FINAL REPORT

VE team photo with Wadsworth IC in Background

US-6 Access ramps

Wadsworth IC structure

Tight slip ramp ahead for merge onto US-6

Value Engineering Study

US-6, Wadsworth Interchange

CDOT Project ES6 006A-047 (17858)

Prepared for

Colorado Department of Transportation

DEPARTMENT OF TRANSPORTATION

Prepared by

CH2MHILL®

Final Report Date: July 30, 2013

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CH2M HILL
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July 30, 2013

Mr. Kevin Brown, P.E. – Resident Engineer
Colorado Department of Transportation
425 B Corporate Circle
Golden, Colorado 80401

Dear Mr. Brown:

Subject: **Value Engineering Report; US-6, Wadsworth Interchange, Denver, Colorado, Project No. ES6 006A-047 (17858), Colorado Department of Transportation**

CH2M HILL is pleased to submit this Final Value Engineering (VE) report for the subject project. The enclosed VE Summary section contains all of the pertinent information concerning the VE study that was held in Denver, Colorado during the week of February 11, 2013.

The March 4, 2013 Preliminary VE report proposed CDOT's and the design team's consideration of 9 highly recommended VE proposals totaling an estimated initial cost savings of $6,617,000, a future cost savings of $1,361,000 expressed in present worth, and a net life-cycle savings of $7,978,000 in potential savings. These proposals would not compromise project functionality in the opinion of the VE team. This net savings total included 3 cost-increase proposals recommended for functional enhancement.

Another grouping of 6 proposals totaling an initial savings of $6,969,000, a future savings of $470,000, and a net life-cycle savings of $7,439,000 are possible for maximum potential savings, but were not as highly recommended by the VE team unless cost savings was paramount. Additionally, 14 VE observations were made by the VE team for the design team's consideration as the design for this project is completed.

Following review of the Preliminary VE report, CDOT and the design team determined the final dispositions of the VE proposals and observations. Four cost-saving proposals have been accepted or conditionally accepted for an aggregated initial cost savings of $1,312,000 and a future cost savings of $528,000 (expressed in present worth), resulting in a life-cycle cost savings of $1,840,000. Additionally, CDOT and the design team have indicated concurrence with 10 of the 14 VE observations and suggested further study of another.

The VE Overview section contains more detail about the VE methodology. The narratives of the VE proposals and observations follow in subsequent sections of the VE report. Minutes from the VE Study Resolution Meeting attended by CDOT, the City of Lakewood, FHWA, and the project design team are included in the VE Summary section of this Final VE report.

CH2M HILL appreciated this opportunity to provide value engineering services on this important project. We wish you continued success through the design completion and through construction. Please contact me at (208) 383-6299 should you have any questions or comments concerning this Final VE report.

Sincerely,
CH2M HILL

Paul Johnson

Paul Johnson, CVS
Value Engineering Team Leader

c: CDOT VE and Project Management Representatives
CH2M HILL Design Team Members

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Contents

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VE Summary

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VE Summary

Summary Narrative

This Final Value Engineering (VE) Report pertains to the project US-6, Wadsworth Interchange, located in Lakewood Colorado in the Denver Metropolitan area. This VE study of the subject project was conducted by CH2M HILL for the Colorado Department of Transportation (CDOT). Refer to *Figure 1 – Site Location Map, Figure 2 – Existing US-6, Wadsworth Interchange, and Figure 3 – Proposed Wadsworth Interchange*.

The project was in the preliminary engineering design phase at the time of the VE study. The VE Orientation Meeting and site visit were held on Monday, February 11, 2013. The VE study continued through Friday, February 15, 2013. The study was held at CH2M HILL's office in Denver (Englewood), Colorado.

On March 4, 2013, a Preliminary VE Report was distributed to CDOT and the design team for review, from which the final dispositions of the VE proposals and observations were determined.

Five representatives from CDOT participated in the VE study on a full time basis, and another five CDOT representatives participated in the study on a part-time basis. The CDOT participants represented the disciplines of structures, roadway, drainage, project management, environmental, traffic, construction, utilities, right-of-way, and cost estimating. A Certified Value Specialist (CVS) with CH2M HILL facilitated the VE study. Representatives from the design team took the VE team on a site tour on Monday afternoon, February 11th. CDOT management and design representatives participated in the VE team's mid-week briefing on February 12th. Additionally, CDOT, the design team, and FHWA and City of Lakewood representatives participated in the VE Out-brief presentation on February 15, 2013.

The Preferred Alternative will replace the existing US 6/Wadsworth interchange and widen Wadsworth between 4th and 14th Avenues. The existing cloverleaf will be replaced with a tight diamond with loop design, consisting of a diamond interchange with a loop ramp in the northwest quadrant. The structurally deficient bridge over Wadsworth will be replaced, and all entrance and exit ramps will be lengthened. Along Wadsworth, the Preferred Alternative will add a travel lane in each direction and a multi-use sidewalk on both sides of Wadsworth. A raised median will be added to the center of the roadway to control left turns and U-turns.

Following the week of the VE study, the VE team conducted a final review of the narratives and calculations in the VE proposals to make them as thorough as possible for review by the CDOT design team and FHWA. All proposals, calculations, and supporting sketches were included in the March 4, 2013 Preliminary VE Report.

In keeping with standard Value Methodology, the functions of the US-6, Wadsworth Interchange Project were considered with respect to the issues and concerns that had been raised during the information-gathering process. Ideas were brainstormed by the VE team

pertaining to all large components of the planned highway improvement project. Advantages and disadvantages of the ideas were then discussed in the analysis phase of the study, and each idea received a pass or fail rating. Numerous ideas passed by the VE team were then developed into full VE proposals, including narrative discussions of the VE idea compared to the base design, supporting sketches, and cost estimate calculations. Other ideas were developed as observations for functional versus economic reasons. Several ideas were failed outright during initial discussions.

The 13 ideas brainstormed by the VE team and passed for further development are presented in *Table 1 – VE Proposal Summary*. Another 14 ideas were developed as Observations and are presented in *Table 2 – VE Observations.* The Observations were written on a variety of subjects to serve as reminders to the design team and stakeholder agencies as the design is finalized.

Another idea was initially passed and developed as a VE proposal, but was then determined during the development phase of the VE study to be infeasible. This idea is still included in this report to document the VE effort and to demonstrate that every reasonable path toward functional enhancement and cost savings was explored by the VE team, but not every idea was determined by the team to be feasible. This idea is outlined in *Table 3 – Ideas Studied But Not Proposed*, and the supporting narrative and calculations for this "not-proposed" idea are included later in the report.

Another 11 ideas generated during the Creative Phase were failed during the Analysis Phase. These ideas and the reasons for not developing them as VE proposals are included in *Table 4 – Ideas Failed During Analysis Phase.*

Several of the 13 proposals included in Table 1 are mutually exclusive from the others. Four of the proposals in Table 1 represent a cost *increase* over the original design, and are proposed for functional reasons.

There are 6 proposals indicated with an "X" in Table 1 that could be accepted together for a maximum potential initial cost savings of $6,969,000, a future savings of $470,000 expressed in present worth, and a net life-cycle savings of $7,439,000.

A different subset of 9 proposals was highly recommended by the VE team for functional reasons. These proposals, indicated with a "Y" in Table 1, total an initial savings of $6,617,000, a future savings of $1,361,000 expressed in present worth, and a net life-cycle savings of $7,978,000. These net savings totals include 3 cost-increase proposals. The other 4 proposals not indicated with a "Y" could still be accepted, but were not deemed as the highest-priority cost-saving proposals by the VE team.

The VE proposals and observations are presented in detail in the subsequent sections of this report.

Note that the VE proposals are relative cost comparisons that warrant thorough review by the design team for a final analysis of cost-saving potential to the project.

Study Results (Accepted Cost Savings)

As part of the review of the Preliminary VE Report, CH2M HILL asked that CDOT and the design team document the final dispositions of the proposals and observations from the VE

study. This group has identified the proposals and observations that are Accepted, Conditionally Accepted, Recommended for Further Study, or Rejected, along with narrative comments regarding the proposals and observations. CH2M HILL has prepared this Final VE Report documenting the final study results. CDOT's report of the dispositions, incorporated into this Final VE Report, is intended to fulfill FHWA's requirement for a Value Engineering study on this project.

The following Table 1 – VE Proposal Summary shows that CDOT and the design team have accepted or conditionally accepted four VE proposals, totaling an initial cost savings of $1,312,000, a future savings of $528,000, expressed in present worth, and a net life-cycle savings of $1,840,000.

Accepted and Conditionally Accepted proposals include:

- Proposal B3: Consider using a thin bond overlay on the US-6 over Wadsworth Boulevard bridge deck and approach slabs to lower the dec profile by about 3 inches. Accepted. Initial cost premium (increase) of ($160,000), future savings of $528,000, expressed in present worth, and life-cycle savings of $368,000.
- Proposal C1: Consider pre-casting the portion of the deck over each of the box beams versus a cast in place deck construction. Conditionally Accepted. Initial and life-cycle savings of $415,000.
- Proposal R1: For ramps on the south side of 6th Avenue, use permanent pavement versus temporary pavement to minimize throw-away cost. Review what temporary pavement could be made permanent. Accepted. Initial and life-cycle savings of $483,000.
- Proposal S1: Utilize berms where space permits along Wadsworth Blvd. to decrease the net height of the 15-foot wall, still keeping the top of the wall at 15 feet above existing grade. Conditionally Accepted. Initial and life cycle savings of $574,000.

Net Total Accepted/Conditionally Accepted Initial Cost Savings: $1,312,000

Net Total Accepted/Conditionally Accepted Future Cost Savings: $528,000 (expressed in present worth)

Net Total Accepted/Conditionally Accepted Life-Cycle Cost Savings: $1,840,000

The net accepted VE proposals totaling $1,840,000 represents a savings of 2.7% of the estimated project cost of $68.3 million.

This savings represents a Return-on-Investment (ROI) of approximately 48 to 1. This means that for every dollar invested in the VE study, the owner agencies are realizing a savings of $48.

Of the 14 VE observations outlined in Table 2, CDOT and the design team have indicated concurrence with 10 observations, a desire for further study of one observation, and disagreement with the remaining three observations.

Refer to the VE Study Resolution Meeting Minutes following Tables 1 and 2 in the VE Summary section. This document contains additional information concerning the rationale for acceptance or rejection of the VE proposals and observations.

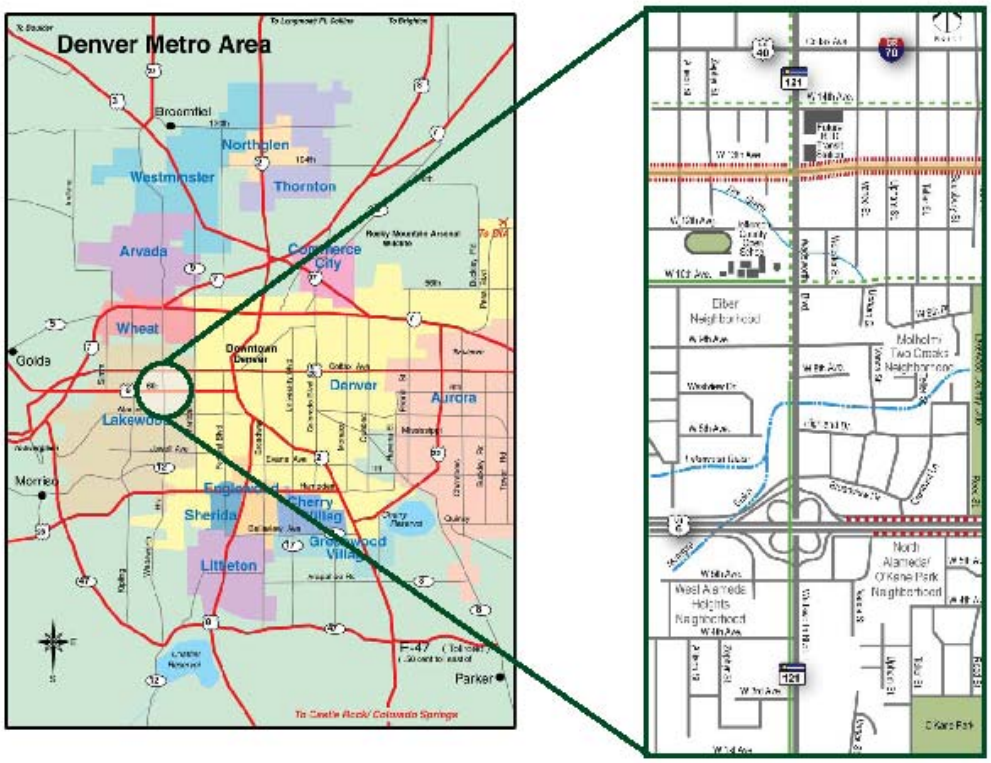

FIGURE 1
SITE LOCATION MAP
US-6, Wadsworth Interchange
CDOT Project ES6 0006A-047 (17858)
Colorado Department of Transportation

Figure 1 – Site Location Map

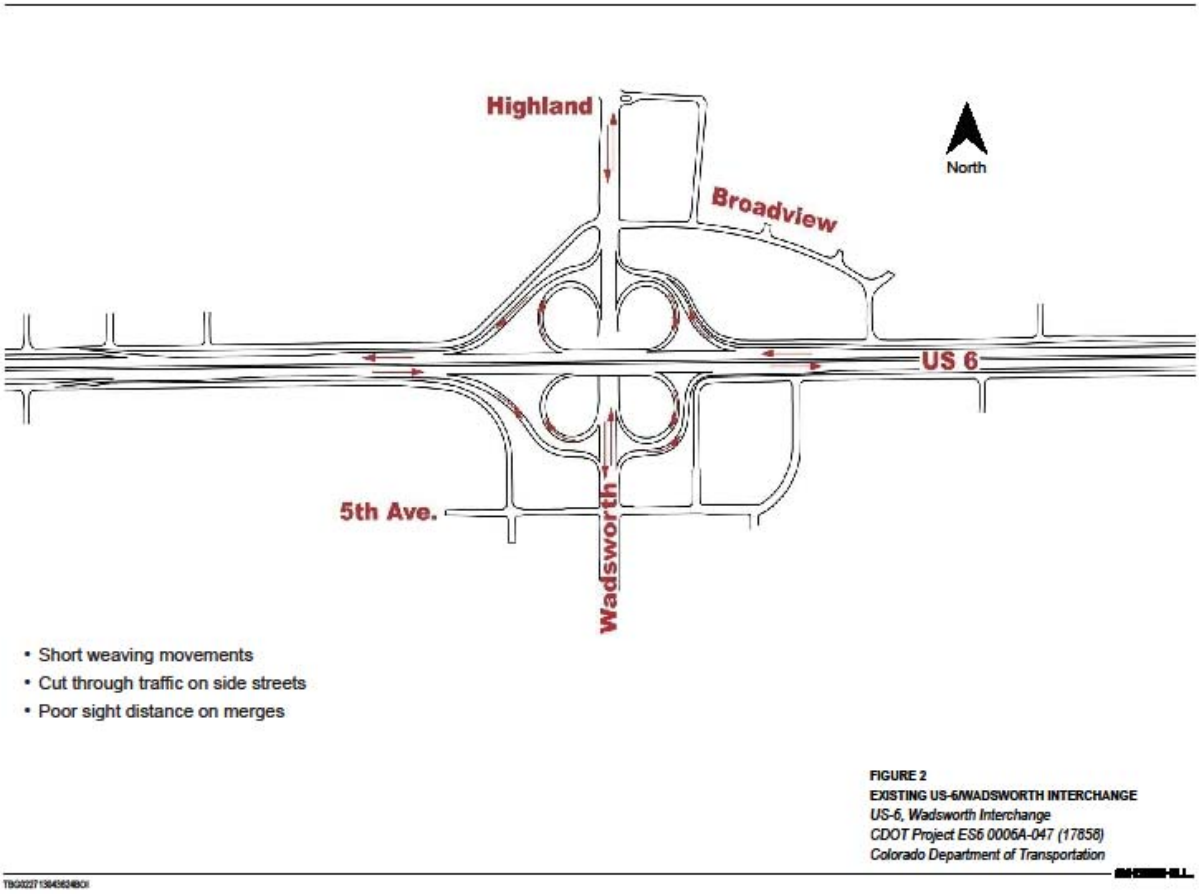

Figure 2 – Existing US-6, Wadsworth Interchange

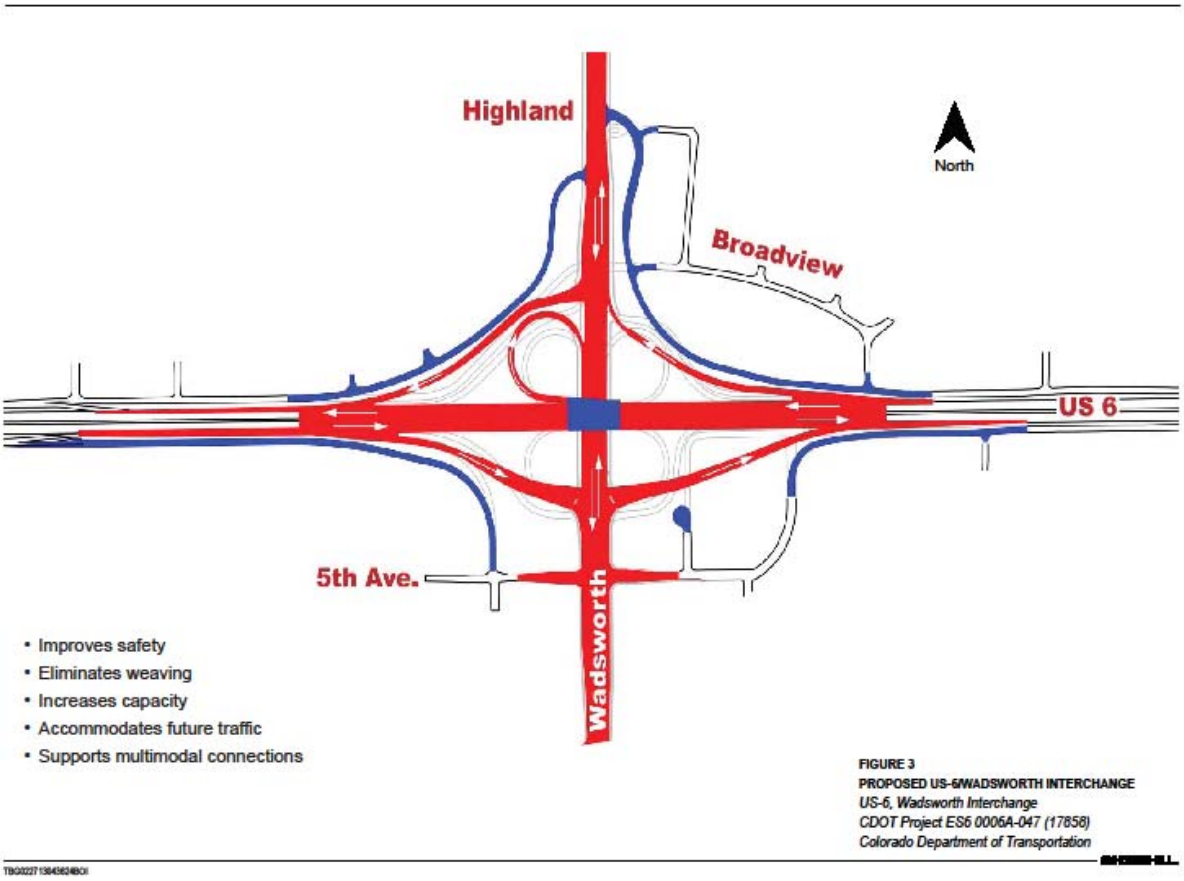

Figure 3 – Proposed US-6, Wadsworth Interchange

TABLE 1
VE Proposal Summary
CDOT, US-6, Wadsworth IC

Proposal No.	Greatest Initial Cost-Saving Potential X	Recommended by VE Team Y	Proposal Description	Estimated Initial [I], Future [F], Net Life-Cycle [LC] Cost Savings (Increase)[1]	Proposal Disposition (Accepted, Rejected, Modified)	Estimated Accepted Cost Savings	Owner and Design Team Response
Bridge Proposals							
B1	X	Y	Consider shortening the bridge by eliminating multi-modal path on the west side next to the roadway, and placing a box culvert on the east side.	I: $4,398,000 F: $0 LC: $4,398,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
B2		Y	Prepare the bridge structure of US-6 over Wadsworth Blvd. with mechanical connectors for widening of 6th Ave. to the south side.	I: ($18,000) F: $574,000 LC: $556,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
B3		Y	Consider using a thin bond overlay on the US-6 over Wadsworth Blvd. bridge deck and approach slabs to lower the deck profile by about 3 inches. *B3 is partially overlapping with B1. Assume 60% of the cost of B3 is valid if B1 is accepted.*	I: ($160,000) F: $528,000 LC: $368,000 Assume 60% of B3 if B1 is Accepted: I: ($96,000) F: $317,000 LC: $221,000	Accepted	I: ($160,000) F: $528,000 LC: $368,000	Refer to the attached VE Study Resolution Meeting Minutes

