Value Engineering Study

Final Report

VE Number: 202201

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County

Item No. 5-483.10

Workshop Dates: January 10-14, 2022

Contact: Patrice Miller, CVS
CVS No. 201410500

Office Phone (602) 493-1947

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Disclaimer

The information contained in this report summarizes the professional opinions of the VE Team members during the Value Engineering Study. These opinions were based on the information provided to the VE Team at the time of the Study. This information may develop further as the project continues, and new data may become available after this report was created. Evaluation on how this new information may affect the value proposals and findings contained in this report must be considered when using its content to judge their feasibility or any decision made about them.

This report was prepared by:

RHA, LLC

TeamRHA.com
6677 W Thunderbird Rd K183,
Glendale, AZ 85306
Office 602.493.1947
fax 602.275.2972

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Section

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Introduction

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Section 1 – Introduction

1.1 Value Methodology

The value methodology (Synonyms: value analysis, value engineering, and value management) is a function-oriented, systematic, team approach to add customer value to a program, facility, system, or service. Improvements like performance, quality, initial and life cycle cost are paramount in the value methodology.

Figure 1-1: The VM Process

The workshop is conducted in accordance with the methodology as established by SAVE International, the value society, and is structured using the Job Plan as outlined below.

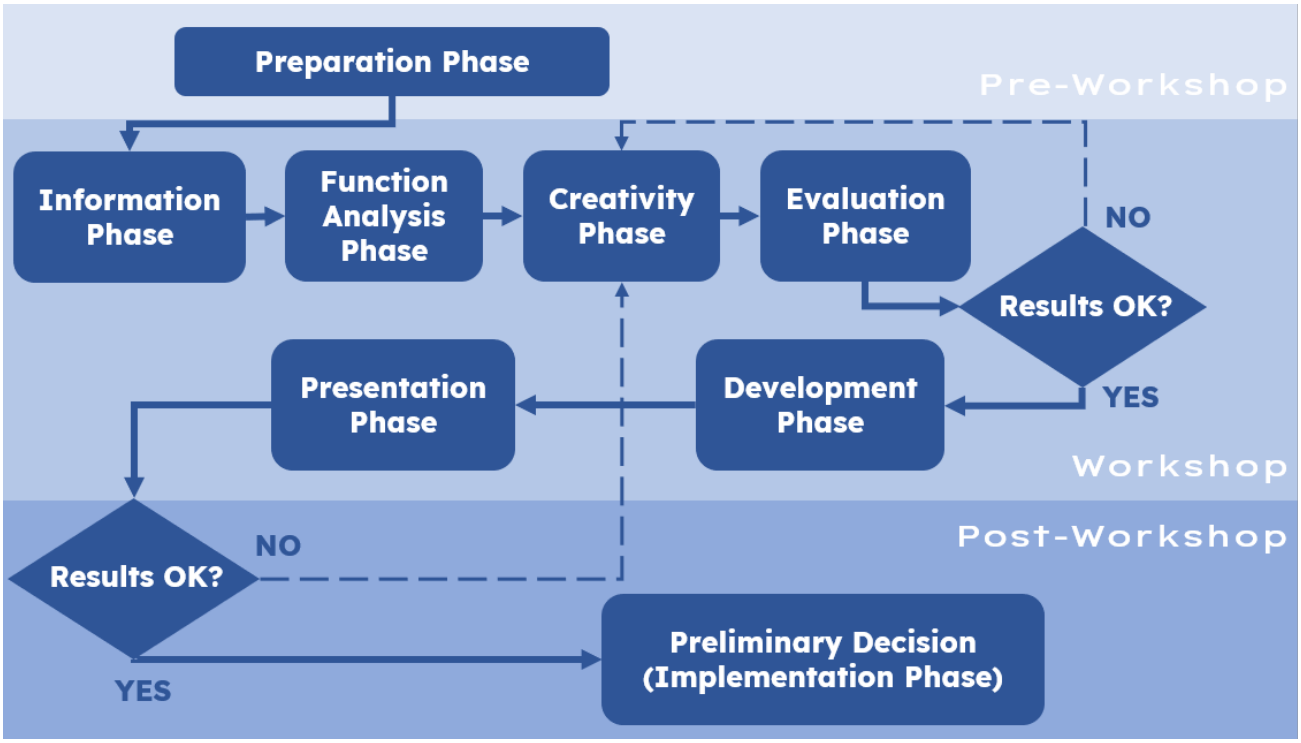
Table 1-1: The VM Job Plan

Value Methodology Stage / Phase	VM Phase Functions Achieved	Objectives of this Phase	Outcomes of this Phase
Phase 1: Preparation Phase	Identify Subject Identify Goals Define Value Organize Effort	• Identify the study project • Identify roles and responsibilities • Define study scope, goals, and objectives • Select team leader • Conduct pre-study meeting • Select VE Team members • Identify stakeholders, decision-makers, and technical reviewers • Obtain time commitment • Identify data collection • Select study dates • Determine study logistics, agenda • Collect and distribute data • Perform technology dry-run for a virtual workshop • Send team primer to VE Team • Team members to complete Key Issues Memos (KIM)	• Fosters understanding of VE Study priorities • Defines and manages expectations • Organizes the VE Study • Offers a thorough review of the project • Tests meeting platform and virtual tools to maximize engagement and collaboration • Primes the team for the VE workshop

