000	Luminaire High Pressure Sodium (1000 W)	EACH	211	$1,500	$316,500
	MAINLINE HOV/HOT GATES				
202-01040	Removal of HOV Gate	EACH	5	$2,700	$13,500
	MAINLINE SOUNDWALLS				
607-15000	Fence Concrete (Sound Barrier)	SF	45,500	$40	$1,820,000
607-XXXXX	Wall Rehabilitation	L S	1	$2,000,000	$2,000,000
	MAINLINE ITS, Tolling & ATM				
	TS, Tolling & ATM (Includes 30% Contingency)	L S	1	$13,893,230	$13,893,230
	SIGNS AND SIGN STRUCTURES				
	Sign Structures	L S	1	$2,161,400	$2,161,400

FIELD INSPECTION REVIEW (F.I.R.) MASTER COST ESTIMATE

I-25 Managed Lanes from US 36 to 120th Avenue

Prepared by Parson Brinckerhoff | Preparer: LMN | Checked by: DP | Date: 1/15/2013

ITEM NUMBERS	DESCRIPTIONS	UNITS	QUANTITY	UNIT COST (2012)	TOTAL COST
	88TH AVENUE RECONSTRUCTION				
	Construction *	L S	1	$1,600,000	$1,600,000
	CONSTRUCTION TRAFFIC CONTROL				
630-00000	FLAGGING	HOUR	3000	$22	$66,000
630-00003	UNIFORM TRAFFIC CONTROL	HOUR	1000	$62	$62,000
630-00007	TRAFFIC CONTROL INSPECTION	DAY	450	$118	$53,100
630-00012	TRAFFIC CONTROL MANAGEMENT	DAY	268	$545	$146,060
630-80001	FLASHING BEACON (PORTABLE)	EACH	45	$387	$17,415
630-80336	BARRICADE (TYPE 3 M-B) (TEMPORARY)	EACH	12	$159	$1,908
630-80341	CONSTRUCTION TRAFFIC SIGN (PANEL SIZE A)	EACH	65	$35	$2,275
630-80342	CONSTRUCTION TRAFFIC SIGN (PANEL SIZE B)	EACH	45	$44	$1,980
630-80343	CONSTRUCTION TRAFFIC SIGN (PANEL SIZE C)	EACH	50	$50	$2,500
630-80355	PORTABLE MESSAGE SIGN PANEL	EACH	6	$2,500	$15,000
630-80360	DRUM CHANNELZING DEVICE	EACH	280	$20	$5,600
630-80363	DRUM CHANNELZING DEVICE (WITH LIGHT)(FLASHING)	EACH	25	$31	$775
630-80370	CONCRETE BARRIER (TEMPORARY)	LF	46000	$27	$1,242,000
630-80380	TRAFFIC CONE	EACH	100	$8	$800
630-80358	ADVANCE WARNING FLASHING OR SEQUENCING PANEL (TYPE C)	EACH	4	$880	$3,520
630-85010	IMPACT ATTENUATOR (TEMPORARY)	EACH	18	$2,700	$48,600
630-85041	MOBILE ATTENUATOR	EACH	2	$5,700	$11,400
Project Construction Bid Items					**$45,755,813**

		Percentage	COST	
Project Construction Bid Items			**$45,755,813**	(A)
Contingencies	Percent of (A)	2.20%	$1,006,600	(B)
Drainage	Percent of Drainage Items	10.00%	$61,600	(C)
Proposed and Temporary Striping Contingency	Percent of Construction Traffic Control Items	37.00%	$621,900	(D)
Construction Signing & Traffic Control Contingency	Percent of (A+B+C+D)	1.00%	$474,500	(E)
Mobilization	Percent of (A+B+C+D+E)	2.10%	$1,006,300	(F)
Total of Construction Bid Items	(A+B+C+D+E+F)		**$48,926,713**	(G)
Utilities	Percent of (G)	1.00%	$489,300	(H)
Subtotal of Construction Cost	(G+H)		**$49,416,013**	(I)
Construction Engineering (Includes 88th Avenue Reconstruction)	Percent of (I)	19.00%	$9,389,000	(J)
Right-of-Way	Project Dependent	N/A	$0	(K)
F/A - MCR	Project Dependent	N/A	$3,500,000	
Total Project Cost			**$62,305,013**	(L)

NOTES:

* COSTS FOR 88TH AVENUE PROVIDED BY CDOT.