TABLE 1
VE Proposal Summary
CDOT, US-6, Wadsworth IC

Proposal No.	Greatest Initial Cost-Saving Potential X	Recommended by VE Team Y	Proposal Description	Estimated Initial [I], Future [F], Net Life-Cycle [LC] Cost Savings (Increase)[1]	Proposal Disposition (Accepted, Rejected, Modified)	Estimated Accepted Cost Savings	Owner and Design Team Response
B4			Shorten the proposed bridge, omit the sidewalk on the west side & keeping only the sidewalk on the east side of Wadsworth under 6th Ave. *B4 is mutually exclusive with B1.*	I: $1,115,000 F: $0 LC: $1,115,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
B5			Widen the 6th Ave. bridge structure over Wadsworth to accommodate another lane in each direction for future expansion. This proposal still requires the temporary bridge during construction. *Proposal B5 is mutually exclusive with C2.*	I: ($2,114,000) F: $892,000 LC: ($1,222,000)	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
Construction Proposals							
C1	X	Y	Consider pre-casting the portion of the deck over each of the box beams versus a cast in place deck construction. *C1 is partially overlapping with B1. Assume 60% of the cost of C1 is valid if B1 is accepted.*	I: $415,000 F: $0 LC: $415,000 Assume 60% of C1 if B1 is Accepted: I: $249,000 F: $0 LC: $249,000	Condition-ally Accepted	I: $415,000 F: $0 LC: $415,000	Refer to the attached VE Study Resolution Meeting Minutes

TABLE 1
VE Proposal Summary
CDOT, US-6, Wadsworth IC

Proposal No.	Greatest Initial Cost-Saving Potential X	Recommended by VE Team Y	Proposal Description	Estimated Initial [I], Future [F], Net Life-Cycle [LC] Cost Savings (Increase)[1]	Proposal Disposition (Accepted, Rejected, Modified)	Estimated Accepted Cost Savings	Owner and Design Team Response
C2A			Build new bridge in phases and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will require additional widening that will accommodate 1 additional lane in each direction for future widening. *Proposal C2Ais mutually exclusive with B5 and C2B.*	I: ($138,000) F: $892,000 LC: $754,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
C2B	X	Y	Build new single span bridge in phases and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will require additional widening that will accommodate 1 additional lane in each direction for future widening. This C2B proposal assumes acceptance of Proposal B1 for a single span bridge. C2B shows the savings associated with this proposal in conjunction with B1.	I: $846,000 F: $470,000 LC: $1,316,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
Pedestrian Proposals							
P1			Eliminate the sidewalk on the west side of Wadsworth Blvd. from Lakewood Gulch at the north end to the south signal of the interchange. *Proposal P1 is mutually exclusive with B1, except that some additional*	I: $1,498,000 F: $0 LC: $1,498,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes

TABLE 1
VE Proposal Summary
CDOT, US-6, Wadsworth IC

Proposal No.	Greatest Initial Cost-Saving Potential X	Recommended by VE Team Y	Proposal Description	Estimated Initial [I], Future [F], Net Life-Cycle [LC] Cost Savings (Increase)[1]	Proposal Disposition (Accepted, Rejected, Modified)	Estimated Accepted Cost Savings	Owner and Design Team Response
			sidewalk on the west side could be omitted.				
Roadway Proposals							
R1	X	Y	For ramps on the south side of 6th Ave. use permanent pavement versus temporary pavement to minimize throw-away cost. Review what temp pavement could be made permanent.	I: $483,000 F: $0 LC: $483,000	Accepted	I: $483,000 F: $0 LC: $483,000	Refer to the attached VE Study Resolution Meeting Minutes
R2		Y	Convert the slip ramps between Garrison and Wadsworth to auxiliary lanes. Provide continuous lane between Wadsworth Blvd to Garrison St.	I: ($238,000) F: $0 LC: ($238,000)	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
Structural Proposals							
S1	X	Y	Utilize berms where space permits along Wadsworth Blvd. to decrease the net height of the 15-foot wall, still keeping the top of the wall at 15 feet above existing grade.	I: $574,000 F: $0 LC: $574,000	Conditionally Accept	I: $574,000 F: $0 LC: $574,000	Refer to the attached VE Study Resolution Meeting Minutes

TABLE 1
VE Proposal Summary
CDOT, US-6, Wadsworth IC

Proposal No.	Greatest Initial Cost-Saving Potential X	Recommended by VE Team Y	Proposal Description	Estimated Initial [I], Future [F], Net Life-Cycle [LC] Cost Savings (Increase)[1]	Proposal Disposition (Accepted, Rejected, Modified)	Estimated Accepted Cost Savings	Owner and Design Team Response
Drainage Proposals							
D1	X	Y	Use PVC pipe material instead of RCP material in the storm drain system.	I: $419,000 F: $0 LC: $419,000	Rejected	I: $0 F: $0 LC: $0	Refer to the attached VE Study Resolution Meeting Minutes
TOTALS							
	X		**Total of Greatest Potential VE Cost-Saving Proposals[2] (B1, C1 in part, C2B, R1, S1, D1)**	I: $6,969,000 F: $470,000 LC: $7,439,000			
		Y	**Total of VE Team's Recommended Combination of Proposals[2] (B1, B2, B3 in part, C1 in part, C2B, R1, R2, S1, D1)**	I: $6,617,000 F: $1,361,000 LC: $7,978,000			
			Total of Proposals Accepted or Conditionally Accepted by Owner subject to final design review and implementation			I: $1,312,000 F: $528,000 LC: $1,840,000	

Notes:

[1] The Initial, Future, Net Life-Cycle Cost Savings (or increase, if in parenthesis) represent the difference between the current design approach and the VE proposal.

[2] The sum of proposals per the X and Y designations can be changed for different combinations of proposals. However, some of the proposals may be mutually exclusive.

TABLE 2
VE Observations
CDOT, US-6, Wadsworth IC

No.	Observation Title	Owner and Design Team Response
Aesthetics Observations		
1	Time Frame Requirement for Lakewood's Participation of Funding of Design Elements	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
Bridge Observations		
2	Consider the Need for a Snow Fence at the Bridge Structure	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
Construction Observations		
3	Consider Opportunities to Shorten Phasing of the Project	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
4	Consider Funding Stream for Any Opportunity to Include Wadsworth 10th to 14 Street Project in the Interchange Project	Disagree. Refer to the attached VE Study Resolution Meeting Minutes.
Drainage Observations		
5	Consolidate Water Quality Basins	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
Environmental Observations		
6	Alternative Noise Barrier Material: Transparent Panel	Study further. Refer to the attached VE Study Resolution Meeting Minutes.
7	Consider Additional Phase II Investigation	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
8	Consider NEPA Approval Requirements for Removal of Slip Ramps	Disagree. Refer to the attached VE Study Resolution Meeting Minutes.

TABLE 2
VE Observations
CDOT, US-6, Wadsworth IC

No.	Observation Title	Owner and Design Team Response
9	Address Historic 4(f) Section 106 Requirements for Old Structures	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
Roadway Observations		
10	Directional Handicap Ramps for Pedestrian Improvements	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
Traffic Observations		
11	Pedestrian Poles for Pedestrian Crossings at Intersections	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
12	Add Variable Message Signs on Wadsworth	Disagree. Refer to the attached VE Study Resolution Meeting Minutes.
Multi-Modal Observations		
13	Consider Pedestrian Safety at Loop Ramp and West Side of Wadsworth through the Interchange	Concur. Refer to the attached VE Study Resolution Meeting Minutes.
Estimating Observations		
14	General Comments to the Cost Estimate	Concur. Refer to the attached VE Study Resolution Meeting Minutes.

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US 6 and Wadsworth Final Engineering Design

Purpose:	**VE Study Resolution Meeting**		
Day:	**Wednesday**	Date:	**June 19th, 2013**

Location:	**CH2M HILL**	**Englewood, CO**

Participants

Attendee	Representing
Kevin Brown	CDOT
Stephen Bokros	CDOT
Ben Waldman	City of Lakewood
Melinda Urban	FHWA
Carlos Sala	CH2M HILL
Doug Stewart	CH2M HILL
Zeke Lynch	CH2M HILL

Attendee	Representing
Aaron Swafford	CH2M HILL
Will Voss	CH2M HILL
John Padon	City of Lakewood
Alivia Plankis	CH2M HILL
John Rohner	CH2M HILL
Jaime Davis	CH2M HILL
Paul Johnson	CH2M HILL

Purpose

The purpose of this meeting was to review and determine a disposition for the proposals and observations provided through the VE Study of the US6 and Wadsworth Interchange project, CDOT Project # ES6-006A-047(17858).

The VE Study Resolution Team consisted of individuals from CDOT, Lakewood, FHWA, and the Project Design Team. See the attendees list above. Each group was included in the discussion and finalizing the disposition for the VE Study proposals and observations.

Actions

The following accounts for the disposition of each proposal and observation made during the meeting:

Proposal B1

Consider shortening the bridge by eliminating multi-modal path on the west side next to the roadway, and placing a box culvert on the east side.

The consensus for this proposal was to reject. The Resolution Team rejected this proposal since it does not meet safety and mobility goals as outlined in the Environmental Assessment.

Proposal B2

Prepare the bridge structure of US-6 over Wadsworth Blvd. with mechanical connectors for widening of 6th Ave. to the south side.

The consensus for this proposal was to reject. There is no future plan to widen US 6 beyond the current six lane configuration in CDOT, Jefferson County or DRCOG plans. The Resolution Team decided against spending funding for future unplanned infrastructure.

Proposal B3

Consider using a thin bond overlay on the US-6 over Wadsworth Blvd. bridge deck and approach slabs to lower the deck profile by about 3 inches.
B3 is partially overlapping with B1. Assume 60% of the cost of B3 is valid if B1 is accepted.

The consensus for this proposal was to accept. The Design Team will consider lowering the US6 profile to reduce earthwork cost and improve the loop ramp grade during final design.

Proposal B4

Shorten the proposed bridge, omit the sidewalk on the west side & keeping only the sidewalk on the east side of Wadsworth under 6th Ave.
B4 is mutually exclusive with B1.

The consensus for this proposal was to reject. See B1 discussion.

Proposal B5

Widen the 6th Ave. bridge structure over Wadsworth to accommodate another lane in each direction for future expansion. This proposal still requires the temporary bridge during construction.
Proposal B5 is mutually exclusive with C2.

The consensus for this proposal was to reject. See B2 discussion.

Proposal C1

Consider pre-casting the portion of the deck over each of the box beams versus a cast in place deck construction.
C1 is partially overlapping with B1. Assume 60% of the cost of C1 is valid if B1 is accepted.

The consensus for this proposal was to conditionally accept. The Design Team will consider including this proposal in the design if appropriate during the final design.

Proposal C2A

Build new bridge in phases and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will require additional widening that will accommodate 1 additional lane in each direction for future widening.

Proposal C2 is mutually exclusive with B5 and C2B.

The consensus for this proposal was to reject. See B2 discussion. In addition, the current approach is 2 phase construction, which is more economical than 3 phases on US 6 and the construction of a very large box culvert.

Proposal C2B

Build new single span bridge in phases and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will require additional widening that will accommodate 1 additional lane in each direction for future widening. This C2B proposal assumes acceptance of Proposal B1 for a single span bridge. C2B shows the savings associated with this proposal in conjunction with B1.

The consensus for this proposal was to reject. See B1 and B2 discussion.

Proposal P1

Eliminate the sidewalk on the west side of Wadsworth Blvd. from Lakewood Gulch at the north end to the south signal of the interchange.

Proposal P1 is mutually exclusive with B1, except that some additional sidewalk on the west side could be omitted.

The consensus for this proposal was to reject. See B1 discussion.

Proposal R1

For ramps on the south side of 6th Ave. use permanent pavement versus temporary pavement to minimize throw-away cost. Review what temp pavement could be made permanent.

The consensus for this proposal was to accept.

Proposal R2

Convert the slip ramps between Garrison and Wadsworth to auxiliary lanes. Provide continuous lane between Wadsworth Blvd to Garrison St.

The consensus for this proposal was to reject. Closing these ramps was already considered during the Environmental Assessment and not included in this project. The Design Team will consider methods to stop US 6 eastbound vehicles from exiting across the EB Garrison entrance ramp.

Proposal S1

Utilize berms where space permits along Wadsworth Blvd. to decrease the net height of the 15-foot wall, still keeping the top of the wall at 15 feet above existing grade.

The consensus for this proposal was to conditionally accept. The Design Team will consider locations that berms can physically be constructed and locations private property owners accept them.

Proposal D1
Use PVC pipe material instead of RCP material in the storm drain system.

The consensus for this proposal was to reject. The Resolution Team decided to reject this proposal because of the higher maintenance cost for PVC pipes the City of Lakewood would incure.

Observation No. 1: Time Frame Requirements for Lakewood's Participation of Funding of Design Elements.

The consensus of this observation is to concur. Ben Waldman/City of Lakewood will provide a coordination schedule from the City of Lakewood that integrates with the current project schedule.

Observation No. 2: Consider the Need for a Snow Fence at the Bridge Structure.

The consensus of this observation is to concur. Snow fence will be added during the final design phase.

Observation No. 3: Consider Opportunities to Shorten Phasing of the Project.

The consensus of this observation is to concur.

Observation No. 4: Consider Funding Stream for any Opportunity to Include Wadsworth 10th to 14th Ave Project in the Interchange Project.

The consensus of this observation is to disagree. At this time construction of the interchange is not funded except for Highland Street to 10th Avenue, which is funded but for fiscal year 2015.

Observation No. 5: Consolidate Water Quality Basins.

The consensus of this observation is to concur.

Observation No. 6: Alternative Noise Barrier Material: Transparent Panel.

The consensus of this observation is to further study. It was noted maintenance may be difficult and the panels may get scratched. If considered, the City of Lakewood requests an exhibit showing location they will be installed on this project and examples of prior use.

Observation No. 7: Consider Additional Phase II Investigation.

The consensus of this observation is to concur. The locations specified are planned.

Observation No. 8: Consider NEPA Approval Requirements for Removal of Slip Ramps.

The consensus of this observation is to disagree. See R2 discussion.

Observation No. 9: Address Historic 4(f) Section 106 Requirements for Old Structures.

The consensus of this observation is to concur. All structures were evaluated in the Environmental Assessment with the possible exception of South Lakewood Gulch. This will be included in the re-evaluation if it was not already evaluated.

Observation No. 10: Directional Handicap Ramps for Pedestrian Improvements.

The consensus of this observation is to concur.

Observation No. 11: Pedestrian Poles for Pedestrian Crossings at Intersections.

The consensus of this observation is to concur.

Observation No. 12: Add Variable Message Signs on Wadsworth.

The consensus of this observation is to disagree. VMS are planned to be included in the corridor, outside of the current project limits.

Observation No. 13: Consider Pedestrian Safety at Loop Ramp and West Side of Wadsworth through the Interchange.

The consensus of this observation is to concur. A memorandum discussing pedestrian movement at the loop ramp will be developed after the VE Study completion.

Observation No. 14: General Comments to the Cost Estimate.

a. Sound Wall Height in estimate is 12', the requirements from the Environmental Assessment is 15'.

   The consensus of this observation is to concur.

b. 304-06007 ABC Class 6 by the CY is listed. Use 304-06000 ABC Class 6 by the TON as the price differential is substantial.

   The consensus of this observation is to concur.

Team Endorsement

The VE Study Resolution Team was in consensus and endorsed all of the decisions made at this meeting.

TABLE 3
Ideas Studied but Not Proposed
CDOT, US-6, Wadsworth IC

Proposal No.	Proposal Description	Reason for Failing Idea
Ideas Studied but Not Propose:		
M1-NP	Consider use of rubblized asphalt pavement prepared to the proper specification for the aggregate base course instead of new imported aggregate base course	The Value Engineering team does not recommend this proposal for further consideration. Even though this proposal appears to provide significant cost benefit compared to the cost in the proposed design estimate, the team recommends a change in the pay item. Changing the plan pay item quantity from cubic yard to tons will reduce the cost of this pay item in the cost estimate (paying by tons is cheaper than paying by cubic yard) at which point, this proposal will not provide any cost savings benefit. The VE team, hence, does not recommend this proposal. The change of pay item is recommended.

TABLE 4
Ideas Failed During Analysis Phase
CDOT, US-6, Wadsworth IC

Proposal No.	Proposal Description	Reason for Failing Idea
Brainstorming Ideas that Failed:		
F1	Consider alternate designs for bridge girders such as steel versus precast or single span.	The structure selection report was done, and precast was selected.
F2	Build the bridge structure offsite, and roll into place. Minimizes inconvenience to traveling public.	Concern about bridge size, may be too wide. Would need to build in segments. Requires a specialized contractor. Would need a large are to construct nearby. Consider elevation difference of 6 feet for new vs old bridge.
F3	Consider a series of pipes or other drainage alternatives in lieu of concrete box culverts at the gulches. Consider a "squashed pipe option."	Had been reviewed by design team.
F4	Review requirement for sound walls to be 15 feet high. Reduce the height if the local community supports the idea. Design suggestion.	Mitigation requirement difficult to change.
F5	Consider alternate designs and bid options for concrete and asphalt pavement, letting the market decide which is most cost effective.	Requires two different plan sets. Must base decision on life-cycle cost, which can create controversy between the bidders/suppliers.
F6	Mill and fill existing pavement on Wadsworth. Full depth pavement construction for the widened sections. Also, planning to use concrete versus asphalt on Wadsworth. 6th Ave is mill and fill, and ramps are full depth asphalt.	Would not blend with 10th to Colfax which is bidding as concrete.
F7	Eliminate the detached multi-use path on the west side of Wadsworth Blvd. Provide a 5-foot wide attached sidewalk in lieu of the path, for length of project (10th Ave. to 4th Ave.).	Providing just a sidewalk will encourage pedestrian use across un-signalized crossings, potentially creating a dangerous situation.

TABLE 4
Ideas Failed During Analysis Phase
CDOT, US-6, Wadsworth IC

Proposal No.	Proposal Description	Reason for Failing Idea
F8	Consider using existing box culvert at McIntyre Gulch under 6th Ave, and the other is at Lakewood Gulch across Wadsworth, for pedestrian pathway versus removal. Verify that either or both of these were built in 1942.	The old culverts are made out of brick and need to be replaced.
F9	Consider placing Wadsworth over US-6 versus the other way around. Review impact to sound walls, utilities, etc. Reduces sound of highway.	Fail due to wider structure requirement, complications with ditch crossings. Could enhance pedestrian crossings.
F10	Use 11 foot vs. 12 foot lane widths on Wadsworth.	There are two 11-foot lanes and a third 12-foot lane in the design now
F11	At McIntyre Gulch provide another box next to the drainage culvert for the multi-use path, versus having a sidewalk on the west side of Wadsworth. At Quebec S of Lincoln there is a combined drainage structure and path with the path elevated by about 3 feet. McIntyre Gulch crosses through private property. Long detour and R/W concerns. Tie into Lakewood Gulch trail. Could be an auxiliary path, but would not be used for pedestrians along Wadsworth.	Opportunity for Lakewood, but not for the current project.

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VE Overview

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VE Overview

Introduction

Value Engineering (VE) is a systematic problem-solving technique involving a thorough analysis of project functions. Public and private organizations conduct VE studies for their major projects to reduce costs while meeting the intended functions, and to maximize function for roughly the same cost. CH2M HILL conducts two types of VE studies:

- Concept-level VE studies
- Mid-design VE studies

Value engineering can be represented by the following Value Equation: V = F/C.

- "V" stands for *value* from the Owner's perspective. Value is achieved by either reducing cost but still accommodating the Basic function, or by enhancing function for the same cost.
- "F" stands for *function*. Basic functions of the subject project under study can be described by simple verb-noun (with occasional adjective) definitions, such as: "Improve Safety," "Promote Livability," "Accommodate Growth," "Promote Economy," "Access Business/Residential," and many other functions.
- "C" stands for *cost* of the function. High-cost functions become the subject of brainstorming, because various alternatives may be able to accomplish the basic function at a reduced cost.

The subject project is referred to as US-6, Wadsworth Interchange Project (or the project). The project is located in the City of Lakewood within the Denver Metropolitan area. This VE study of the subject project was conducted by CH2M HILL for the Colorado Department of Transportation (CDOT).

