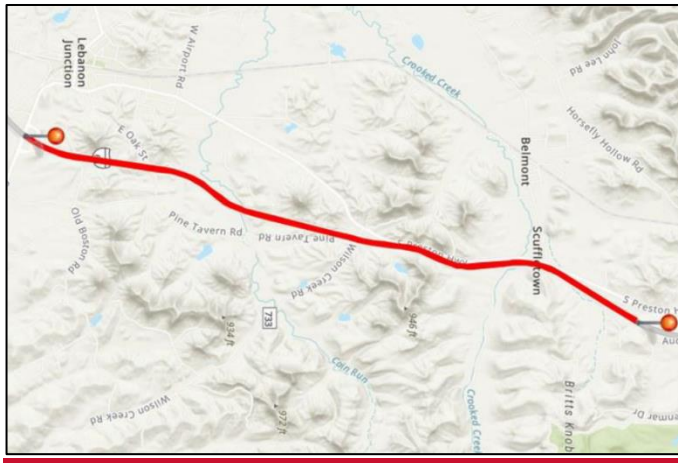


Value Engineering Study Report

I-65 from MP 104.7 to MP 110.7
Kentucky Transportation Cabinet (KYTC)

Value Engineering Study
Item #5-22066.00 VE20201

Bullitt County, Kentucky

February 20-22, 2023

Prepared by:

HDR Engineering, Inc.
101 South 5th Street,
Suite 2830
Louisville, KY 40205

Disclaimer

The information contained in this report is based on the professional opinions of the Value Engineering (VE) team members as developed during the study. These opinions are based on the information that was provided to the team at the time of the study. As the project continues to develop, recommendations and findings should be reevaluated as new information is received.

All costs displayed in the report are based on best available information at the time of the study and, unless otherwise noted, used the estimate as provided to the VE team. All drawings, graphics, maps, photos, etc., used in the report were supplied by the study sponsor or developed during the study.

The disposition of recommendations is based on the information in this report; it is independent of the resolutions generated after the study. HDR has no participation, direct or indirect, in such decisions.

For any recommendations that are accepted by the owner and design team as a result of this VE study, the responsibility for implementation into the design rests with the designer of record.

Study Statistics	
Baseline Capital Cost:	$59.4M
Number of Recommendations:	4
Total Number of Team Members:	5
KYTC Employees:	1
Others:	4
Facilitator Consultant:	HDR

Contents

Tables

Figures

Appendices

Executive Summary

Introduction

This report summarizes the events and results of the virtual Value Engineering (VE) study conducted by HDR Engineering, Inc. for the Kentucky Transportation Cabinet (KYTC) on the I-65 from MP 104.7 to MP 110.7 project in Bullitt County, Kentucky. The VE study consisted of a 3-day workshop that was conducted virtually with a multidisciplinary team on February 20-22, 2023 using Microsoft Teams.

Project Overview

KYTC, in cooperation with the Federal Highway Administration (FHWA), has proposed improvements to approximately 6 miles of Kentucky Interstate 65 (I-65) from MP 104.7 to MP 110.7 in Bullitt County, Kentucky. The improvements will result in replacing the existing concrete pavement with asphalt pavement.

The proposed project typical section consists of six lanes (three 12-foot lanes in each direction), shoulders of 12 feet (10’ paved) with a depressed median.

At the time of the VE study, the total cost of construction was estimated at $59.4 million. An estimate for other items such as construction engineering was not provided.

Scope of VE Study

The primary objectives of the study, through execution of the Value Methodology Job Plan (Appendix A), were to:

- Verify or improve on the various design concepts for the identified section of the I-65 from MP 104.7 to MP 110.7 project.
- Conduct a thorough review and analysis of the key project functions using an independent, multidiscipline, cross-functional team.
- Make recommendations that could improve the value of the project through innovative measures aimed at improving the performance while reducing costs of the project.

VE Recommendations and Study Results

The VE team generated 19 ideas for the project. These concepts were compared against the baseline developed by the project team. The concepts that resulted in improved performance were further developed by the VE team and resulted in four recommendations.

The cost savings are shown in Table 1 (described in more detail within Section 2.3, Proposed Improvements).

Table 1. Summary of Recommendations

#	Recommendation Title	Cost Savings / (Cost Added) ($M)			
		Construction	User Delay	Time Driven	Total Cost
	Baseline	**$59.40**	**$13.38**	**$1.06**	**$72.82**
1	Revise Pavement Design	$1.09			$71.73
2	Use A+B Incentive/Disincentive	$7.26	$1.17	0.53	$63.86
3	Use Break and Seat in Select Areas	$4.23	$1.17	0.53	$66.89
4	Use a Drainage Blanket	$(2.39)			$75.21

The individual recommendations are summarized below; the detailed information about each recommendation is included in Section 7.3.

1—Revise Pavement Design – The VE team recommends revisiting the pavement design and parameters to validate evaluation of concrete and asphalt, and improve its design with alternative techniques and materials, including a token quantity of geotextile fabric and #2,#3, #23 rock for spot repairs/undercut areas, and reduction of unnecessary pavement depth.

2—Use A+B Contracting Method –A+B is generally used as incentive/disincentive to reduce the construction time and reduce user delay costs.

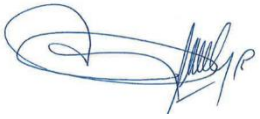
3— Use Break and Seat in Select Areas – Break and seat is a rehabilitation method broadly used in reconstruction projects to minimize cost and reduce construction time. For this project, use a break and seat method on already stabilized sub-base sections from MP 104.7 through 106.5.

4— Use a Drainage Blanket – As an alternative to the crushed stone base layer this concept recommends the use of an asphalt drainage blanket over DGA to drain the pavement.

Implementation of Recommendations

To facilitate implementation, a Value Engineering Recommendation Approval Form is included as Appendix B. If the Cabinet elects to reject or modify a recommendation, please include a brief explanation of the decision.

The VE team wishes to express its appreciation to the project design managers for the excellent support they provided during the study. We hope that the recommendations and design considerations provided will assist in the management decisions necessary to move the project forward through the project delivery process.



Jose Theiler, PE, CVS®
VE Facilitator

1 Introduction

This VE report summarizes the events of the virtual VE study conducted for the Kentucky Transportation Cabinet (KYTC) and facilitated by HDR using Microsoft Teams. The subject of the study was the I-65 from MP 104.7 to MP 110.7 project. The VE study was conducted February 20-22, 2023 while the project was in the final PS&E design phase.

1.1 Scope of VE Study

Value is expressed as the relationship between functions and resources, where function is measured by the performance attributes defined by the customer, and resources are measured in materials, labor, price, and time required to accomplish that function. VE focuses on improving value by identifying the most resource-efficient way to reliably accomplish a function that meets the performance expectations of the customer.

The primary objectives of the study, through execution of the Value Methodology Job Plan (Appendix A), were to:

- Verify or improve on the various concepts for the identified section of the I-65 from MP 104.7 to MP 110.7 project.
- Conduct a thorough review and analysis of the key project functions using a multidiscipline, cross-functional team.
- Make recommendations that could improve the value of the project through innovative measures aimed at improving the performance while reducing costs of the project.

With this process, the VE team identified the essential project functions and alternative ways to achieve those functions; the team then selected the optimal recommendations to develop into workable solutions for value improvements.

1.2 VE Team Members

The VE study was facilitated by a Certified Value Specialist (CVS) from HDR. Multiple representatives and members of the KYTC project team also participated in the VE process to provide insight into the project's background and design development, as well as their requirements for the project and expectations for the VE study. Their support of this study is greatly appreciated, and the results provided herein reflect the information they provided throughout the study.

The VE team included the following individuals. See Appendix C for details of attendees.

Kevin Gearlds | HDR
Katy Stewart | KYTC
Travis Thompson | HDR
Jose Theiler, PE, CVS | HDR

Figure 1. Team Photo

2 Information Phase

To successfully identify alternatives, it is essential that the VE team first understand the project objectives and problems that must be solved. The VE team received the documentation and drawings from the project design team as shown in Table 2. The design team also introduced the project and its characteristics on the first day of the study. Project details and challenges as presented by the design team are summarized below.

2.1 Information Provided to VE Team

Table 2 lists the project documents provided to the VE team for use during the study.

Table 2. Information Provided to the VE Team

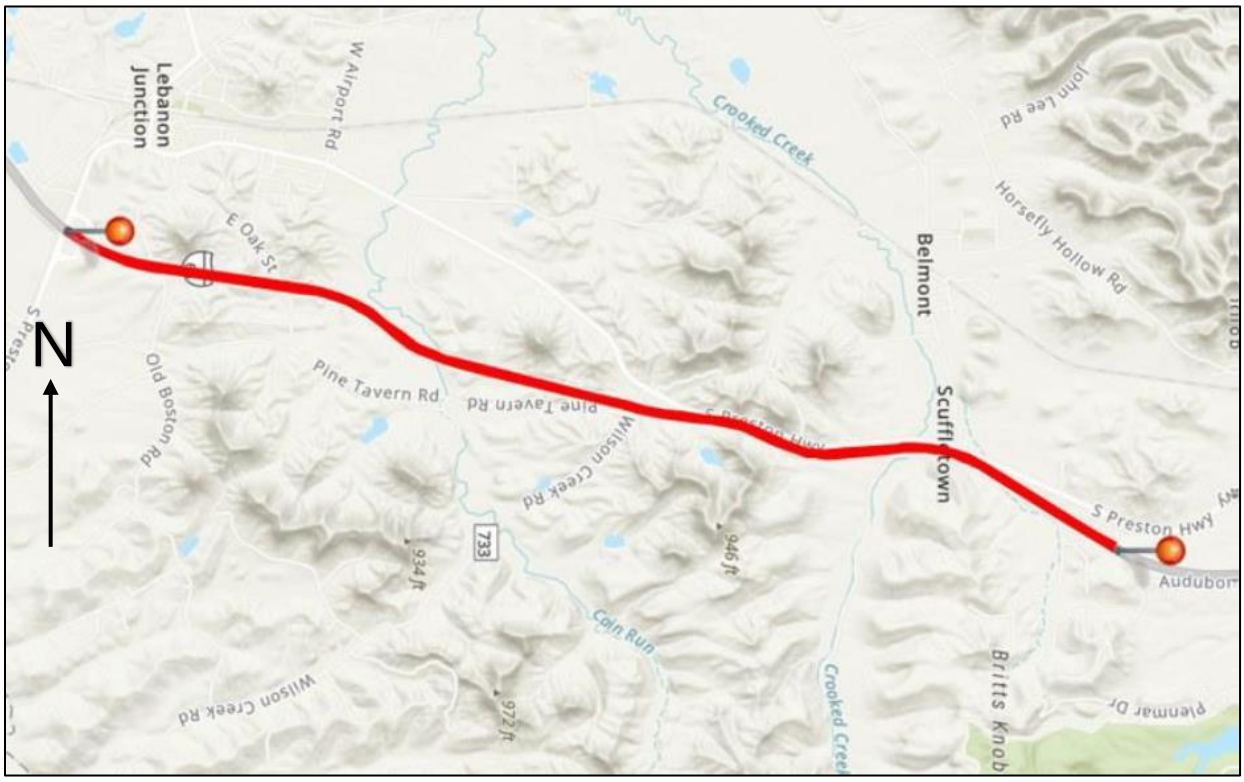
Document/Drawing/Schematic	Document Date
Cost Estimate	Feb-2023
Typical Section	Feb-2023
Google Earth .KMZ File	Feb-2023
Construction TCP	Feb-2023
KTC Pavement Investigation report	2022
Pre-design conference meeting minutes	Jun-2022
Various Field Conditions pictures	2022

2.2 Project History and Purpose and Need

The following project history and information was extracted from the information and documentation provided by KYTC.

KYTC in cooperation with the Federal Highways Administration (FHWA) is proposing pavement improvements to approximately 6 miles of Kentucky's interstate 65 (I-65) from MP 104.7 to MP 110.7, in Bullitt County, Kentucky. The purpose of the project is to improve pavement conditions. KTC's Pavement Report shows considerable deterioration at the different pavement strata, recommending full replacement of pavement in both directions of traffic.

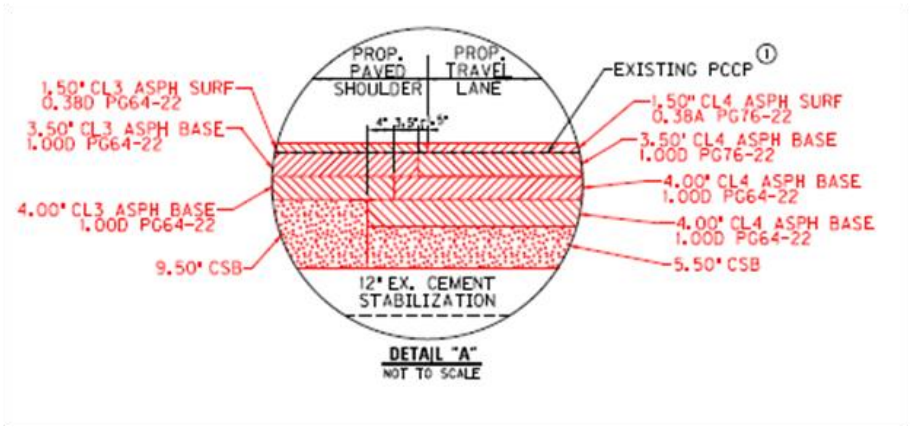
Figure 2. Project Vicinity Map

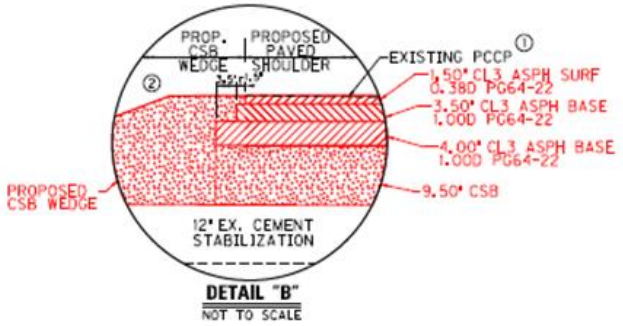


2.3 Proposed Improvements

The KYTC performed a lifecycle cost analysis and pavement design alternatives analysis to determine the pavement structure that offered the best value, including multiple thickness asphalt and concrete types. The selected pavement design shows cement stabilization treatments in different sections, some existing and others with a new 8" layer. In addition, 5.5 Inches of CSB under travel lanes, and 9.5 Inches under shoulders; 4 Inches of CL4 Asphalt base 1.0OD PG64-22 under travel lanes, 7.5 Inches (4"+3.5") of CL4 Asphalt Base 1.0OD PG-22 on travel lanes and shoulders, and 1.5 Inches of CL4 Asphalt Surface 0.38A PG76-22. Figure 3 and Figure 4 show depictions for each section of roadway and mileposts.

Figure 3. Selected Pavement Section from MP 104.7 to 106.5





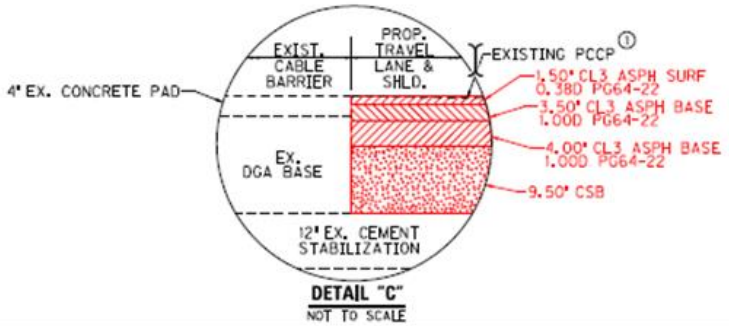
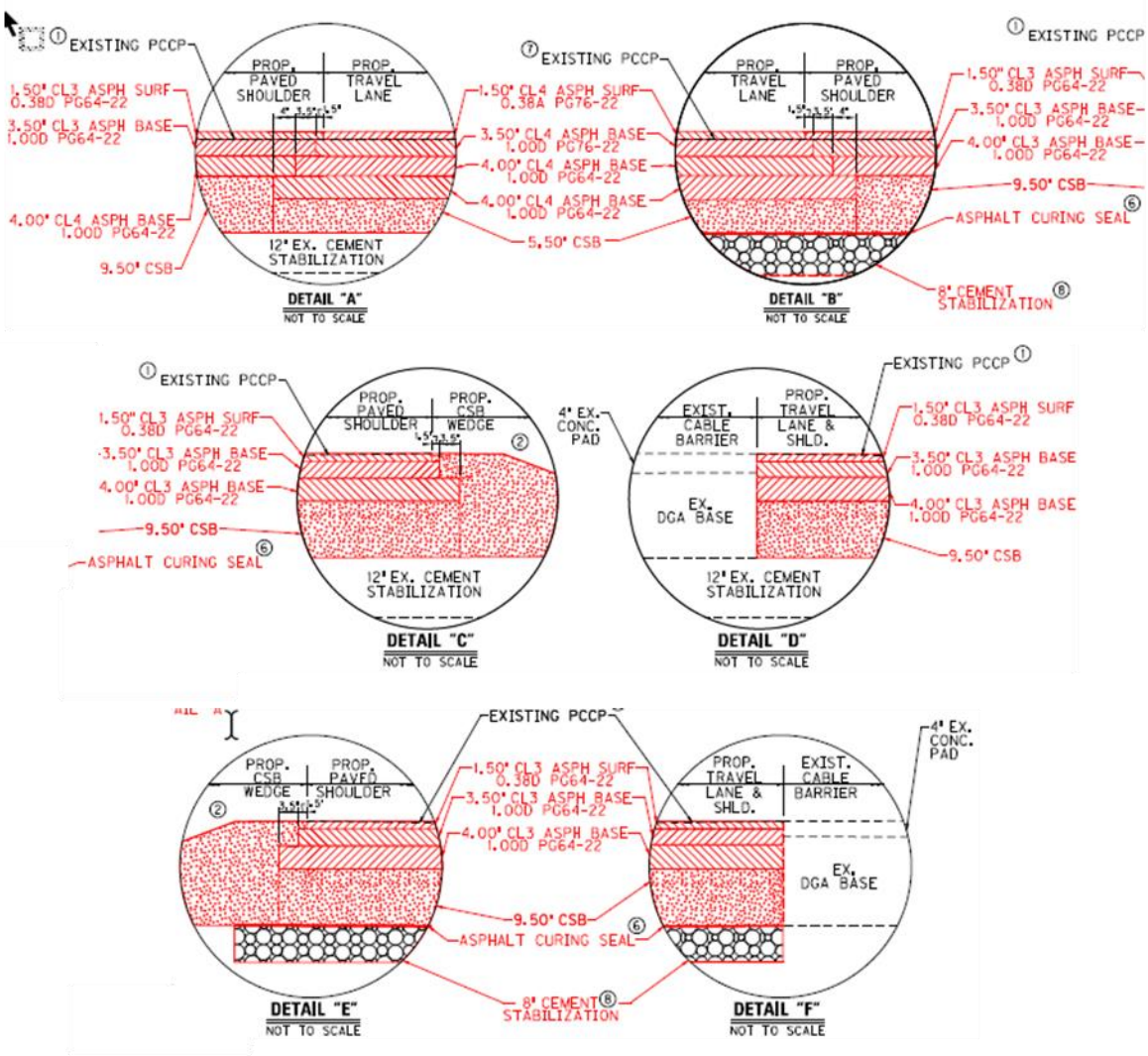


Figure 4. Selected Pavement Section from MP 106.5 to 110.7



2.4 Project Constraints and Risks

As part of the project briefing, the VE team was given the following project constraints, controlling factors, and other issues that needed to be considered when evaluating ideas.