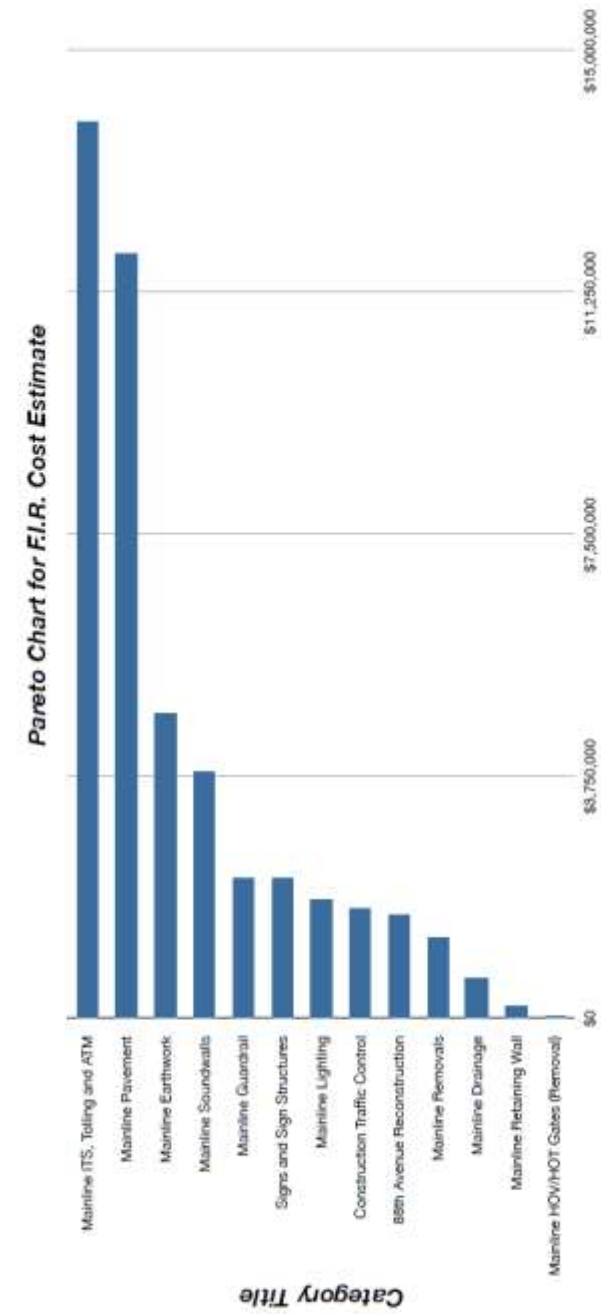
4.5 PARETO CHART

I-25 Managed Lanes from US 36 to 120th Avenue

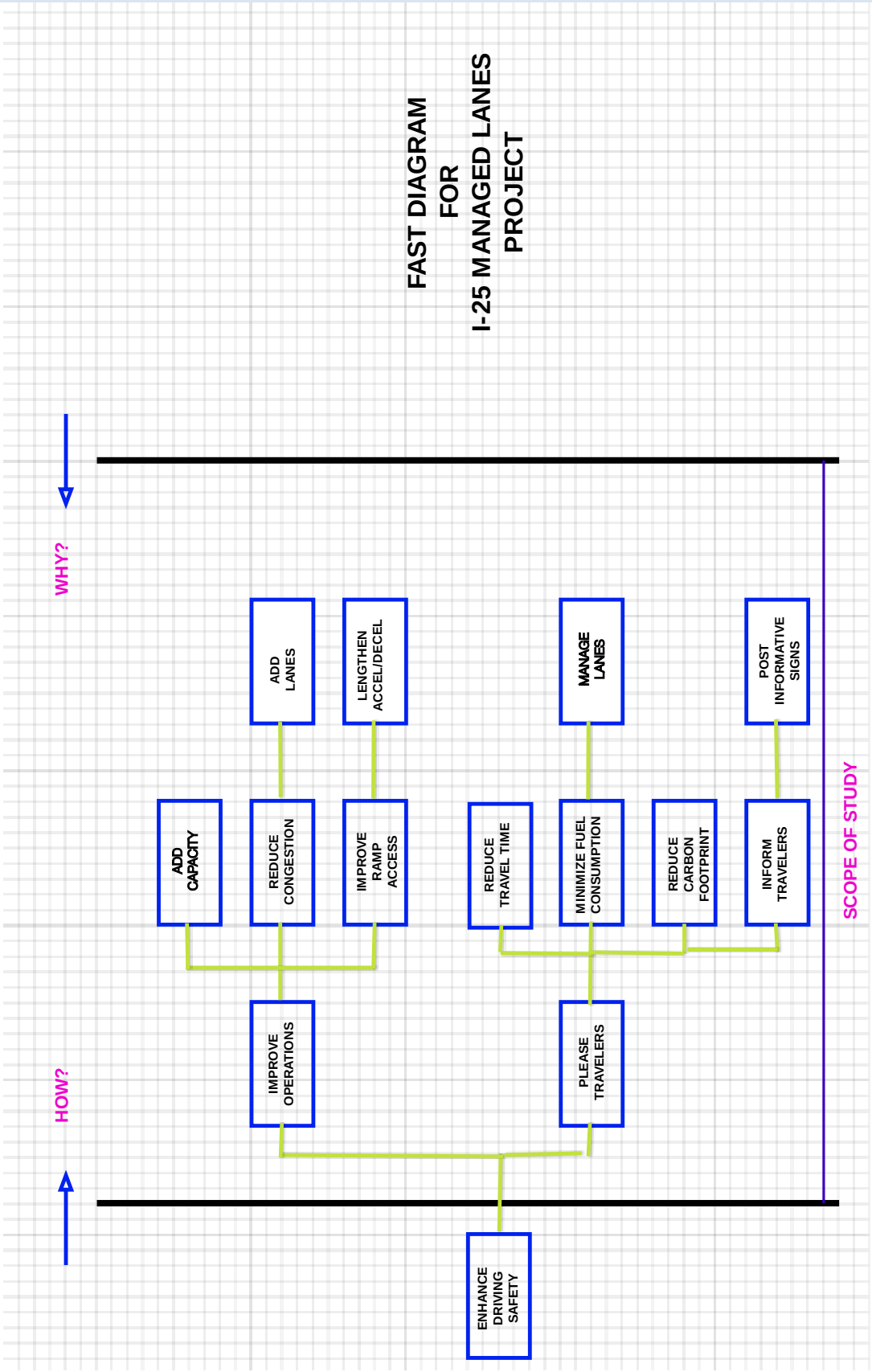
Field Inspection Review (F.I.R.) Cost Estimate

Mainline ITS, Tolling and ATM	$13,883,230
Mainline Pavement	$11,847,400
Mainline Earthwork	$4,718,000
Mainline Soundwalls	$3,820,000
Mainline Guardrail	$2,163,100
Signs and Sign Structures	$2,161,400
Mainline Lighting	$1,823,150
Construction Traffic Control	$1,685,933
88th Avenue Reconstruction	$1,600,000
Mainline Removals	$1,238,900
Mainline Drainage	$616,200
Mainline Retaining Wall	$180,000
Mainline HOV/HOT Gates (Removal)	$13,500
Project Construction Bid Items Only -- no contingencies included	***$45,760,813***

Note -- Differs slightly from published estimate (rounding?)



4.6 FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM



4.7 CREATIVE IDEA / EVALUATION WORKSHEETS

PROJECT: **Colorado Department of Transportation**
I-25 Managed Lanes: US 36 to 120th Ave
IM 0253-222 PCN 18695

SHEET NO.: 1 OF 4

CREATIVE IDEA / EVALUATION WORKSHEETS

NO.	IDEA DESCRIPTION	RATING
	ITS/Tolling (IT)	
IT-1	Don't use lane control for general purpose lanes	5
IT-2	Eliminate lane control for the northbound lanes	5
IT-3	Minimize signs and devices	5
IT-4	Do not add extra fiber optic cable as currently proposed	5
IT-5	Use standard Variable Message Signs (VMS) in lieu of full color matrix signs	4
IT-6	Eliminate all proposed cameras	5
IT-7	Combine detection devices	DS
IT-8	Provide for better coordination of traffic management assets on the alignment	DS
IT-9	Maximize use of existing sign structures	DS
IT-10	Minimize median access for sign maintenance	DS
IT-11	VE Team Question – is the current design configuration an integral part of an area-wide traffic operations management concept?	DS
IT-12	Reduce the number of traffic management devices to the minimum	See IT-3
IT-13	Use an express lane approach in the new lanes	2

PROJECT: **Colorado Department of Transportation**
I-25 Managed Lanes: US 36 to 120th Ave
IM 0253-222 PCN 18695

SHEET NO.: 2 OF 4

CREATIVE IDEA / EVALUATION WORKSHEETS

NO.	IDEA DESCRIPTION	RATING
IT-14	Define lane enforcement concept	DS
IT-15	Implement incident management concept	DS
IT-16	Implement ramp metering for corridor	DS
	PAVEMENT (PV)	
	Northbound Lanes	
PV-1	Extend lane from Station 83+00 to 91+00	5
PV-2	Continue fifth lane from Project Start to 84th Avenue for lane continuity (4,000')	4
PV-3	Use 4" overlay in lieu of full-depth shoulder replacement on outside shoulders	2
PV-4	Use full auxiliary lane between Thornton Parkway and 104th Avenue	4
PV-5	Use parallel on-ramp from 104th Avenue	4
	Southbound Lanes	
PV-6	Review managed lane entrance south of 120th Avenue	DS
PV-7	Use 4" overlay in lieu of full-depth shoulder replacement on outside shoulders	2
PV-8	Provide parallel acceleration lane south of 104th Avenue	4
PV-9	Provide parallel, 1000' deceleration lane at approach to off-ramp at Thornton Parkway	4

PROJECT: **Colorado Department of Transportation** SHEET NO.: 3 OF 4
I-25 Managed Lanes: US 36 to 120th Ave
IM 0253-222 PCN 18695