Project Description

CH2M HILL facilitated a VE study on the US-6, Wadsworth Interchange Project, for the Colorado Department of Transportation (CDOT). The initial project involved the environmental study of the existing interchange at 6th Avenue & Wadsworth, including Wadsworth Boulevard from 4th Avenue to 14th Avenue. Wadsworth Boulevard is a segment of State Highway 121 and 6th Avenue is a segment of US 6 within the Lakewood City limits. This project has been established to prepare Preliminary and Final Design based on the Preferred Alternative identified through the EA document process.

This project is intended to produce the following improvements:

1. Increased capacity
2. Improved Safety
3. Higher level-of-service
4. Improved safety and accommodations for bicyclists/pedestrians

5. Improved riding surface (smoother and/or stronger pavement)
6. Bridge Replacements
7. Reconstruction

The Preferred Alternative will replace the existing US 6/Wadsworth interchange and widen Wadsworth between 4th and 14th Avenues. The existing cloverleaf will be replaced with a tight diamond with loop design, consisting of a diamond interchange with a loop ramp in the northwest quadrant. The structurally deficient bridge over Wadsworth will be replaced, and all entrance and exit ramps will be lengthened. Along Wadsworth, the Preferred Alternative will add a travel lane in each direction and a multi-use sidewalk on both sides of Wadsworth. A raised median will be added to the center of the roadway to direct left turns and U-turns.

Construction funding has been provided for Wadsworth Capacity Improvements from 10th Avenue to 14th Avenue. This section will not be included in the VE Study.

Refer to *Figure 1 - Site Location Map*, included in the VE Summary section.

VE Participants

The VE team members who participated in the VE study are identified below.

VE Team Members, February 11-15, 2013

VE Team Members

Paul Johnson, CVS, VE Team Leader, CH2M HILL
Ali Harajli, P.E., VE Structural Engineer, CDOT
Joy French, P.E., Roadway Engineer, CDOT
Leela Rajasekar, Traffic Engineer, CDOT
Jim Martin, Construction, CDOT
Stephen Bokros, Project Manager, CDOT
*Sina Khavary, Cost Estimating, CDOT
*Jordan Rudel, Environmental, CDOT
*Nancy Terry, Right-of-Way, CDOT
*Al Gross, Drainage Engineer, CDOT
*Dave Ruble, Utilities, CDOT

** Part time participation during the week*

CDOT, CH2M HILL and Consultant Design Representatives who provided information to the VE Team at the VE Orientation Meeting and Site Visit on February 11, attended the Mid-Week Briefing on February 13, and attended the VE Out-Brief Presentation on February 15, 2013

Kevin Brown, Resident Engineer, CDOT [1,4,5]
Aaron Swafford, Project Manager, CH2M HILL[1,2,4,5]
Will Voss, Design Manager, CH2M HILL[1,2,4,5]
Mandy Whorton, Environmental Planner, CH2M HILL[1,4]
John Rohner, Bridge Engineer, CH2M HILL[1,4,5]
Doug Stewart, Drainage Engineer, CH2M HILL[1,2,4,5]
Kevin Ryburn, Construction Engineer, CDOT [1, 4]

Stephen Bokros, Project Manager, CDOT [1,2,4,5]
Lindy Howard, Utilities, CH2M HILL[1,4,5]
Zeke Lynch, Traffic Engineer, CH2M HILL[1,5]
Chris Horn, FHWA [5]
Jill Brogdan, Finance Department, CDOT [5]

Don Hunt, Geotechnical and Pavement Engineer, RockSol Consulting Group, Inc. [1,5]

City of Lakewood Participants on February 12 and February 15
Roger Wadnal, Comprehensive Planner, City of Lakewood[3]
Al Colussy, Architect, KLIPP[3]
Dave Baskett, City of Lakewood [5]
Ben Waldman, City of Lakewood [5]

(1)Participated in VE Orientation Meeting on February 11
(2) Attended the Site Tour with the VE Team on February 11
(3) Briefed the VE team on City of Lakewood Aesthetic Design Concepts for the Highway Project on February 12
(4)Participated in the VE team's Mid-Week Briefing to the Owner and design team on February 13
(5) Attended the VE Out-Brief Presentation on February 15

Study Methodology

During the VE study, the VE team moved through the following phases, as outlined in the attached *VE Study Agenda*.

Information Phase

On Monday, February 11, 2013 the CDOT project manager, and CH2M HILL design team for the subject project provided the VE team with project design information, design drawings, project estimate, discipline-specific reports, and other miscellaneous project information for reference during the VE study. Refer to the topics noted in the VE Study Agenda (introductions; overview of study agenda and VE process; CDOT overview of the project; and the CH2M HILL design team presentation, including questions and answers for each topic).

A site tour followed on Monday afternoon, February 11th.

On Tuesday, February 12, City of Lakewood representatives presented aesthetic concepts that the City wishes to further discuss with CDOT. Aesthetic improvements are proposed for the US-6 Bridge over Wadsworth, along at noise walls, and within the landscaped sections surrounding the interchange. The interchange will serve as the gateway to the City of Lakewood.

Function Analysis Phase

Following the conclusion of the VE Orientation Meeting, on Monday, February 11, 2013, the VE team continued to review the design information and discussed issues identified on the site tour. The project components were discussed, as well as the preliminary cost estimate,

and were expressed in terms of functions that the US-6, Wadsworth Interchange project is intended to serve. Team Focus Questions and Answers were addressed.

Creative Phase

Following the project tour and VE Orientation Meeting, the VE team worked on its own through Friday morning, February 15, 2013. The VE team selected the Basic functions for further analysis of the US-6, Wadsworth Interchange project, on the basis of their apparent cost, cost-to-worth ratios, and potential for improvement. A formal brainstorming session generated numerous alternative methods to achieve the selected Basic functions.

Analysis Phase

The VE team listed the alternatives for the project and gave them pass or fail ratings, based on their apparent advantages and disadvantages. The VE team then refined the selected alternatives into more comprehensive scope descriptions for subsequent analysis.

Development Phase

A rigorous economic analysis of alternative ideas for the project allowed estimated costing to be done. A detailed technical examination followed, including approximate quantities, costs, and calculations for ideas shown to have potential for significant savings.

As the VE team went through the technical and economic analysis, several proposals, in the opinion of the VE team, would have the potential to reduce the project cost from the base design.

Presentation Phase

The VE team recorded and compiled ideas, observations, calculations, and cost analyses for an Executive Summary Presentation (VE Out-Brief) that was given to CDOT managers and the CH2M HILL design team on Friday, February 15, 2013 at CH2M HILL's Denver office.

Implementation Phase

On March 4, 2013, a Preliminary VE Report was distributed to CDOT and the design team for review. The final phase of the VE study was the Implementation Phase, which has consisted of CDOT's and the CH2M HILL design team's acceptance, conditional acceptance, recommendation for further study, or rejection of each VE proposal or observation. The Preliminary VE Report was produced by CH2M HILL for review by all project team members as the first step toward documenting decisions made by these parties. This Final VE Report fully documents the VE study and results, and has been produced following determination of the final disposition of each VE proposal and observation for the US-6, Wadsworth Interchange Project.

Study Results

Team Focus Questions and Answers

To begin the study with a consistent understanding of the focus of the VE study, the VE team facilitator asked the VE team to address six basic questions. Those questions, and the VE team's responses, are outlined below.

1. What is the problem we are about to discuss?

Refer to Purpose and Need from the FONSI and Final Section 4(f) Evaluation:

> The purpose of the US-6/Wadsworth project is to improve traffic flow and safety, accommodate high traffic volumes, and increase multi-modal travel options and connections at the US-6 and Wadsworth Interchange and along Wadsworth between 4th Avenue and 10th Avenue *(changed from 14th, because 10th to 14th is a separately funded project)*. The existing design and configuration of the interchange and roadway within the project limits are deficient to meet growing traffic and multi-modal travel demands. Improvements are needed to:
>
> - Improve safety for motorists, pedestrians, and bicyclists
> - Improve operational efficiency of the interchange on Wadsworth
> - Meet current and future traffic demands
> - Support multi-modal connections

The current cost estimate is approximately $80 million for the overall project inclusive of construction, and project administration, including the concrete adjustment for Wadsworth Blvd. Add $15 million if the Garrison Bridge replacement is included. This value does not include ROW, or design, which are in separate budgets. The current budget for the project is being established, but will be based on the cost estimates.

2. Why do we consider this a problem?

- Capacity of the Wadsworth Blvd. is insufficient as of today.
- Pedestrian facilities are lacking.
- This interchange has a high accident rate in Lakewood.
- Funding for the current project has not yet been secured. Funds are being secured from numerous sources including Seventh Pot, RAMP, Bridge Enterprise (BE), FASTER, HES, RPP, BR, City of Lakewood local agency match, DRCOG funds. These sources include federal funding through FHWA, and state specific sources, and local match.

3. Why do we believe a solution is necessary?

- To improve traffic flow, and reduce inconvenience to the traveling public due to delay.
- To improve safety for motorists and pedestrians.
- Funding is anticipated to come together within 1 year so that the project can be advertised for bid in March 2014. If all necessary funding sources are not realized in this timeframe, the project could be subject to delay, and the cost of inflation will then be a factor. It would be most economical to do the project all at once, but if the funding stream takes more time, then the project could be broken up into segments.
- First priority: DRCOG funding needs to be encumbered by 2015. $8 million from DRCOG. This money is committed to the project already.
- Next priority: RAMP funding would need to be spent by 2017. Verify amount (large amount).
- Bridge Enterprise funding has already been requested for the Garrison bridge replacement.

- Wadsworth bridge won't be replaced from BE, but is planned to be funded from the other sources identified.

4. What are the highest cost components of the project?

The Project Cost Estimate by CH2M HILL for CDOT, dated October 16, 2012 at preliminary design completion, totals $68,267,758 (rounded to $68.3 million) expressed in year 2012 dollars. This is the total estimated project cost, including a subtotal for construction of $35.1 million, and related construction markups and CDOT management costs of $33.2 million. The markup on direct construction equates to 94.7 percent of the subtotal of construction cost. This total does not include escalation, right-of-way, or design costs.

The cost breakdown by major categories within the estimate is as follows, including the line item's percentage of the overall construction estimate.

• Structures:	$22.9 million	33.5%
• Signals:	$1.5 million	2.2%
• Signage, Striping (S&S):	$1.7 million	2.6%
• Roadway:	$32.0 million	46.9%
• Lighting:	$2.2 million	3.3%
• Land:	$1.4 million	2.1%
• Intelligent Transportation System (ITS):	$0.5 million	0.7%
• Environmental:	$0.7 million	1.0%
• Drainage:	$5.3 million	7.8%

The following cost model prepared by the VE team, is a summary of the design team's Cost Estimate for this project.

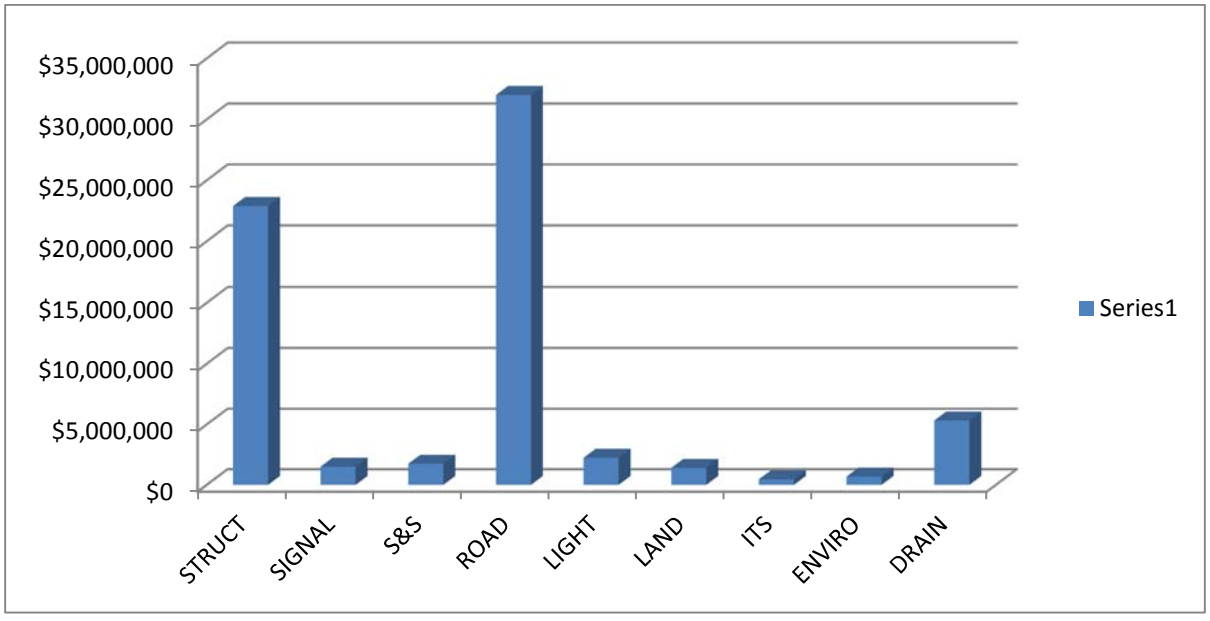

Figure 4 - Cost Model for US-6, Wadsworth Interchange

5. **What are the highest risk issues associated with the project?**
    - Utility relocations: Necessary potholing to identify locations and to relocate major utilities such as the high pressure gas line, and the major fiber optic line.
    - Phasing of the project to build the temporary and permanent bridge, and sequencing.
    - Securing necessary funding in the desired timeframe.
    - Drainage design with unique geometry for culverts to avoid interferences below and above culverts.

6. **What are the expected outcomes from the VE study?**
    - Cost savings where possible without compromising functionality.
    - Review and comment on phasing and constructability plan, and if there are further efficiencies that can be considered.
    - Fulfill the FHWA VE requirement for the project.
    - Comment on timeframes needed for decisions about aesthetic enhancements to walls, bridge, quadrants.

Basic Functions

During the Function Analysis Phase, the VE team identified functions for each of the major project components of the US-6, Wadsworth Interchange Project. This exercise is helpful in bringing the VE team to a more complete level of understanding of the project goals, drivers, and purpose.

Functions are described in simple verb–noun definitions (along with occasional adjectives and descriptive statements), and are intended to help clarify the scope of the project for purposes of VE analysis. Functions of a project can be categorized as Higher-Order (H) functions, Basic (B) functions, Secondary (S) functions, and All the Time (A) functions.

Higher-Order (H) functions describe the overall purpose of the project, but are not viewed to be within the specific scope of the VE study. These are the high-ideals of the project to which all Basic functions of the highway project are intended to support. The Basic and Secondary functions themselves are within the purview of the VE team to review for possible alternatives representing an economy to the project. Basic (B) functions describe the most important elements of the project. Secondary (S) functions describe meaningful, yet secondary elements of the project that need to be accommodated to deliver the project, but do not themselves represent a primary purpose for implementing the project. In many projects, the costs devoted to accomplishing Secondary functions are often higher than they really need to be; therefore, Secondary functions receive much scrutiny in a VE study along with Basic functions.

All the Time (A) functions describe meaningful objectives that a project should strive to meet.

High-cost areas of the project where opportunities for VE savings exist can be found primarily in Basic and Secondary functions. That is why the VE team spends time

identifying project functions. Alternatives are evaluated that can meet the intended function without compromise to quality or the function itself. For example, if a lot of money is being spent on the Secondary function "Reduce Noise Transmission," (such as if the noise walls are higher than they are required to be) then it is incumbent on the VE team to explore other technically feasible and lower cost alternatives to this function.

The functions generated by the VE team are identified below, along with the designators in parentheses as to the type of function they represent.

Table 5 – Functions of the US-6, Wadsworth Interchange Project

Functions: H = Higher Order; B = Basic; S = Secondary; A = Higher Order	
Higher Order Functions (H) Link Communities (H) Promote Economy (H) Promote Livability **Overall Project** (B) Move Traffic Efficiently (B) Accommodate Pedestrians (B) Accommodate Bicycles (B) Transport People (B) Transport Goods (B) Minimize Congestion (B) Improve Safety (S) Decrease Frustration (A) Enable Emergency Access (A) Extend Pavement Life **US-6 Roadway** (B) Move Traffic Efficiently (B) Transport People (B) Transport Goods (B) Minimize Congestion (S) Decrease Frustration (B) Improve Safety **US-6, Wadsworth Interchange** (B) Improve Safety (B) Link Interstate/Arterials (B) Free Flow Movement (WB US-6 to SB Wadsworth) (B) Controlled Movement (other maneuvers) (B) Grade Separate Traffic (B) Span Gap (B) Link Sides (S) Gateway to Community	**US-6, Wadsworth Blvd.** (B) Transport People (B) Transport Goods (A) Accommodate Business Access (A) Accommodate Residential Access (B) Accommodate Multi-Modal Use (B) Accommodate Buses (S) Link Transportation Alternatives (light rail, bike, bus, pedestrians) (B) Eliminate Choke Point (Wadsworth to 3 lane vs. 2) (B) Match N-S Construction (3 vs. 2 lane) (B) Lane Balance Lanes (3 vs 2 each direction) **Drainage** (S) Move Water (S) Prevent Flooding (S) Prevent Erosion (S) Shed Water (S) Prevent Hydroplaning (S) Dry Pavement/Base (S) Reduce Future Maintenance (S) Accommodate Irrigation (S) Detain Stormwater (S) Treat Stormwater **Lighting** (S) Illuminate Interchange (S) Illuminate Roadways (S) Illuminate Multi-Modal Paths (B) Improve Safety (S) Improve Visibility

Functions: H = Higher Order; B = Basic; S = Secondary; A = Higher Order	
Sound Walls (S) Reduce Noise Transmission (A) Comply with Environmental Commitment (H) Improve Livability (S) Enhance Aesthetics (S) Screen Highway **Utility Relocations** (B) Clear Path (Roadway) (S) Undergrounding for Safety and Aesthetics (A) Maintain Utility Service	**Right-of-Way** (A) Accommodate Roadway Footprint (B) Accommodate Multi-Modal (A) Accommodate Construction **Project Delivery** (S) Permit Project (S) Design Project (S) Construct Project (S) Fund Project (S) Administer Project (S) QA/QC Project

FAST Diagram

The VE team then arranged the functions into a FAST diagram. FAST stands for "Function Analysis System Technique." The following FAST diagram links the Basic and Higher-Order functions into "How-Why" relationships for the US-6, Wadsworth Interchange Project.

Development of a FAST diagram helps a VE Team better understand the nature of the problem under study, because a full understanding of the problem leads to development of more meaningful solutions.

VE Proposals and Observations

The VE team identified numerous ideas during the Creative Phase to generate ideas for design alternatives. The VE team then reviewed the most promising ideas to evaluate whether they merited a formal proposal.

VE participants then collaborated during the proposal development phase to calculate proposals and prepare observations assigned to them. The VE cost estimator provided support in proposal calculations.

Although the VE team did not completely develop every idea, team members followed the sequence of steps listed below when developing proposals:

1. Prepare a short proposal description
2. Identify advantages and disadvantages
3. Prepare a narrative discussing the idea
4. Calculate potential cost savings
5. Prepare supporting sketches where applicable to illustrate the proposal
6. Conclude whether the idea should be proposed, based on calculations

The proposals studied can be found in *Table 1 – VE Proposal Summary.* During this evaluation process, a variety of implementable cost-saving opportunities were found.

The 13 ideas brainstormed by the VE team and passed for further development are presented in *Table 1 – VE Proposal Summary*. Another 14 ideas were developed as Observations and are presented in *Table 2 – VE Observations.* The Observations were written on a variety of subjects to serve as reminders to the design team and stakeholder agencies as the design is finalized.

Another idea was initially passed and developed as a VE proposal, but was then determined during the development phase of the VE study to be infeasible. This idea is still included in this report to document the VE effort and to demonstrate that every reasonable path toward functional enhancement and cost savings were explored by the VE team, but not every idea was determined by the team to be feasible. This idea is outlined in *Table 3 – Ideas Studied But Not Proposed*, and the supporting narrative and calculations for this "not-proposed" idea is included later in the report.

Another 11 ideas generated during the Creative Phase were failed during the Analysis Phase. These ideas and the reasons for not developing them as VE proposals are included in *Table 4 – Ideas Failed During Analysis Phase.*

As stated in the Preliminary VE Report, several of the 13 proposals included in Table 1 were mutually exclusive from the others. Four of the proposals in Table 1 represented a cost *increase* over the original design, and were proposed for functional reasons.

There were 6 proposals indicated with an "X" in Table 1 that could be accepted together for a maximum potential initial cost savings of $6,969,000, a future savings of $470,000 expressed in present worth, and a net life-cycle savings of $7,439,000.