Constraints:

- Asphalt pavement only
- No betterments other than pavement structure
- April letting

A risk analysis was not completed as part of this VE; however, during the VE study, the team identified several risks.

- Labor availability
- Materials availability
- Bid Issues, including protest, >10% variance with Engineer's estimate, re-let, etc.
- Unknown site conditions (settlement, water, others).

2.5 Project Observations

The first day of the VE study included a presentation from the project design team and a virtual tour of the project using Google Earth and KMZ files. The following summarizes project issues, project drivers, and observations identified during this session:

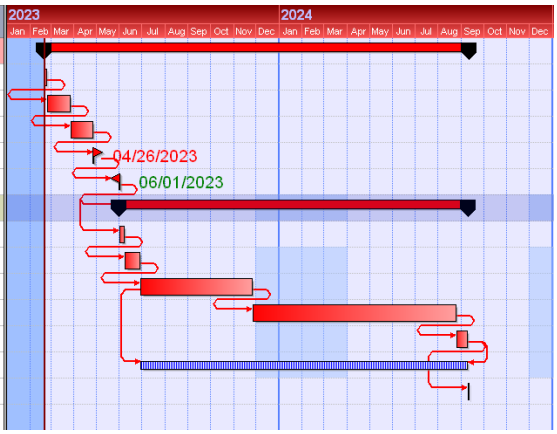
- Pavement unit prices in the base cost are high
- GPR used in certain areas, may need additional sub-base stabilization
- Site conditions may differ from forensic analysis
- Quantities may not have elements needed for stabilization
- MOT amount in the base cost may be too low
- There are 6 crossovers, two seem to be for ramp extensions
- Hauling PCC out of site may be above $8/SY. High risk
    - Opportunity to keep risk by offering a closer site of disposal
- Contingency seems high at 20%, usually 5 to 10%. During the workshop the base cost estimate was updated and contingency was reduced to 10%.
- Fuel and asphalt adjustments included in the base cost (~$1.5M)
- Requirement to avoid longitudinal joints (echelon requirement) may put a burden on contractor availability (3 pavement crews at the same time are required)
- Mobilization and MOT seem disproportionate with the I-65 to the south (recent project)
- Rumble strips on shoulders may need treatment to be used as part of the traffic – not included in the base cost

- Break & seat treatment on already stabilized sub-based was not considered.
- Four pavement plants are close to the project (north) along I-65.
- Geotextiles in the base cost (inner layer) – unknown reason for it (Qty is equal than Cement Stabilization). During the workshop, the design team provided a new base cost estimate without geotextile pay items.
- Aggressive schedule: requires two demo/removal crews working simultaneously. Pavement operations would be linear S to N. Not likely that contractors have 6 crews to double up production (i.e., echelon requirement).

2.6 Project Schedule

The project was at the 90% PS&E design phase, with a letting planned for April 26, 2023. Construction duration is set to two seasons, approximately 343 calendar days. The project delivery is Design-Bid-Build.

ID	Description	Remaining Duration	Start	Finish
100	5-22066.00 - I-65 Bullitt County Pave...	568	A02/20/2023	09/10/2024
110	VE Study	3	A02/20/2023	02/23/2023
120	Plans Updates	32	02/24/2023	03/27/2023
130	Advertisement	30	03/28/2023	04/26/2023
140	Letting	0		04/26/2023
150	NTP	0	06/01/2023	
160	Construction	343	06/01/2023	09/09/2024
210	Mobilize	7	06/01/2023	06/07/2023
200	Construct Crossovers #1, #2, #3 & #4	21	06/08/2023	06/28/2023
170	Construct Northbound Lanes	150	06/29/2023	11/25/2023
180	Construct Southbound Lanes	150	11/26/2023	08/25/2024
190	Remove crossovers	15	08/26/2024	09/09/2024
230	Construction Engineering and Inspec...	315	06/29/2023	09/09/2024
220	Project end	1	09/10/2024	09/10/2024



2.7 Project Cost Estimate

At the time of the study, the project development team provided the VE team with the most recent cost estimate; later during the workshop, they provided an updated estimate, which was used for the VM analysis. An abbreviated estimate is shown in Table 3. See Appendix D for the Project Team's expanded estimate.

Table 3. Cost Estimate – Baseline Concept

Cost Item	Cost	Percent of Total	Cumulative Percentage
Paving	$44,021,529	33.7%	34%
Roadway	$7,619,044	17.7%	51%
Contingency (10%)	$5,403,804	15.6%	67%
Mobilization / Demobilization	$2,326,997	15.4%	82%
Traffic Counter	$70,471	8.7%	91%
Total	**$59,441,845**	100.0%	100%

2.8 Project Risks

A risk analysis was not completed as part of this project; however, risk identification was performed by soliciting potential project risks from the stakeholders, project team, and VE team on the first day of the study. The following risks were identified and quantified:

Table 4. Project Risks

ID	Description	P%	Cost Impacts ($K)			Schedule Impacts (D)		
			Low	Likely	High	Low	Likely	High
001	Bid Issues - Rejections, Reconciliation, Re-let, etc.	50%				15	30	60
002	Materials Availability	25%	$75	$112	$150			
003	Labor Availability	50%	$30	$52	$75			
004	Unknown site conditions	50%	$600	$900	$1,200			

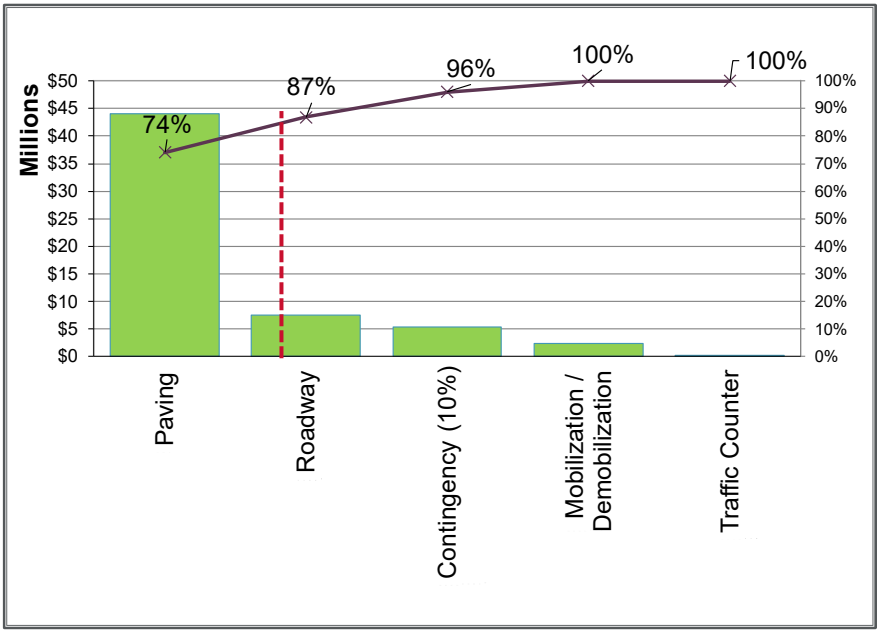
3 Project Analysis

3.1 Cost Model

The VE facilitator prepared a cost model from the cost estimate, which was provided by the project team. The model was organized to identify major construction elements, the design team's estimated costs, and the percent of total project cost for the significant cost items (Figure 5).

The cost model allows the team to focus on project elements with the highest degree of impact and utilize their time most effectively.

Figure 5. Cost Model



4 Function Analysis Phase

4.1 Overview

Function analysis results in a unique view of the project. It transforms project elements into functions, which help guide the VE team in considering the functional concepts of the project–independent of the current design. Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level (Table 5). Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions.

Table 5. Random Function Identification

Project Element	Functions
Project Purpose/Need	Address Pavement Condition Replace Pavement Rehabilitate Pavement Meet Standards Minimize Maintenance Introduce Traffic Deliver Design Avoid (longitudinal) Joints
Pavement	Break (existing) Pavement Remove (existing) Pavement Compact Pavement Separate Layers Prevent (reflective) Cracking Stabilize Roadbed Repair Pavement Carry Loads Protect Roadbed Smoothen Surface Increase Friction Remove Water
Earthwork	Create Grade Move Soil Remove Pavement
Traffic Control	Separate Traffic Inform Users Protect Workers Divert Traffic Control Movements Minimize Traffic Disruptions
Drainage	Collect Runoff Convey Runoff Maintain (Positive) Drainage

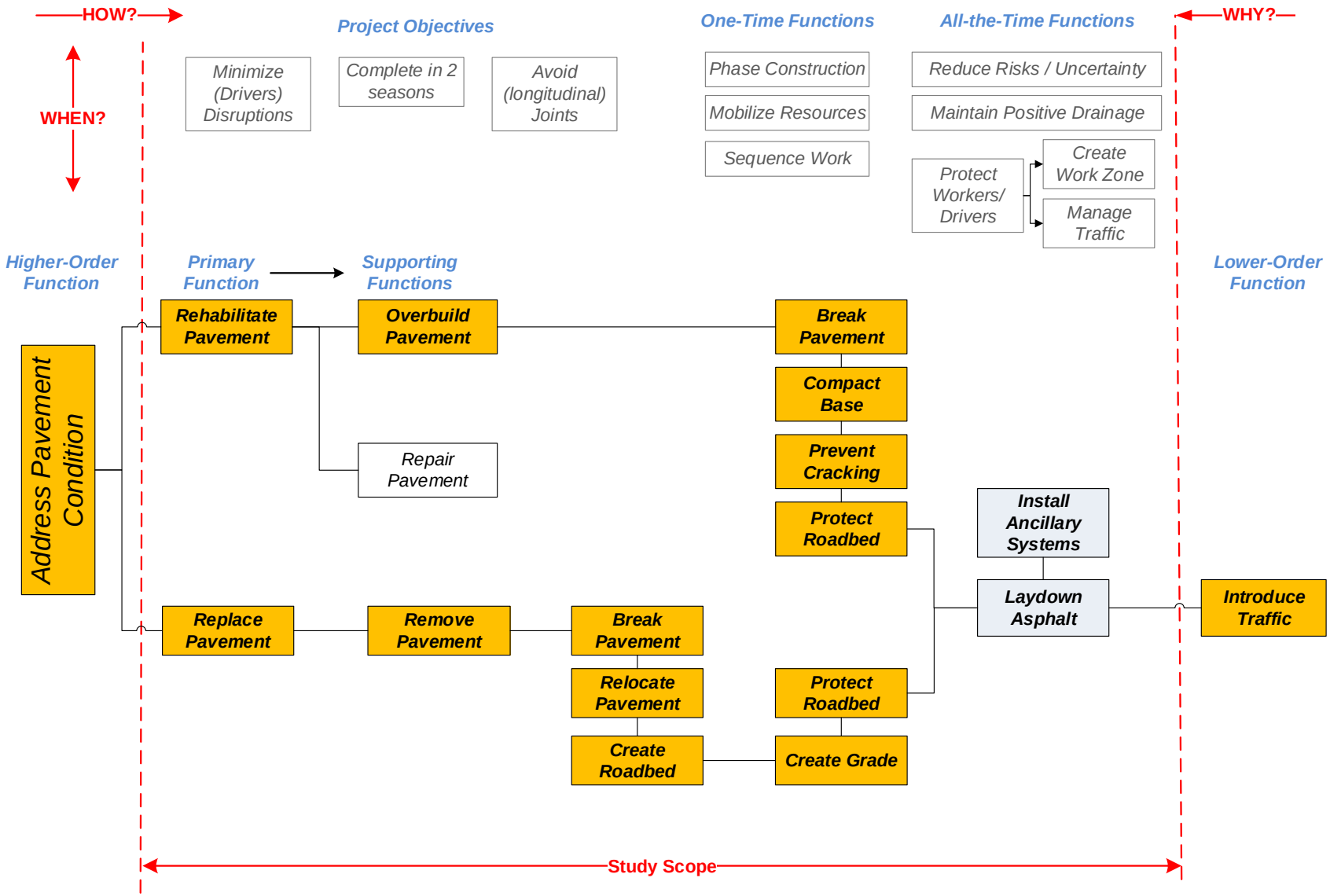
Table 5. Random Function Identification

Project Element	Functions
Other	Manage Risks / Uncertainty Stage Construction Deploy Resources Sequence Activities Create Work Zone Control Erosion

4.2 Function Analysis System Technique Diagram

The Function Analysis System Technique or “FAST” diagram arranges the functions in logical order so that when read from left to right, the functions answer the question “How?” If the diagram is read from right to left, the functions answer the question “Why?” Functions connected with a vertical line are those that happen at the same time as, or are caused by, the function at the top of the column. The FAST diagram (Figure 6) provided the VE team with an understanding of which functions offer the best opportunity for cost or performance improvement.

Figure 6. FAST Diagram



5 Creativity Phase

During the Creativity Phase, the VE team generated ideas on how to perform the various functions. The idea list was grouped by function or major project element. All of the ideas generated are recorded in Table 6. The final disposition of each idea is included at the end of Section 6.

Table 6. Creative Idea List

Idea No.	Description
Function: Convey Runoff	
15	Provide a drainage blanket
Function: Fund Risks	
13	Lower contingency level to 5-10% and/or identify specific risks that lead to a much higher contingency
19	Include rock and fabric in estimate to account for extra areas found in the field that need stabilization
Function: Improve Environment	
11	Stockpile removed pavement in a preselected nearby location (contractor retains)
12	KYTC maintenance crews can use the stockpiled pavement for maintenance purposes (KYTC retains)
Function: Improve Pavement Conditions	
14	Take a more in-depth look at the CSB and asphalt unit bid prices and adjust to current bid levels
Function: Manage Traffic	
5	Different MOT scheme, construct one lane at a time. Keep traffic in the same direction of travel (don't shift traffic to opposite side)
Function: Sequence Work	
6	Pave one lane at a time with asphalt, instead of echelon paving.
9	Extend the project completion date.
10	Use A+B incentives and disincentives to accelerate construction time.
17	Break the deconstruction and grading phase into two sections to be worked on simultaneously (two deconstruction and earthwork crews)
18	Break the pavement operations up into two simultaneous operations.
Function: Support Loads	
1	Use break and seat method on already stabilized sub-base sections.
2	Partial replacement in strategic locations where failures are occurring and diamond grind the rest of existing pavement.
3	Use concrete pavement.