Value Methodology Stage / Phase	VM Phase Functions Achieved	Objectives of this Phase	Outcomes of this Phase
Phase 2: Information Phase	Analyze Information Transform Information Orient Participants	• Present design concept • Present stakeholders' interests • Review project issues and objectives • Discuss deviation from design standards • Define project performance metrics • Discuss problems the project must solve • identify issues the design may not address • Visit project site / virtual site tour	• It brings all VE Team members to a common understanding of the project, including its challenges and constraints • Establishes the benchmark for which to identify alternatives • Gains a real-world perspective of the project and builds the foundation for function analysis
Phase 3: Function Analysis Phase	Define Functions Allocate Resources Allocate Performance Prioritize Functions	• Identify and classify functions • Apply cost and risk relative to performance • Prioritize functions • Select specific functions for study	• Provides a comprehensive understanding by focusing on what the project does rather than what it is • Identifies what the project must do to satisfy needs and objectives • Focuses on functions with the greatest opportunity for project improvements
Phase 4: Creativity Phase	Generate Ideas	• Brainstorm to generate performance-focused ideas for alternative ways to perform functions • Discuss, build on and clarify ideas	• The VE Team develops a broad array of ideas that provide a wide variety of possible alternative components or methods to improve project value
Phase 5: Evaluation Phase	Evaluate Ideas Select Ideas	• Eliminate obvious "fatal flaw" ideas • Score ideas based on meeting performance criteria, value key and project/study goals • Discuss conflicting rankings, further clarify ideas and determine final rankings • Discuss ideas with client and decision-makers (midpoint review) • Assign alternatives for the development phase	• Prioritizes ideas for development, focusing on those with the highest potential for performance improvement and cost savings • Determine value: performance/cost • Focuses team's effort to develop alternatives that best meet client study objectives
Phase 6: Development Phase	Transform Ideas Develop Information	• Validate and refine idea concepts • Compare to the original design concept • Define implementation considerations • Prepare sketches and calculations • Measure performance • Estimate costs, life-cycle cost benefits/costs	• Provides a side-by-side comparison of baseline and alternative—concepts, initial costs, life-cycle costs, sketches, performance metrics