A different subset of 9 proposals was highly recommended by the VE team for functional reasons. These proposals, indicated with a "Y" in Table 1, totaled an initial savings of $6,617,000, a future savings of $1,361,000 expressed in present worth, and a net life-cycle savings of $7,978,000. These net savings totals included 3 cost-increase proposals. The other 4 proposals not indicated with a "Y" still could have been accepted, but were not deemed as the highest-priority cost-saving proposals by the VE team. The VE proposals and Observations are presented in detail in the subsequent sections of this report.

Refer to the VE Summary section for a summary of the VE proposals and observations that have been accepted or conditionally accepted for incorporation into the final design for the US-6, Wadsworth Interchange Project.

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

US-6, WADSWORTH INTERCHANGE, CDOT

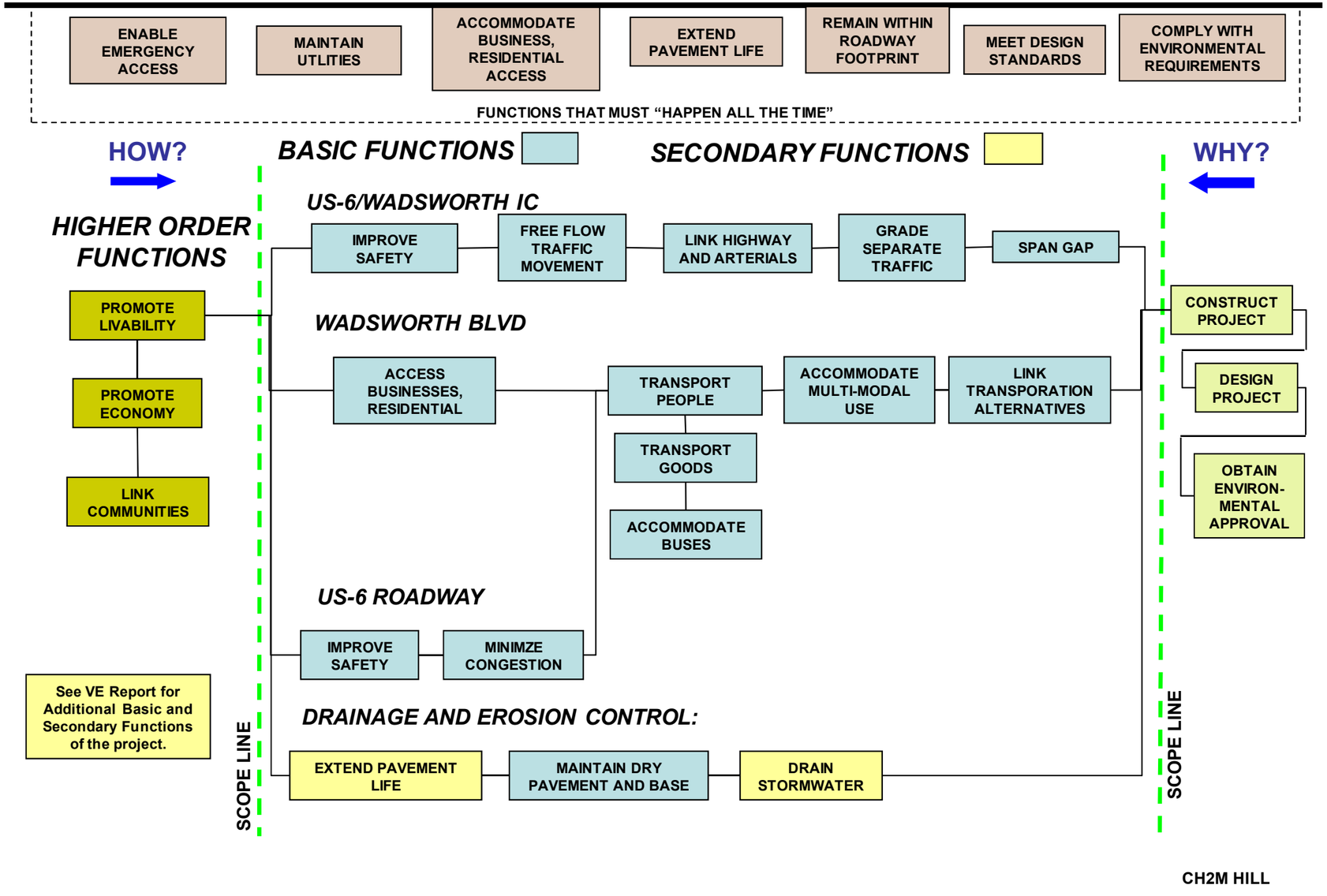

Figure 5 - FAST Diagram

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VE Proposals

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Value Engineering Proposal No. B1

Proposal Title

Consider shortening the bridge by eliminating multi-modal path on the west side next to the roadway, and placing a box culvert on the east side.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$4,398,000	$0	$4,398,000

Advantages	Disadvantages
1. Shorter single span Bridge. 2. Shorter construction time. 3. Less future maintenance. 4. Less accidents/enhanced safety.	1. Added cost of abutments & wing walls. 2. Additional culvert cost for Pedestrians.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The new bridge layout was developed based on the assumption of accommodating both pedestrians and bicycle traffic on both sides of Wadsworth Blvd. This multi-modal path width is about 23 ft on each side, and the corresponding bridge length is 248'-6". Refer to Figure B1-1 below, provided by the design team.

Figure B1-1: Cross Section of Proposed US-6 Bridge over Wadsworth Blvd.

VE Team's Proposal:

The VE team proposes to eliminate the multi-modal path on both sides and use a box culvert for pedestrians and bicycle traffic on one side only. This will shorten the bridge since we do not have to extend the span to cover the multi-modal paths shown. This proposal allows the use of box culverts on both sides to accommodate the pedestrians. In this configuration the center piers can be omitted and the bridge can be converted to a single span. Refer to Figure B1-2 below.

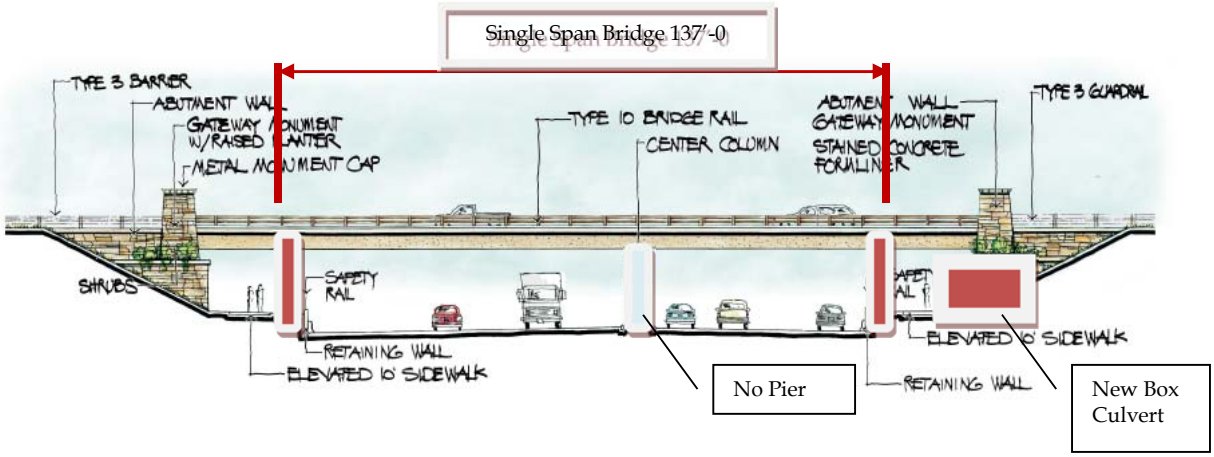

Figure B1-2: Single Span Bridge with Box Culverts on Either Side for Multi-Modal Access

Calculations – Initial Capital Cost

Current Design Concept:

Bridge cost as shown in the engineer's cost estimate at 30% design: Area: 248.5ft x 130.5 ft = 32,429.25 SF 32,429.25 SF x $180/SF = $5,837,265	$5,837,265
Subtotal	$5,837,265
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$5,527,890
Total	**$11,365,155**
Total, Rounded	**$11,365,000**

Value Engineering Team's Proposal:

Proposed single span bridge with culverts on either side: Area: 136 ft x 130.5 ft = 17,748 SF 17,748 SF x $180/SF = $3,194,640	$3,194,640
Culvert (area=10ftx130.5=1,350) @ 125 $/sf	$163,125

Cost of abutment concrete (Vol.1=[Area=10ft*130.5ft]*2.5ft*2/27=241.7 CY	$125,183
Cost of wing wall concrete: (Vol.2=[Area=10*15]*1.5*4/27)=33.33 CY	$17,267
Cost of abutment & wing wall rebar =@270 lbs/CY*(Vol.1+Vol.2)	$77,963
Subtotal	$3,578,178
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$3,388,535
Total	$6,966,713
Total, Rounded	**$6,967,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $11,365,000 - $6,967,000 =	**$4,398,000**

Calculations – Future Cost

Some future cost savings could be realized with one less sidewalk, but this has not been calculated. Also, a crash barrier won't be needed at the piers because the piers are omitted with the VE proposal, resulting in lower future maintenance of the barriers.

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration due to the Shown cost savings.

Prepared By: Ali A. Harajli

Checked By: Jim Martin, Paul Johnson

Value Engineering Proposal No. B2

Proposal Title

Prepare the bridge structure of US-6 over Wadsworth Blvd. with mechanical connectors for widening of 6th Ave. to the south side.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
($18,000)	$574,000	$556,000

Advantages	Disadvantages
1. Work can be done economically in the current project. 2. Minimizes future cost if the bridge is ever widened. 3. Shorter future construction time. 4. Enhanced safety during future construction.	1. Minimal additional initial cost. 2. Minimal additional construction time.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The proposed design is to build the 6th Ave. structure over Wadsworth Blvd. back to the original width plus 18 feet to accommodate the ramp widening. There is no widening consideration for future lanes beyond the existing 3 lanes in each direction for US6

VE Team's Proposal:

The VE team proposes to add mechanical connectors at the support locations to minimize future construction costs due to the potential widening of 6th Ave. in the future to 4 lanes versus 3 lanes in each direction.

Calculations – Initial Capital Cost

Current Design Concept:

NA. The cost of the connectors is not in the current design, but is suggested in the VE section below.	$0
Subtotal	$0
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$0

Total	**$0**
Total, Rounded	**$0**

Value Engineering Team's Proposal:

Proposed mechanical connector cost at abutment 1: 2 connectors per ft x 20 ft = 40 connectors 40 each x $75/each = $$3,000	$3,000
Proposed mechanical connector cost at Pier2: 2 per ft x 20 ft = 40 connectors 40 each x $75/each = $3,000	$3,000
Proposed mechanical connector cost at abutment 3: 2 connectors per ft x 20 ft = 40 connectors 40 each x $75/each = $3,000	$3,000
Subtotal	**$9,000**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$8,523
Total	$17,523
Total, Rounded	**$18,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $0 - $18,000 =	**($18,000)**

Calculations – Future Cost

10% of future bridge cost is the presumed efficiency for having the mechanical connectors in place to accommodate bridge widening, versus more difficult construction to create the connections in the future: Future Area=A1=(130.5ft+24ft)*248.5ft=38,393.5 sf Future value =10%*future bridge cost= 10%*(A1*180$/sf) = $691,079, Present worth (3% discount, at year 20): Present worth factor is 0.55368, derived from the formula: Present Worth Factor = $(1+i)^{-n}$ Where "i" = 3%, and "n" = 20 years PWF = 0.55368 $691,079 x 0.55368 = $382,637 This means that if $382,637 is placed in a savings account earning 3% interest, then the value at year 20 would be $691,000.	$382,637

The effect of inflation is not included in Present Worth analysis because government's revenues are presumed to keep pace with inflation, making future dollars effectively as easy (or difficult) to come by as current day dollars.	
Subtotal	**$382,637**
Markup, revised to 50% which is a standard maintenance value that CDOT uses for aggregate markup on future projects.	$191,318
Total	$573,955
Total, Rounded	**$574,000**

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration due to future cost savings.

Prepared By: Ali A. Harajli

Checked By: Jim Martin, Paul Johnson

Value Engineering Proposal No. B3

Proposal Title

Consider using a thin bond overlay on the US-6 over Wadsworth Blvd. bridge deck and approach slabs to lower the deck profile by about 3 inches.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
($160,000)	$528,000	$368,000

Advantages	Disadvantages
1. Lower roadway embankment cost. 2. Shorter construction time. 3. Less accidents/enhanced safety. 4. Longer life of the bridge deck. 5. Less maintenance and reduced future cost. 6. Lower future overlay cost. 7. Better deck protection against chloride attack.	1. Higher initial deck overlay cost.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The proposed design of the 6th Ave. structure over Wadsworth Blvd. uses a waterproofing membrane with a 3-inch lift of Stone Mastic Asphalt as a topping for the final roadway surface.

VE Team's Proposal:

The VE team proposes consideration of a thin bond overlay on the deck and approach slabs to lower the deck profile by about 2 inches. Instead of a 3-inch asphalt overlay and membrane on the bridge, use ¾-inch to 1-inch of a polyester concrete thin bond overlay for deck protection.

Calculations – Initial Capital Cost

Current Design Concept:

3-inch Asphalt & waterproof membrane: Area (deck)=248.5'x130.5'/9=3,603 SY Area (2_approach slabs)= 40'x130.5/9=580 SY Total area: 3,603 SY + 580 SY = 4,183 SY 4,183 SYx $30SY= $125,498	$125,498

Embankment cost: 150 ft per 1-inch transition: Volume (CY)= 2″ x 150ft/inch x 130.5ft x 2sides/27 Volume= 2,700 CY @ $14/CY= $40,600	$40,600
Time to construct Embankments 1 day @ $3,000/day	$3,0000
Subtotal	$169,098
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$160,136
Total	$329,234
Total, Rounded	$329,000

Value Engineering Team's Proposal:

3/4″ thin bonded overlay Area (deck)=248.5'x130.5'/9=3,603 SY Area (2_approach slabs)=40'x130.5/9=580 Total area: 3,603 SY + 580 SY = 4,183 SY 4,183 SYx $60SY= $250,995	$250,995
Subtotal	**$250,995**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$237,692
Total	$488,687
Total, Rounded	$489,000

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $329,000- $489,000 = ($160,000)	**($160,000)**

Calculations – Future Cost

Asphalt needs to be replaced roughly every 5 years within the 20 years service life of the thin bonded overlay. The cost to replace the asphalt during the life of the thin bonded overlay will be evaluated.. The present worth value is: Present Worth (PW)=Future Worth(FW)/$(1+i)^n$. The interest rate (i=discount factor) assumed is 3% and n is the number of years for the evaluated period.

3″ Asphalt replacement ever 5 years Total area: 3,603 SY + 580 SY = 4,183 SY	$351,674

Present worth for each replacement= [Area=4,183 SY]x $30SY= $125,498 Present worth factors for years [5,10,15,20] are [0.86,0.74,0.64,0.55] The final present worth is the sum of the multiplication of the present worth and the present worth factor for each interval.	
Subtotal	$351,674
Markup, 50.0% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$175,837
Total	$527,511
Total, Rounded	**$528,000**

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration due to the shown cost savings.

Prepared By: Ali A. Harajli Checked By: Jim Martin, Paul Johnson

Value Engineering Proposal No. B4

Proposal Title

Shorten the proposed bridge, omit the sidewalk on the west side & keeping only the sidewalk on the east side of Wadsworth under 6th Ave.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$1,115,000	$0	$1,115,000

Advantages	Disadvantages
1. Shorter Bridge. 2. Shorter construction time. 3. Less future maintenance. 4. Less accidents/enhanced safety.	1. Added cost of wing walls. 2. Review if further environmental review needed with this proposal. 3. Possible reevaluation of funding criteria for grants received through DRCOG.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The new bridge layout was developed based on the assumption of accommodating both pedestrians and bicycle traffic on both sides of Wadsworth. This multimodal path width is about 23 ft on each side and the corresponding bridge length is 248'-6". Refer to Figure B4-1.

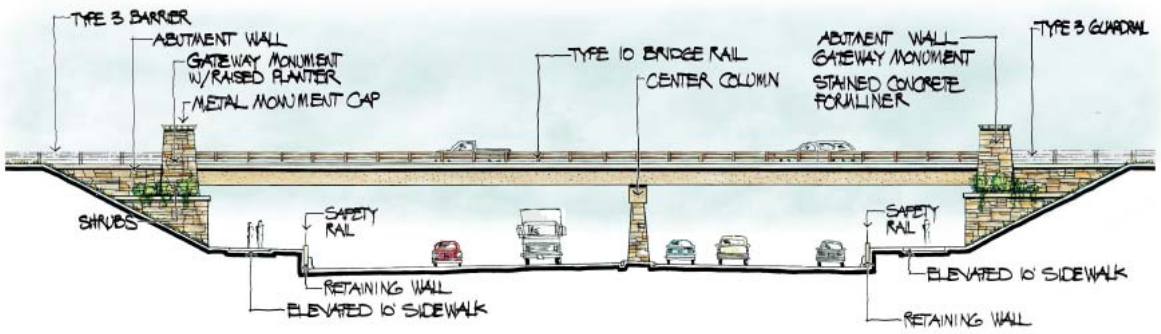

Figure B4-1: Cross Section of Proposed US-6 Bridge over Wadsworth Blvd.

VE Team's Proposal:

The VE team proposes to eliminate the multimodal path on the West side and maintain what is originally proposed on the east side for pedestrians and bicycle traffic. This will shorten the bridge since we do not have to extend the span to cover the multi-modal path on the west side. Refer to Figure B4-2.

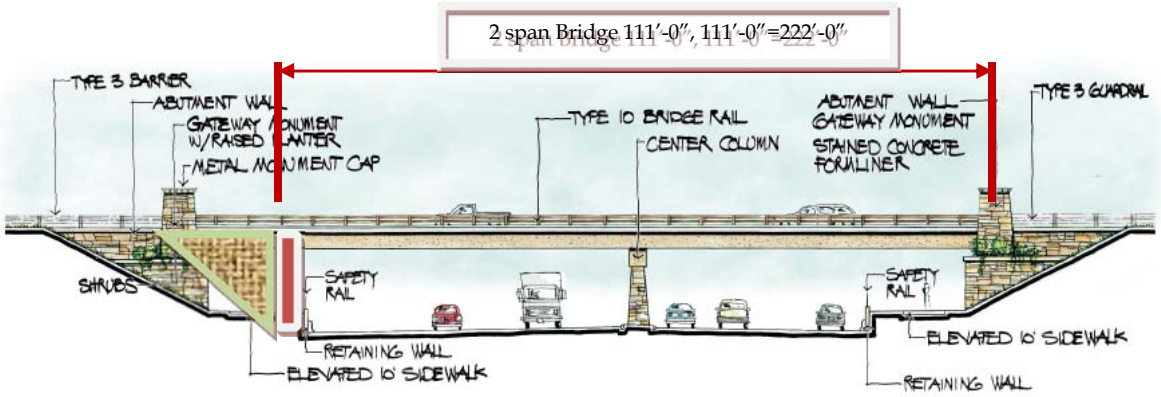

Figure B4-2: VE Proposal for Shorter Bridge with One Pedestrian Path on East Side of Wadsworth under the Bridge

Calculations – Initial Capital Cost

Current Design Concept:

Default design bridge cost (area=248.5ftx130.5ft, @ 180$/sf)	$5,837,265
Subtotal	$5,837,265
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$5,527,890
Total	**$11,365,155**
Total, Rounded	**$11,365,000**

Value Engineering Team's Proposal:

Proposed design bridge cost (area=137ftx130.5ft @ 180$/sf)	$5,296,995
Subtotal	$5,296,995
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$5,016,254
Total	$10,313,249
Total, Rounded	**$10,313,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $11,365,000 - $10,313,000=	**$1,115,000**

Calculations – Future Cost

NA.

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration due to the shown cost savings.

Prepared By: Ali A. Harajli

Checked By: Jim Martin, Paul Johnson

Value Engineering Proposal No. B5

Proposal Title

Widen the 6th Ave. bridge structure over Wadsworth to accommodate another lane in each direction for future expansion.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
($2,114,000)	$892,000	($1,222,000)

Advantages	Disadvantages
1. Improve construction phasing. 2. Widening of US-6 at a reduced cost. 3. Less accidents/enhanced safety.	1. Added initial cost. 2. Impacts to Right of Way. 3. North West ramp realignment.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The proposed bridge layout was developed based on the assumption of accommodating 3-(three) traffic lanes in both directions on 6th avenue. The current cross section width is 130.5 ft.