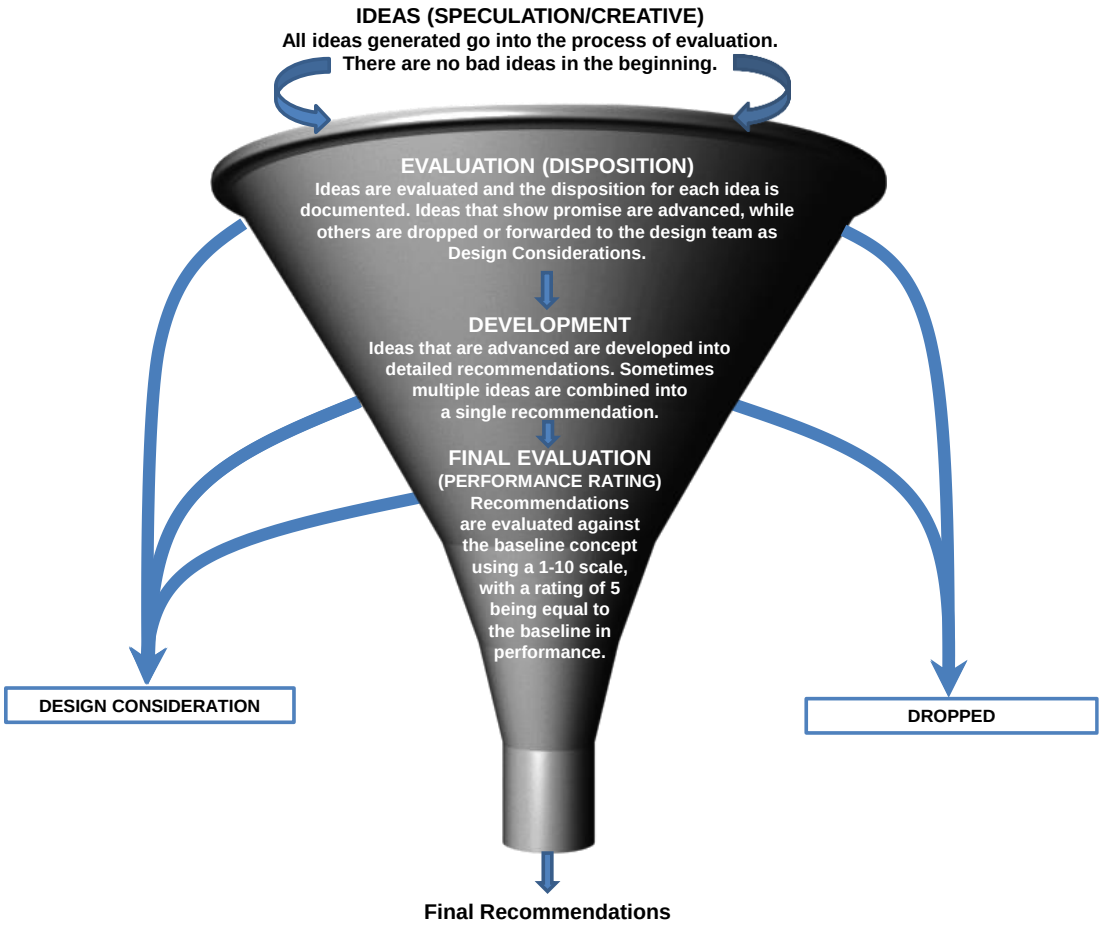
Table 6. Creative Idea List

Idea No.	Description
4	Use bid options, including concrete and asphalt pavement.
7	Provide geotextile fabric and rock roadbed in place of lime or cement stabilization.
8	Eliminate geotextile bond breaker
16	Revise pavement design evaluation - validate existing design or propose a new design

6 Evaluation Phase

Although each project is different, the evaluation process for each VE effort can be thought of in its simplest form as a way of combining, evaluating, and narrowing ideas until the VE team agrees on the recommendations to be forwarded. Figure 7 depicts the typical information flow for this part of the Value Methodology Job Plan.

Figure 7. VE Process Information Flow



6.1 Evaluation Process

The evaluation process begins by going through the ideas brainstormed during the Creativity Phase. Considering the information provided to the VE team at the time of the study and the constraints and controlling decisions that were also given to them, the team discussed the ideas and documented their advantages and disadvantages based on their relationship to the baseline concept.

The VE team also compared each idea with its baseline concept to determine whether the performance of the attribute was better than, equal to, or worse than the baseline concept.

Each idea was then carefully evaluated, with the VE team reaching consensus on the overall ranking of the idea (ranking values 0 through 3, as defined below).

3 = Advance for further development

2 = Design consideration; include as a comment or consideration for design team

1 = Poor Opportunity/dropped from further development

0 = Unacceptable impact/fatal flaw

This ranking resulted in the initial disposition of the idea. Those ideas ranked as a 3 were developed further; low-ranking ideas (those ranked 0 or 1) were dropped from further consideration; and those that were ranked 2 were brought forward as ideas the design team should pursue.

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Convey Runoff					
15	Provide a drainage blanket	• Improved subsurface drainage removal • Improves durability of roadbed • Costs less than asphalt base course	• May require a change in setup at asphalt plant • May impact median cable barrier • Pavement design thickness may be different and require additional excavation	*3*	
Function: Fund Risks					
13	Lower contingency level to 5-10% and/or identify specific risks that lead to a much higher contingency	• Reduces costs	• May not have enough contingency at time of bidding	*2*	*Design team should evaluate the need for a 20% contingency this late in design*
19	Include rock and fabric in estimate to account for extra areas found in the field that need stabilization	• May help mitigate different field conditions, quantities, and method of contingency	• Increase costs (high unit price due to small quantity)	*2*	*Design team to validate or consider adding as may be an oversight.*
Function: Improve Environment					
11	Stockpile removed pavement in a preselected nearby location (contractor retains)	• Save money in hauling operations • Recycle material may reduce demand on environment and resource • Reduce overall cost of project	• Requires KYTC to find location or use right-of-way • May require environmental permit • May require FHWA approval • May delay letting	*3*	*Combine 11,12*

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
12	KYTC maintenance crews can use the stockpiled pavement for maintenance purposes (KYTC retains)	• Save money in hauling operations • Recycle material may reduce demand on environment and resource • Reduce overall cost of project • Reduces cost of maintenance materials for other locations • May reduce disposal cost by contractor	• District 5 may not have staffing to handle disposal and cleanup • May tie up maintenance crews longer than anticipated	*3*	*Combine 11,12*
Function: Improve Pavement Conditions					
14	Take a more in-depth look at the CSB and asphalt unit bid prices and adjust to current bid levels	• May lead to cost reductions	• Increases risk of being exposed to market fluctuations	*2*	*Design team to use current bidding prices and adjust for quantities*
Function: Manage Traffic					
5	Different MOT scheme, construct one lane at a time. Keep traffic in the same direction of travel (don't shift traffic to opposite side)	• Crossovers not needed • Crossover removal not needed	• Increased construction duration • Increases risk of conflict by bringing traffic closer • Increased exposure risk • Split traffic during middle lane construction • Introduces construction joints • Lower driver expectations • Increases barrier req's (more mobilization)	*1*	

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Sequence Work					
6	Pave one lane at a time with asphalt, instead of echelon paving.	• Increases the pool of bidders, more competition	• Increases maintenance (longitudinal joints) • Increased construction duration • Increased exposure time for workers	*1*	
9	Extend the project completion date.	• Reduces risk to contractor • May lead to improved bid prices • May increase the number of bidders	• May increase mobilization and demobilization of equipment • May increase MOT bid costs • May tie up equipment for longer periods	*1*	
10	Use A+B incentives and disincentives to accelerate construction time.	• May reduce construction duration • May reduce user delay costs • May reduce MOT costs	• May lead to quality issues • Will increase costs • May reduce the number of bidders	*3*	
17	Break the deconstruction and grading phase into two sections to be worked on simultaneously (two deconstruction and earthwork crews)	• Reduce construction duration • Reduce MOT costs • Reduce user costs	• Requires two crews • Requires additional resources • May dictate means and methods to contractor	*2*	*A strategy the contractor can use to take advantage of the incentives recommendation*
18	Break the pavement operations up into two simultaneous operations.	• Reduce construction duration • Reduce MOT costs • Reduce user costs	• Requires two crews • Requires additional resources • May dictate means and methods to contractor	*2*	*A strategy the contractor can use to take advantage of the incentives recommendation*

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Support Loads					
1	Use break and seat method on already stabilized sub-base sections.	• Won't have to haul off removed pavement • Reduces construction cost • Reduces construction duration	• Reflective cracking if not broken correctly • If hidden subgrade issues could reflect to surface • Concerns with longevity • Reconstruct at overpasses for vertical clearance • More CSB under shoulders • Will need to raise median cable barriers	*3*	
2	Partial replacement in strategic locations where failures are occurring and diamond grind the rest of existing pavement.	• Reduces project cost • Reduces construction duration • Modify MOT to reduce impacts to traveling public • Reduces user delay costs	• Increases risk of pavement failure • Increases long and short-term maintenance	*1*	
3	Use concrete pavement.	• Increased life of facility • Reduced maintenance costs	• Increase schedule duration • Increases capital costs • Maintaining traffic difficulties • Increased riding noise • More difficult to construct	*1*	
4	Use bid options, including concrete and asphalt pavement.	• Increases competition	• Will require additional design	*1*	

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
7	Provide geotextile fabric and rock roadbed in place of lime or cement stabilization.	• May reduce costs • Removes stabilization cure time	• Reduces the moisture barrier effectiveness • Decreases long-term durability	*3*	*Combine 7,16*
8	Eliminate geotextile bond breaker	• May not be needed • Reduces costs	• None discussed	*2*	*Design should look into confirming the pay item and the purpose of bond breaker.*
16	Revise pavement design evaluation - validate existing design or propose a new design	• May lead to a reduction in cost • May lead to materials types usage • May lead to improved load capacity • May validate pavement requirements	• May lead to increased cost • May lead to invalidation of current design • May lead to loading capacity	*3*	*Combine 7,16*

7 Development Phase

This phase of the Value Methodology Job Plan takes the ideas that ranked the highest in the Evaluation Phase and further develops them into full VE recommendations. In many cases, it is possible that one or more ideas were combined to form an overall recommendation, which was then evaluated further by the VE team.

In the case of this project, of the 19 ideas that were generated during the Creativity Phase, seven were evaluated high enough to be developed further and combined. Seven ideas were deemed more appropriate as a design consideration for the project team, rather than developed into a VE recommendation (Section 7.4). For the Development Phase, narratives, drawings, calculations, and cost estimates were prepared for each recommendation.

The VE recommendation documents in this section are presented as written by the team during the VE study. While they have been edited from the draft VE report to correct errors or better clarify the recommendation, they represent the VE team's findings during the VE study.

Each recommendation consists of a summary of the baseline concept, a description of the suggested change, a listing of its advantages and disadvantages, discussion of schedule and risk impacts (if applicable), a cost comparison, change in performance, and a narrative comparing the baseline design with the recommendation. Sketches, calculations, and performance measure ratings are also presented. The cost comparisons reflect a comparable level of detail as in the baseline estimate.

7.1 Summary of Recommendations

Table 8 is a summary of all recommendations generated and their cost impact to the project.

The recommendations identified all consider multiple aspects of total value, including assessing the impacts to performance, cost, time, and risk in comparison to the baseline concept. The potential of each recommendation summarized in Table 8 is based on the following:

- Initial Cost Savings Potential – A quantified indication of the recommendation's impact to the project's initial cost in comparison with the baseline concept. Initial cost savings are conceptual and reflective of the VE team's parametric estimation of possible savings and represent orders of magnitude cost impact of the VE recommendation. Because the cost data depicted represent savings, a number in parentheses represents a cost increase.

Table 8. Summary of Recommendations

#	Recommendation Title	Cost Savings / (Cost Added) ($M)			
		Construction	User Delay	Time Driven	Total Cost
	Baseline	**$59.40**	**$13.38**	**$1.06**	**$72.82**
1	Revise Pavement Design	$1.09			$71.73
2	Use A+B Incentive/Disincentive	$7.26	$1.17	0.53	$63.86
3	Use Break and Seat in Select Areas	$4.23	$1.17	0.53	$66.89
4	Use a Drainage Blanket	$(2.39)			$75.21

7.1.1 FHWA Functional Benefit Criteria

Each year, state departments of transportation are required to report on VE recommendations to the Federal Highway Administration (FHWA). In addition to cost implications, FHWA requires state departments of transportation to evaluate each approved recommendation in terms of the project features that recommendation benefits. If a specific recommendation can be shown to provide benefit to more than one feature described below, count the recommendation in each category that is applicable. These same criteria can be found on each of the individual recommendations that follow.

- **Safety:** Recommendations that mitigate or reduce hazards on the facility.
- **Operations:** Recommendations that improve real-time service and/or local, corridor, or regional levels of service of the facility.
- **Environment:** Recommendations that successfully avoid or mitigate impacts to natural and or cultural resources.
- **Construction:** Recommendations that improve work zone conditions or expedite the project delivery.
- **Right-of-way:** Recommendations that lower the impacts or costs of right-of-way.

7.2 Value Engineering Recommendation Approval

The resolution or disposition of recommendations is based on the information in this report and is independent of the proceeding of the VE study. HDR has no participation, direct or indirect, in such decisions. The VE Recommendation Approval form shown in Appendix B is intended to aid the project manager in tracking and informing the state Value Engineer in annual reporting of VE activities to FHWA. Resolution and disposition of recommendations contained in Appendix B are pending.

7.3 Individual Recommendations

Based on the evaluation process, individual recommendations were developed. Each recommendation consists of a summary of the baseline concept, a description of the recommendation, a listing of its advantages and disadvantages, and a brief narrative that includes justification, sketches, photos, assumptions, and calculations as developed by the VE team. Final recommendations can be found beginning on page 7-3.

VE RECOMMENDATION NO. 1: REVISE PAVEMENT DESIGN	Idea No(s). 7, 16

Baseline Concept

Address condition of I-65 from Milepoint 104.7 to Milepoint 110.70.

Recommendation Concept

The VE team recommends revisit the pavement design and parameters to validate evaluation of concrete and asphalt, and improve its design with alternative techniques and materials, including a token quantity of geotextile fabric and #2,#3, #23 rock for spot repairs/undercut areas, and reduction of unnecessary pavement depth.

Advantages	Disadvantages
• May reduce costs • May reduce stabilazation cure time • May lead to a reduction in cost • May lead to materials types usage • May lead to improved load capacity • May validate pavement requirements	• Reduces the moisture barrier effectivenes • Decreases long-term durability • May lead to increased cost • May lead to invalidation of current design • May lead to loading capacity

Cost Summary	Capital Cost	Right-of-way Cost	Total Cost
Baseline Concept	$51,274,980		$51,274,980
Recommendation Concept	$50,189,512		$50,189,512
Cost Avoidance/(Added Value)	$1,085,468		$1,085,468

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
	✓		✓	

VE RECOMMENDATION NO. 1: REVISE PAVEMENT DESIGN	Idea No(s). 7, 16

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Current Pavement Design Validation - The current pavement design has been validated using the KYTC Web-Based Pavement Design Application. Utilizing a design Resilient Modulus (MR) of 20,000 and Annual Average Daily Truck Traffic (AADTT) of 17,500, the asphalt design resulted in 13 inches of asphalt over 6 inches of crushed stone base. The concrete design resulted in 12 inches of JPC pavement over 6 inches of crushed stone base. These results are similar in comparison to the pavement designs provided for this project. Screen shots of the validated asphalt and JPC designs are presented below.

Asphalt Pavement Design Validation

Title & Info. | Subgrade | AC | PCC | Cost Analysis | Attachments | Design Selection & Notes

Section Description: Route: I-65; Bullitt County;
Analysis Date: 2023-02-20

Structural Design Inputs:

Design CBR: Design MR: 20000 AADTT: 17500

Pavement Structural Design from Design Catalog:

Total minimum Asphalt thickness are 6.7

Required total AC Thickness on 6 inches of aggregate base: 13.00 in.

Driving Lane Material Selection

	Thickness	Item Code	Description
Surface:	1.5	00342	CL4 ASPH SURF 0.38A PG76-22
Base:			**Polish-resistant type A** is correct.
Layer 1:	3.5	00219	CL4 ASPH BASE 1.00D PG76-22
Layer 2:	4.0	00217	CL4 ASPH BASE 1.00D PG64-22
Layer 3:	4.0	00217	CL4 ASPH BASE 1.00D PG64-22
Drain. Blanket:	0	0	None
Aggr. Base:	6	00003	CRUSHED STONE BASE
Stab. Roadbed:	0	0	None

More AC Item

JPC Pavement Design Validation

Title & Info. | Subgrade | AC | PCC | Cost Analysis | Attachments | Design Selection & Notes

Section Description: Route: I-65; Bullitt County;
Analysis Date: 2023-02-20

Structural Design Inputs:

Design CBR: Design MR: 20000 AADTT: 17500

Pavement Structural Design from Design Catalo

Required Thickness: 12.00 in. Designed Thickness: 12 in.