CREATIVE / EVALUATION WORKSHEETS

NO.	IDEA DESCRIPTION	RATING
PV-10	Re-stripe pavement at on-ramp for Thornton Road(accommodate parallel accel. lanes)	DS
	EARTHWORK (EW)	
EW-1	Reduce excavation	See PV-3
	TRAFFIC CONTROL DURING CONSTRUCTION (TC)	
TC-1	Re-sequence construction	DS
TC-2	Reduce temporary Type 7 barriers	5
TC-3	Reduce traffic control inspection (TCI) days	4
TC-4	Create traffic management plan	ABD
TC-5	Provide incident management pull-outs or islands	DS
TC-6	Refurbish and reinstall existing lockers in lieu of new	5
TC-7	Mobile attenuators should be paid for by days	DS
	MISCELLANEOUS (MI)	
MI-1	Optimize conduit for lighting system	DS
MI-2	Use shorter median lighting poles	5

PROJECT: **Colorado Department of Transportation** SHEET NO.: 4 OF 4
I-25 Managed Lanes: US 36 to 120th Ave
IM 0253-222 PCN 18695

CREATIVE / EVALUATION WORKSHEETS

NO.	IDEA DESCRIPTION	RATING
MI-3	Reduce lighting coverage	4
MI-4	Integrate lighting into barriers	DS
MI-5	Put lighting on outside shoulders (note downrated due to being placed in clear zone)	3
MI-6	Consider use of LED lighting	DS
MI-7	Revisit new bridge at 88th Avenue	DS
MI-8	Replace guardrail in lieu of re-setting existing guardrail (potential added value)	DS
MI-9	Selectively use cable guardrail	DS
MI-10	Provide better definition of project requirements	DS

Rating: 1→2 = Not to be Developed; 3 = Varying Degrees of Development Potential;
4→5 = Most likely to be Developed; DS = Design Suggestion; ABD = Already Being Done

4.8 ATTENDANCE SHEETS AND PRESENTATIONS

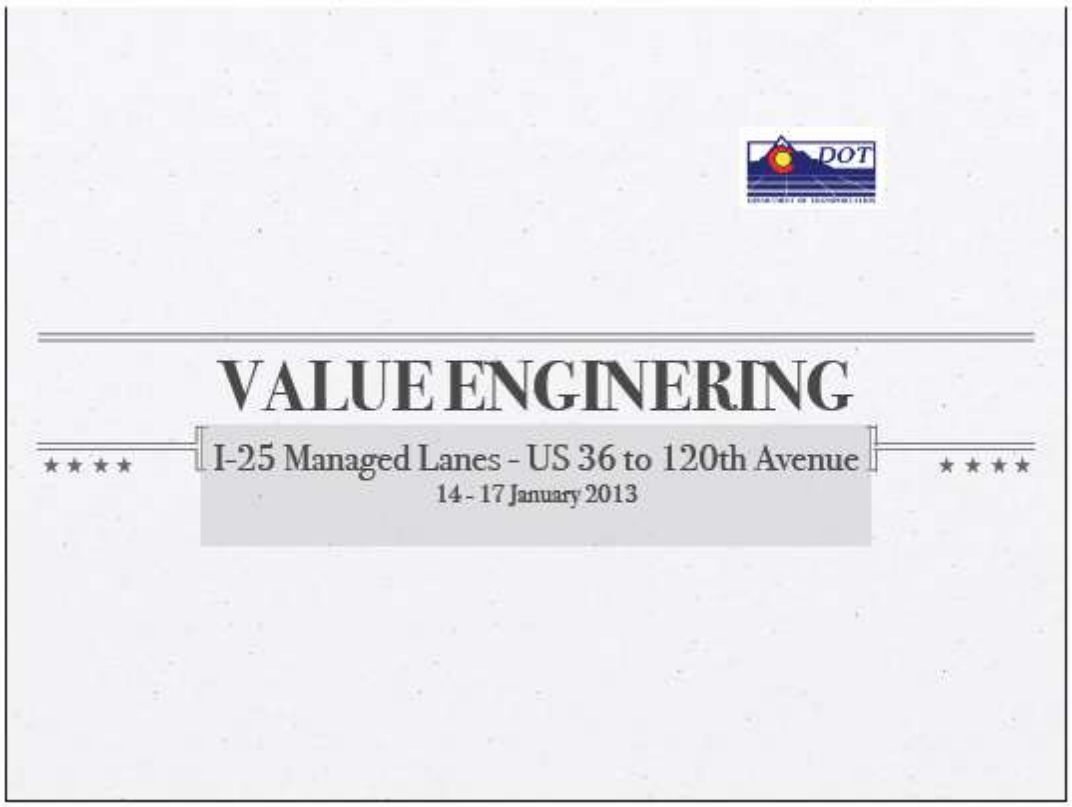
4.8.1 KICK-OFF SESSION ATTENDANCE SHEETS

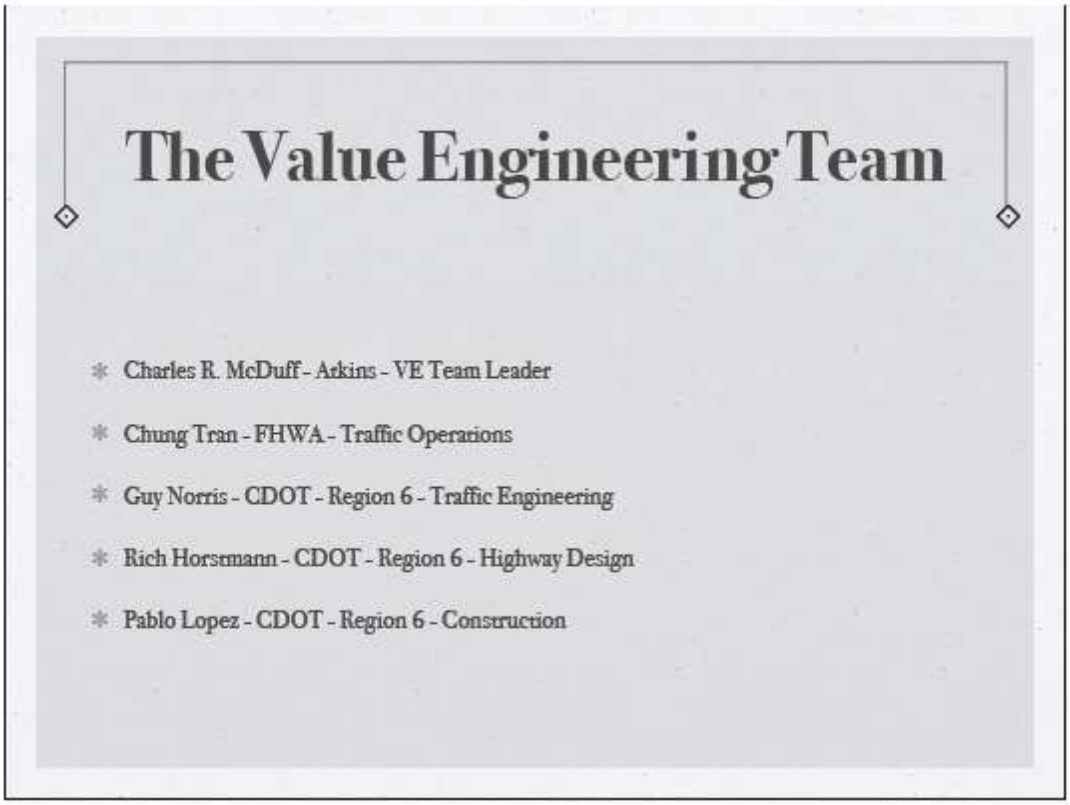
NAME	TITLE	ORGANIZATION	E-MAIL	TELEPHONE
Andrew "Andy" Stratton	Project Manager	CDOT Region 6 North Engineering	Andrew.stratton@state.co.us	(303)398.6746
Rich Horstmann VE Team	Highway Design	Region 6 CDOT	Richard.horstmann@state.co.us	(303)757.9672
Pablo Lopez VE Team	Construction	Region 6 CDOT	Pablo.lopez@state.co.us	(303)398.6771
Guy Norris VE Team	Traffic Engineering	Region 6 CDOT	Guy.norris@state.co.us	(303)757.9029
Chung Tran VE Team	Transportation Operations Specialist	FHWA Resource Center	Chung.tran@dot.gov	(720)963.3201
Monica Pavlik	Sr. Operations Engineer	FHWA – Colorado Division	Monica.pavlik@dot.gov	(720)963.3012
Larry Nechanicky	Project Engineer	Parsons Brinckeroff	Nechanicky@pbworld.com	(303)728.1925
Jim Bumanglag	Deputy Project Manager	Parsons Brinckeroff	Bumanglag@pbworld.com	(303)390.5825
Scott Thomas	ITS Engineer	Apex Design	Scott.thomas@apexdesigpc.com	(720)298.2540
Charles McDuff VE Team	VE Team Facilitator	Atkins	McDuffminime@me.com	(919)576.4017