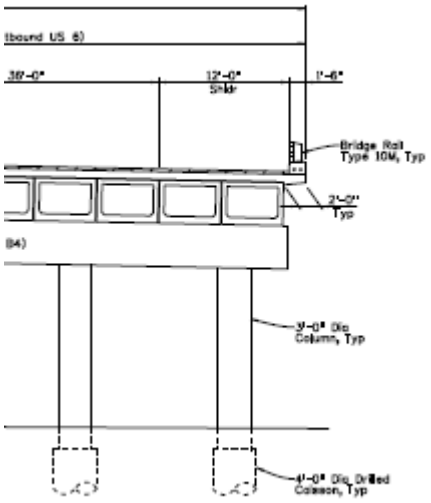

Figure _B5-1

VE Team's Proposal:

The VE team proposes to add one more traffic lane in each direction on 6th avenue resulting in an additional 24 ft to the width proposed by the design team.

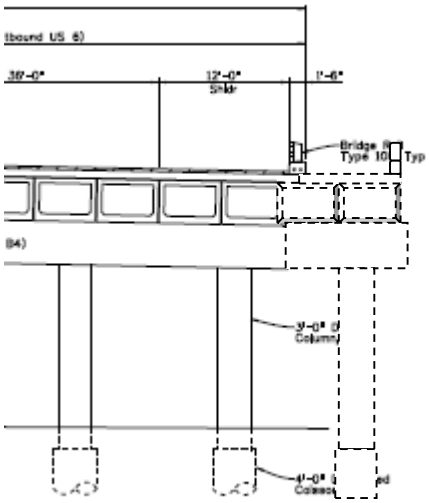

Figure _B5-2.

Calculations – Initial Capital Cost

Current Design Concept:

Default design bridge cost (area=248.5ftx130.5ft, @ $180/sf)	$5,837,265
Subtotal	$5,837,265
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$5,527,890
Total	**$11,365,155**
Total, Rounded	**$11,365,000**

Value Engineering Team's Proposal:

Proposed design bridge cost (area=248.5ftx(130.5ft+24ft) @ $180/sf)	$6,923,203
Subtotal	$6,923,203
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$6,556,273
Total	$13,479,476
Total, Rounded	**$13,479,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $11,365,000 - $13,479,000=	($2,114,000)

Calculations – Future Cost

If US-6 is widened by another lane in each direction in 20 years, then the future cost of that work at the US-6 structure over Wadsworth could be avoided because the bridge infrastructure would already be in place. Future Area=A1=(24ft)*248.5 ft = 5,964 sf Future value = 5,964 SF *$180/sf) = $1,073,520 Present worth (3% discount, at year 20): Present worth factor is 0.55368, derived from the formula: Present Worth Factor = $(1+i)^{-n}$ Where "i" = 3%, and "n" = 20 years PWF = 0.55368 Future savings: $1,073,520 x 0.55368 = $594,387 This means that if $594,387 is placed in a savings account earning 3% interest, then the value at year 20 would be $1,073,520. The effect of inflation is not included in Present Worth analysis because government's revenues are presumed to keep pace with inflation, making future dollars effectively as easy (or difficult) to come by as current day dollars.	$382,637
Subtotal	**$594,387**
Markup, revised to 50% which is a standard maintenance value that CDOT uses for aggregate markup on future projects.	$297,194
Total	$891,581
Total, Rounded	**$892,000**

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration due to the cost savings realized now for mitigating future traffic volume increase, as well as the future savings by not having to construct another 2 lanes on the bridge when US-6 may be widened.

Prepared By: Ali A. Harajli

Checked By: Jim Martin, Paul Johnson

Value Engineering Proposal No. C1

Proposal Title

Consider pre-casting the portion of the deck over each of the box beams versus a cast in place deck construction.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$415,000	$0	$415,000

Advantages	Disadvantages
1. Shorter single span Bridge. 2. Shorter construction time. 3. Less future maintenance. 4. Less accidents/enhanced safety.	None noted.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The proposed bridge layout was developed based on the assumption of using a cast in place deck option.

VE Team's Proposal:

The VE team proposes using the option of precasting the portion of the decks over the box beams. In this configuration the need to place the rebar and curing the deck could be done earlier.

Calculations – Initial Capital Cost

Current Design Concept:

Proposed to pre-pour deck at the casting yard: Time saved for concrete pour= 3 days @ $3,000/day	$9,000
Time saved to tie rebar= 3 days @ $3,000/day	$36,000
Time saved for concrete cure (phase1 & 2)= 6 days @ $3,000/day	$18,000
Time for concrete to reach full strength_Phase1= 25 days @ $3,000/day	$75,000
Time for concrete to reach full strength_Phase2= 25 days @ $3,000/day	$75,000
Subtotal	$213,000

Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$201,711
Total	$414,711
Total, Rounded	$415,000

Value Engineering Team's Proposal:

No added cost per the VE proposal.	$0
Subtotal	$0
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$0
Total	$0
Total, Rounded	**$0**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $415,000 - $0 = $415,000	**$415,000**

Calculations – Future Cost

NA.

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration due to the shown cost savings.

Prepared By: Ali A. Harajli Checked By: Jim Martin

Value Engineering Proposal No. C2A

Proposal Title

Build new bridge in phases and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will require additional widening that will accommodate 1 additional lane in each direction for future widening. This C2A proposal assumes the 2 span base case is built..

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
($138,000)	$892,000	$754,000

Advantages	Disadvantages
1. No need for a temporary bridge. 2. With a widened structure, no need for future widening of the structure to accommodate additional lanes. 3. This approach would have 3 phases, as is being done at the Federal over Colfax bridge, even with an elevation differences between existing and new of 4.5 feet.	1. Increased cost for structure widening.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The design currently requires a temporary bridge to move traffic for construction phasing to be done in two phases.

VE Team's Proposal:

The VE team proposes to use the current structure with a widening to accommodate one additional lane in each direction with construction to be done in three phases. Construct the new bridge in three phases (40' minimum to accommodate 3 lanes in first phase, 40' minimum to accommodate 3 additional lanes in phase 2, remaining width in third phase.) We feel that phase 1 should be on the north side to accommodate the loop ramp and to align US 6 to match the current alignment.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from CDOT Cost Data Book:	
Temporary Bridge	$1,000,000

Subtotal	$1,000,000
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	**947,500**
Total	**$1,947,500**
Total, Rounded	**$1,948,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from CDOT Cost Data Book:	
Additional Cost of the Structure width 24 ft * 248 ft * $180 /sf (for cost breakdown, please see proposal B1)	$1,071,360
Subtotal	
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$1,014,578
Total	$2,085,938
Total, Rounded	**$2,086,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $ 1,948,000 - $2,086,000 =	**($138,000)**

Calculations – Future Cost

If US-6 is widened by another lane in each direction in 20 years, then the future cost of that work at the US-6 structure over Wadsworth could be avoided because the bridge infrastructure would already be in place. Future Area=A1=(24ft)*248.5 ft = 5,964 sf Future value = 5,964 SF *$180/sf) = $1,073,520 Present worth (3% discount, at year 20): Present worth factor is 0.55368, derived from the formula: Present Worth Factor = $(1+i)^{-n}$ Where "i" = 3%, and "n" = 20 years PWF = 0.55368 Future savings: $1,073,520 x 0.55368 = $594,387 This means that if $594,387 is placed in a savings account earning 3% interest, then the value at year 20 would be $1,073,520.	$382,637

The effect of inflation is not included in Present Worth analysis because government's revenues are presumed to keep pace with inflation, making future dollars effectively as easy (or difficult) to come by as current day dollars.	
Subtotal	**$594,387**
Markup, revised to 50% which is a standard maintenance value that CDOT uses for aggregate markup on future projects.	$297,194
Total	$891,581
Total, Rounded	**$892,000**

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration. This proposal provides additional area for potential widening in the future and eliminates the need for a temporary bridge. This will also provide additional area for emergency pull outs, and for snow storage.

Prepared By: Joy French, Leela Rajasekar Checked By: Stephen Bokros

Value Engineering Proposal No. C2B

Proposal Title

Build new single span bridge in phases and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will require additional widening that will accommodate 1 additional lane in each direction for future widening. This C2B proposal assumes acceptance of Proposal B1 for a single span bridge. C2B shows the savings associated with this proposal in conjunction with B1.

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$846,000	$470,000	$1,316,000

Advantages	Disadvantages
1. No need for a temporary bridge. 2. With a widened structure, no need for future widening of the structure to accommodate additional lanes. 3. This approach would have 3 phases, as is being done at the Federal over Colfax bridge, even with an elevation differences between existing and new of 4.5 feet.	1. Increased cost for structure widening.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The design currently requires a temporary bridge to move traffic for construction phasing to be done in two phases.

VE Team's Proposal:

The VE team proposes to use the current structure with a widening to accommodate one additional lane in each direction with construction to be done in three phases. Construct the new bridge in three phases (40′ minimum to accommodate 3 lanes in first phase, 40′ minimum to accommodate 3 additional lanes in phase 2, remaining width in third phase.) We feel that phase 1 should be on the north side to accommodate the loop ramp and to align US 6 to match the current alignment.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from CDOT Cost Data Book:	
Temporary Bridge	$1,000,000
Subtotal	$1,000,000
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	**947,500**
Total	**$1,947,500**
Total, Rounded	**$1,948,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from CDOT Cost Data Book:	
Additional Structure width 24 ft * 131 ft * $180 /sf (for cost breakdown, please see proposal B1)	$565,920
Subtotal	
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$535,926
Total	$1,101,846
Total, Rounded	**$1,102,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $ 1,948,000 - $1,102,000 =	**$846,000**

Calculations – Future Cost

If US-6 is widened by another lane in each direction in 20 years, then the future cost of that work at the US-6 structure over Wadsworth could be avoided because the bridge infrastructure would already be in place. Future Area=A1=(24ft)*131 ft = 3,144 sf Future value = 3,144 SF *$180/sf) = $565,920 Present worth (3% discount, at year 20): Present worth factor is 0.55368, derived from the formula: Present Worth Factor = $(1+i)^{-n}$ Where "i" = 3%, and "n" = 20 years PWF = 0.55368	$313,339

Future savings: $565,920 x 0.55368 = $313,339 This means that if $313,339 is placed in a savings account earning 3% interest, then the value at year 20 would be $565,920. The effect of inflation is not included in Present Worth analysis because government's revenues are presumed to keep pace with inflation, making future dollars effectively as easy (or difficult) to come by as current day dollars.	
Subtotal	**$313,339**
Markup, revised to 50% which is a standard maintenance value that CDOT uses for aggregate markup on future projects.	$156,670
Total	$470,009
Total, Rounded	**$470,000**

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration. This proposal provides additional area for potential widening in the future and eliminates the need for a temporary bridge. This will also provide additional area for emergency pull outs, and for snow storage.

Prepared By: Joy French, Leela Rajasekar Checked By: Stephen Bokros

Value Engineering Proposal No. P1

Proposal Title

Eliminate the sidewalk on the west side of Wadsworth Blvd. from Lakewood Gulch at the north end to the south signal of the interchange.

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$1,498,000	$0	$1,498,000

Advantages	Disadvantages
1. Improved pedestrian safety at loop ramp. 2. Reduction of structure length over Wadsworth Blvd. 3. Driver expectancy from WB US 6th to SB Wadsworth Blvd will be met. 4. Proposal discourages pedestrian traffic in an unsafe condition.	1. Pedestrians are required to cross Wadsworth Blvd. once at an at-grade signal and at a grade separated trail.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The design includes a detached 10-foot multi-use path on both sides of Wadsworth Blvd. extending from 10th Ave. to 4th Ave.

VE Team's Proposal:

The VE team proposes a detached 10-foot multi-use path on the east side of Wadsworth Blvd. from 10th Ave. to 4th Ave. only. There will be no path on the west side from Lakewood Gulch to the signal on the south side of the Interchange.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
Existing Structure: 130.5 ft x 248.5 ft (existing width of Wadsworth) = 32,429.25 SF 32,429.25 SF x $180/SF = $5,837,265 (Refer to Bridge proposal B1 for cost break down)	$5,837,265
Sidewalk: (Estimate line item 608-00000):	$669,600

1240 ft x 10 ft/side x 2 sides = 24,800 SF 24,800 SF x $27/SF = $669,600	
Subtotal	$6,506,865
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$6,162,001
Total	$12,668,866
Total, Rounded	**$12,669,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
New Structure: 130.5 ft x 230 ft (Wadsworth Blvd width w/o sidewalk on west side) = 30,015 SF 30,015 SF x $180/SF = $5,402,700	$5,402,700
Sidewalk: (Estimate line item 608-00000): 1240 ft x 10 ft = 12,400 SF 12,400 SF x $27/SF = $334,800	$334,800
Subtotal	**$5,737,500**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$5,433,413
Total	$11,170,913
Total, Rounded	**$11,171,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $12,669,000- $11,171,000 =	**$1,498,000**

Calculations – Future Cost

Potential reduction in maintenance cost for the sidewalk and landscaping on the west side.

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration. It has the potential to substantially reduce project cost. It is recommended for the safety of pedestrians, to provide safe crossing of the pedestrians on the west side, and it has the potential to reduce structure cost, and meet the driver expectancy for the vehicles on the loop ramp.

Prepared By: Joy French, Leela Rajasekar Checked By: Paul Johnson

Value Engineering Proposal No. R1

Proposal Title

For ramps on the south side of 6th Ave. use permanent pavement versus temporary pavement to minimize throw-away cost. Review what temp pavement could be made permanent.

(Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$483,000	$0	$483,000

Advantages	Disadvantages
1. Eliminates need for permanent pavement later 2. Reduces construction time. 3. Reduces construction cost. 4. Reduces inconvenience to driving public. 5. Eliminates the need for temporary signals.	1. Phasing to be planned with the arrival of the traffic signal poles to be able to install the permanent signals – may take up to 8 weeks for the poles. 2. Would need a weekend closure for the final construction for a tie-in.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The design includes temporary pavement for Ramp A1 and Ramp B1.

VE Team's Proposal:

The VE team proposes the use of permanent pavement for the full length of Ramp A1 and Ramp B1. We do not recommend using temporary pavement at these locations.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
Temporary Pavement HMA 403-33841 6030 sy (Ramp A & Ramp B) * 6" thick * $50/ton	$100,000
Removal of Pavement HMA 202-00220 6030 sy (Ramp A & Ramp B) * $8/SY	$48,240
Temporary Signal 630-86800 for 2 signals at the interchange - LS	$100,000

Pavement HMA 403-33841 6030 sy (Ramp A & Ramp B) * 6″ thick * $50/ton	$100,000
Subtotal	$348,240
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	**$329,783**
Total	**$678,023**
Total, Rounded	**$678,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
Pavement HMA 403-33841 6030 sy (Ramp A & Ramp B) * 6″ thick * $50/ton	$100,000
Subtotal	
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$94,700
Total	$194,700
Total, Rounded	**$195,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $ 678,000- $195,000 =	**$483,000**

Calculations – Future Cost

NA

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration. It has the potential to substantially save the project funds and time. It is recommended for reducing the inconvenience to the driving public, reducing the cost of material and time needed to complete construction. This also eliminates the need for temporary signals.

Prepared By: Joy French, Leela Rajasekar Checked By: Paul Johnson

Value Engineering Proposal No. R2

Proposal Title

Convert the slip ramps between Garrison and Wadsworth to auxiliary lanes. Provide continuous lane between Wadsworth Blvd to Garrison St.

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
($238,000)	$0	($238,000)

Advantages	Disadvantages
1. Reduces safety concern with off ramp traffic crossing over. 2. Improves traffic flow. 3. Provides additional distance for acceleration and deceleration. 4. Is likely to reduce overall noise levels because traffic capacity on frontage road will be reduced to a single lane. 5. It appears that sufficient right-of-way is in place to accommodate this proposal.	1. May require 1601. 2. Type 7 barrier needs to be moved. 3. New Noise Analysis Required for NEPA. 4. Frontage road would become a single lane versus 2 lanes. One lane should still function properly. 5. Discuss with emergency agencies to confirm there is sufficient room for access with the one lane frontage road configuration.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The design currently does not include this section of the roadway.

VE Team's Proposal:

The VE team proposes converting the slip ramps between Garrison St and Wadsworth Blvd to a continuous acceleration/deceleration lane. This proposal will require paving the unpaved section on the frontage roads next to the Type 7 barrier. We have assumed that these unpaved sections are 10 feet wide.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from CDOT Cost Data Book:	
NA	

Subtotal	
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	
Total	
Total, Rounded	

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
Aggregate Base Course: Class 6: 304-06000 1360 ft * 10 ft wide * 6" = 81,600 sq.ft.-in. 81,600 sq.ft.-in. * 1 sq.yd.-in/9 sq.ft.-in. = 9,066.67 sq.yd.-in. 9,066.67 sq.yd.-in. * 133 lbs/sy.-in. * ton/2000 lbs = 602.93 tons 602.93 tons x 2 (two sides) * $20/ton = $24,117.33	$24,117
HMA (64-22) 403-33841 1360 ft * 10 ft wide * 9" = 122,400 sq.ft.-in 122,400 sq.ft.-in. x 1 sq.yd.-in/9 sq.ft.-in = 13,600 sq.yd.-in. 13,600 sq.yd.-in. x 110 lbs/sq.yd.-in x 1 Ton/2000 lbs =748 tons 748 tons * 2 (both sides) * $50/ton	$74,800
HMA (76-28) 403-34871 1360 ft * 10 ft wide * 2" = 27,200 sq.ft.-in 27,200 sq.ft.-in x 1 sq.yd.-in./9sq.ft.-in. = 3,022.22 sq.yd.-in. 3,022.22 sq.yd.-in. x 110 lbs/sq.yd.-in./2000 lbs/ton = 166 tons 166 tons * 2 (both sides) * $70 /ton	$23,240
Remove Type 7 Barrier is assumed to be included in the noise wall construction	
Restriping is assumed to be a minor cost and hence, not included.	
Subtotal	**$122,157**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$115,683
Total	$237,840
Total, Rounded	**$238,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $ 0 - $238,000 =	**($238,000)**

Calculations – Future Cost

NA

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration. This proposal provides a continuous lane between Garrison Road & Wadsworth Blvd. This provides a longer acceleration and deceleration lane for merge/diverge movements and eliminates the possibility of vehicles from the main line crossing over to the frontage roads. This proposal changes the gore points and changes the configuration. This will reduce the frontage road to single lane west bound on the north side and east bound on the south side. This improves safety by reducing accidents involving crossovers. This needs to be reviewed from environmental perspective and there is a potential need for 1601 approval.

Prepared By: Joy French, Leela Rajasekar

Checked By: Jordan Rudel, Stephen Bokros, Paul Johnson

Value Engineering Proposal No. S1

Proposal Title

Utilize berms where space permits along Wadsworth Blvd. to decrease the net height of the 15-foot wall, still keeping the top of the wall at 15 feet above existing grade.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$574,000	$0	$574,000

Advantages	Disadvantages
1. Decrease Wall Materials. 2. Decrease Construction Schedule.	1. Difficult with limited space.

Proposal Description

VE Team's Understanding of the Current Design Concept:

It is understood that the Environmental Assessment "required" 15' tall Sound Walls. Currently, the Engineer's Estimate has a Sound Wall Item (607-15144) for a 12' (144 inch) wall. We assume that the reason for the 12' height is that most of the wall will be placed on a Type 7 Barrier separating the frontage roads from the Freeway. There is approximately 2,200 LF that may not be placed on a Barrier. If the full 15' wall is placed in this length, it will add $642,510 ($50/sq.ft x 3'(15' required height - 12' proposed height) x 2,200 LF of wall x 1.947) which is not included in the current cost estimate.

VE Team's Proposal:

Utilize berms or fill slopes at lower elevation of noise walls as currently designed, making the wall height shorter. Top of wall is still at the same elevation. This could work along Wadsworth in the Northeast quadrant and a portion of the Southeast quadrant, due to more ROW and room for slopes. There is insufficient room on US-6, due to the proximity of the frontage roads.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	$6,750,000
2,200 LF of wall that is probably not on a barrier ($50/sq.ft. x 2,200 LF x 3' additional height x 1.947)	$330,000
Subtotal	**7,080,000**

Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$6,704,760
Total	$13,784,760
Total, Rounded	**$13,785,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	$6,750,000
Construct 3' high berms (at 3:1 side slopes, this will require 9' on each side of wall)	$17,600
Subtotal	**$6,767,600**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$6,408,917.20
Total	$13,176,517.20
Total, Rounded	**$13,177,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $13,785,000 - $13,177,000 =	**$608,000**

Calculations – Future Cost

We feel that there will be no effect on future maintenance costs between the existing proposal and the VE team proposal.