Driving Lane Material Selection

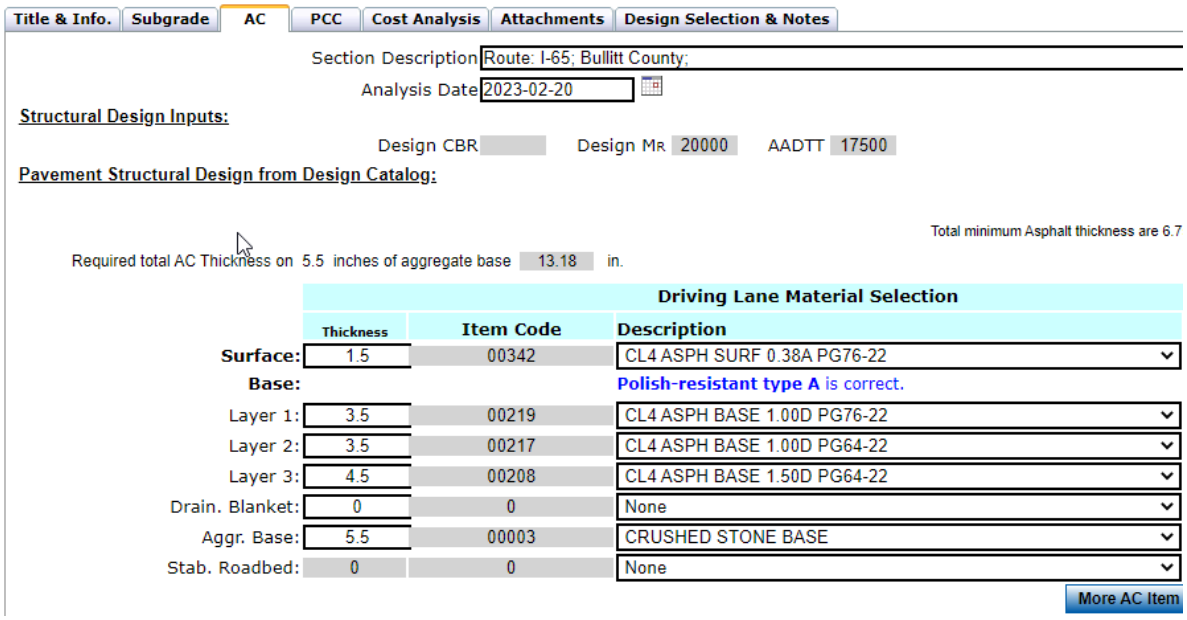
	Thickness	Item Code	Description
JPC Pavement:		02070	JPC PAVEMENT-12 IN
Drain. Blanket:	0		None
Aggr. Base:	6	00003	CRUSHED STONE BASE
Stab. Roadbed:	0	0	None

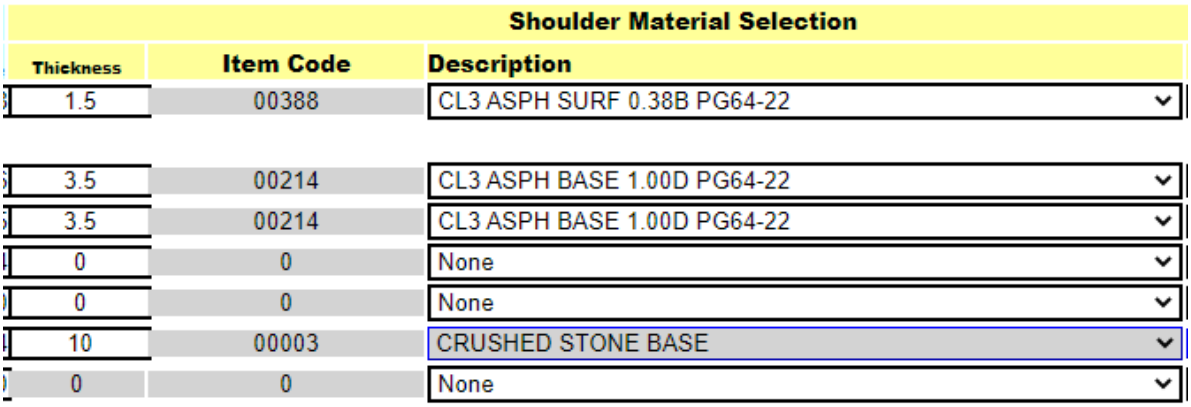
Revised Asphalt Pavement Design - We propose a revision to the proposed design be considered which would maintain the 13 inches of asphalt pavement under the driving lanes but with revised lift thicknesses (1.5", 3.5", 3.5", 4.5") as depicted below. We also recommend the lower most asphalt base layer be changed to CL4 ASPH BASE 1.50D PG64-22.

VE RECOMMENDATION NO. 1: REVISE PAVEMENT DESIGN	Idea No(s). 7, 16

Revising the lift thicknesses under the driving lanes allows for a reduction in the shoulder pavement thickness from 9 inches to 8.5 inches (1.5", 3.5", 3.5").

Revised Asphalt Pavement Design Option





Include Geotextile Fabric and #2, #3, #23 Rock for Spot Repairs/Undercuts

This recommendation provides a token quantity of geotextile fabric and rock to be used at locations where after pavement and crushed stone base removal, short segments or areas of undercutting is deemed necessary by the Engineer. This type of repair is recommended in lieu of chemical stabilization at these locations since the construction methods are easier and the equipment used for chemical stabilization is less accessible in these areas.

Assumptions/Calculations

The quantities assume that 5% of the area under driving lanes and shoulder where chemical stabilization is not already being proposed would need to be removed and replaced with 12 inches of rock wrapped in geotextile fabric. So as to not create pockets of water retention under the new pavement those rock and fabric areas would need to be drained to the median

VE RECOMMENDATION NO. 1: REVISE PAVEMENT DESIGN	Idea No(s). 7, 16

or outside ditch. For calculation purposes, these quantities are reflected on both sides of the table below; it is important that KYTC reviews these areas for positive drainage away from pavement roadbed and account for these quantities.

VE Study Cost Calculations

KYTC - I-65 Bullitt Co

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Crushed Stone Base	Ton	495751	$ 32.00	$ 15,864,032	499756	$ 32.00	$ 15,992,192
Cl. 4 Asphalt Surf 0.38A PG76-22	Ton	20811	$ 130.00	$ 2,705,430	20811	$ 130.00	$ 2,705,430
Cl. 3 Asphalt Surf 0.38D PG64-22	Ton	11561	$ 100.00	$ 1,156,100	11561	$ 100.00	$ 1,156,100
Cl. 4 Asphalt Base 1.00D PG 64-22	Ton	114587	$ 100.00	$ 11,458,700	49393	$ 100.00	$ 4,939,300
Cl. 4 Asphalt Base 1.00D PG 76-22	Ton	49682	$ 95.00	$ 4,719,790	49682	$ 95.00	$ 4,719,790
Cl. 3 Asphalt Base 1.00D PG62-22	Ton	57411	$ 95.00	$ 5,454,045	53583	$ 95.00	$ 5,090,385
Cl. 4 Asphalt Base 1.50D PG 64-22	Ton			$ -	65194	$ 90.00	$ 5,867,460
Fabric - Geotextile Class 1	SY	26096	$ 2.25	$ 58,716	26096	$ 2.25	$ 58,716
Crushed Aggregate Size No. 2	Ton	7516	$ 67.03	$ 503,797	7516	$ 67.03	$ 503,797
				$ -		$ -	$ -
Subtotal Construction				*$ 41,920,610*			*$ 41,033,170*
Mark-Up (MOT, Mob., PE, CEI)	22%			$ 9,354,369			$ 9,156,342
Total Construction				**$ 51,274,980**			**$ 50,189,512**
Utility Costs				$ -		$ -	$ -
Right of Way Costs				$ -		$ -	$ -
TOTAL CAPITAL COST				***$ 51,274,980***			***$ 50,189,512***
COST CAPITAL SAVINGS / (VALUE ADDED)							**$ 1,085,468**

VE RECOMMENDATION NO. 2: USE A+B INCENTIVES	Idea No. 10

Baseline Concept

The baseline concept does not include incentives / disincentives for the contractor.

Recommendation Concept

Use A+B incentives and disincentives to accelerate construction time.

Advantages	Disadvantages
• May reduce construction duration • May reduce user delay costs • May reduce MOT costs	• May lead to quality issues • Will increase construction costs • May reduce the number of bidders

Cost Summary	Construction	User Delays	Time Savings	Total
Baseline Concept	$-	$13,377,000	$531,201	$13,908,201
Recommendation Concept	$225,000	$12,207,000	$-	$12,432,000
Cost Avoidance / (Added Value)	$(225,000)	$1,170,000	$531,201	$1,476,201

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
		✓	✓	

VE RECOMMENDATION NO. 2: USE A+B INCENTIVES	Idea No. 10

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

A+B bidding is a method that rewards a contractor for completing a project as quickly as possible. By providing a cost for each working day, the contract combines the cost to perform the work (A component) with the cost of the impact to the public (B component) to provide the lowest cost to the public. A+B bidding is a cost-plus-time bidding procedure.

Road User Cost for this Section of I-65 is as shown in the table below:

USER COST	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
	Monday		Tuesday		Wed		Thurs		Friday		Sat		Sun	
	USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)	
12-1 am	$210	$166	$0	$0	$273	$268	$0	$0	$332	$298	$355	$395	$0	$0
1-2 am	$198	$108	$0	$0	$227	$204	$0	$0	$277	$214	$307	$310	$0	$0
2-3 am	$211	$91	$0	$0	$208	$181	$0	$0	$245	$197	$210	$224	$0	$0
3-4 am	$209	$102	$0	$0	$233	$176	$0	$0	$260	$225	$195	$230	$0	$0
4-5 am	$385	$165	$0	$0	$420	$253	$0	$0	$409	$306	$265	$284	$0	$0
5-6 am	$716	$246	$0	$0	$778	$319	$0	$0	$736	$385	$374	$460	$0	$0
6-7 am	$1,029	$429	$0	$0	$1,175	$497	$0	$0	$1,106	$545	$425	$588	$0	$0
7-8 am	$1,081	$600	$0	$0	$1,122	$694	$0	$0	$1,116	$737	$518	$627	$0	$0
8-9 am	$915	$623	$0	$0	$995	$711	$0	$0	$996	$794	$680	$733	$0	$0
9-10 am	$895	$683	$0	$0	$987	$705	$0	$0	$1,094	$1,085	$892	$932	$0	$0
10-11 am	$994	$737	$0	$0	$1,025	$777	$0	$0	$1,169	$1,096	$1,086	$1,135	$0	$0
11-12 am	$1,045	$792	$0	$0	$1,103	$940	$0	$0	$1,326	$1,097	$1,219	$1,254	$0	$0
12-1 pm	$1,246	$882	$0	$0	$1,195	$893	$0	$0	$1,346	$1,366	$1,324	$1,231	$0	$0
1-2 pm	$1,383	$873	$0	$0	$1,243	$1,016	$0	$0	$1,388	$1,616	$1,277	$1,230	$0	$0
2-3 pm	$1,300	$1,033	$0	$0	$1,281	$1,137	$0	$0	$1,457	$1,648	$1,280	$1,149	$0	$0
3-4 pm	$1,336	$1,126	$0	$0	$1,447	$1,262	$0	$0	$1,517	$3,377	$1,326	$1,209	$0	$0
4-5 pm	$1,283	$1,288	$0	$0	$1,457	$1,361	$0	$0	$1,503	$3,546	$1,337	$1,132	$0	$0
5-6 pm	$1,313	$1,185	$0	$0	$1,550	$1,291	$0	$0	$1,456	$1,725	$1,316	$927	$0	$0
6-7 pm	$1,141	$816	$0	$0	$1,015	$979	$0	$0	$1,166	$1,433	$1,139	$843	$0	$0
7-8 pm	$797	$581	$0	$0	$638	$619	$0	$0	$872	$1,113	$996	$689	$0	$0
8-9 pm	$563	$553	$0	$0	$947	$613	$0	$0	$754	$1,010	$878	$622	$0	$0
9-10 pm	$501	$418	$0	$0	$589	$546	$0	$0	$676	$808	$749	$561	$0	$0
10-11 pm	$411	$341	$0	$0	$464	$446	$0	$0	$677	$651	$586	$516	$0	$0
11-12 pm	$391	$239	$0	$0	$365	$425	$0	$0	$495	$525	$509	$369	$0	$0
TOTAL	$19,555	$14,078	$0	$0	$20,735	$16,316	$0	$0	$22,374	$25,795	$19,246	$17,649	$0	$0

The average user cost per day based on the information in the table (provided by KYTC) is $38,937.

Assumptions/Calculations

Assumptions are based on a previously used KYTC Special Note for A+B bidding.

Assume $39,000 for the average daily user benefit. The bidder shall establish the number of calendar days necessary to complete the work in accordance with the plans and specifications and show this number in the bid proposal. The product of this number of calendar days multiplied by the average daily user benefit of $39,000 per day shall be added to the total bid determined for bid items. The product of calendar days times the average daily road user benefit shall not be considered in determining mobilization and demobilization costs.

The maximum number of calendar days permitted for completion of work will be determined by KYTC.

Each bid submitted shall consist of two parts:

A. The dollar amount for all work to be performed under the contract.

B. The total number of calendar days required for lane closures.

The lowest bid will be determined by the Department as the lowest combination of (A) and (B) according to the following formula:

(A) + [(B) x ($39,000)]

The value $39,000 per calendar day is the stipulated adjustment of road user benefit/cost. The above formula shall be used only for determination of the lowest bidder and shall not be used to determine the final payment to the contractor when the project is completed.

VE RECOMMENDATION NO. 2: USE A+B INCENTIVES	Idea No. 10

On a similar project for a bridge construction in Butler County, when A+B method was used, the project had $25,000 in user delay costs, and a corresponding $5,000/day incentive for early completion. Following this model and using proportional values, the contractor would be paid an incentive of $7,500 for each calendar day the project is completed before the established completion date based on the "B" value of the bid. The incentive shall not exceed $500,000 in total.

A disincentive fee of $39,000 per calendar day will be charged for each calendar day when the number of calendar days exceeds the number of calendar days "B" established for the selection of the lowest bidder.

In summary, assuming a schedule reduction of 1 month (30 days), the total savings are:

User Delay costs:

- Baseline: $39,000 * 343 days = $13,377,000
- Recommended: $13,377,000 - $39,000 * 30 days = $12,207,000
- UDC Savings: $1,170,000

Incentive Costs:

- Baseline: $0
- Recommended: $7,500 * 30 days = $225,000
- Added Value: $225,000

In addition, the cost of overhead and escalation avoidance calculations are shown below:

	Baseline Concept						
SCHEDULE IMPACTS	Start Date	Construction Duration (months)	Finish Date	Amount	Contracting Method	Overhead/Mo (PE, CN, CEI)	Inflationary Value
Construction	6/1/2023	15.40	9/8/2024	$ 51,738,954	Design Bid Build	$ 268,774	$ 2,750,000
CEI	6/1/2023		10/8/2024	$ 3,104,337		$ 12,095	$ 165,000

	Recommended Concept		
SCHEDULE IMPACTS	Time Savings (Mo)	OVH Savings	Inflationary Savings
Construction	1.0	$ 268,774	$ 128,000
CEI	1.0	$ 12,095	$ 165,000

Inflationary Calculations					
i(%)	Escalation Multiplier	Base Escalating Period	Days/Mo	Escalation Multiplier	Recom. Escalating
5.7%	1.0532	11.0	30.25	1.0507	10.51

Total Savings (YOE)	**$ 573,869**
Total Savings (PDC)	**$ 531,201**

VE RECOMMENDATION NO. 3: USE BREAK & SEAT IN SELECT AREAS	Idea No(s). 1

Baseline Concept

The baseline concept shows a full reconstruction of pavement for the entire length of the project.

Recommendation Concept

Use a break and seat method on already stabilized sub-base sections from MP 104.7 through 106.5.

Advantages	Disadvantages
• Won't have to haul off removed pavement • May reduce construction cost • Reduces construction duration	• Reflective cracking if not broken correctly • Hidden subgrade issues could reflect to surface • Concerns with longevity • Reconstruct at overpasses for vertical clearance • More CSB under shoulders • Will need to raise median cable barriers

Cost Summary	Construction	User Delays	Time Savings	Total
Baseline Concept	$43,109,969	$13,377,000	$531,201	$57,018,170
Recommendation Concept	$38,880,523	$12,207,000	$-	$51,087,523
Cost Avoidance/(Added Value)	$4,229,446	$1,170,000	$531,201	$5,930,647

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
		✓	✓	

VE RECOMMENDATION NO. 3: USE BREAK & SEAT IN SELECT AREAS	Idea No(s). 1

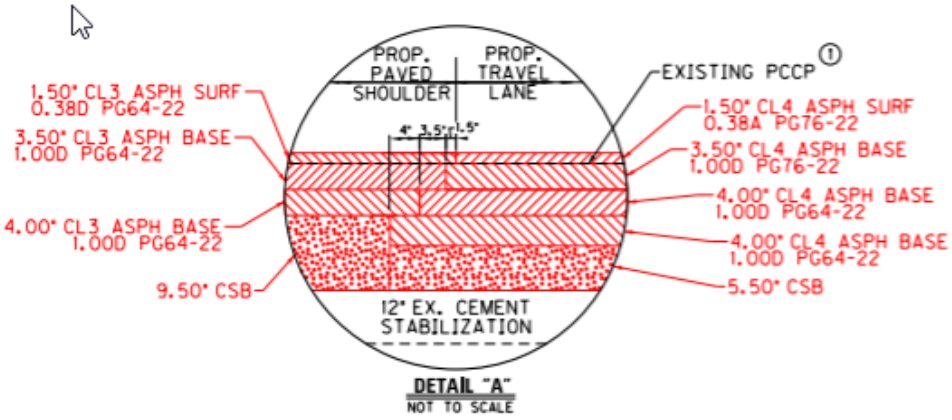
Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

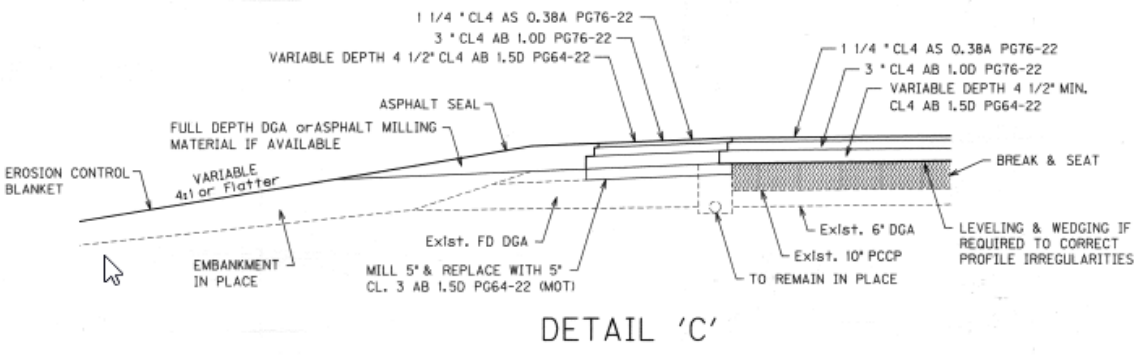
The feasibility of performing a break and seat treatment on the existing concrete pavement where the subgrade has already been chemically stabilized was explored in lieu of excavating all the existing pavement structure and replacing with a full depth pavement design. The section in question is from mile point 104.7 to 106.5, approximately 1.7 miles in length. The cable rail system in the median will have to removed and reinstalled after the completion of the new pavement.