4.8.2 CLOSING PRESENTATION ATTENDANCE SHEETS

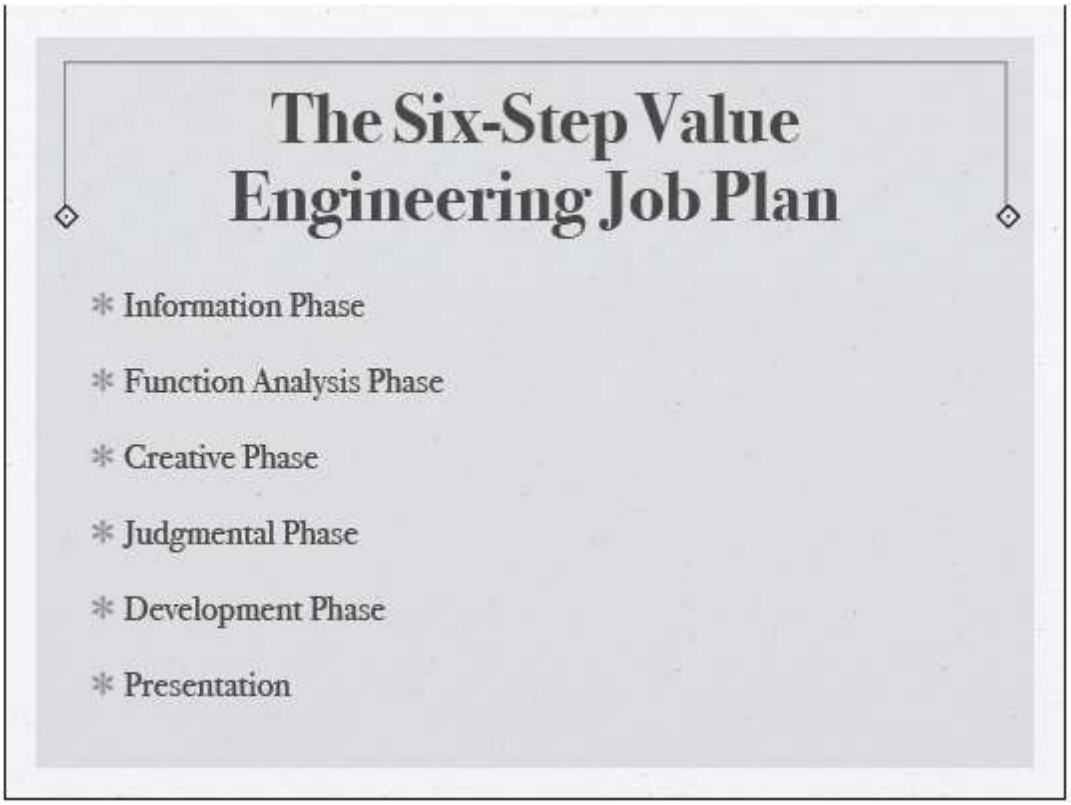
NAME	TITLE	ORGANIZATION	E-MAIL	TELEPHONE
Steve Olson	Project Manager	CDOT	Michael.olson@state.co.us	(303)775.9255
Steve Hersey	PE III – Traffic Engineering	CDOT	Steven.hersey@state.co.us	(303)757.9511
Ali Imansepahi	US 36 Traffic/ITS	CDOT	Ali.imansepahi@state.co.us	(303)916.6600
Mark Gosselin	PE III	CDOT	mark.gosselin@state.co.us	(303)404.7020
Jay Hendrickson	RE	CDOT	Duane.hendrickson@state.co.us	(303)398.6749
Shawn Yu	PE III – EEMA	CDOT HQ	Shawn.yu@state.co.us	(303)757.9293
Guy Norris	PEI	Region 6 CDOT	Guy.norris@state.co.us	(303)757.9672
Andrew “Andy” Stratton	Project Manager	Region 6 CDOT	Andrew.stratton@state.co.us	(303)398.6746
Rich Horstmann VE Team	Highway Design	Region 6 CDOT	Richard.horstmann@state.co.us	(303)757.9672
Pablo Lopez VE Team	Construction	Region 6 CDOT	Pablo.lopez@state.co.us	(303)398.6771
Guy Norris VE Team	Traffic Engineering	Region 6 CDOT	Guy.norris@state.co.us	(303)757.9029
Monica Pavlik	Senior Operations Engineer	FHWA – Colorado Division	Monica.pavlik@dot.gov	(720)963.3012
Shaun Cutter	Program Delivery Team Leader	FHWA – Colorado Division	Shaun.cutting@dot.gov	(720)963.3033
Chung Tran VE Team	Transportation Operations Specialist	FHWA Resource Center	Chung.tran@dot.gov	(720)963.3201
Greg Jones	PEI	ODOT	Gregory.jones@state.co.us	(303)757.9872
Jim Bumanglag	Deputy Project Manager	Parsons Brinckeroff	Bumanglag@pbworld.com	(303)390.5825
Scott Thomas	ITS Engineer	Apex Design	Scott.thomas@apexdesigpc.com	(720)298.2540
Charles McDuff VE Team	VE Team Facilitator	Atkins	McDuffminime@me.com	(919)576.4017
Brook Svoboda	Director of Planning Division	City of Northglenn	bsvoboda@northglenn.co.us	(303)450.8937
Gene Putnam	Transportation Manager	City of Thornton	Gene.putnam@cityofthornton@net	(720)977.6524
Jeanne Shreve	Transportation Coordinator	Adams County	jshreve@adco.gov	(720)523.6847
Karen Stuart	Executive Director	Smart Commute TMO	Karen.stuart@smartcommutemetronorth.org	(303)916.0806
Nick Farber		High Performance Transportation Enterprise	Nicholas.farber@state.co.us	(303)757.9448