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further review.

Prepared By: Stephen Bokros Checked By: Paul Johnson

Value Engineering Proposal No. D1

Proposal Title

Use PVC pipe material instead of RCP material in the storm drain system.

Cost Saving (Increase)

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$419,000	$0	$419,000

Advantages	Disadvantages
1. Cost savings. 2. Simplifies construction.	1. City of Lakewood may not approve of this pipe material type.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The proposed storm drain system design is composed of reinforced concrete pipe (RCP).

VE Team's Proposal:

Use alternative pipe material: Poly Vinyl Chloride (PVC) instead of Reinforced Concrete (RCP). PVC pipe material was recently approved for use in CDOT projects by CDOT Pipe Materials Task Group.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
15" PVC pipe - 390 ft @ $41.80	$16,302
18" PVC pipe - 11,602 ft @ $47.25	$548,194
24" PVC pipe - 4,811 ft @ $63.00	$303,093
30" PVC pipe – 1,271 ft @ $86.00	$109,306
36" PVC pipe – 1,046 ft @ $105.00	$109,830
Subtotal	**$1,086,725**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$1,029,129
Total	$2,115,854
Total, Rounded	**$2,116,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from CDOT Estimating Database:	
15" PVC pipe - 390 ft @ $32.00	$12,480
18" PVC pipe - 11,602 ft @ $38.00	$440,876
24" PVC pipe - 4,811 ft @ $50.00	$240,550
30" PVC pipe – 1,271 ft @ $70.00	$88,970
36" PVC pipe – 1,046 ft @ $85.00	$88,910
Subtotal	**$871,876**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$825,581
Total	$1,697,457
Total, Rounded	**$1,697,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: = $2,116,000 – $1,697,000 =	**$419,000**

Calculations – Future Cost

Not applicable, future cost is roughly the same, so no future cost difference.

Value Engineering Team Recommendation

The Value Engineering team recommends this proposal for further consideration. PVC is believed to function and perform the same and cost less money.

Prepared By: Alfred Gross, Sina Khavary Checked By: Paul Johnson

VE Observations

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VE Observations

Aesthetics Observations

1. Time Frame Requirement for Lakewood's Participation of Funding of Design Elements

Be clear on timeframes required for Lakewood's participation in funding of design elements at the Wadsworth structure, and noise walls, and landscaping at the quadrants. Set deadlines for required information and convey these deadlines to Lakewood.

The general order of priority in terms of timing to integrate elements into the design, and funding, appears to the VE team to be:

a. Aesthetic elements related to the bridge design, particularly those elements affecting geometric and structural elements.
b. Aesthetic elements related to noise walls.
c. Features proposed within landscaping areas in the quadrants of the interchange, to the extent that utility rough-ins to serve the features (water, power, data) need to be coordinated.

Bridge Observations

2. Consider the Need for a Snow Fence at the Bridge Structure

Consider the need for a snow fence at the bridge structure, as a safety feature. The proposed open railing does not meet current design requirements concerning snow fences, and for providing safety features for the traffic traveling on Wadsworth, under US-6.

Construction Observations

3. Consider Opportunities to Shorten Phasing of the Project

Shorten the phasing of the project. It appears that there are opportunities for concurrent activities that can reduce the project schedule. For example, the temporary bridge may begin construction at the same time as the culvert construction in Phase 1. This would reduce the overall length of construction. Due to lack of time the VE team has not summarized these alternatives. Jim Martin – CDOT Construction VE team member, is available provide further comments at a later date.

4. Consider Funding Stream for Any Opportunity to Include Wadsworth 10th to 14 Street Project in the Interchange Project

If funding is identified prior to June 2013, consider including the Wadsworth 10th to 14th Street project as part of the current project, for cost efficiency, to reduce overall construction duration and inconvenience to the traveling public.

Drainage Observations

5. Consolidate Water Quality Basins

Consider consolidating permanent water quality basins to treat water quality with equivalent area. Review the drainage report and overall feasibility. Fewer basins relate to reduced maintenance demands. Consider combining permanent water quality (PWQ) treatment to minimize the total number of ponds constructed on this project.

Environmental Observations

6. Alternative Noise Barrier Material: Transparent Panel

Consider transparent acrylic panels for noise wall. There may be concerns with maintenance i.e. cleaning of the panels. Transparent panels provide a traffic safety value by removing shadow zones that would otherwise be present with solid structure barriers when the roadway is on the north side of the structure. Transparent panels also assist with the visibility of property owner views.

7. Consider Additional Phase II Investigation

Consider conducting additional Hazardous Material Phase II investigation in areas where subsurface work will occur during construction. Specifically, the Diamond Shamrock located at 715 Wads Blvd. was documented as having multiple underground leaks which this project is anticipating to encounter during construction. Additional investigation prior to acquisition may assist in valuing the property prior to the ROW purchase price agreements.

8. Consider NEPA Approval Requirements for Removal of Slip Ramps

Consider NEPA requirements for removal of slip ramps at Garrison/Carr Bridge. The project area for the EA/FONSI was specific to Wadsworth/US6. The proposal for Garrison/Carr is outside of the Purpose and Need identified in the decision document. Consider doing a separate CATEX clearance for NEPA and combine projects during construction.

9. Address Historic 4(f) Section 106 Requirements for Old Structures.

Consider reviewing the culverts and other structures 50 years or older for historic eligibility. For example, US-6 over South Lakewood Gulch is being replaced as a minor structure built in 1942. This may not have been accounted for in the previous NEPA evaluation.

Roadway Observations

10. Directional Handicap Ramps for Pedestrian Improvements

Consider directional handicap ramps for pedestrian access improvements per MUTCD requirements.

Traffic Observations

11. Pedestrian Poles for Pedestrian Crossings at Intersections

Use MUTCD requirements for pedestrian pole installation at intersections. This work does not currently appear to be referenced in the plans.

12. Add Variable Message Signs on Wadsworth

Add variable message signs on Wadsworth to inform the public of traffic flow or issues on US-6 one on either side of the interchange. Please coordinate with Jill Scott with CDOT on this effort. Lakewood has a grant with DRCOG for purposes of dynamic signal changes in coordination with VMS.

Multi-Modal Observations

13. Consider Pedestrian Safety at Loop Ramp and West Side of Wadsworth through the Interchange

Address the concern with the sidewalk on the west side of Wadsworth through the Interchange, and signalization needed for pedestrian safety across the loop ramp.

Estimate Review Observations

14. General Comments to the Cost Estimate

a. Sound Wall Height in estimate is 144 inches (12'), the requirement from the Environmental Assessment is 15'. Some portions of the wall will not be located on a barrier, so the full height will be needed. Adjust estimate to reflect this.

b. 304-06007 ABC Class 6 by the CY is listed. The VE team recommends that 304-06000 ABC Class 6 by the Ton be used as the price difference is substantial.

VE Ideas Studied But Not Proposed

Value Engineering Proposal No. M1-NP

Proposal Title

Consider use of rubblized asphalt pavement prepared to the proper specification for the aggregate base course instead of new imported aggregate base course.

Initial Saving (Increase): +	Future Saving (Increase) Present Worth Basis =	Net Life Cycle Saving (Increase):
$471,000	$0	$471,000

Advantages	Disadvantages
1. Access to material (on site). 2. Eliminate stockpiles. 3. Save hauling time. 4. No disposal costs will be incurred.	1. Investigate possible environmental issues.

Proposal Description

VE Team's Understanding of the Current Design Concept:

The current design calls for new aggregate base course material under the pavement. This includes the planned replacement of all existing pavement as well as any new pavement on Wadsworth Blvd., and the ramps.

VE Team's Proposal:

Use milled asphalt generated at the project site as the base course material. Consider using this material as the base material to reduce asphalt thickness (64-22) for the new ramps.

Calculations – Initial Capital Cost

Current Design Concept:

Construction Cost with Contractor Markups, from Engineer's Estimate at 30% Design:	
304-06007 Aggregate Base Course (Class 6) 10,000 cy * $25.50/cy	$255,000
Subtotal	**$**255,000

Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$241,485
Total	$496,485
Total, Rounded	**$497,000**

Value Engineering Team's Proposal:

Construction Cost with Contractor Markups, from CDOT Cost Database:	
304-09100 Aggregate Base Course (Recycled Asphalt Pavement): 10,000 CY* 133 lbs/CY / 2000 lbs/Ton * $20/Ton	$13,300
Subtotal	**$13,300**
Markup, 94.7% (includes all estimate markups to the subtotal of construction costs as shown in the Engineer's Estimate dated 16OCT2012)	$12,595
Total	$25,895
Total, Rounded	**$26,000**

Net Initial Capital Cost Saving (Increase):

Current Design Cost – VE Cost: $ 497,000- $26,000 =	**$471,000**

Calculations – Future Cost

NA

Value Engineering Team Recommendation

The Value Engineering team does not recommend this proposal for further consideration. Even though this proposal appears to provide significant cost benefit compared to the cost in the proposed design estimate, the team recommends a change in the pay item. Changing the plan pay item quantity from cubic yard to tons will reduce the cost of this pay item in the cost estimate (paying by tons is cheaper than paying by cubic yard) at which point, this proposal will not provide any cost savings benefit. The VE team, hence, does not recommend this proposal. The change of pay item is recommended.

Prepared By: Joy French, Leela Rajasekar Checked By: Paul Johnson, Stephen Bokros

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Attachments

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Welcome

US 6 & Wadsworth
Engineering Design
Value Engineering Study

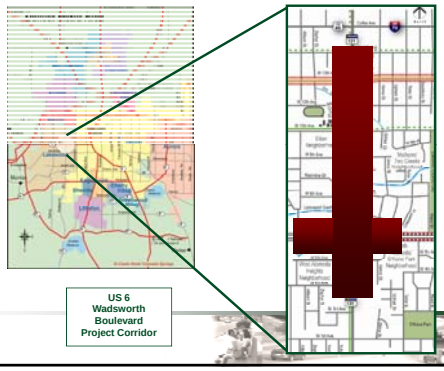
Agenda

- Project Location
- Project Overview and Background
- Reference Material
- Project Schedule
- Preliminary Construction Cost Estimate
- Environmental/Community Involvement
- Traffic, Safety, Bike and Pedestrians
- Pavement and Geotechnical
- Roadway
- Bridge and Structures
- Drainage and Water Quality
- Lighting
- Utilities
- Right of Way
- Construction Phasing
- Adjacent Improvements
- Sensitive Issues

Safety Moment

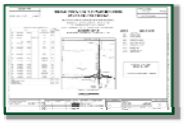
- Building Evacuation

Project Location



Project Recap

- Project Initiated April 2007
  - 15% Conceptual Design Plans June 2009
  - Signed FONSI March 2010

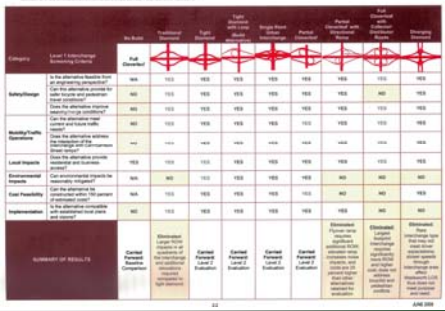


- Purpose and Need
- Mitigation & Monitoring Commitments
- FIR Held on November 5, 2012

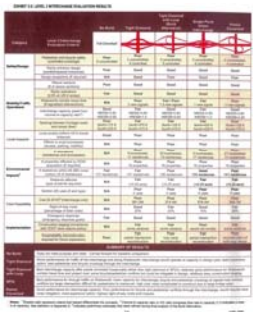
Existing Interchange

- Short weaving movements
- Cut through traffic on side streets
- Poor sight distance on merges

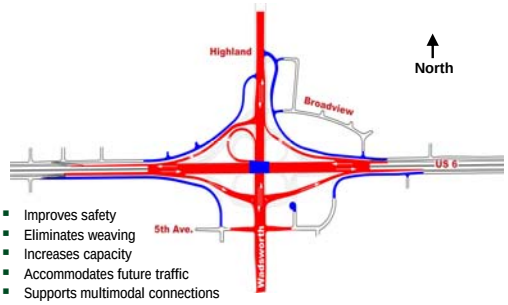
Alternatives – Level 1



Alternatives – Level 2



Tight Diamond w/ Loop



- Improves safety
- Eliminates weaving
- Increases capacity
- Accommodates future traffic
- Supports multimodal connections

Wadsworth Boulevard

- Six through travel lanes
- Raised median
- Detached sidewalks

Reference Material/Computer Design Information

- FONSI, EA and supporting environmental documentation
- Plans
- Reports
  - Structure Selection Reports
  - Geotechnical Report
  - Pavement Design Report
  - Hydraulic Report
  - Water Quality Report
- PDF files of plans, cross sections, reports and Microstation files are on Sharepoint.

Project Schedule

- Current Dates
  - 9/27 FOR meeting
  - 12/3 Submittal of record plan sets

Preliminary Construction Cost Estimate

- FIR Level Estimate
  - Construction Cost = $56.9 M
  - Construction Management = $10.8 M
  - Services During Construction = $0.6 M
  - Total = $68.3 M

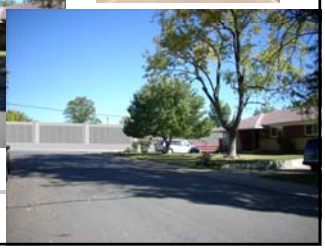
Environmental Background

- NEPA streamlining pilot project
  - EA completed June 2009
  - FONSI signed March 2010
  - Reevaluation will be required for interchange
- Many beneficial impacts
- Substantial noise issues along US 6
- Early right-of-way acquisitions and relocations
- Historic property impacts
- Some stream/gulch impacts
- Coordination with future Two Creeks Park

Noise Mitigation

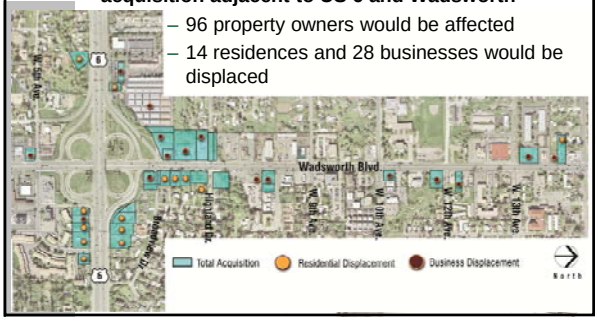
Noise Wall Aesthetics





Right-of-Way and Relocations

- **Build Alternative would require property acquisition adjacent to US 6 and Wadsworth**
  - 96 property owners would be affected
  - 14 residences and 28 businesses would be displaced



Historic Properties

- Nine individual historic properties and three historic districts in study area
- Four historic homes northeast of interchange acquired
- Significant impacts to other historic properties avoided through design modification
- Memorandum of Agreement requires interpretive displays and distribution of historic information (with Lakewood)

Surface Water and Wetlands

Dry Gulch

Lakewood Gulch

Community Involvement

- Agency Charter singed with FHWA, CDOT, RTD, Lakewood, and CH2M HILL
- 23 local, state, federal agencies consulted
  - 34 individual meetings in addition to agency scoping and hearing presentations
- Extensive public involvement during EA
  - Mailing list of 3,700
  - 6 public meetings/open houses held
  - 25+ neighborhood/business assoc. meetings
  - Business interviews / affected owner meetings

Community Input – Key Issues

- Traffic noise along US 6 west of Wadsworth
- Safety concerns, especially interchange ramps
- Need for ADA-compliant ped / bicycle facilities
- Neighborhood cut-through traffic
- Future transit on Wadsworth
- Concerns about ROW and businesses affected
- Concern about overlapping construction with RTD
- Flooding on Wadsworth at Lakewood Gulch

Traffic Operations

- Interchange identified by DRCOG as 1 of 18 bottleneck locations in the Denver Region
- The full cloverleaf configuration results in:
  - Low speeds
  - Tight curves
  - Poor level of service
  - Inadequate accel/decel

Traffic Operations

- The Wadsworth Blvd. corridor is a major regional arterial with:
  - Demand exceeding the 4-through lane capacity
  - Signalized, side street stop control, and numerous driveway accesses
  - Intersections in close proximity to the US 6 interchange
  - Striped two side-by-side continuous left-turn lanes north of US 6
  - Signal priority on Wadsworth resulting in poor LOS at the cross streets

Safety

- US 6 currently performs at a LOSS of II, which is a "Better than Expected Safety Performance"
- The interchange is one of the highest crash locations within the City of Lakewood
- The congested conditions result in high frequency but low severity crashes. Most common types are:
  - Rear end
  - Hit fixed objects
  - Sideswipe same direction
  - Overturning
  - Approach turn and broadside
  - Head on and sideswipe

Bicycles and Pedestrians

- Navigating high speed, high volume, free flow ramps is difficult
- Missing or substandard sidewalks
  - 50% eastside - 85% westside
- Increase in activity anticipated
  - Redevelopment
  - RTD Station
- Wadsworth is the only crossing of US 6 for 2.5-miles

Traffic Issues and Design Decisions

- Project not meant to "fix" capacity issues on US 6
- Design must accommodate 25% more traffic in 2035
  - *ADT WW – 65,700 >> 82,500*
  - *ADT US 6 – 122,300 >> 156,000*
- Carr Street / Garrison Street slip ramps provide neighborhood access
- Servicing left turn volumes at the interchange critical to maintaining acceptable level of service
- Tried to limit the number of new traffic signals on WW
- Selection of the preferred alternative was based on a prioritization of distinguishing criteria which included interchange capacity, corridor travel time, and bicycle and pedestrian safety as three of the top four criteria.

Pavement and Geotechnical

- RockSol drilled a total of 80 boreholes
  - Meet final design level requirements.
- Information provided:
  - Subsurface soil
  - Groundwater
  - Bedrock
- Design information provided:
  - Pavement design
  - Bridge foundation design
  - Retaining wall design
  - Soundwall design
  - Concrete box culvert design
  - Water quality pond

Pavement and Geotechnical

- Subsurface soil:
  - Sandy clay, silty to clayey sand, slightly silty to silty sand, gravelly sand, sandy silt, and sandy gravel.
- Sedimentary bedrock encountered:
  - 2 feet to 27 feet below existing grades
  - Consisted of claystone and silty to clayey sandstone.
- Groundwater from 6 feet to 49 feet

Pavement and Geotechnical

- Pavement thickness recommendations:
  - Mainline US6
  - Interchange ramps
  - US6 Frontage Roads
  - Wadsworth Boulevard
  - Side streets
- Life Cycle Cost Analysis (LCCA):
  - Wadsworth Boulevard
  - US6 Frontage Roads.

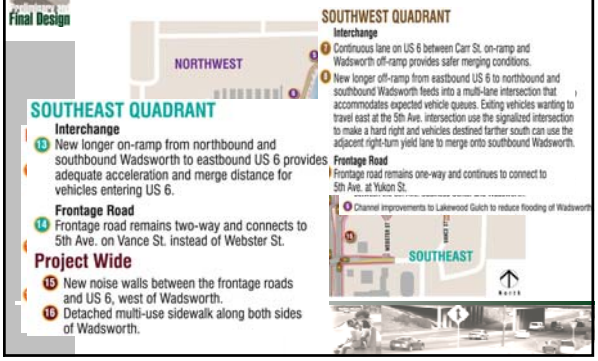
Pavement and Geotechnical

- LCCA results:
  - Rigid pavement option is less costly than the flexible pavement
  - Difference of 37.4 percent at the 75% probability level.