The break and seat treatment quantities were estimated using an example typical treatment and pavement design from a previous section of I-65 that was completed in 2008 in District 3 south of this project. The original project typical and the example typical from the District 3 project are shown below.

Original Proposed Typical Section



Example Proposed Break & Seat Typical Section



VE RECOMMENDATION NO. 3: USE BREAK & SEAT IN SELECT AREAS	Idea No(s). 1

Assumptions/Calculations

Cost savings were calculated in the table below.

VE Study Cost Calculations

KYTC - I-65 Bullitt Co

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Remove PCC Pavement	SQYD	400,333	$ 8.00	$ 3,202,664	340,898	$ 8.00	$ 2,727,187
Crushed Stone Base	Ton	495751	$ 32.00	$ 15,864,032	462839	$ 32.00	$ 14,810,848
Cl. 4 Asphalt Base PG 64-22	Ton	114587	$ 100.00	$ 11,458,700	88886	$ 100.00	$ 8,888,596
Cl. 4 Asphalt Base PG 76-22	Ton	49682	$ 95.00	$ 4,719,790	49682	$ 95.00	$ 4,719,790
Break & Seat Pavement	SQYD	0		$ -	59435	$ 0.74	$ 43,982
Remove Cable Barrier	LF	0		$ -	9504	$ 7.72	$ 73,371
Reinstall Cable Barrier	LF	0		$ -	9504	$ 53.32	$ 506,753
Remove Cable Barrier Term Section	Each	0		$ -	2	$ 1,342.00	$ 2,684
Install Cable Barier Term Section	Each	0		$ -	2	$ 7,065.00	$ 14,130
		0		$ -			$ -
		0		$ -			$ -
		0		$ -			$ -
				$ -		$ -	$ -
Subtotal Construction				*$ 35,245,186*			*$ 31,787,341*
Mark-Up (MOT, Mob., Contingency)	22%			$ 7,864,783			$ 7,093,182
Total Construction				**$ 43,109,969**			**$ 38,880,523**
Utility Costs				$ -		$ -	$ -
Right of Way Costs				$ -		$ -	$ -
TOTAL CAPITAL COST				***$ 43,109,969***			***$ 38,880,523***
COST CAPITAL SAVINGS / (VALUE ADDED)							**$ 4,229,446**

In addition, it's estimated that this method would save time on the schedule. Assuming a schedule reduction of 1 month (30 days), the total savings are:

Road User Cost for this Section of I-65 is as shown in the table below:

USER COST	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
	Monday		Tuesday		Wed		Thurs		Friday		Sat		Sun	
	USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)	
12-1 am	$210	$166	$0	$0	$273	$268	$0	$0	$332	$298	$355	$395	$0	$0
1-2 am	$198	$108	$0	$0	$227	$204	$0	$0	$277	$214	$307	$310	$0	$0
2-3 am	$211	$91	$0	$0	$208	$181	$0	$0	$245	$197	$210	$224	$0	$0
3-4 am	$209	$102	$0	$0	$233	$176	$0	$0	$260	$225	$195	$230	$0	$0
4-5 am	$385	$165	$0	$0	$420	$253	$0	$0	$409	$306	$265	$284	$0	$0
5-6 am	$716	$246	$0	$0	$778	$319	$0	$0	$736	$385	$374	$460	$0	$0
6-7 am	$1,029	$429	$0	$0	$1,175	$497	$0	$0	$1,106	$545	$425	$588	$0	$0
7-8 am	$1,081	$600	$0	$0	$1,122	$694	$0	$0	$1,116	$737	$518	$627	$0	$0
8-9 am	$915	$623	$0	$0	$995	$711	$0	$0	$996	$794	$680	$733	$0	$0
9-10 am	$895	$683	$0	$0	$987	$705	$0	$0	$1,094	$1,085	$892	$932	$0	$0
10-11 am	$994	$737	$0	$0	$1,025	$777	$0	$0	$1,169	$1,096	$1,086	$1,135	$0	$0
11-12 am	$1,045	$792	$0	$0	$1,103	$940	$0	$0	$1,326	$1,097	$1,219	$1,254	$0	$0
12-1 pm	$1,246	$882	$0	$0	$1,195	$893	$0	$0	$1,346	$1,366	$1,324	$1,231	$0	$0
1-2 pm	$1,383	$873	$0	$0	$1,243	$1,016	$0	$0	$1,388	$1,616	$1,277	$1,230	$0	$0
2-3 pm	$1,300	$1,033	$0	$0	$1,281	$1,137	$0	$0	$1,457	$1,648	$1,280	$1,149	$0	$0
3-4 pm	$1,336	$1,126	$0	$0	$1,447	$1,262	$0	$0	$1,517	$3,377	$1,326	$1,209	$0	$0
4-5 pm	$1,283	$1,288	$0	$0	$1,457	$1,361	$0	$0	$1,503	$3,546	$1,337	$1,132	$0	$0
5-6 pm	$1,313	$1,185	$0	$0	$1,550	$1,291	$0	$0	$1,456	$1,725	$1,316	$927	$0	$0
6-7 pm	$1,141	$816	$0	$0	$1,015	$979	$0	$0	$1,166	$1,433	$1,139	$843	$0	$0
7-8 pm	$797	$581	$0	$0	$638	$619	$0	$0	$872	$1,113	$996	$689	$0	$0
8-9 pm	$563	$553	$0	$0	$947	$613	$0	$0	$754	$1,010	$878	$622	$0	$0
9-10 pm	$501	$418	$0	$0	$589	$546	$0	$0	$676	$808	$749	$561	$0	$0
10-11 pm	$411	$341	$0	$0	$464	$446	$0	$0	$677	$651	$586	$516	$0	$0
11-12 pm	$391	$239	$0	$0	$365	$425	$0	$0	$495	$525	$509	$369	$0	$0
TOTAL	$19,555	$14,078	$0	$0	$20,735	$16,316	$0	$0	$22,374	$25,795	$19,246	$17,649	$0	$0

The average user cost per day based on the information in the table (provided by KYTC) is $38,937.

VE RECOMMENDATION NO. 3: USE BREAK & SEAT IN SELECT AREAS	Idea No(s). 1

- Baseline: $39,000 * 343 days = $13,377,000
- Recommended: $13,377,000 - $39,000 * 30 days = $12,207,000
- UDC Savings: $1,170,000

In addition, the cost of overhead and escalation avoidance calculations are shown below:

	Baseline Concept						
SCHEDULE IMPACTS	Start Date	Construction Duration (months)	Finish Date	Amount	Contracting Method	Overhead/Mo (PE, CN, CEI)	Inflationary Value
Construction	6/1/2023	15.40	9/8/2024	$ 51,738,954	Design Bid Build	$ 268,774	$ 2,750,000
CEI	6/1/2023		10/8/2024	$ 3,104,337		$ 12,095	$ 165,000

	Recommended Concept		
SCHEDULE IMPACTS	Time Savings (Mo)	OVH Savings	Inflationary Savings
Construction	1.0	$ 268,774	$ 128,000
CEI	1.0	$ 12,095	$ 165,000

Inflationary Calculations					
i(%)	Escalation Multiplier	Base Escalating Period	Days/Mo	Escalation Multiplier	Recom. Escalating
5.7%	1.0532	11.0	30.25	1.0507	10.51

Total Savings (YOE)	**$ 573,869**
Total Savings (PDC)	**$ 531,201**

VE RECOMMENDATION NO. 4: USE A DRAINAGE BLANKET	Idea No(s). 15

Baseline Concept

The project uses a crushed stone base layer that is daylighted out to the median and outside shoulder as pavement drainage.

Recommendation Concept

As an alternative to the crushed stone base layer this concept recommends the use of an asphalt drainage blanket over DGA to drain the pavement.

Advantages	Disadvantages
• Improved subsurface drainage removal • Improves durability of roadbed • Reduced risk of failure in future	• May require a change in setup at asphalt plant • May impact median cable barrier • Pavement design thickness may be different and require additional excavation • Bridge clearances would need to be confirmed • Initial construction cost is higher than baseline

Cost Summary	Capital Cost	Right-of-way Cost	Total Cost
Baseline Concept	$39,192,647		$39,192,647
Recommendation Concept	$41,578,448		$41,578,448
Cost Avoidance/(Added Value)	$(2,385,801)		$(2,385,801)

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
	✓			

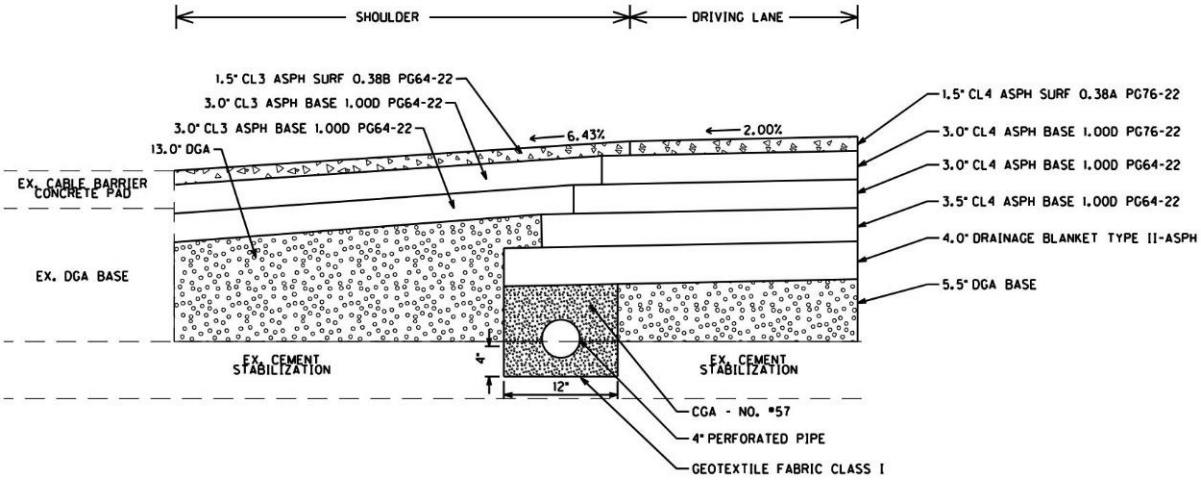
VE RECOMMENDATION NO. 4: USE A DRAINAGE BLANKET	Idea No(s). 15

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

In an effort to more effectively drain the new pavement, this idea uses an asphalt drainage blanket (Drainage Blanket Type II – Asphalt). The use of this drainage blanket would require the project to switch from using crushed stone base to using dense graded aggregate. Longitudinal edge drains would also be needed to carry water that infiltrated the drainage blanket to perforated pipe headwalls.

I-65 Drainage Blanket Pavement Detail



This concept would raise the asphalt grade to 3.5 inches above existing grade, which is 2 inches more than the baseline proposed raise in grade of 1.5 inches. Bridge clearances would need to be checked for minimum clearance compliance and cross-slopes to the cable median barrier checked to see if these could remain in place. Shoulder cross slope in a normal section would steepen to approximately 6.43% from the 5.25% baseline.

Using the drainage blanket changes the asphalt base thicknesses needed, as shown below in the pavement design output. Adding 4 inches of Type II Asphalt Drainage banket allows the CL 4 Asphalt Base layers to be reduced in thickness by 2 inches (3.0, 3.0, 3.5).

VE RECOMMENDATION NO. 4: USE A DRAINAGE BLANKET	Idea No(s). 15

Title & Info. | Subgrade | AC | PCC | Cost Analysis | Attachments | Design Selection & Notes

Section Description: Route: I-65; Bullitt County;
Analysis Date: 2023-02-20

Structural Design Inputs:

Design CBR | Design MR: 20000 | AADTT: 17500

Pavement Structural Design from Design Catalog:

Total minimum Asphalt thickness are 6.7

Required total AC Thickness on 5.5 inches of aggregate base: 11.18 in. Credit from Drainage Blanket is 2 inches.

Driving Lane Material Selection

	Thickness	Item Code	Description
Surface:	1.5	00342	CL4 ASPH SURF 0.38A PG76-22
Base:			Polish-resistant type A is correct.
Layer 1:	3	00219	CL4 ASPH BASE 1.00D PG76-22
Layer 2:	3	00217	CL4 ASPH BASE 1.00D PG64-22
Layer 3:	3.5	00217	CL4 ASPH BASE 1.00D PG64-22
Drain. Blanket:	4	00018	DRAINAGE BLANKET-TYPE II-ASPH
Aggr. Base:	5.5	00001	DGA BASE
Stab. Roadbed:	0	0	None

More AC Item

Shoulder Material Selection

Thickness	Item Code	Description
1.5	00388	CL3 ASPH SURF 0.38B PG64-22
3	00214	CL3 ASPH BASE 1.00D PG64-22
3	00214	CL3 ASPH BASE 1.00D PG64-22
0	0	None
0	0	None
13	00001	DGA BASE
0	0	None

VE RECOMMENDATION NO. 4: USE A DRAINAGE BLANKET	Idea No(s). 15

Assumptions/Calculations

VE Study Cost Calculations

KYTC - I-65 Bullitt Co

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Crushed Stone Base	TON	495751	$ 32.00	$ 15,864,032		$ 32.00	$ -
Dense Gradded Aggregate	TON				520950	$ 36.46	$ 18,993,837
Cl. 4 Asphalt Base PG 64-22	TON	114587	$ 100.00	$ 11,458,700	85836	$ 100.00	$ 8,583,600
Cl. 4 Asphalt Base PG 76-22	TON	49682	$ 95.00	$ 4,719,790	42664	$ 95.00	$ 4,053,080
Drainage Blanket Type II - Asphalt	TON			$ -	53269	$ 0.74	$ 39,419
Perforated Pipe	LF			$ -	126720	$ 14.67	$ 1,858,982
Non-Perforated Pipe	LF			$ -	2112	$ 21.41	$ 45,218
Perforated Pipe Headwall	EA			$ -	422	$ 893.71	$ 377,146
Crushed Aggregate #2	Ton			$ -	422	$ 67.03	$ 28,287
Inspect & Certify Edge Drain System	LS			$ -	1	$ 13,500.00	$ 13,500
				$ -		$ -	$ -
Subtotal Construction				*$ 32,042,522*			*$ 33,993,069*
Mark-Up (MOT, Mob., PE, CEI)	22%			$ 7,150,125			$ 7,585,379
Total Construction				**$ 39,192,647**			**$ 41,578,448**
Utility Costs				$ -		$ -	$ -
Right of Way Costs				$ -		$ -	$ -
TOTAL CAPITAL COST				***$ 39,192,647***			***$ 41,578,448***
COST CAPITAL SAVINGS / (VALUE ADDED)							**$ (2,385,801)**

7.4 Design Considerations

The VE team generated the following design suggestions for the project design team's consideration. These items represent ideas that are general in nature and are listed below in Table 9. Design Considerations . Additional details can be found in the evaluation form in Section 6.

Table 9. Design Considerations

Idea No.	Description
8	Eliminate geotextile bond breaker
13	Lower contingency level to 5-10% and/or identify specific risks that lead to a much higher contingency
14	Take a more in-depth look at the CSB and asphalt unit bid prices and adjust to current bid levels
17	Break the deconstruction and grading phase into two sections to be worked on simultaneously (two deconstruction and earthwork crews)
18	Break the pavement operations up into two simultaneous operations.
19	Include rock and fabric in estimate to account for extra areas found in the field that need stabilization

VE DESIGN CONSIDERATION NO. 1: RECYCLE CONCRETE PAVEMENT	Idea No(s). 11, 12

Baseline Concept

The baseline concept assumes that the contractor will haul and dispose of concrete and base materials

Recommendation Concept

The VE team suggests to stockpile the removed pavement in a preselected nearby location (contractor retains) for later disposal. If interest and need warrants it, KYTC maintenace crews can use the stockpiled pavement for maintenance purposes (KYTC retains)

Advantages	Disadvantages
• Save money in hauling operations • Recycle material may reduce demand on environment and resource • Reduce overall cost of project • Reduces cost of maintenance materials for other locations • May reduce disposal cost by contractor	• Requires KYTC to find location or use right-of-way • May require environmental permit • May require FHWA approval • May delay letting • District 5 may not have staffing to handle disposal and cleanup • May tie up maintenance crews longer than anticipated

Cost Summary	Construction Cost	Right-of-way Cost	Total Cost
Baseline Concept			
Recommendation Concept			
Cost Avoidance/(Added Value)			

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
	✓	✓		

VE DESIGN CONSIDERATION NO. 1: RECYCLE CONCRETE PAVEMENT	Idea No(s). 11, 12

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Stockpile removed pavement in a preselected nearby location (contractor retains) - The objective of this recommendation is to potentially lower the unit cost of the Remove PCC Pavement bid item by providing an area off of right-of-way for removed pavement to be stockpiled. The contractor would retain ownersip of this removed material for crushing and reuse on private projects. The cost to haul the removed material could potentially be lowered. This stockpiled pavement would be used by the contractor on other projects at a future date.