4.8.3 CLOSING VE TEAM PRESENTATION






On-Call Team Members
Bob Mero - Materials
Mark Carillo - Maintenance
Ali Imansepahi - Tolling/ATM
Praveen Ommi - Assistant VE Team Leader - Atkins/Orlando
Monica Rosario - Administrative Assistant/Research - Atkins/Miami


The Six-Step Value Engineering Job Plan
Information Phase
Function Analysis Phase
Creative Phase
Judgmental Phase
Development Phase
Presentation

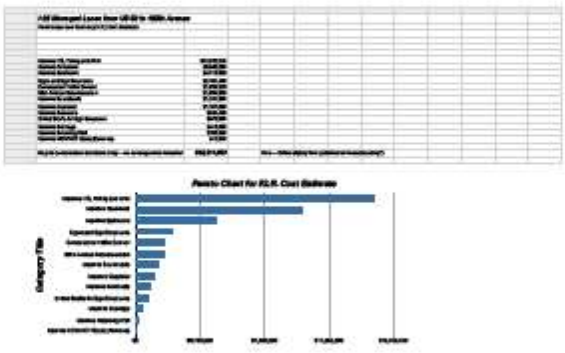
Typical Job Plan Approach

* Provide ideas/alternatives that could make a solid difference in the project
* A few good ideas that are well documented rather than a wheelbarrow full of gnat bites
* Usually do not use the word "eliminate" in a VE alternative
* The results of the workshop are intended to represent a Smorgasbord of ideas that the decision makers can elect to choose from

Condition of Project at Time of Workshop

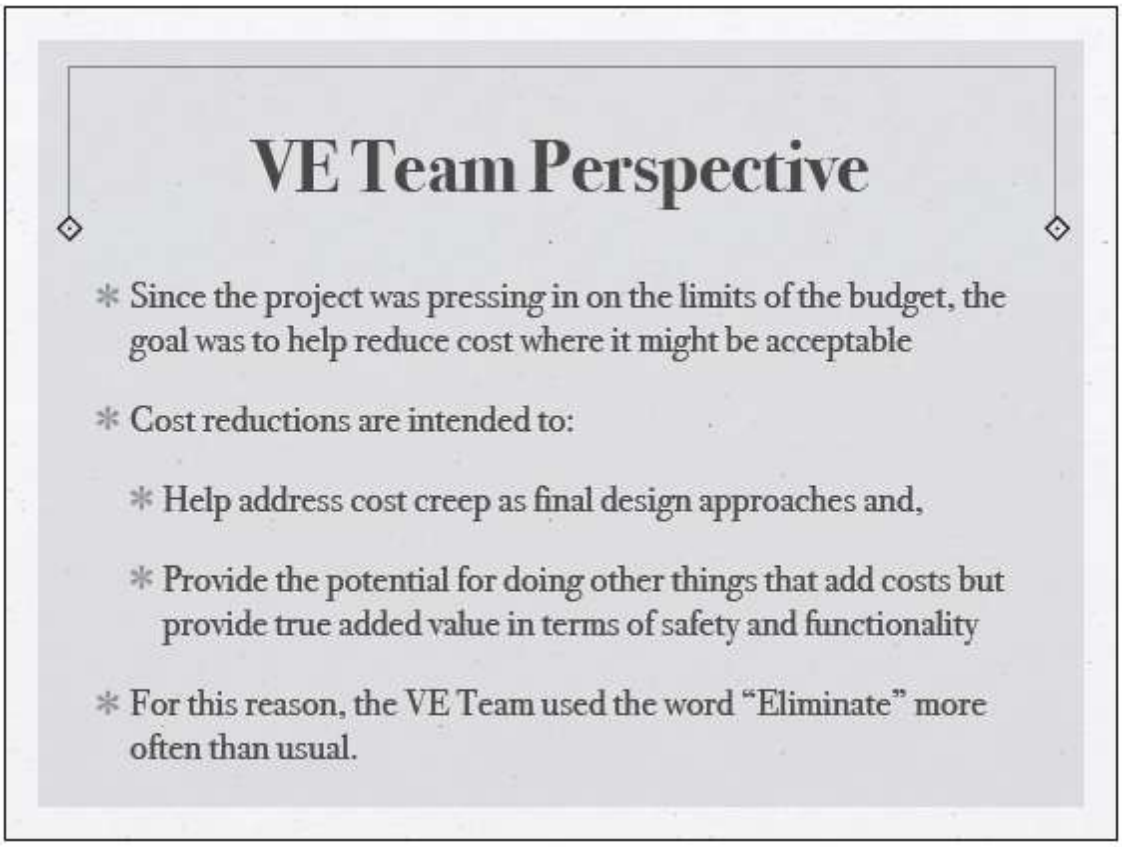
* The plans had advanced from the Field Inspection Review held on 10 December 2012
* Final Office Review expected to occur in March
* Most of the drawings used during the workshop were reflective of their FIR stage with some changes:
  * Noise wall No. 2 put back in the plans
  * Some of the FIR comments have been addressed