Roadway

- Criteria
  - US6 – Urban Freeway – 70 mph Design Speed (DS)
    - Six lanes with auxiliary lanes west of Wadsworth
  - Wadsworth Blvd – Urban Primary Arterial – 45 mph DS
    - Six lane with raised medians/left turn lanes
  - Ramps – 50 mph DS
  - Loop Ramp – 25 mph DS
  - West 5th Avenue – 35 mph DS
  - West 10th Avenue – 35 mph DS
  - Frontage Roads – 30 mph DS
  - Local Roads – 30 mph DS

Roadway



Roadway

- Design Decisions
  - Tight 150' radius loop to limit ROW impacts
  - Steep loop grade at 5% (design criteria exception)
  - Mill and overlay area added during preliminary design

Bridge and Structures

- US6 over Wadsworth Blvd Replacement
  - 3 options evaluated for FIR submittal
    - Steel plate girders w/CIP deck
    - Precast prestressed spliced bulb-tee girders w/CIP deck
    - **Precast prestressed adjacent box girders w/composite deck topping**
  - Issues: US6 WB-SB loop ramp & vertical clearance
  - Post FIR: decision made to proceed forward with vertical walls in lieu of 2:1 slopes in front of abutments

Bridge and Structures

- US6 over McIntyre Gulch Replacement
  - 3 structure types considered for FIR submittal
    - Single Span Bridge
    - Precast Concrete or Metal Arch
    - Pipe Culvert System
  - 2 structure types evaluated
    - **CIP/Precast Concrete Box Culverts (3 cell)**
    - CIP Reinforced Concrete Rigid Frame (2 cell on footings)
  - Issues: maintaining existing flow and phasing

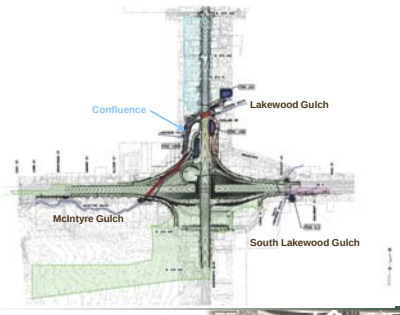
Bridge and Structures

- Wadsworth Blvd over Lakewood Gulch Replacement
  - 3 structure types considered for FIR submittal
    - Single Span Bridge
    - Precast Concrete or Metal Arch
    - Pipe Culvert System
  - 2 structure types evaluated
    - **CIP/Precast Concrete Box Culverts (3 cells @ 18'x10') with adjacent one cell (14'x10') for pedestrian path**
    - CIP Reinforced Concrete Rigid Frame (3 cell on footings @ 23'x13'), one cell bottom raised for ped path
  - Issues: vertical clearance and phasing

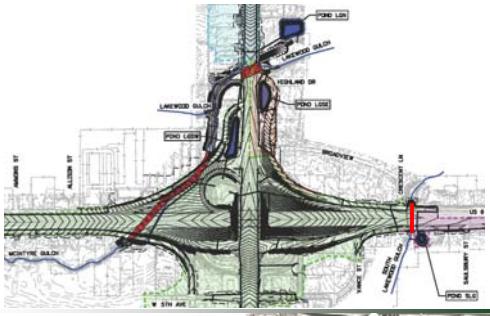
Bridge and Structures

- US6 over South Lakewood Gulch Replacement
  - Minor structure
    - Built in 1942
    - Replace OR extend, complete repairs necessary and convert to traditional CBC (per Staff Bridge)
    - Repairs and extension were 50-60% of complete replacement so decision was made to replace
  - CDOT Standard CBC to be used
  - Issues: phasing

Drainage and Water Quality



Drainage and Water Quality



Lighting

- Original Design Criteria
  - CDOT's Criteria for Illuminance and Uniformity
  - Standard Cobra Head 35' Fixtures with 6' Arm and High Pressure Sodium Luminaries (HPS)
  - LED Luminaries on Signal Poles
- Revised Direction From City of Lakewood
  - COL Will Take Over Ownership and Maintenance of Wadsworth Fixtures from Xcel
  - Wadsworth Fixtures will be Spaced at COL Preference of 150' and Will Now Have LED Luminaries
- Lighting is Required During Construction

Utilities

- Existing Utilities Data File
  - Development
    - Database search
    - Received keymaps & as-builts from utilities
    - Located, marked, and surveyed all buried utilities
  - Next steps
    - Meetings with each utility
    - Potholes
    - Revise existing base map based on pothole data

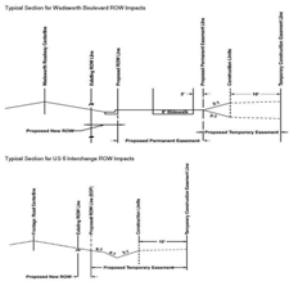
Utilities

- Types of Utilities Impacted
  - Water
  - Sanitary
  - Electrical
  - Gas
  - Telecommunications
  - Irrigation

Utilities

- Major Utility Issues
  - Century Link Duct Bank in NB Wadsworth
  - Level 3 underground facility (fiber optic)
- Minor issues
  - Intermediate pressure gas lines
  - 27" PVC Sanitary Line near Lakewood Gulch & McIntyre Gulch will need to be relocated
  - Utilities will need to be relocated from existing frontage roads and moved to new frontage roads
  - Sustain existing irrigation facilities & modify
  - Culvert crossings

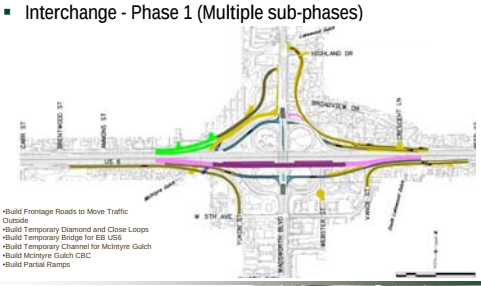
Right-of-Way



Right-of-Way

Construction Phasing

- Interchange - Phase 1 (Multiple sub-phases)



•Build Frontage Roads to Move Traffic Outside
•Build Temporary Diamond and Close Loops
•Build Temporary Bridge for EB US6
•Build Temporary Channel for McIntyre Gulch
•Build McIntyre Gulch CBC
•Build Partial Ramps

Construction Phasing

- **Interchange - Phase 2**

•Shift EB US6 Traffic to Temporary Bridge and WB Traffic to EB Lanes

•Build WB Half of New Bridge, WB US6 and Loop

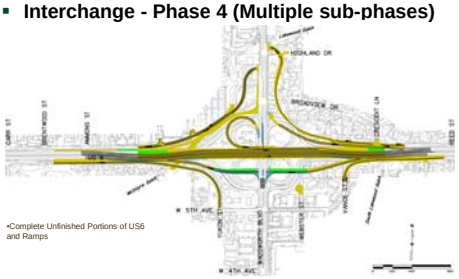
Construction Phasing

- **Interchange - Phase 3**

•Build EB Half of New Bridge and EB US6

Construction Phasing

- **Interchange - Phase 4 (Multiple sub-phases)**



•Complete Unfinished Portions of US6 and Ramps

Construction Phasing

- **Wadsworth Blvd (Multiple phases)**

•Build outside then inside
•Build outside of one cell of CBC then middle to divert water

Adjacent Improvements

- Wadsworth Blvd (10th to Colfax) Capacity Project
- RTD West Corridor
- Sheridan Interchange Reconstruction
- US6 over Garrison Street
- Wadsworth from Highland to 10th

Sensitive Issues

- Noise Mitigation
- Cut Through Traffic
- Detached Multi Use Trail

Questions

Finished
Extra Slides

Pavement and Geotechnical

- RockSol drilled a total of 80 boreholes for the US6 and Wadsworth Interchange project from West 4th Avenue to West 14th Avenue. The boreholes were drilled to final design level requirements.
- The boreholes were drilled to obtain information on the subsurface soil, groundwater, and bedrock conditions for a combination of pavement design, bridge foundation design, retaining wall design, soundwall design, concrete box culvert design, and water quality pond design purposes for the proposed improvements within the project limits.

Pavement and Geotechnical

- Subsurface soil (fill material and native soils) conditions encountered generally consisted of sandy clay, silty to clayey sand, slightly silty to silty sand, gravelly sand, sandy silt, and sandy gravel.
- Sedimentary bedrock was encountered at depths ranging from 2 feet to 27 feet below existing grades and generally consisted of claystone and silty to clayey sandstone.
- Groundwater was encountered at approximate depths ranging from 6 feet to 49 feet below the surface within native soils and sandy bedrock layers.

Pavement and Geotechnical

- Geotechnical design recommendations for the proposed structures were provided and included alternative foundation design options, where appropriate.
- Pavement thickness recommendations were provided for mainline US6, interchange ramps, US6 Frontage Roads, Wadsworth Boulevard, and several side streets within the project limits.
- A Life Cycle Cost Analysis (LCCA) was performed for Wadsworth Boulevard and the US6 Frontage Roads within the project limits.

Pavement and Geotechnical

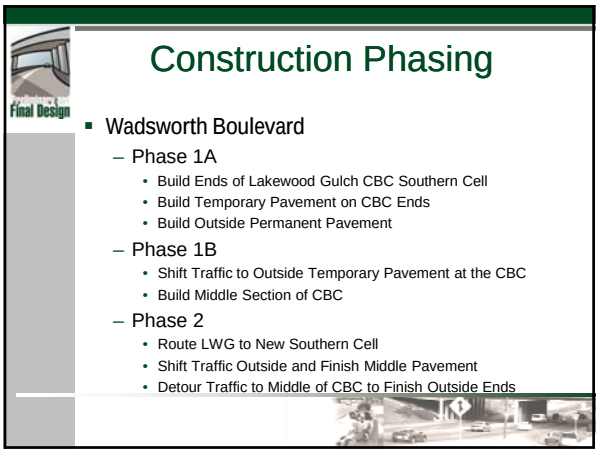
- Based on the results of the LCCA, the probabilistic analysis indicated the rigid pavement option is less costly than the flexible pavement option by a difference of 37.4 percent at the 75% probability level.

Construction Phasing

- HMA on US 6 and Ramps
- PCCP on Wadsworth and Frontage Roads
- Interchange
  - Phase 1
    - Build Frontage Roads to Move Traffic Outside
    - Build Temporary Diamond and Close Loops
    - Build Temporary Bridge for EB US6
    - Build Temporary Channel for McIntyre Gulch
    - Build McIntyre Gulch CBC
    - Build Partial Ramps

Construction Phasing

  - Phase 2
    - Shift EB US6 Traffic to Temporary Bridge and WB Traffic to EB Lanes
    - Build WB Half of New Bridge, WB US6 and Loop
  - Phase 3
    - Build EB Half of New Bridge and EB US6
  - Phase 4
    - Complete Unfinished Portions of US6 and Ramps


Final Design
Construction Phasing
Wadsworth Boulevard
Phase 1A
Build Ends of Lakewood Gulch CBC Southern Cell
Build Temporary Pavement on CBC Ends
Build Outside Permanent Pavement
Phase 1B
Shift Traffic to Outside Temporary Pavement at the CBC
Build Middle Section of CBC
Phase 2
Route LWG to New Southern Cell
Shift Traffic Outside and Finish Middle Pavement
Detour Traffic to Middle of CBC to Finish Outside Ends

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Executive Summary Presentation

Value Engineering Study

US-6, Wadsworth Interchange
CDOT Project ES6 0006A-047 (17858)
Colorado Department of Transportation

February 15, 2013

Presented at CH2M HILL Office, Denver, Colorado

CDOT VE Team Members and
CH2M HILL Facilitator Paul Johnson, CVS

1

OVERVIEW

- VE Focus on US-6/Wadsworth Interchange
- VE Team, Owner and Design Team
- Why VE is Used
- VE Methodology
- VE Study Recommendations
  - Proposals
  - Observations
- Follow-up Tasks
  - Preliminary VE Report
  - Proposal Dispositions – by CDOT and CH2M HILL Design Team
- Questions/Comments

2

VE Team

- **Joy French**, Roadway Engineer, CDOT
- **Ali Harajli**, Bridge Engineer, CDOT
- **Leela Rajasekar**, Traffic Engineer, CDOT
- **Jim Martin**, Construction, CDOT
- ***Jordan Rudel**, Environmental, CDOT
- **Stephen Bokros**, Project Manager, CDOT
- ***Nancy Terry**, Right-of-Way, CDOT
- ***Al Gross**, Drainage Engineer, CDOT
- ***Dave Ruble**, Utilities, CDOT
- ***Sina Khavary**, Estimating, CDOT
- **Paul Johnson**, VE Team Leader, CH2M HILL

* Part time participation during the week

3

Owner (CDOT) and Design (CH2M HILL) Participants

- **Kevin Brown**, Resident Engineer, CDOT
- **Aaron Swafford**, Project Manager, CH2M HILL
- **Will Voss**, Design Manager, CH2M HILL
- **Mandy Whorton**, Environmental Planner, CH2M HILL
- **John Rohner**, Bridge Engineer, CH2M HILL
- **Doug Stewart**, Drainage Engineer, CH2M HILL
- **Kevin Ryburn**, Construction Engineer, CDOT
- **Stephen Bokros,** Project Manager, CDOT
- **Lindy Howard,** Utilities, CH2M HILL
- **Zeke Lynch,** Traffic Engineer, CH2M HILL
- **Don Hunt,** Geotechnical and Pavement Engineer, RockSol Consulting Group, Inc.

City of Lakewood Participants on Feb. 12

- **Roger Wadnal**, Comprehensive Planner, City of Lakewood
- **Al Colussy**, Architect, KLIPP

4

Why Use Value Engineering?

- Focus on essential functions not systems or procedures
- Embraces creativity and out of the box thinking
- Uses initial and life-cycle cost analysis for decision making
- Provides an organized framework for alternative development
- Consistently achieves the desired results (from 5:1 to 50:1 ROI) when implemented at early-to-mid design phase

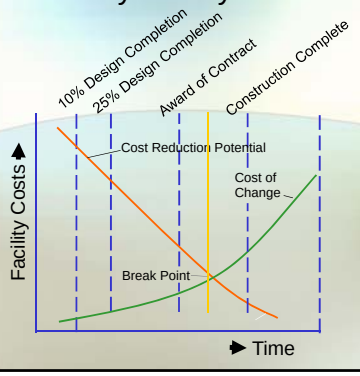
5

The Optimal Time to Use Value Engineering

- Early on in a project design phase (or by the conclusion of the Preliminary Engineering Phase for a highway or bridge design)
- Cost savings are best achieved between 80% of conceptual and 20% of definitive design

6

Opportunities for Savings in Facility Life Cycle



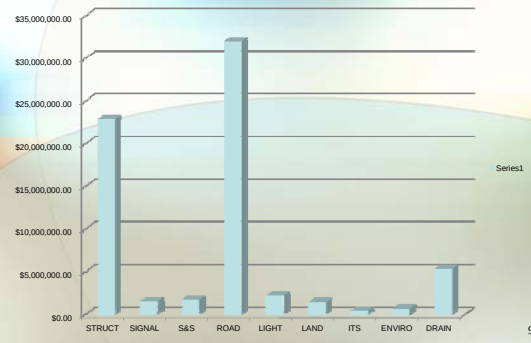
7

The VE Job Plan: A Structured Six-Phase Approach

- Information Phase
- Function Analysis Phase
- Creative Phase
- Evaluation Phase
- Development Phase
- Presentation Phase

8

Cost Model



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Team Focus QA

Project's Purpose and Need

Improvements are needed to:

- **Improve safety for motorists, pedestrians, and bicyclists**
- **Improve operational efficiency of the interchange on Wadsworth**
- **Meet current and future traffic demands**
- **Support multi-modal connections**

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Team Focus QA

- **Funding for this $80 million project ($95 million if Garrison Bridge replacement is included) is anticipated to come together within 1 year so that the project can be advertised for bid in March 2014.**
- **If all necessary funding sources are not realized in this timeframe, the project could be subject to delay, and the cost of inflation will then be a factor.**
- **It would be most economical to do the project all at once, but if the funding stream takes more time, then the project could be broken up into segments.**

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Team Focus QA

What are the highest risk issues associated with the project?

- **Utility relocations: Necessary potholing to identify locations and to relocate major utilities such as the high pressure gas line, and the major fiber optic line.**
- **Phasing of the project to build the temporary and permanent bridge, and sequencing.**
- **Securing necessary funding in the desired timeframe**
- **Drainage design with unique geometry for culverts to avoid interferences below and above culverts.**

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Team Focus QA

What are the expected outcomes from the VE study?

- **Increase the value of the project by looking for opportunities to increase the functionality of the project within the same budget.**
- **Try to identify opportunities for cost savings that fully respect the functionality and commitments on the project.**
- **Fulfill the FHWA VE requirement for the project.**
- **Comment on timeframes needed for decisions about aesthetic enhancements to walls, bridge, quadrants.**

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VE Study Recommendations

VE Proposals and Observations

- Table 1 – VE Proposal Summary
- Table 2 – VE Observations
- Table 3 – Ideas Studied but Not Proposed
- Table 4 – Ideas Failed During Analysis Phase

14

VE Implementation Phase (Follow-up Tasks)

- Distribute Preliminary VE Report (within 10 days)
- CDOT and CH2M HILL Design Team Provides Dispositions in consultation with Design Team to Complete the final VE Process

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Conclusion

- Q/A
- Thanks for the opportunity for CH2M HILL to work with CDOT on the VE study for this very important project!

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Agenda and Coordination Information for Value Engineering Study

Value Engineering Study
US-6, Wadsworth Interchange
CDOT Project ES6 0006A-047 (17858)

Colorado Department of Transportation

Orientation Meeting Date: Monday, February 11, 2013
VE Study Date: Continuing through Friday, February 15, 2013
Executive Summary Presentation on Friday, February 15, 10:00 a.m. to 12:00 p.m.

Introduction and Project Description

CH2M HILL will facilitate a Value Engineering (VE) study on the US-6, Wadsworth Interchange Project, for the Colorado Department of Transportation (CDOT). The initial project involved the environmental study of the existing interchange at 6th Avenue & Wadsworth, including Wadsworth Boulevard from 4th Avenue to 14th Avenue. Wadsworth Boulevard is a segment of State Highway 121 and 6th Avenue is a segment of US 6 within the Lakewood City limits. This project has been established to prepare Preliminary and Final Design based on the Preferred Alternative identified through the EA document process.

This project is intended to produce the following improvements:

1. Increased capacity
2. Improved Safety
3. Higher level-of-service
4. Improved safety and accommodations for bicyclists/pedestrians
5. Improved riding surface (smoother and/or stronger pavement)
6. Bridge Replacements
7. Reconstruction

The Preferred Alternative will replace the existing US 6/Wadsworth interchange and widen Wadsworth between 4th and 14th Avenues. The existing cloverleaf will be replaced with a tight diamond with loop design, consisting of a diamond interchange with a loop ramp in the northwest quadrant. The structurally deficient bridge over Wadsworth will be replaced, and all entrance and exit ramps will be lengthened. Along Wadsworth, the Preferred Alternative will add a travel lane in each direction and a multi-use sidewalk on both sides of Wadsworth. A raised median will be added to the center of the roadway to direct left turns and U-turns.

Construction funding has been provided for Wadsworth Capacity Improvements from 10th Avenue to 14th Avenue. This section will not be included in the VE Study.

Value Engineering Study Goals and Methodology

The general mission of the VE study is to provide CDOT with recommendations for improved value solutions, where possible, for meeting the transportation goals of the project. A VE Team will provide recommendations that seek to minimize total initial and life-cycle cost, and will also address functional improvements, where possible. A Certified Value Specialist (CVS) with CH2M HILL will lead the VE Team, consisting of CDOT staff identified in the following section.

VE Study Participants

- VE Team Leader – Paul Johnson, CVS, CH2M HILL;
  - Office: (208) 383-6299; cell: (208) 890-8203; paul.johnson@ch2m.com
- Roadway Engineer - Joy French joy.french@state.co.us
- Drainage - Al Gross alfred.gross@state.co.us
- Bridge – Ali Harajli ali.harajli@state.co.us
- Construction - Jim Martin jim.martin@state.co.us
- Estimator - Sina Khavary sina.khavary@state.co.us
- Traffic* - Leela Rajasekar leela.rajasekar@state.co.us
- Materials/Geotech* - David Kosmiski david.kosmiski@state.co.us
- ROW* - Nancy Terry nancy.terry@state.co.us
- Utilities* - Dave Ruble dave.ruble@state.co.us
- Environmental* - Jordan Rudel jordan.rudel@state.co.us
- Maintenance* - TBD

*Potentially part time participation

CDOT and Agency Managers

Additional CDOT design and management representatives involved in the project may attend the orientation meeting at the CH2M HILL Office on Monday, February 11, and the VE Executive Summary presentation on Friday, February 15, 2013.

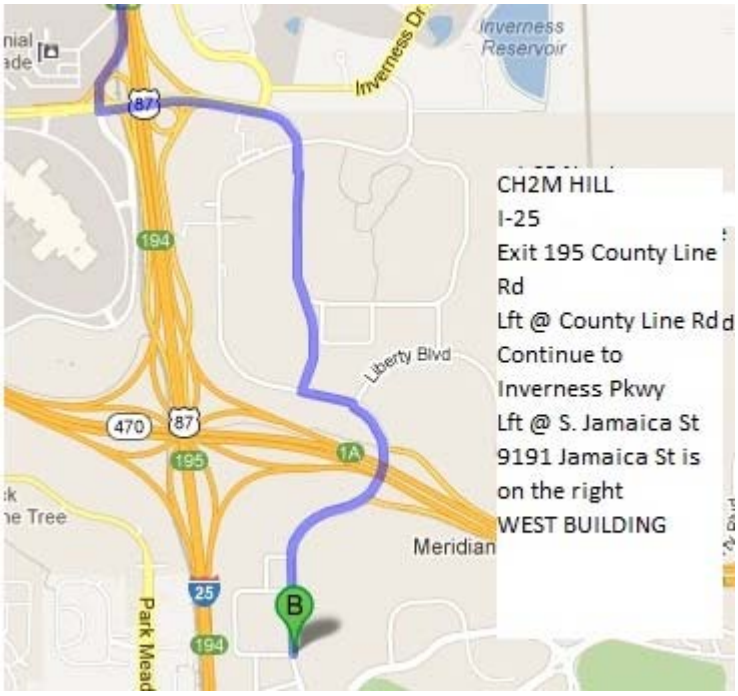
CH2M HILL Project Management and Design Team

The project manager for CH2M HILL is Aaron Swafford (720) 286-5340, and the design manager is Will Voss (720) 286-5129. They and any other necessary CH2M HILL design or management representatives, and CDOT management representatives, are requested to present the project history and design information to the VE Team at the Orientation Meeting on the first day of the VE study – February 11th. The CH2M HILL design and CDOT management representatives are also requested to attend the VE Executive Summary presentation on February 15th.