KYTC Maintenance crews can use the stockpiled pavement for maintenance purposes (KYTC retains) – The objective of this recommendation is to potentially lower the unit cost of the Remove PCC Pavement bid item by providing an area on right-of-way for removed pavement to be stockpiled. KYTC would retain ownership of this stockpiled material. The cost to haul the removed material could potentially be lowered. This stockpiled pavement would be used by KYTC maintenance forces at a future date. KYTC would crush the removed pavement to a size suitable for maintenace purposes, such as #23 stone, CLII Channel Lining, DGA.

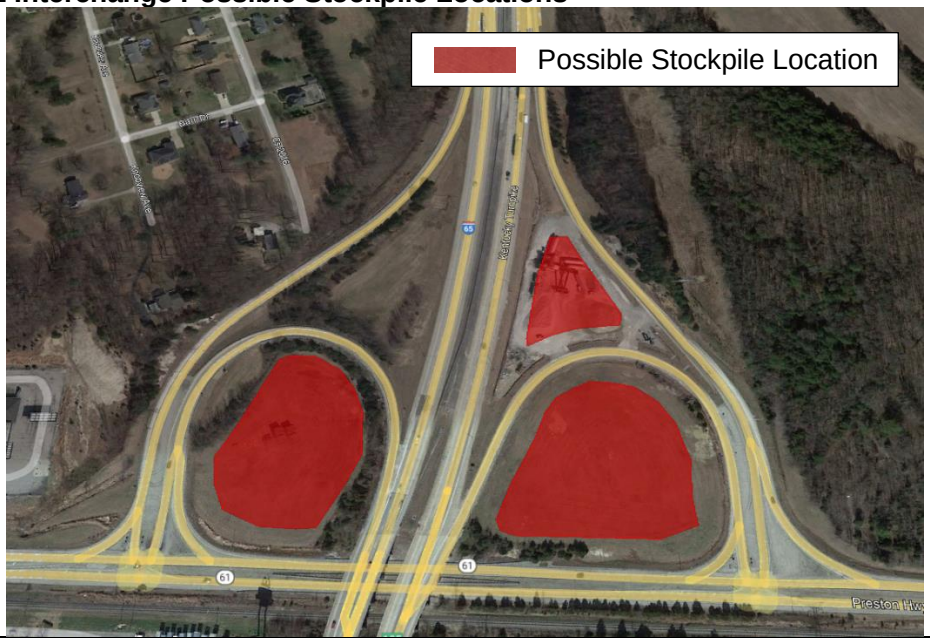
Locations in interchange gore areas were selected where access from ramps was available. The stockpile area was located at least 60 feet away from driving lanes as to not create a roadside hazard or restrict sight distance.

Three sites were identified as possible stockpile locations on right-of-way.

- I-65 / KY 61 interchange – south end of project area
- I-65 / KY 313 (Joe Prather Highway) – approximatly 2.0 miles south of project area
- I-65 / KY 3538 (Ohm Drive) – approximatly 3.6 miles north of project area

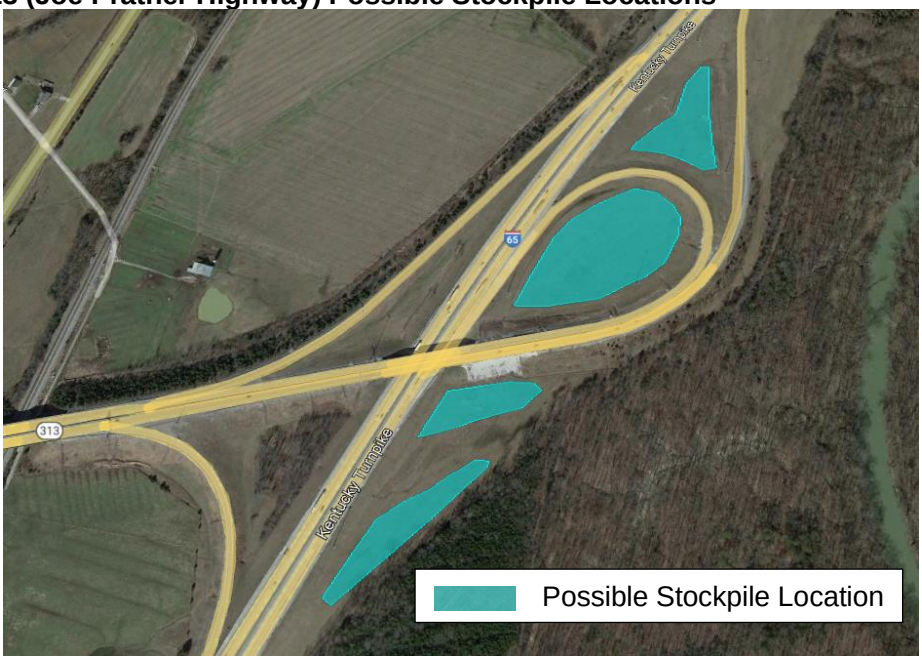
The KY 245 inerchange gore was not selected as a possible stockpile site due to existing landscaping in the interchange and this is considered as the “Gateway to the Bourbon Trail”.

I-65 / KY 61 Interchange Possible Stockpile Locations



VE DESIGN CONSIDERATION NO. 1: RECYCLE CONCRETE PAVEMENT	Idea No(s). 11, 12

I-65 / KY 313 (Joe Prather Highway) Possible Stockpile Locations



I-65 / KY 3538 (Ohm Drive) Possible Stockpile Location

VE DESIGN CONSIDERATION NO. 1: RECYCLE CONCRETE PAVEMENT	Idea No(s). 11, 12

Concrete Crushing Operation and Machinery

Assumptions/Calculations

Stockpile removed pavement in a preselected nearby location (contractor retains) - Contractor would make agreements with property owners or use nearby property that they own for stockpile locations. They would then set up a crushing operation for use on other projects. The contractor would not want to have this material placed within the project limits since, that would require them to pay their personnel scale wages to crush material that would not be used for this project. Any savings for this scenario would be hard to quantify since the haul location is not know and would be up to the contractor. It would also be nearly impossible to calculate how much the finished crushed material would cost the contractor to produce since the labor and equipment cost are not known.

KYTC Maintenance crews can use the stockpiled pavement for maintenance purposes (KYTC retains) – Assumptions:

- KYTC District 5 maintenance forces have a need for the removed concrete pavement material to use as aggregate, channel lining, etc.
- District 5 has the staffing to crush the material to a usable size.
- The size of locations on right-of-way are large enough to store and process the removed pavement.

In evaluating this recommendation, it was found that District 5 does not have a need for the quantity of material that this operation would generate. It was also found that District 5 does not have the maintenance staff required to dedicate to this operation. After reviewing a project in District 1 where this was done, it appears that there would be a need for one large location to store and process the removed pavement. The areas identified would not be large enough to accommodate this scale of operation.

VE DESIGN CONSIDERATION NO. 1: RECYCLE CONCRETE PAVEMENT	Idea No(s). 11, 12

For these reasons, no further efforts were put into developing cost comparisons for this recommendation. However, KYTC should evaluate the value of this opportunity for other locations, quantities or other purposes and needs.

Appendix A

Value Methodology Process

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Appendix A. Value Methodology Process

Value Methodology is a systematic process using a multidisciplinary team to improve the value of a project through the analysis of its functions. This process incorporates, to the extent possible, the values of design, construction, maintenance, contractor, state, local, and federal approval agencies, other stakeholders, and the public.

The primary objective of a Value Engineering (VE) study is value improvement. Value improvements might relate to scope definition, functional design, constructability, coordination (both internal and external), or the schedule for project development. Other possible value improvements are reduced environmental impacts, reduced public (traffic) inconvenience, or reduced project cost.

The VE team employed the eight-phase Value Methodology in analyzing the project. This process is recommended by SAVE International® and is composed of the following phases:

Preparation

Prior to the start of a VE study, the Project Manager, and the VE facilitator carry out the following activities:

- Initiate study – Identify study project and define study goals
- Organize study – Conduct pre-VE study meeting and select team members
- Prepare data – Collect and distribute data and prepare cost models.
- All the information gathered prior to the VE study is given to the team members for their use.

The following phases are typically conducted during the Workshop:

Information – The team reviews and defines the current conditions of the project and identifies the goals of the study.

Function Analysis – The team defines the project functions using a two-word active verb/ measurable noun context. The team reviews and analyzes these functions to determine which need improvement, elimination, or creation to meet the project's goals.

Creativity – The team employs creative techniques to identify other ways to perform the project's function(s).

Evaluation – The team follows a structured evaluation process to select those ideas that offer the potential for value improvement while delivering the project's function(s) and considering performance requirements and resource limits.

Development – The team develops the selected ideas into alternatives (or proposals) with a sufficient level of documentation to allow decision makers to determine if the alternative should be implemented.

Presentation – The team facilitator develops a report and/or presentation that documents and conveys the adequacy of the alternative(s) developed by the team and the associated value improvement opportunity.

Implementation – After the workshop, those involved in the decision-making process will review the data given to them in the Presentation Phase and make a determination as to which recommendations are accepted.

Appendix B

VE Recommendation Approval Form

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Appendix B. VE Recommendation Approval Form

Project: I-65 from MP 104.7 to MP 110.7
VE Study Date: February 20-22, 2023

			FHWA Functional Benefit						
	Recommendation	**Approved Y/N**	**Safety**	**Operations**	**Environment**	**Construction**	**Right-of-Way**	**VE Team Estimated Construction Cost Avoidance or (Cost Added)**	**Actual Estimated Construction Cost Avoidance or Cost Added**
1	Revise Pavement Design			1		1		$1.09	
2	Use A+B Incentive/Disincentive				1	1		$8.96	
3	Use Break and Seat in Select Areas				1	1		$5.93	
4	Use a Drainage Blanket			1				($2.39)	
TOTALS				2	2	3		**Varies**	

.

Please provide justification if the value engineering study recommendations are **not** approved or are implemented in a modified form.

KYTC is required to report Value Engineering results annually to FHWA. To facilitate this reporting requirement, the Value Engineering Recommendation Approval Form is included herein. If the Cabinet elects to reject or modify a recommendation, please include a brief explanation of why.

_____ _____

Signature – Project Manager Date

_____

Name (please print)

FHWA Functional Benefit Criteria

Each year, State DOTs are required to report on VE recommendations to FHWA. In addition to cost implications, FHWA requires the DOTs to evaluate each approved recommendation in terms of the project feature or features that recommendation benefits. If a specific recommendation can be shown to provide benefit to more than one feature described below, count the recommendation in *each category that is applicable*.

Safety: Recommendations that mitigate or reduce hazards on the facility.

Operations: Recommendations that improve real-time service and/or local, corridor, or regional levels of service of the facility.

Environment: Recommendations that successfully avoid or mitigate impacts to natural and/or cultural resources.

Construction: Recommendations that improve work zone conditions or expedite the project delivery.

Right-of-Way: Recommendations that lower the impacts or costs of right-of-way.

Appendix C

VE Study Memo, Agenda, and Attendees

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Appendix C. VE Study Memo, Agenda and Attendees

Memo

Date:	Tuesday, February 14, 2023
Project:	I-65 – Pavement Rehabilitation – MP 104.700 – 110.700
To:	VE Team Members
From:	Jose Theiler, PE, CVS®
Subject:	Value Engineering Study

Congratulations!!! You have been chosen to participate in this Value Engineering (VE) study because of your expertise and valuable contributions to the project.

This memo is to introduce some of the expectations for the upcoming VE study. I'm looking forward to working with you on this endeavor. My hope is that this memo will provide information about the project and expectations on working together.

If you have any questions, please contact me, Jose Theiler, at 561-386-3879 (cell), or e-mail: jose.theiler@hdrinc.com.

VE Study Dates and Location

The VE study will be held virtually on Monday, February 20, 2023 through Monday, February 20, 2023 using Microsoft Teams as follows:

Microsoft Teams meeting
Join on your computer, mobile app or room device
Click here to join the meeting
Meeting ID: 238 225 725 435
Passcode: oAAais
Download Teams | Join on the web
Or call in (audio only)
+1 402-513-9026,,382316000# United States, Omaha
(833) 255-2803,,382316000# United States (Toll-free)
Phone Conference ID: 382 316 000#
Find a local number | Reset PIN
Learn More | Meeting options

What to Bring

Be sure to bring your normal tools of the trade (e.g., calculator, laptop computer, scale, etc.). Bring a creative and open mind. VE studies are a lot of work, but if you bring your creativity and sense of humor you will have a good time and a rewarding experience.

Ground Rules

1. A VE study follows a prescribed process that has been proven over many years to produce the best results. This process requires the team members be fully engaged and have an open mind to "step" outside of the box throughout the week.

2. To maintain our schedule and provide the best results to the project team, I ask that we follow some basic ground rules:
    a. Virtual Meetings Guidelines: The meeting invitation includes a Virtual Meeting Ground Rules to help with the difficulties of virtual meetings; please follow these guidelines.
    b. We will use Microsoft Teams as a holding place for conversations, notes, documentation, etc. Follow the link [insert link to document location] to make sure you have access and become familiar with the site.
    c. Please be prepared to attend the entire duration of the workshop. You were selected to assist on this team based on your expertise. If you cannot be in attendance for the entire time, then please notify me prior to the study. When team members leave part way through, or come and go frequently, the VE team can lose its momentum and cohesiveness. We understand that conducting business virtually is different and typical interruptions or noise background is expected at times. Please minimize disruptions by muting your phone or asking for a break.
    d. Avoid multitasking during the study. Unless it is information to assist the team, please try to wait until breaks to return phone calls, check on messages, or sort through e-mails.
    e. Dress code. I want everyone to be comfortable. Some of us will attend from our homes; please dress appropriately (business casual).
    f. A laptop is required for the workshop. We will develop recommendations using templates in Word format and will exchange and share files throughout the workshop.
3. Our success will be evaluated based on the level of contribution that we bring to the project. Remember that the goal of any VE study is to add value to the project; saving money is just a byproduct. We want to make recommendations based on solid engineering judgment that will result in an improved project.

Value Engineering Job Plan

The VE team will employ the eight-phase VE job plan in analyzing the project. This process is recommended by SAVE International® and AASHTO, and is composed of the following phases:

Pre-study: - The VE coordinator and the Team Leader meet to discuss the project, the study scope, focus and reach, duration, team members and other logistics.

Information Phase – The objective of this phase is to obtain a thorough understanding of the project's design criteria and objectives by reviewing the project's documents and drawings, cost estimates, and schedules. Elements include:

- Overview of the VE process
- Understanding of study objectives
- Project Overview and Briefing by the Design team
    - Provide insight on project history, design concepts, environmental issues, etc.
    - Discuss any design concerns and new concepts involved with the project.
    - All appropriate project disciplines should be discussed.
    - Discuss/identify any risks or issues that the VE team should concentrate on.
    - Provide VE team with any specific project constraints.
    - Q&A – Presenters answers questions from the VE team.

- Risk Elicitation: I will conduct a brief risk elicitation session to identify and quantify the top 10 risks of the project. This information may provide an opportunity for the VE team to develop response strategies in the form of recommendations.

Function Analysis Phase – Identifying each of the key functions of the project is the most important phase of value engineering, as it is the basis for unlocking the creativity of team members. As part of this phase, the team performs the following tasks with the assistance of the VE Facilitator:

- Defines project and risk functions and assigns them to key project components.
- Classifies functions as either “basic” or “secondary.”
- Sequence functions to understand their relationships using the Function Analysis System Technique (FAST).
- Establishes performance measures.
- Creates the project’s cost model.

Brainstorming/Creative Phase – During this phase the team will employ creative techniques such as team brainstorming to develop a number of alternative concepts that satisfy the project’s basic and supporting functions, and mitigate project risks.

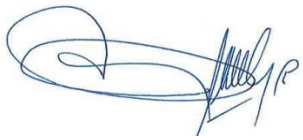
Evaluation Phase – The purpose of this phase is to evaluate the alternative concepts developed by the VE team during the brainstorming sessions. To that purpose, the team discusses advantages and disadvantages, and uses a number of tools to determine the qualitative and quantitative merits of each concept.

Development Phase – Those concepts that ranked highest in the evaluation are further developed into VE recommendations. Recommendation narratives, additional advantages and disadvantages, drawings, calculations, and life cycle cost analysis are prepared for each recommendation.

Presentation Phase – The VE team presents their finding during an oral presentation to the owner and the project team. Following the workshop, a written report is submitted that summarizes the study, its findings, and recommendations.

Implementation Phase –The KYTC stakeholders and decision makers review the report and proceeds to determine whether to accept or not each recommendation.