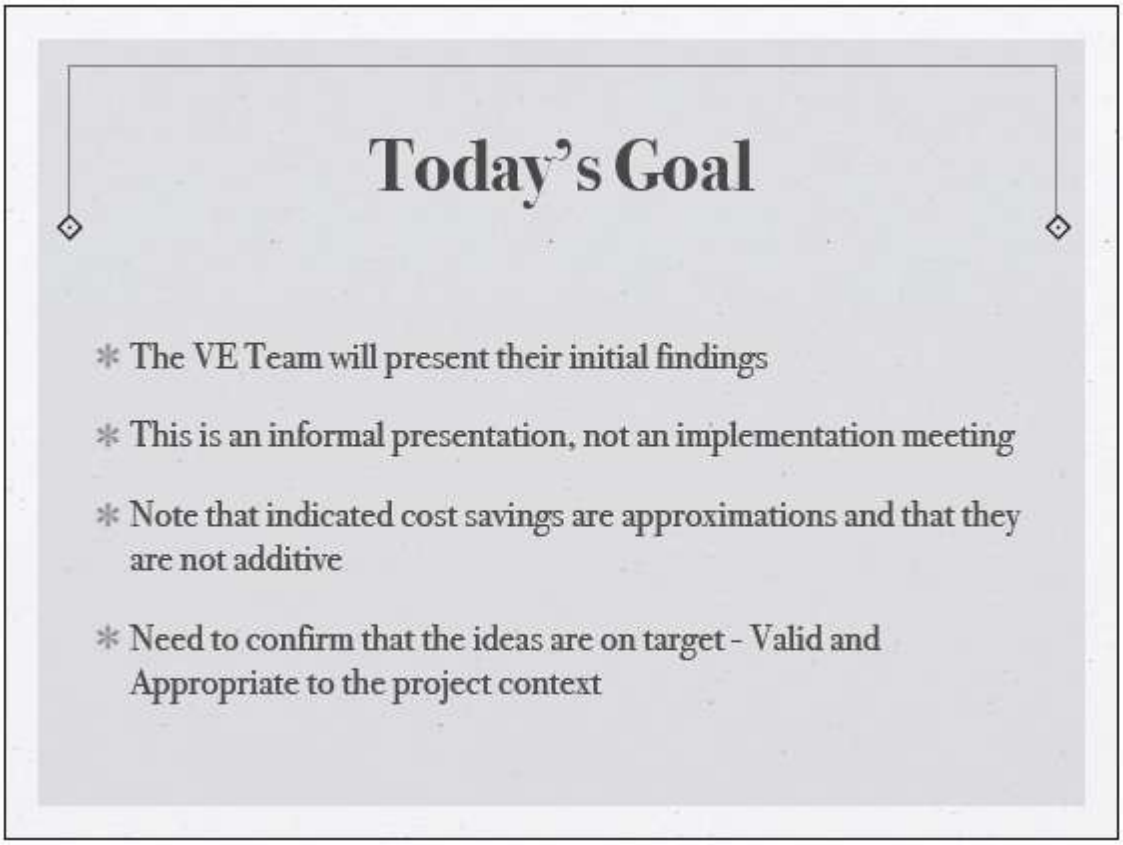
The VE Topic Source



Study Results

* The VE Team generated 43 creative ideas – of these, 30 survived the Judgment Phase
* The VE team developed 14 alternatives in which cost factors were identified
* There were16 Design Suggestions documented. These were in the form of suggestions to enhance the project outcome and functionality. These Design Suggestions could be very useful also in getting the most "bang for the buck"


VE Team Perspective
* Since the project was pressing in on the limits of the budget, the goal was to help reduce cost where it might be acceptable
* Cost reductions are intended to:
* Help address cost creep as final design approaches and,
* Provide the potential for doing other things that add costs but provide true added value in terms of safety and functionality
* For this reason, the VE Team used the word "Eliminate" more often than usual.


Today's Goal
* The VE Team will present their initial findings
* This is an informal presentation, not an implementation meeting
* Note that indicated cost savings are approximations and that they are not additive
* Need to confirm that the ideas are on target - Valid and Appropriate to the project context

CDOT – North I-25 Managed Lanes
Summary of Value Engineering Responses

The following table identified in summary format the results reported in the attached, more detailed report that was generated as a result of the implementation meeting for the above referenced project. Where some of the results are still under study, the facilitator of the VE study has provided a conservative estimate of the value expected to be received from the alternative in question.

	Description	***Disposition***	***Cost Impact***
ITS/TOLLING (IT)			
Alternative IT-1	Don't use lane control for the general purpose lanes	Alternative Declined	None
Alternative IT-2	Eliminate Lane Control for Northbound Traffic	Accepted part of alternative	$6,024,800
Alternative IT-3	Minimize signs and devices	Alternative Declined	None
Alternative IT-4	Do not add extra fiber optic cable	Alternative Declined	None
Alternative IT-5	Use standard variable message signs (VMS) in lieu of full color matrix signs	Alternative Declined	None
Alternative IT-6	Eliminate proposed CCTV cameras	Alternative Declined	None
Design Suggestion IT-7	Combine detection devices	Accepted	Savings not identified
Design Suggestion IT-8	Provide for coordination of traffic management assets	Accepted	Savings not identified
Design Suggestion IT-9	Maximize use of sign structures	Accepted	Already being included by designer and CDOT
Design Suggestion IT-11	Set objective to integrate this project into an area-wide master plan for ATM	Accepted	Already being included by designer and CDOT
Design Suggestion IT-14	Define enforcement	Accepted	Already being included by designer and CDOT
Design Suggestion IT-15	Implement incident management concept	Not accepted at this time	None
Design Suggestion IT-16	Implement Ramp Metering for Corridor	Not accepted	None
Pavement (PV)			

Alternative PV-4	Provide auxiliary lane between Thornton Parkway and 104th Avenue	Not Accepted	None
Alternative PV-8	On SB I-25, provide parallel acceleration lane from 104th Avenue	Not Accepted	None
Alternative PV-9	Provide parallel deceleration lane – 1000' approach to Thornton Parkway	Not Accepted	None
Alternative PV-9A	Provide 500' parallel deceleration lane for the approach to Thornton Parkway	Not Accepted	None
Alternative PV-10	Restripe Thornton Parkway – Southbound Ramp	Accepted	Minor cost additive
Traffic Control During Construction (TC)			
Design Suggestion TC-1	Re-sequence construction phasing	Will Consider	No cost identified at this time
Alternative TC-2	Reduce temporary Type 7 barriers	Will Consider	Potential savings was identified as $1,210,395
Alternative TC-3	Reduce Traffic Control Inspection (TCI) Days	Will Consider	Potential savings was identified as $44,934
Design Suggestion TC-6	Pay for Mobile attenuators by day	Accepted	No cost identified at this time
Miscellaneous (MI)			
Design Suggestion MI-1	Optimize conduit sizes	Will Consider	Not cost identified at this time
Alternative MI-2	User shorter light standards	Not Accepted	None
Alternative MI-3	Reduce lighting coverage	Not Accepted	None
Design Suggestion MI-4	Integrate lighting into barrier walls	Not Accepted	None
Design Suggestion MI-6	Consider use of Led fixtures for roadway lighting	Will Consider	Will increase cost but cost not identified at this time
Design Suggestion MI-7	Revisit possibility of new bridge at 88th Avenue	Not Accepted	Note – schedule will not permit
Design Suggestion MI-8	Replace in lieu of resetting existing guardrail	Will Consider	May reduce cost
Design Suggestion MI-10	Enhance definition of project definitions	Will Consider	Will flesh this out as project progresses – no cost identified

CDOT – North I-25 Manage Lanes
Value Engineering Responses
February 13, 2013

The following responses to the Value Engineering Study Report were prepared by the following:

Parsons Brinckerhoff: David Ungemah, Les Jacobson, Dave Poling, Jeff Wilson, Jim Bumanglag, Larry Nechanicky
Apex Design: Scott Thomas

ITS/TOLLING (IT)

Alt No IT-1	Description: Don't use lane control for the general purpose lanes	Recommendation: Decline

Recommendation Discussion:

The primary purpose of ATM is to be able to provide back of queue protection across all lanes. There will be more collisions in the general purpose lanes than in the managed lanes. Showing lane control and speed warning just over the managed lanes would not provide significant benefits.

Recommendation: Do not implement alternative.

Alt No IT-2	Description: Eliminate Lane Control For Northbound Traffic	Recommendation: Implement partially as described

Recommendation Discussion:

There are 3 suggested alternatives included in IT-2:

1) Eliminate NB overhead supports and devices except at 65+00 and 117+00:

This is a viable alternative, especially with the results of the modeling of the alternative configuration for ending the managed lane in the vicinity of 120th northbound. The alternatives are to have full ATM northbound, no ATM northbound, or a less intensive ATM northbound that could take the form of a small number of VMS signs only (on the order of 3 to 5) only, or a combination of more widely spaced ATM gantries with shoulder mounted speed advisories between the ATM gantries. We can discuss the less intensive ATM options and approaches in more detail, if CDOT is interested, or we can cover it in the ConOps. Not installing ATM NB at all is a viable and operationally justifiable option.