Value Methodology Stage / Phase	VM Phase Functions Achieved	Objectives of this Phase	Outcomes of this Phase
Phase 7: Presentation Phase	Present Information Propose Change	• Present developed ideas to client, designers, decision-makers, stakeholders • Document feedback • Produce draft report	• Ensures management and other key stakeholders understand the rationale of the value alternatives and design suggestions
Phase 8: Implementation Phase	Implement Change Manage Change Realize Value	• Document process and study findings • Develop and distribute VE study summary report • Review study summary report • Assess alternatives for acceptance • Prepare draft implementation dispositions • Resolve conditionally accepted alternatives • Develop an implementation plan with the project manager • Project manager sign-off on VE implementation plan • Final presentation of study results	• Involves those who will implement and increases the likelihood of implementation • Improves the actual value of the project

Figure 1-2: The VM Process Flowchart



1.2 Report Contents

The report provides the outcomes associated with this VE workshop and includes the following sections:

Section 1: Introduction – This section outlines the VE process and explains the content of the report.

Section 2: Project Description – This section outlines the project background, project corridor and project purpose and need.

Section 3: Executive Summary – This section is an overview that includes summary of results, a list of the VE Team members and the VE punch list.

Section 4: Summary Information – This section provides an overview in table format of the VE Proposals and Design Comments.

Section 5: VE Proposals and Design Suggestions – This section includes alternatives developed as a workbook during the workshop. Each workbook contains the following information:

- Unique Identifying Number (i.e., Value Engineering Proposal No. 1, 2, 3, 4, etc.)
- Creative Idea Number
- Creative Idea Title
- Function Identification
- VE Proposal Synopsis
- Baseline Concept – brief description
- VE Proposal Description – brief description
- Advantages
- Disadvantages
- Cost Summary
- Sketches/Diagrams (Baseline and Proposed), if applicable
- Discussion & Justification
- Initial Cost Information
- Life-cycle Cost Information, if applicable

Section 6: Appendices

- Appendix A – Study Participants
- Appendix B – Pareto Cost Models
- Appendix C – Function Analysis
- Appendix D - Creative Idea List and Evaluation
- Appendix E – Supporting Data
    - Risk Identification
    - VE Team Observations
    - Agenda

Section

2

Project Description

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Section 2 – Project Description

2.1 Purpose & Need

The purpose of the I-71 widening and reconstruction is to address the capacity deficiencies and operational issues that currently characterize the existing corridor and provide increased efficiency and safety for the traveling public.

2.2 Background

The Kentucky Transportation Cabinet (KYTC) is in the design phase of a project to widen I-71 between KY 329 (MP 14.1) and KY 393 (MP.18.0). It will serve through traffic on I-71, as well as local users traveling to and from the Louisville Metro and Crestwood/Buckner areas.