I’m looking forward to working with you on this VE study and I really appreciate each of you blocking time out of your busy schedules to participate. Please don’t hesitate to call or e-mail me if you have any questions.
Sincerely,



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M 561.386.3879
jose.theiler@hdrinc.com

Agenda

Day 1	Monday, February 20, 2023 Objective for the day: Learn about VE and the project	
8:00	**Connect to Microsoft Teams**	**All audiences** Project owner, PMs, designers, VE team
8:15 *Information Phase*	• **Roll call** • **Study kickoff** • **Review ground rules for virtual meetings** • **VE Process Overview:** an instructional presentation on the principles of value engineering and their application to the project	**All audiences facilitated by** Jose Theiler, PE, CVS
8:45 *Information Phase*	**Project Overview** • Purpose and need of the project • Goals and objectives of the project • Constraints • Basis of design • Virtual site visit • Questions and answers **Risk Elicitation** • Base Cost and Schedule Review • Identify and quantify top 10 risks that can impact project cost and schedule	**All audiences facilitated by** Project team/designer
10:30	**Break**	
10:40 *Function Analysis Phase*	Roll call **Function Analysis**	**VE team facilitated by** Jose Theiler, PE, CVS
12:00	**Lunch**	
1:00 *Creative Phase*	Roll call **brainstorming**	**VE team facilitated by** Jose Theiler, PE, CVS
3:00	**Break**	
3:10 *Evaluation Phase*	Roll call **Evaluate Ideas** • Discuss advantages and disadvantages for each idea • Score ideas based on predetermined criteria to develop further into recommendations	**VE team facilitated by** Jose Theiler, PE, CVS
4:10	**Break**	
4:15 *Evaluation Phase*	Roll call **Continue evaluating ideas**	**VE team facilitated by** Jose Theiler, PE, CVS
05:00	**Adjourn**	

Day 2	Tuesday, February 21, 2023 Objective for the day: Brainstorming Ideas and Evaluation	
8:00 *Evaluation Phase*	**Connect to Microsoft Teams** • Roll call • Day 1 recap • Continue evaluating ideas	**VE team facilitated by** Jose Theiler, PE, CVS
8:30	**Break**	

8:35
Development Phase
	Roll call
	Recommendation Assignments
	• Assignments of recommendations
	• Instructions to develop recommendations
	  ○ Cloud file system and procedure
	  ○ Check-ins
	• Walkthrough of templates
	  ○ Word document example
	  ○ Cost estimate and cost/time calculations
		VE team facilitated by
		Jose Theiler, PE, CVS

10:00
Development Phase
	Roll call
	Develop Ideas into Recommendations
	• Individual/team assignments
	• Development of recommendations
	  ○ Test design feasibility
	  ○ Design analysis
	  ○ Technical narratives
	  ○ Advantages and disadvantages
	• Cost analysis
		VE team facilitated by
		Jose Theiler, PE, CVS

12:00	**Lunch**	
1:00 – 5:00 *Development Phase*	**Continue Developing Recommendations** **Check-in Every Hour** • Technical Write-up • Graphics/Sketches • Cost estimates	**VE team facilitated by** Jose Theiler, PE, CVS
04:30	**Adjourn**	

Day 3	Wednesday, February 22, 2023 Objective for the day: Presentation of VE Findings	
8:00 *Development Phase*	**Connect to Microsoft Teams** Roll call	**VE team facilitated by** Jose Theiler, PE, CVS
08:15 *Development Phase*	**Wrap-up recommendations**	**VE team facilitated by** Jose Theiler, PE, CVS
9:45	**Break**	
10:05 *Development Phase*	Roll call **Peer review of recommendations**	**VE team facilitated by** Jose Theiler, PE, CVS
12:00	**Lunch**	
01:00 *Presentation Phase*	Roll call **Finalize Close-out Presentation** **Team Rehearsal**	**VE team facilitated by** Jose Theiler, PE, CVS
2:15	**Break**	

02:30 *Presentation Phase*	**Presentation of VE Findings** • Team presents recommendations to management • Questions and answers	**All audiences** Project owner, PMs, designers, VE team
	Adjourn	

VE Study Attendees
Kentucky Transportation Cabinet 5-222066.00

Feb 2023						
20	21	22	NAME	ORGANIZATION – POSITION/DISCIPLINE	EMAIL	PHONE
✓		✓	Garrison, Billy J.	WSP – Designer PM	Billy.Garrison@wsp.com	
✓	✓	✓	Gearlds, Kevin	HDR – Construction	Kevin.Gearlds@hdrinc.com	
✓		✓	Johannes, Andre A	KYTC	Andre.Johannes@ky.gov	
✓		✓	Mills, Ross B	KYTC PM	Ross.Mills@ky.gov	
✓			Otte, David W	KYTC – Quality Assurance	David.Otte@ky.gov	
✓	✓	✓	Stewart, Katy R	KYTC – Quality Assurance Manager	Katy.Stewart@ky.gov	
✓	✓	✓	Theiler, Jose	HDR – Value Engineer	Jose.Theiler@hdrinc.com	561.386.3879
✓	✓	✓	Thompson, Travis	HDR – Roadway	Travis.Alan.Thompson@hdrinc.com	
✓	✓	✓	Walker, Kevin	HDR - Geotechnical	Kevin.Walker@hdrinc.com	

Appendix D

Project Estimate

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Estimate I-65 ASPHALT

Estimated Cost:$54,038,041.21

Contingency: 10.00%

Estimated Total: $59,441,845.33

I-65 Pavement Rehab
05-22066 - Bullitt County
Asphalt Alternate

Base Date: 02/05/23

Spec Year: 08

Unit System: E

Work Type: ASPHALT PAVEMENT & ROADWAY REHAB

Highway Type: INTERSTATE

Urban/Rural Type: RURAL

Season: SPRING

County: BULLITT

Latitude of Midpoint: 0

Longitude of Midpoint: 0

District: 05

Federal Project Number:

State Project Number:

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
Group 0001: PAVING					
0005	00003 CRUSHED STONE BASE	495,751.00	TON	$32.00	$15,864,032.00
0006	00008 CEMENT STABILIZED ROADBED	137,984.00	SQYD	$3.38	$466,385.92
0007	00013 LIME STABILIZED ROADBED	137,984.00	SQYD	$3.38	$466,385.92
0008	00014 LIME	1,788.00	TON	$214.19	$382,971.72
0009	00100 ASPHALT SEAL AGGREGATE	841.00	TON	$105.00	$88,305.00
0010	00103 ASPHALT SEAL COAT	101.00	TON	$800.00	$80,800.00
0011	00214 CL3 ASPH BASE 1.00D PG64-22	57,411.00	TON	$95.00	$5,454,045.00
0012	00217 CL4 ASPH BASE 1.00D PG64-22	114,587.00	TON	$100.00	$11,458,700.00
0013	00219 CL4 ASPH BASE 1.00D PG76-22	49,682.00	TON	$95.00	$4,719,790.00
0014	00339 CL3 ASPH SURF 0.38D PG64-22	11,561.00	TON	$100.00	$1,156,100.00
0015	00342 CL4 ASPH SURF 0.38A PG76-22	20,811.00	TON	$130.00	$2,705,430.00
0016	00358 ASPHALT CURING SEAL	276.00	TON	$660.20	$182,215.20
0017	02542 CEMENT	2,682.00	TON	$215.16	$577,059.12
0018	02702 SAND FOR BLOTTER	345.00	TON	$30.56	$10,543.20
0019	02060 PCC PAVEMENT DIAMOND GRINDING	11,299.00	SQYD	$9.00	$101,691.00
0020	20071EC JOINT ADHESIVE	253,440.00	LF	$0.22	$55,756.80
0021	24891EC PAVE MOUNT INFRARED TEMP EQUIPMENT	9,280,670.00	SF	$0.02	$185,613.40

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
0022	24970EC ASPHALT MATERIAL FOR TACK NON-TRACKING	370.00	TON	$177.58	$65,704.60

Total for Group 0001:$44,021,528.88

Group 0002: ROADWAY

0026	00078 CRUSHED AGGREGATE SIZE NO 2	159.00	TON	$67.03	$10,657.77
0030	01982 DELINEATOR FOR GUARDRAIL MONO DIRECTIONAL WHITE	218.00	EACH	$11.17	$2,435.06
0031	01983 DELINEATOR FOR GUARDRAIL MONO DIRECTIONAL YELLOW	21.00	EACH	$11.99	$251.79
0032	01985 DELINEATOR FOR BARRIER - YELLOW	748.00	EACH	$13.04	$9,753.92
0033	02003 RELOCATE TEMP CONC BARRIER	31,680.00	LF	$7.49	$237,283.20
0034	02058 REMOVE PCC PAVEMENT	400,333.00	SQYD	$8.00	$3,202,664.00
0035	02351 GUARDRAIL-STEEL W BEAM-S FACE	5,377.00	LF	$32.16	$172,924.32
0036	02367 GUARDRAIL END TREATMENT TYPE 1	10.00	EACH	$3,286.29	$32,862.90
0037	02369 GUARDRAIL END TREATMENT TYPE 2A	11.00	EACH	$987.54	$10,862.94
0038	02381 REMOVE GUARDRAIL	6,377.00	LF	$1.88	$11,988.76
0039	02483 CHANNEL LINING CLASS II	6.00	TON	$101.09	$606.54
0040	02562 TEMPORARY SIGNS	2,000.00	SQFT	$7.81	$15,620.00
0041	02575 DITCHING AND SHOULDERING	28,440.00	LF	$4.37	$124,282.80
0042	02650 MAINTAIN & CONTROL TRAFFIC	1.00	LS	$500,000.00	$500,000.00
0043	02655 CROSSOVER	4.00	LS	$75,000.00	$300,000.00

Line #	Item Number	Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
0044	02696	SHOULDER RUMBLE STRIPS	121,769.00	LF	$0.10	$12,176.90
0045	02726	STAKING	1.00	LS	$150,000.00	$150,000.00
0050	02775	ARROW PANEL	4.00	EACH	$1,213.06	$4,852.24
0052	03171	CONCRETE BARRIER WALL TYPE 9T	31,680.00	LF	$21.86	$692,524.80
0055	05950	EROSION CONTROL BLANKET	22,000.00	SQYD	$1.65	$36,300.00
0056	06401	FLEXIBLE DELINEATOR POST-M/W	670.00	EACH	$45.64	$30,578.80
0057	06404	FLEXIBLE DELINEATOR POST-M/Y	64.00	EACH	$49.21	$3,149.44
0058	06407	SBM ALUM SHEET SIGNS .125 IN	32.00	SQFT	$35.51	$1,136.32
0059	06410	STEEL POST TYPE 1	56.00	LF	$27.47	$1,538.32
0060	06511	PAVE STRIPING-TEMP PAINT-6 IN	150,000.00	LF	$0.25	$37,500.00
0061	06542	PAVE STRIPING-THERMO-6 IN W	99,519.00	LF	$1.07	$106,485.33
0062	06543	PAVE STRIPING-THERMO-6 IN Y	69,556.00	LF	$1.02	$70,947.12
0063	06546	PAVE STRIPING-THERMO-12 IN W	2,380.00	LF	$3.72	$8,853.60
0064	06549	PAVE STRIPING-TEMP REM TAPE-B	2,500.00	LF	$1.95	$4,875.00
0065	06550	PAVE STRIPING-TEMP REM TAPE-W	1,750.00	LF	$2.20	$3,850.00
0066	06551	PAVE STRIPING-TEMP REM TAPE-Y	1,750.00	LF	$1.68	$2,940.00
0067	06568	PAVE MARKING-THERMO STOP BAR-24IN	126.00	LF	$13.22	$1,665.72
0068	06574		48.00	EACH	$131.27	$6,300.96

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
	PAVE MARKING-THERMO CURV ARROW				
0069	06613 INLAID PAVEMENT MARKER-B W/R	1,513.00	EACH	$24.23	$36,659.99
0070	06614 INLAID PAVEMENT MARKER-B Y/R	79.00	EACH	$24.78	$1,957.62
0071	10020NS FUEL ADJUSTMENT	524,544.00	DOLL	$1.00	$524,544.00
0072	10030NS ASPHALT ADJUSTMENT	978,854.00	DOLL	$1.00	$978,854.00
0073	20071EC JOINT ADHESIVE	231,000.00	LF	$0.22	$50,820.00
0074	20191ED OBJECT MARKER TY 3	10.00	EACH	$58.16	$581.60
0078	20411ED LAW ENFORCEMENT OFFICER	300.00	HOUR	$73.19	$21,957.00
0086	25075EC QUEUE PROTECTION VEHICLE	500.00	HOUR	$95.37	$47,685.00
0087	25117EC FURNISH QUEUE PROTECTION VEHICLES	16.00	MONT	$5,134.23	$82,147.68
0088	26136EC PORTABLE QUEUE WARNING ALERT SYSTEM	16.00	MONT	$4,074.25	$65,188.00
0089	26137EC QUEUE WARNING PCMS	64.00	MONT	$6.95	$444.80
0090	26138EC QUEUE WARNING PORTABLE RADAR SENSORS	64.00	MONT	$5.25	$336.00

Total for Group 0002:$7,619,044.24

Group 0003: TRAFFIC COUNTER

0093	04793 CONDUIT-1 1/4 IN	40.00	LF	$11.00	$440.00
0094	04795 CONDUIT-2 IN	75.00	LF	$17.00	$1,275.00
0095	04820 TRENCHING AND BACKFILLING	115.00	LF	$6.64	$763.60
0096	04829	12.00	EACH	$2,315.00	$27,780.00

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
	PIEZOELECTRIC SENSOR				
0097	04830 LOOP WIRE	7,500.00	LF	$0.60	$4,500.00
0098	04895 LOOP SAW SLOT AND FILL	675.00	LF	$10.50	$7,087.50
0099	20391NS835 ELECTRICAL JUNCTION BOX TYPE A	5.00	EACH	$5,725.00	$28,625.00

Total for Group 0003:$70,471.10

Group 0004: MOBILIZATION / DEMOBILIZATION

0091	02568 MOBILIZATION	1.00	LS	$1,551,331.33	$1,551,331.33
0092	02569 DEMOBILIZATION	1.00	LS	$775,665.66	$775,665.66

Total for Group 0004:$2,326,996.99

Appendix E

Close-out Presentation

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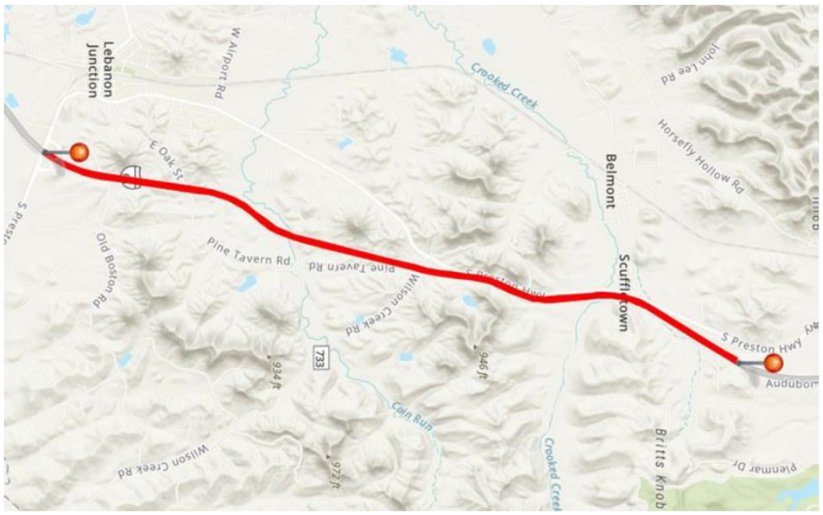

VALUE ENGINEERING STUDY

I-65 from MP 104.700 to 110.700

February 20-22, 2023

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SAFETY FIRST

- Emergency exits
- Meeting point
- CPR
- The number for “911”

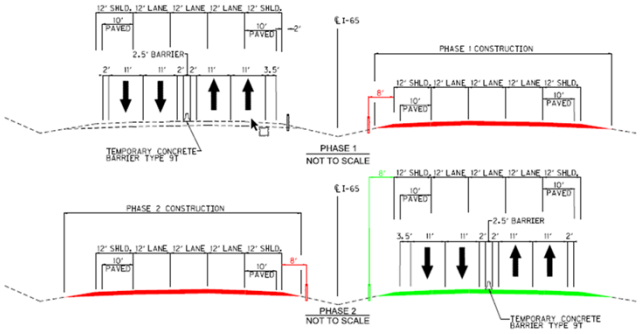
Value Engineering Team

- Travis Thompson, HDR
- Katy Stewart, KYTC
- Kevin Gearlds, HDR
- Kevin Walker, HDR
- Jose Theiler, HDR

Project Information

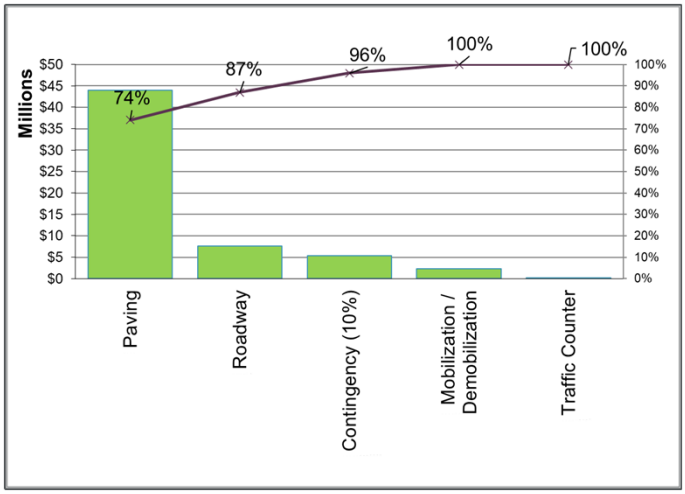
Purpose & Need: Address Pavement Condition