Recommendation: Accept this part of the alternative and do not implement full ATM in the NB direction at this time. Rather to recommend that full ATM be deferred until additional growth in the corridor occurs and conditions would support that level of investment.

In the meantime, it is suggested that CDOT apply the queue warning aspect of ATM in locations where there is the highest likelihood of congestion or collisions. We believe that there are two locations for VMS placement that will support this concept. The first is just north of the US 36 interchange to cover congestion approaching 84th. There is already a VMS in the design at that location, so this one is covered. The second is in advance of the 120th St Interchange, probably about a mile in advance, to cover the end of the managed lane and the drop lane to 120th. If we forecast that the congestion would be severe or would occur often, we would recommend either multiple signs in advance or a sign further upstream than 1 mile. However, in this situation, we think a 1-mile advance works well. This also puts the VMS at the same location as the mile advance guide sign for the 120th exit. Finally, in the full ATM design, there would be a full ATM gantry at this location so it would support the full ATM build out at a later date. The savings is for all NB ATM elements except the VMS in advance of the 120th exit and the VMS north of US 36 approaching 84th. Our estimate for these two signs is $210,500 each for sign, structure, controller, and cabinet. Total savings is about $3,670,000.

2) Eliminate all side mount signs, and

3) Reduce SB locations to one mile spacing.

The preliminary design shows an overhead VMS on every other ATM gantry (approximately 1 mile spacing for overhead VMS). On the gantries without overhead VMS, we are showing side mount DMS on both sides of the roadway. This was based on the WSDOT design. They are very happy with this design, but we can certainly look at alternatives that would provide the needed capabilities at a lower cost. It is very important that the system provide reasons to the drivers for why there are lane closures or reduced speeds recommended. It is also very important that the reasoning is given reasonably close to the slowdown or lane closure/blockage. If these conditions aren't met, the credibility of the system suffers, many drivers will not take the action recommended, and the effectiveness of the system is compromised.

Recommendation: Do not implement the second two alternatives listed in IT-2.

Alt No IT-3	Description:Minimize Signs and Devices	Recommendation:Decline

Recommendation Discussion:

This alternative eliminates ATM altogether. Improving safety is a key element of the project and the TIGER grant. ATM treatments, such as queue warning, are being incorporated into the project to address safety by reducing rear-end collisions. Therefore, it is recommended that ATM remain a project component to help achieve the project safety goals.

Recommendation: Do not implement alternative.

Alt No IT-4	Description: Do Not Add Extra Fiber Optic Cable	Recommendation: Decline

Recommendation Discussion:

We checked with CDOT ITS (Jill Scott) on the existing fiber allocation and there is only one buffer tube (12 fibers) not in use. The additional ITS/ATM/Tolling equipment will require an additional cable, so we feel this is needed.

Recommendation: Do not implement alternative.

Alt No IT-5	Description: Use Standard Variable Message Signs (VMS) In Lieu of Full Color Matrix Signs	Recommendation: Decline

Recommendation Discussion:

This alternative deals directly with the large overhead VMS, proposed on every other gantry. Full color is not necessary for these signs. However, the cost difference between full color and monochrome is shrinking. Full color provides much more flexibility in the messages and types of messages provided. The savings for this alternative were estimated to be $163,200 for 12 signs, or just under 7 percent of the cost of the signs. It is the preference of CDOT to have full color capabilities.

Recommendation: Do not implement alternative.

Alt No IT-6	Description: Eliminate Proposed CCTV Cameras	Recommendation: Decline

Recommendation Discussion:

The proposed CCTVs on the south end are primarily for tolling purposes and will be used to view the gates sets and roadway simultaneously. The newly added CCTVs on the rest of the corridor are to provide better surveillance coverage for the additional ATM elements.

The alternative design suggests using the internal diagnostics to monitor the system. Internal diagnostics work very well for most things that an operator would want to see. However, there are a few things that the cameras provide in lieu of sending someone out in the field for things the diagnostics can't do. These include:

- Testing. When the signs are first installed in the field, they will have to be tested. This includes testing the diagnostics. Conditions in the field are different than in the factory or at a test facility. It is not good practice to test a system with the system itself. Having operators be able to see the signs as they post messages is very valuable.
- Concerns over sign visibility. In Les Jacobson's experience, it is not unusual for the public to call in about the visibility of a sign message. Call outs to the field can be saved with the cameras. Over the life of the system, this can provide a substantial savings.
- Independent confirmation of messages. Although the diagnostics should cover the question of what message is on the sign, there are times when communication to the field is down or there is a discrepancy between a report from the public or field personnel and what the diagnostics display. The ability to independently check the message on the sign can be very valuable in these cases, both in terms of responsiveness and in terms of saving a call out to the field.

Recommendation: Do not implement alternative.

Alt No IT-7	Description: Combine Detection Devices	Recommendation: Accept

Recommendation Discussion:

The detection devices being designed for this project consist of MVRD (side-fire radar units), TTI (toll tag readers), and DTD ATRs. Ramp Meters are also along the corridor and utilize MVRD units. The MVRD for ITS will provide lane-by-lane volume, speed, and occupancy that will feed into the ATM system. The ITS and Ramp Meter MVRD units will be combined to cut down on field devices. The TTI readers will provide travel time over the segments throughout the corridor for the GP and managed lanes. The DTD ATR utilizes a Diamond counter.

Recommendation: Accept. As the design progresses and the ATM infrastructure is finalized, we will revisit the device locations and needs, and look for ways to combine detection devices.

Alt No IT-8	Description: Provide for Coordination of Traffic Management Assets	Recommendation: Accept

Recommendation Discussion:

Every attempt is being made for opportunities for sharing gantries, detectors, CCTV, etc. for the items needed by the managed lanes features.

Recommendation: Accept. This alternative was used in the design of the systems

Alt No IT-9	Description: Maximize Use of Sign Structures	Recommendation: Accept

Recommendation Discussion:

The design has included extensive consideration for every way possible to share gantries and use existing where possible and feasible without compromising the operation of the system.

Recommendation: Accept. This alternative was used in the design of the systems.

Alt No IT-11	Description: Set Objective to Integrate this Project Into Area Wide Master Plan for ATM	Recommendation: Accept

Recommendation Discussion:

We agree with this suggestion. This alternative is used in the design of the systems.

Recommendation: Accept.

Alt No IT-14	Description: Define Enforcement Concept	Recommendation: Accept

Recommendation Discussion:

The Concept of Operations document being developed will address this.

Recommendation: Accept.

Alt No IT-15	Description: Implement Incident Management Concept	Recommendation: Decline

Recommendation Discussion:

There is an incident management plan for this corridor. Although it is not currently scoped for this project the IMP could benefit by being revisited. For now it will be mentioned in the Concept of Operations as a consideration.

Recommendation: Do not implement alternative.