Location

The VE study, Days 1 through 5 (Monday, February 11 through Friday, February 15, 2013) will take place at the CH2M HILL office in Denver, West Building, 9191 South Jamaica Street, Englewood, CO 80112. Refer to the maps below to the CH2M HILL office. The VE study will be held in Conference Room West 1D.

This room is scheduled for the entire 5-day VE study, including the VE Orientation Meeting on Monday, February 11, from 8:00 a.m. to noon; and the VE Out-Brief Presentation on Friday, February 15, from 10:00 a.m. through noon.



Pre-Study Information Gathering

The CH2M HILL VE Team Leader will coordinate with the CH2M HILL design manager to request compilation of pertinent project design information for the VE study. This information will be made available to all VE study participants for review in advance of the study.

The VE Team Leader will confirm that sufficient copies of existing design documentation will be available to the VE Team during the week of the study. Pertinent documentation includes, but is not limited to: design drawings, construction cost estimates, environmental documents, soils reports, aerial photographs, right-of-way file, the structure selection report, and other information that describes existing conditions.

A subset of pertinent design information will be reproduced by CH2M HILL and sent to VE Team members for their review prior to the VE study. This information can be sent or accessed electronically, at the discretion of CH2M HILL and CDOT.

Parking and Building Access

The VE team representatives from CDOT should park in the lot adjacent to the West building at the CH2M HILL campus (address included above). There is no charge for parking.

Please enter through the lobby doors for the West building and sign in daily. A visitor's name badge will be provided for use on a daily basis.

Jaime Davis from CH2M HILL will assist the VE team in the lobby. Her contact information is (720) 286-1061 or (303) 241-1513 mobile.

Materials and Equipment for VE Study Support

CH2M HILL will provide an In-Focus projector (or conference room projector) and screen in order to accommodate PowerPoint or other presentations by CDOT, and CH2M HILL design and VE staff at the VE Orientation Meeting. Use of the In-Focus/conference room projector is requested for use by the VE team for the duration of the week.

CH2M HILL will arrange to have several loaner laptops available in the conference room for use by CDOT staff during the VE study. The laptops will be needed for preparation of the VE proposals. Laptops won't be needed on Day 1 (Feb. 11), but will be needed on Days 2 through 5 (Feb. 12-15) of the VE study.

Note that it is not mandatory that every CDOT participant has a laptop, because several persons can share a laptop in small groups during the Development phase of the VE study; however 2 to 3 laptops will be needed overall.

All VE study participants are requested to bring their own reference books or materials, electronically or in hard copy. Reference books include any resource that may be needed for VE study calculations, such as roadway design guidelines, cost estimating references, green book, and other transportation design guidelines.

VE Study Agenda

Monday, February 11	***Phase 1 – Information***
	Participants: All CH2M HILL VE team members, CDOT Resident Engineer (Kevin Brown) CDOT Project Manager (Stephen Bokros), CH2M HILL Project Manager (Aaron Swafford), CH2M HILL Design Manager (Will Voss), FHWA (Chris Horn), and any other agency representatives invited by name.
	Location: CH2M HILL West Building, 9191 South Jamaica Street, Englewood, CO 80112.
8:00 a.m. to 8:15 a.m.	**ARRIVAL AND CHECK IN AT SECURITY STATION** CDOT staff will need to sign in and receive visitor's badges prior to the 8:00 a.m. meeting start.
8:15 a.m. to 8:30 a.m.	**INTRODUCTIONS**
8:30 a.m. to 9:00 a.m.	**OVERVIEW OF STUDY AGENDA AND VE PROCESS –** Paul Johnson, VE Team Leader
9:00 a.m. to 9:30 a.m.	**CDOT OVERVIEW OF THE US-6, WADSWORTH IC PROJECT (Kevin Brown)** • Project Inception and Need • Overview of Existing Facilities • What CDOT would like from the VE Study • Design Objectives • Permitting Agency Requirements • Project Funding/Constraints • Scheduling Requirements/Commitments • Community Concerns • Other Sensitive Issues • General Comments
9:30 a.m. to 11:30 a.m.	**DESIGN TEAM PRESENTATION –** by Aaron Swafford and Will Voss *(Including Q/A for each topic)* • Project Location • Overview of Preliminary Design, and US-6 alignment alternatives and Wadsworth IC geometric alternatives, leading to the selected alternative • Reference Material/Computer Design Information • Project Schedule • Preliminary Construction Cost Estimate • Environmental Requirements/Commitments • Community Involvement • Traffic, Safety, Bike and Peds • Pavement and Geotechnical

- Roadway
- Bridges and Structures
- Drainage and Water Quality
- Lighting
- Utilities
- Right of Way
- Construction Phasing
- Adjacent Improvements
- Sensitive Issues

11:30 a.m. to 3:00 p.m.
Lunch Break during tour

SITE TOUR

A CDOT van and driver (name) are requested for the tour. If a van is not available, CH2M HILL can use personal and/or rental cars. The VE team would appreciate one or two design representatives to attend the tour with us. VE staff should bring their own reflective safety vests and hardhats.

3:00 p.m. to 4:00 p.m.

REVIEW OF DESIGN INFORMATION (by individual VE team members)

Participants: **VE Team Only**

Location: CH2M HILL, West Building.

4:00 p.m. to 5:00 p.m.

TEAM FOCUS QUESTIONS AND ANSWERS

- What is the problem we are about to discuss?
- Why do we consider this a problem?
- Why do we believe a solution is necessary?
- What are the highest cost components of the project?
- What are the highest risk issues associated with the project?
- What are the expected outcomes from the VE study?

VALUE ENGINEERING STUDY

Tuesday, February 12

Phase 1 – Information – Continued

Participants: VE Team only

Location: CH2M HILL West Building.

8:00 a.m. to 10:00 a.m.
Break, 10:00 a.m. to 10:15 a.m.

FUNCTIONAL ANALYSIS

- Identify significant project functions with opportunities for cost reduction or functional enhancement
- Criteria development if appropriate
- FAST Diagram

Phase 2 – Creative

10:15 a.m. to 3:00 p.m.
Lunch Break: 12:00 p.m. to 1:00 p.m.

BRAINSTORMING

- Generate alternative solutions to current designs
- Validation of design elements

	Phase 3 – Analysis
3:30 p.m. to 5:00 p.m.	**PASS/FAIL OF ALTERNATIVE SOLUTIONS** (Discussion of advantages and disadvantages)
Wednesday, February 13	***Phase 3 – Analysis – Continued***
	Participants: VE Team only
	Location: CH2M HILL West Building.
8:00 a.m. to 10:00 a.m. *Break from 10:00 a.m. to 10:15 a.m.*	**SELECTION AND REFINEMENT OF PROMISING ALTERNATIVE SOLUTIONS**
	Phase 4 – Development
10:15 a.m. to 5:00 p.m. *Mid-Week Briefing to CDOT and CH2M HILL design staff from 1:00 p.m. to 2:00 p.m.*	**WRITE-UPS, ECONOMIC CALCULATIONS, SKETCHES FOR COST PROPOSALS** **MID-WEEK BRIEFING**
Thursday, February 14	***Phase 4 – Development* – Continued**
	Participants: VE Team only
	Location: CH2M HILL West Building.
8:00 a.m. to 5:00 p.m.	**WRITE-UPS, ECONOMIC CALCULATIONS, SKETCHES FOR COST PROPOSALS – Continued**
Friday, February 15	
8:00 a.m. to 10:00 a.m.	**COMPLETE WRITE-UPS, AND CROSS CHECK PROPOSALS; PREPARE EXECUTIVE SUMMARY PRESENTATION**
	Participants: VE Team only
	Location: CH2M HILL West Building
Friday, February 15	***Phase 5 – Presentation***
10:00 a.m. to 12:00 p.m.	**Participants:** CDOT and Agency Managers, FHWA, CH2M HILL design staff, and all VE Team members
	Location: CH2M HILL West Building, 9191 South Jamaica Street, Englewood, CO 80112.
	EXECUTIVE SUMMARY PRESENTATION TO CDOT AND DESIGN TEAM (This Presentation will conclude the Value Engineering Study.)
	The Preliminary VE Report will be prepared within 7 working days following the VE study. One hard copy and an electronic copy (consolidated PDF of the report) will be distributed to CDOT, CH2M HILL Design Team, Agency and VE participants both in hard copy and electronic PDF format.

Follow-up

Phase 6 – Implementation

The Implementation Phase will be subsequent to the VE Study, following CDOT, CH2M HILL Design, and other participants' review of the Preliminary VE Report. CDOT and CH2M HILL Design will determine acceptance, rejection, or modification of the VE proposals for incorporation into the design as appropriate. A Final VE Report summarizing the final disposition of the VE proposals can be produced upon request from CDOT, or the Preliminary VE Report along with a proposal disposition memo from CDOT may suffice as the Final VE Report.

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February 11-15, 2013; Paul Johnson, CVS and VE Team Members

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Obs.1		N/A	N/A	N/A	D2	OT2	Aesthetics		Be clear on timeframes required for Lakewood's participation in funding of design elements at the Wadsworth structure, and noise walls, and landscaping at the quadrants.	
P1		C1	OM+	S1	D1	OT1	Bridge		Potential to shorten the bridge. Don't extend the span to cover the multi-modal path width. Add a box culvert on both sides to accommodate the pedestrians. Consider an alternative for a box culvert on one side and a sidewalk on the other side.	Problems with going under the approaches are lighting, safety for peds. Review cost of abutment wall. Ok to calculate.
P2		C2	OM+ slight	S1	D2	OT2	Bridge		Shorten the bridge. Omit the sidewalk on the west side of the structure, and keep the sidewalk as designed on the east side. The planned signalization and crosswalks would move pedestrians to the east side.	
P1		C1	OM+	S1	D1	O1	Bridge		Use a single-span bridge over Wadsworth if the pedestrian improvements can be in separate box structures on either side. Abutments shift in.	Ok. See above.
Obs.1							Bridge		Consider the need for a snow fence at the bridge structure, as a safety feature.	Idea pertains to omitting open type 10. Should have a fence since it's an overpass. Metal fence would be preferred by City.

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	F						Bridge		Consider alternate designs for bridge girders such as steel versus precast or single span. The structure selection report was done, and precast was selected.	
P2 (negative savings)		C-	OM+	S1	D1	OT3	Bridge		Widen the 6th Ave. bridge structure over Wadsworth to accommodate another lane in each direction for future expansion. Would help with construction phasing. Would set the stage for future widening of US-6. Cost and difficulty of widening 6th ave will be significant and it may not happen for decades. Could impact Right of Way.	Higher cost and longer tunnel effect, but worth looking at. Design team looked at plans for Valley Highway, Sheridan and Federal which aren't being widened the additional 2 lanes. Kipling is not under construction. Helps if the temp bridge could be omitted.
P1 (Negative savings)		C- minimal increase	OM+	S1	D1	OT1	Bridge		As an alternative to bridge widening, prepare the bridge structure with mechanical connectors for widening to the south side, to avoid the loop ramp on the north side.	OK to review minor cost increase with this proposal. Phasing considerations.
P1		C3	OM+ minor	S1	D2	OT2	Bridge		Thin bond overlay on the deck and approach slab to adjust the deck profile by about 3 inches. Instead of 3" asphalt overlay on the bridge, use ¾" thin bond overlay of polyester concrete. Longer lasting. Consider overlay potential as adjacent roadway receives overlays.	OK to review. Still design for weight of a 3" asphalt overlay. SMA benefit.

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Obs							Construction		Shorten the phasing of the project. Review opportunities for concurrent activities that can reduce the project schedule.	
Obs.							Construction		If funding is identified prior to June 2013, consider including the 10^{th} to 14^{th} project as part of the current project, for cost efficiency, to reduce overall construction duration and inconvenience to the traveling public.	
P1; changed to Fail	F	C2	Neutral	S1	D2	OT1	Construction		Build the bridge structure offsite, and roll into place. Concern about bridge size, may be too wide. Would need to build in segments. Requires a specialized contractor. Minimizes inconvenience to traveling public. Would need a large are to construct nearby. Consider elevation difference of 6 feet for new vs old bridge.	Difficulty in building substructure in advance. Elevation difference between existing and new bridge (6 ft) is a significant concern. Still introduces inconvenience to the public.
P3		C2	Neutral	S1	D3	OT2	Construction		Build new bridge and continue to use traffic on the old bridge versus building a temporary bridge. New footprint will be over the old footprint. Would have to make a wider bridge offsent from centerline of US-6. Final elevation of new bridge will be 6 feet higher. Sheridan is a temporary bridge. Affects phasing.	

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P1		C2	Neutral	S1	D1	OT1	Construction		Consider precast deck with beams when shipped to the bridge location, versus cast-in-place deck. Post tension the boxes from the side. Saves time in deck construction. Allows a way to tie in the beams together from the sides. Speeds up construction. Consider weight for transport.	Could consider this with a grout pour to seal the gaps, with the 3/4" polyester topping or asphalt topping.
Obs.							Construction		Identify funding soon to permit design-build, or CM/GC versus design-bid-build. Discussion of project delivery options in addition to design-bid-build.	Moving forward with DBB. Can consider CM/GC or A+B.
P2 failed	F	C2	Neutral	S1	D1	OT1	Drainage		Consider a series of pipes or other drainage alter+J20natives in lieu of concrete box culverts at the gulches. Consider a "squashed pipe option."	OK. Has been reviewed by design team. Conspan was reviewed.
P2		C2	Neutral	S1	D1	OT1	Drainage		Use PVC vs. RCP for storm drain system.	
Obs.		C3	OM+	S1	D1	OT1	Drainage		Consolidate water quality basins. Review report and overall feasibility. Relates to reduced maintenance for fewer basins. Consider combining permanent water quality (PWQ) treatment to the least number of ponds as possible.	May be limited on volume with the two smaller ponds. If keep the pond at South Lakewood Gulch. Hinges on replacement of one of the ponds at Lakewood Gulch. Will be examined in next design phase.
Obs.			OM-	S1	D1	OT2	Environmental		Consider acrylic see-through panels for noise walls. Have these at Golden. Some concerns about cleaning. May help resident's views which they indicated they would like to have.	OK. Decision will be made with stakeholder input;

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Obs							Environmental		Further investigation of Hazardous Materials, and Dealing with them in advance, to reduce the contractor risk.	Ok ; handling as properties acquired.
Obs.							Environmental		Consider NEPA requirements for removal of slip ramps at Garrison/Carr bridge.	Ok as obs.
Obs.							Environmental		Review noise analysis to consider effects from the increased height of Wadsworth IC.	Ok as obs.
Obs.							Environmental		Consider historic nature of the culvert that may have been built in the 1940's.	Ok as obs.
P2; Fail	F	C1	Neutral	S1	D2	OT3	Environmental		Review requirement for sound walls to be 15 feet high. Reduce the height if the local community supports the idea. Design suggestion.	Mitigation requirement difficult to change.
P1		C2	Neutral	S2	D1	OT1	Materials		Consider rubble-ized asphalt and/or concrete for base material versus using as much imported structural base (64-22). Could cause concern regarding environmental. Investigate rationale.	Will be taking out a lot of asphalt. Could use RAP for ramps. Helps with sustainability. Could be a project special condition. Should work with phasing.
	F						Materials		Consider alternate designs and bid options for concrete and asphalt pavement, letting the market decide which is most cost effective. Requires two different plan sets. Must base decision on life-cycle cost, which can create controversy between the bidders/suppliers.	

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	F	C1	OM-	S3	D3	OT3	Materials		Mill and fill existing pavement on Wadsworth. Full depth pavement construction for the widened sections. Also, planning to use concrete versus asphalt on Wadsworth. 6th Ave is mill and fill, and ramps are full depth asphalt. Would not blend with 10th to Colfax which is bidding as concrete.	
Obs.1		C+	OM-				Multi-Modal		Address the concern with the sidewalk on the west side, and signalization needed for pedestrian safety across the loop ramp.	
	F						Multi-Modal		Eliminate the detached multi-use path on the west side of Wadsworth Blvd. Provide a 5-foot wide attached sidewalk in lieu of the path, for length of project (10^{th} Ave. to 4^{th} Ave.). Providing just a sidewalk will encourage use.	

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P1		C1	OM+	S1	D1	OT2	Multi-Modal		Eliminate multi-use path on west side and shift pedestrians to path on east side. Address concern with pedestrian crossings, south to north, on west side of Wadsworth in particular, across the loop ramp at grade. Consider the investment in the multi-use path, and if further investment should be done to grade separate the path across the loop ramp for safety. Ramp speed is being designed at 30 mph. Sight distance to crossing will be minimal. Shift the multi-use path to the east for safer access, and shorten bridge. Consider drainage concerns.	Mandy: Was discussed during EA. Some people walk through the area in an unsafe condition. Would still support an improved path on the east side, but don't close off the west side. Consider signal timing and crossing Wadsworth twice. Could work into the EA if a better solution is found.
	F						Multi-Modal		Consider using existing box culvert at McIntyre Gulch under 6th Ave, and the other is at Lakewood Gulch across Wadsworth, for pedestrian pathway versus removal. Verify that either or both of these were built in 1942. The old culverts are made out of brick and need to be replaced.	
N/A							Right of Way		Review opportunities for sale of remnant parcels following the project construction.	Already being done.
Obs.							Roadway		Consider directional handicapped ramps for pedestrian access improvements.	Compare this standard with Lakewood. VE suggests MUTCD 2009 just adopted.

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P1		C2	Neutral	S1	D1	OT1	Roadway		For ramps on the south side of 6th Ave. use permanent pavement versus temporary pavement to minimize throw-away cost. Review what temp pavement could be made permanent.	Will: Difficulty in timing of switching from ramps to existing loops to the diamond. Diamond goes through the loops. Can shut down the movement while building the pavement. Earthwork with grade differences. Temp pavement expedites construction.
P2		Neutral	Neutral	S1	D1	OT1	Roadway		Convert the slip ramps between Garrison and Wadsworth to auxiliary lanes versus slip ramps. Continuous lane from on -ramp WB between Carr and Wadsworth. Reduces safety concern with traffic exiting US-6 across the slip ramp when US-6 traffic is backed up. This may require a new 1601 (changes to interchanges).	OK to review. Environmental work would need to be done. Lakewood likes the idea.
	F						Roadway		Consider placing Wadsworth over US-6 versus the other way around. Review impact to sound walls, utilities, etc. Fail due to wider structure requirement, complications with ditch crossings. Could enhance pedestrian crossings. Reduces sound of highway.	
	F						Roadway		Use 11 foot vs. 12 foot lane widths on Wadsworth. There are two 11-foot lanes and a third 12-foot lane in the design now.	

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	F						Structures		At McIntyre Gulch provide another box next to the drainage culvert for the multi-use path, versus having a sidewalk on the west side of Wadsworth. At Quebec S of Lincoln there is a combined drainage structure and path with the path elevated by about 3 feet. McIntyre Gulch crosses through private property. Long detour and R/W concerns. Tie into Lakewood Gulch trail. Could be an auxiliary path, but would not be used for pedestrians along Wadsworth. Opportunity for Lakewood, but not for the current project.	
P2		C2	Neutral	S1	D1	OT1	Structures		Utilize berms or fill slopes at lower elevation of noise walls as currently designed, making the wall height shorter. Top of wall is still at the same elevation. Could work along Wadsworth due to more R/W and room for slopes. Insufficient room on US-6.	Not feasible along US-6 due to tight R/W. Opportunities along Wadsworth.
Obs.							Traffic		Use MUTCD requirements for pedestrian pole installation at intersections. Not currently referenced in plans re: MUTCD.	
P2		C increase	OM-	S1	D1	OT1	Traffic		Add variable message signage on Wadsworth to inform the public of traffic flow or issues on US-6.	Plans for VMS at Alameda and Wadsworth.