- I-65 from MP 104.7 to MP 110.7
- Six 12’ lanes
- 10’ inside & outside paved shoulder
- MOT:
  - Close NB lanes & divert traffic to SB lanes using two 11’ lanes in each direction
  - Reverse to build SB lanes
- Schedule
  - Letting: April 2023
  - Construction: 2 seasons



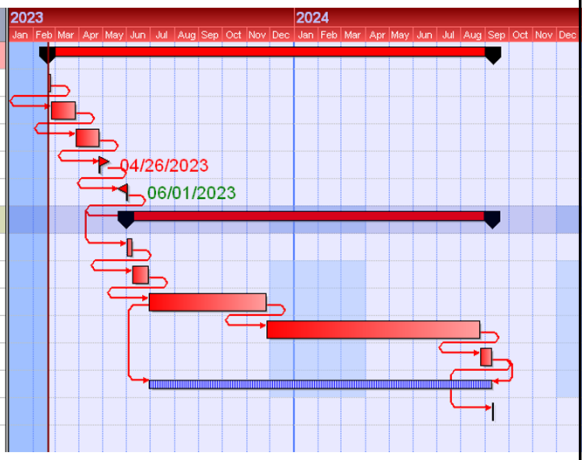
PROJECT ESTIMATE

Description		Amount
Paving	$	44,021,529
Roadway	$	7,619,044
Contingency (10%)	$	5,403,804
Mobilization / Demobilization	$	2,326,997
Traffic Counter	$	70,471
Total Cost	**$**	**59,441,845**



PROJECT SCHEDULE

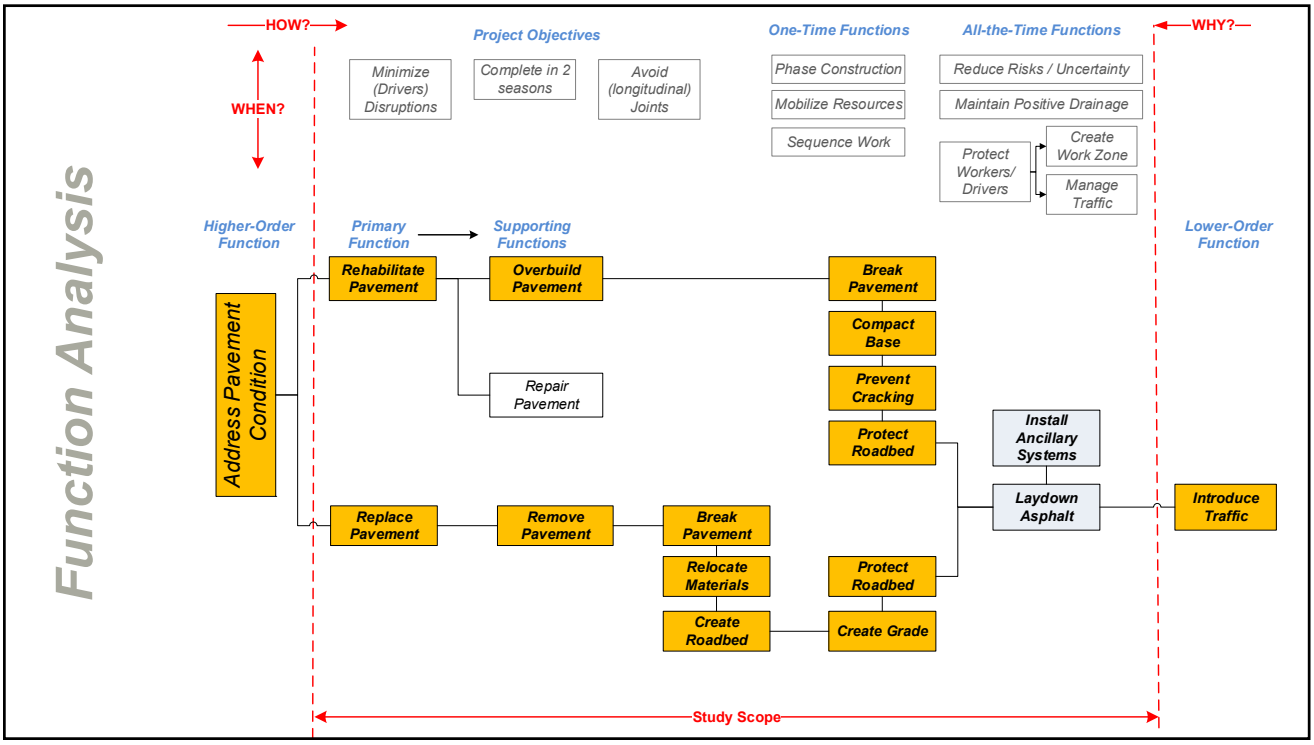
ID	Description	Remaining Duration	Start	Finish
100	5-22066.00 - I-65 Bullitt County Pave...	568	A02/20/2023	09/10/2024
110	VE Study	3	A02/20/2023	02/23/2023
120	Plans Updates	32	02/24/2023	03/27/2023
130	Advertisement	30	03/28/2023	04/26/2023
140	Letting	0		04/26/2023
150	NTP	0	06/01/2023	
160	Construction	343	06/01/2023	09/09/2024
210	Mobilize	7	06/01/2023	06/07/2023
200	Construct Crossovers #1, #2, #3 & #4	21	06/08/2023	06/28/2023
170	Construct Northbound Lanes	150	06/29/2023	11/25/2023
180	Construct Southbound Lanes	150	11/26/2023	08/25/2024
190	Remove crossovers	15	08/26/2024	09/09/2024
230	Construction Engineering and Inspec...	315	06/29/2023	09/09/2024
220	Project end	1	09/10/2024	09/10/2024



PROJECT RISKS

	Very Low	Low	Medium	High	Very High
Very High					
High					
Medium			003 - Labor Availability	001 - Bid Issues	004 - Unknown site conditions
Low			002 - Materials Availability		
Very Low					

Function Analysis

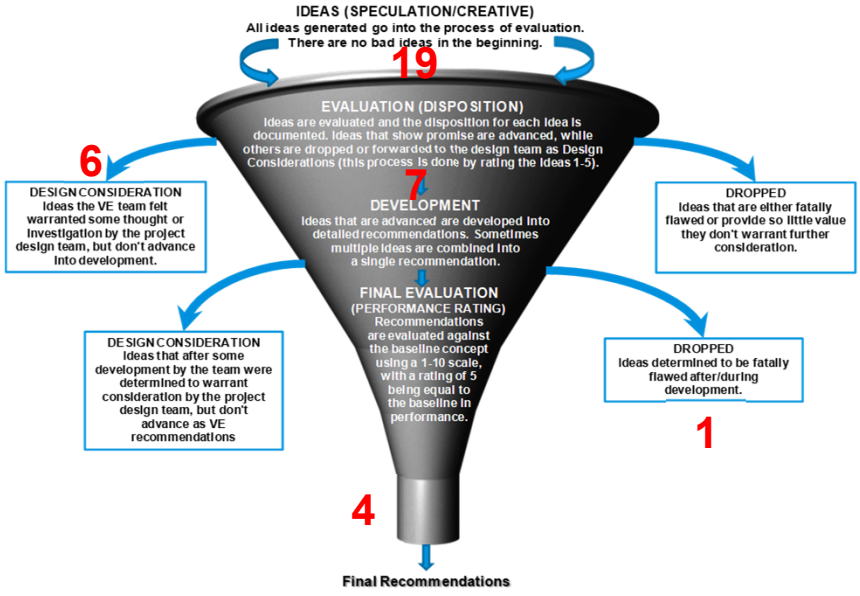


Objectives of the Study

Through application of the VE job plan the objective of the VE study was to **validate or improve** on the various concepts of the project.

$$Value = \frac{Worth}{Cost} = \frac{Performance}{Cost}$$

Evaluation Process – Tiered Approach



Revise Pavement Design

Title & Info. | Subgrade | AC | PCC | Cost Analysis | Attachments | Design Selection & Notes

Section Description: Route: I-65; Bullitt County;

Analysis Date: 2023-02-20

Structural Design Inputs:

Design CBR | Design Mr: 20000 | AADTT: 17500

Pavement Structural Design from Design Catalog:

Total minimum Asphalt thickness are 6.7

Required total AC Thickness on 5.5 inches of aggregate base: 13.18 in.

Driving Lane Material Selection

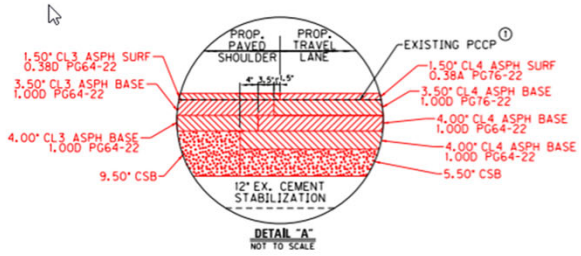
	Thickness	Item Code	Description
Surface:	1.5	00342	CL4 ASPH SURF 0.38A PG76-22
Base:			Polish-resistant type A is correct.
Layer 1:	3.5	00219	CL4 ASPH BASE 1.00D PG76-22
Layer 2:	3.5	00217	CL4 ASPH BASE 1.00D PG64-22
Layer 3:	4.5	00208	CL4 ASPH BASE 1.50D PG64-22
Drain. Blanket:	0	0	None
Aggr. Base:	5.5	00003	CRUSHED STONE BASE
Stab. Roadbed:	0	0	None

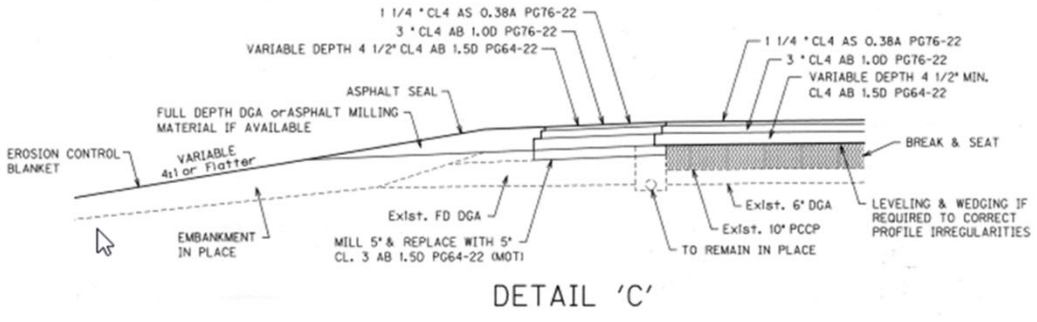
More AC Item

Shoulder Material Selection

Thickness	Item Code	Description
1.5	00388	CL3 ASPH SURF 0.38B PG64-22
3.5	00214	CL3 ASPH BASE 1.00D PG64-22
3.5	00214	CL3 ASPH BASE 1.00D PG64-22
0	0	None
0	0	None
10	00003	CRUSHED STONE BASE
0	0	None

Use Break & Seat in Select Areas



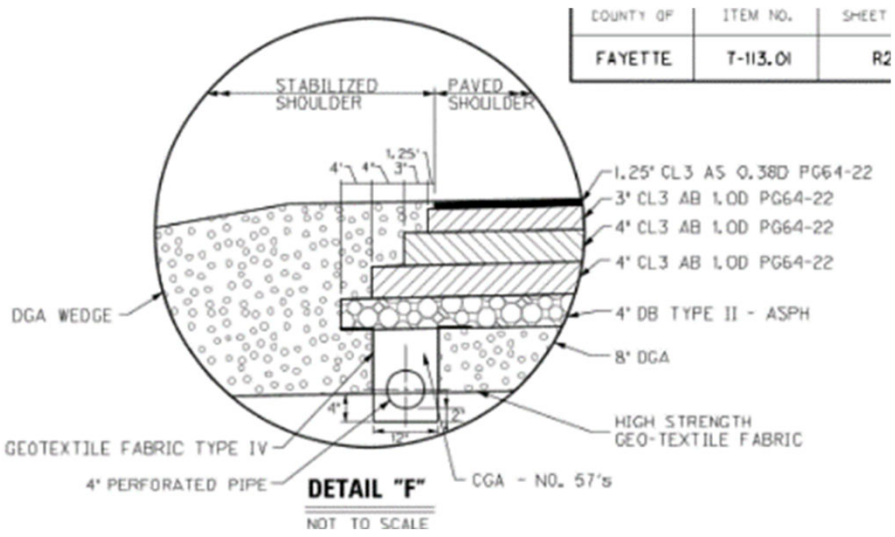


DETAIL 'C'

Use A+B Incentives

USER COST	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
	Monday		Tuesday		Wed		Thurs		Friday		Sat		Sun	
	USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)		USER COST ($)	
12-1 am	$210	$166	$0	$0	$273	$268	$0	$0	$332	$298	$355	$395	$0	$0
1-2 am	$198	$108	$0	$0	$227	$204	$0	$0	$277	$214	$307	$310	$0	$0
2-3 am	$211	$91	$0	$0	$208	$181	$0	$0	$245	$197	$210	$224	$0	$0
3-4 am	$209	$102	$0	$0	$233	$176	$0	$0	$260	$225	$195	$230	$0	$0
4-5 am	$385	$165	$0	$0	$420	$253	$0	$0	$409	$306	$265	$284	$0	$0
5-6 am	$716	$246	$0	$0	$778	$319	$0	$0	$736	$385	$374	$460	$0	$0
6-7 am	$1,029	$429	$0	$0	$1,175	$497	$0	$0	$1,106	$545	$425	$588	$0	$0
7-8 am	$1,081	$600	$0	$0	$1,122	$694	$0	$0	$1,116	$737	$518	$627	$0	$0
8-9 am	$915	$623	$0	$0	$995	$711	$0	$0	$996	$794	$680	$733	$0	$0
9-10 am	$895	$683	$0	$0	$987	$705	$0	$0	$1,094	$1,085	$892	$932	$0	$0
10-11 am	$994	$737	$0	$0	$1,025	$777	$0	$0	$1,169	$1,096	$1,086	$1,135	$0	$0
11-12 am	$1,045	$792	$0	$0	$1,103	$940	$0	$0	$1,326	$1,097	$1,219	$1,254	$0	$0
12-1 pm	$1,246	$882	$0	$0	$1,195	$893	$0	$0	$1,346	$1,366	$1,324	$1,231	$0	$0
1-2 pm	$1,383	$873	$0	$0	$1,243	$1,016	$0	$0	$1,388	$1,616	$1,277	$1,230	$0	$0
2-3 pm	$1,300	$1,033	$0	$0	$1,281	$1,137	$0	$0	$1,457	$1,648	$1,280	$1,149	$0	$0
3-4 pm	$1,336	$1,126	$0	$0	$1,447	$1,262	$0	$0	$1,517	$3,377	$1,326	$1,209	$0	$0
4-5 pm	$1,283	$1,288	$0	$0	$1,457	$1,361	$0	$0	$1,503	$3,546	$1,337	$1,132	$0	$0
5-6 pm	$1,313	$1,185	$0	$0	$1,550	$1,291	$0	$0	$1,456	$1,725	$1,316	$927	$0	$0
6-7 pm	$1,141	$816	$0	$0	$1,015	$979	$0	$0	$1,166	$1,433	$1,139	$843	$0	$0
7-8 pm	$797	$581	$0	$0	$638	$619	$0	$0	$872	$1,113	$996	$689	$0	$0
8-9 pm	$563	$553	$0	$0	$947	$613	$0	$0	$754	$1,010	$878	$622	$0	$0
9-10 pm	$501	$418	$0	$0	$589	$546	$0	$0	$676	$808	$749	$561	$0	$0
10-11 pm	$411	$341	$0	$0	$464	$446	$0	$0	$677	$651	$586	$516	$0	$0
11-12 pm	$391	$239	$0	$0	$365	$425	$0	$0	$495	$525	$509	$369	$0	$0
TOTAL	$19,555	$14,078	$0	$0	$20,735	$16,316	$0	$0	$22,374	$25,795	$19,246	$17,649	$0	$0

Use a Drainage Blanket



Recycle Concrete Pavement

Recycle Concrete Pavement

Design Suggestions

Idea #	Idea Description
8	Eliminate geotextile bond breaker
13	Lower contingency level to 5-10% and/or identify specific risks that lead to a much higher contingency
14	Take a more in-depth look at the CSB and asphalt unit bid prices and adjust to current bid levels
17	Break the deconstruction and grading phase into two sections to be worked on simultaneously (two deconstruction and earthwork crews)
18	Break the pavement operations up into two simultaneous operations.
19	Include rock and fabric in estimate to account for extra areas found in the field that need stabilization

Summary

VE Alt #	Idea Description	Cost Savings (or Added Cost)	Performance / Risk
Construction Alternatives			
1	Revise Pavement Design	$1,085,468	Improved (M)
2	A+B Incentives/Disincentives	$1,480,000	Improved (CI, SEI)
3	Use Break and Seat Pavement Methodology	$5,930,000	Improved (S, SEI, CI)
Maintainability / Drainage Alternatives			
4	Use a Drainage Blanket	-$2,385,801	Improved (M, Risk)

Performance Attribute Legend:
M – Maintainability, CI – Construction Impacts, S - Schedule I Impacts, Risk Impacts,
SEI - Socio-Environmental Impacts

QUESTIONS

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