Alt No IT-16	Description: Implement Ramp Metering for Corridor	Recommendation: Decline

Recommendation Discussion:

Southbound: All SB on-ramps within the corridor have ramp meters, with the exception of 120th Avenue. The SB on-ramp at 120th does not have a ramp meter because RTD and CDOT agreed to not induce delay for buses leaving the park-n-Ride. There is not room to easily widen the ramp to include an HOV/bus bypass lane due to a retaining wall to the west.

Northbound: Along NB I-25, there is a ramp meter at 84th. NB ramp meters at Thornton and 104th are not warranted and it is CDOT's practice to only install ramp meters at locations where there is an anticipated benefit.

Recommendation: Do not implement alternative.

PAVEMENT (PV)

Alt No PV-4	Description: Provide Auxiliary Lane Between Thornton Parkway and 104th Avenue	Recommendation: Decline

Recommendation Discussion:

This alternative may help traffic flow and should probably have a modeling analysis performed to verify if there is a benefit. Essentially it adds additional paved surface and cost. Adding additional paved surface also may affect how the project is viewed environmentally as it is a departure of staying within the existing footprint of the interstate.

Recommendation: Do not implement alternative.

Alt No PV-8	Description: On SB I-25, Provide Parallel Acceleration Lane from 104th Avenue	Recommendation: Decline

Recommendation Discussion:

This alternative may help traffic flow but as with PV-4 it adds additional paved surface and cost. Existing ramp metering helps overall traffic flow in the peak hours to sort itself out for entering onto I-25.

Recommendation: Do not implement alternative.

Alt No PV-9	Description: Provide Parallel Deceleration Lane – 1000' Approach to Thornton Parkway	Recommendation: Decline

Recommendation Discussion:

This recommendation for the SB I-25 ramp to Thornton Parkway may help with deceleration although it is not entirely needed, as it is a long ramp that allows for deceleration upon leaving I-25 and it does not experience backup onto I-25.

Recommendation: Do not implement alternative.

Alt No PV-9A	Description: Provide 500 Foot Parallel Deceleration Lane for the Approach to Thornton Parkway	Recommendation: Decline

Recommendation Discussion:

Similar to PV-9, this recommendation for the SB I-25 ramp to Thornton Parkway may help with deceleration although it is not entirely needed, as it is a long ramp that allows for deceleration upon leaving I-25 and it does not experience backup onto I-25.

Recommendation: Do not implement alternative.

Alt No PV-10	Description: Restripe Thornton Parkway Southbound Ramp	Recommendation: Accept

Recommendation Discussion:

Agree that a striped parallel acceleration lane would allow for a smoother transition and acceleration lane based on restriping.

Recommendation: Accept.

TRAFFIC CONTROL DURING CONSTRUCTION (TC)

Alt No TC-1	Description: Re-Sequence Construction Phasing	Recommendation: Consider

Recommendation Discussion:

Overall the phase construction will have a comprehensive review looking at opportunities for reducing number of shifts and avoiding scarring on new pavement. Key to an effective overall construction phasing plan will be the consideration of how I-25 at 88th Avenue will be lowered, as this was only noted in the FIR plans as needing additional construction phasing by the Final Office Review.

Recommendation: Consider.

Alt No TC-2	Description: Reduce Temporary Type 7 Barriers	Recommendation: Consider

Recommendation Discussion:

As with TC-1, overall the phase construction will have a comprehensive review looking at opportunities for efficiencies including reduction of Temporary Type 7 Barriers. As noted in the Value Engineering analysis this may require extra moves to reset barrier, thus it may mean performing some slight additional shifts contrary to the efforts of TC-1 which is intended to reduce traffic shifts.

Recommendation: Consider.

Alt No TC-3	Description: Reduce Traffic Control Inspection (TCI) Days	Recommendation: Consider

Recommendation Discussion:

The actual number of TCI Days required will ultimately be a function of what the final analysis of project duration will be. This will of course match up with the required TCI Days quantified.

Recommendation: Consider.

Alt No TC-6	Description: Pay for Mobile Attenuators by Day	Recommendation: Accept

Recommendation Discussion:

Agree that the overall costs of the Mobile Attenuators should be paid as “days” and that it is likely to be a higher cost than what is currently reflected in the estimate. This is also consistent with remarks received from CDOT EEMA stating that Mobile Attenuators should be paid as “days”.

Recommendation: Accept.

MISCELLANEOUS (MI)

Alt No MI-1	Description: Optimize Conduit Sizes	Recommendation: Consider

Recommendation Discussion:

The lighting plan for the project will be fully designed for the Final Office Review. Until then the 3” conduit will be considered a placeholder for the mainline lighting. We will consider the possibility of using 2” conduit as the design progresses.

Recommendation: Consider.

Alt No MI-2	Description: Use Shorter Light Standards	Recommendation: Decline

Recommendation Discussion:

CDOT Region 6 has added lighting to the entire project limits having determined that it be consistent with lighting on the southern end of I-25. To be consistent (with T-REX being the basis of the design) lighting would require using 70’ high light standards.

Recommendation: Do not implement alternative.

Alt No MI-3	Description: Reduce Lighting Coverage	Recommendation: Decline

Recommendation Discussion:

As with MI-2, CDOT's intent is to illuminate the entire corridor, therefore this alternative is not considered.

Recommendation: Do not implement alternative.

Alt No MI-4	Description: Integrate Lighting Into Barrier Walls	Recommendation: Decline

Recommendation Discussion:

As a Design Suggestion this would enhance lighting adjacent to the barriers but is not needed on the project.

Recommendation: Do not implement alternative.

Alt No MI-6	Description: Consider Use of LED Fixtures For Roadway Lighting	Recommendation: Consider

Recommendation Discussion:

With an accelerated schedule to advertise this project there are some challenging issues to be resolved to be able to accept this recommendation, including coordinating and getting local agency formal acceptance, and working out installation and maintenance issues. At this point in the project design will proceed with HPS fixtures as potential discussions continue.

Recommendation: Consider.

Alt No MI-7	Description: Revisit Possibility of New Bridge at 88th Avenue	Recommendation: Decline

Recommendation Discussion:

This alternative has considerably more costs associated with it, and it has been determined that with the frequency of hits to the 88th Avenue structure implementing the lowering of I-25 at this site is imperative on this project.

Recommendation: Do not implement alternative.

Alt No MI-8 & 9	Description: Replace In Lieu of Reset Existing Guardrail	Recommendation: Consider

Recommendation Discussion:

There will likely be opportunities where installing new Type 3 guardrail makes sense. A quick estimate performed on replacing all of the guardrail shows additional cost of $60-$70k. This will be reviewed at all locations where resetting Type 3 guardrail has been called out.

Recommendation: Consider.

Alt No MI-10	Description: Enhance Definition of Project Requirements	Recommendation: Consider

Recommendation Discussion:

Knowledge gained from this project would be helpful to future projects in terms of documenting lessons learned. Agree that CDOT could capitalize on the knowledge gained. Developing success measures would be meaningful for those measures that can be defined. Because this project is unique some actual success measures may reveal themselves and come about through the process of design through construction, thus documenting the lessons learned would be invaluable.

Recommendation: Consider.