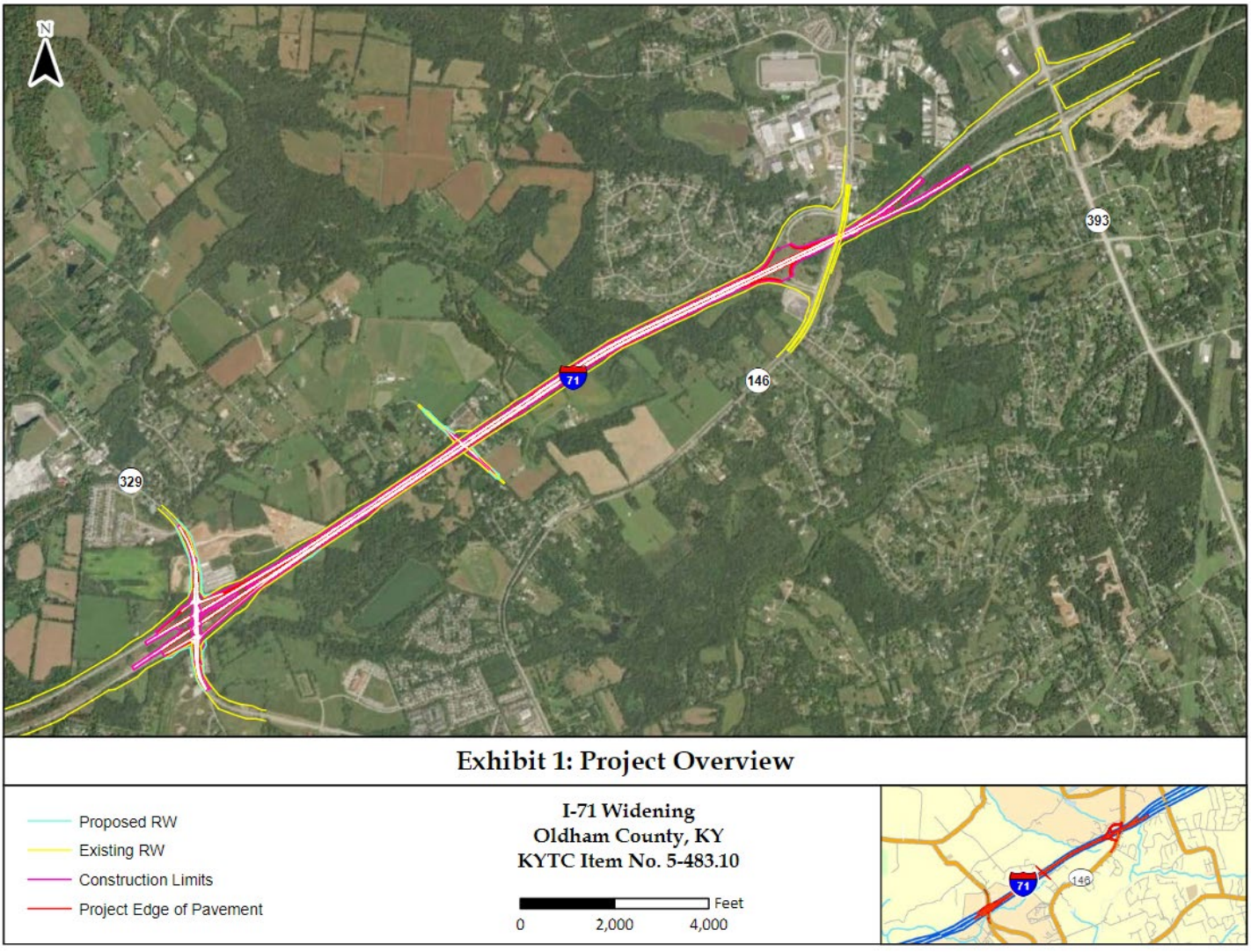

Exhibit 1: Project Overview

This portion of I-71 is classified as an Urban Interstate. This project is identified in the 2020 Kentucky Highway Plan as Item No. 5-483.10, Widen I-71 from four to six lanes from KY 329 (MP 14.1) to KY 393 (MP 18.0). The proposed project will address increasing traffic volumes and traffic flow characteristics,

thus improving overall corridor performance. Additionally, maintenance activities will be needed within the foreseeable future, regardless of the transportation demands

This portion of I-71 was originally constructed during the late 1960s. The original design speed was 70 mph, and is a fully controlled access facility. This segment was originally constructed with 6" Dense Graded Aggregate (DGA) and 10" concrete pavement including a sand pavement drain system. The pavement has since been overlaid with asphalt. The segment of I-71 begins with a bifurcated template that transitions to a common median just north of the KY 329 interchange, then ends in a bifurcated template near MP 18.0.

2.3 Value Engineering (VE) Study Baseline

The following table lists the criteria and construction cost of the "preferred alternative," that was used as the baseline concept for the VE Team to study and provide VE alternatives.

Alternative Name	**Criteria**	**Construction Cost**
I-71 ALT 1A (14' inside shoulder and auxiliary lanes)	▪ 3-12' lanes NB and SB ▪ 12' outside shoulder, 10' paved ▪ 14' inside shoulder paved in common median ▪ NB auxiliary lane from KY 329 on ramp to KY 146 off ramp. ▪ SB auxiliary lane from KY 146 on ramp to Sta. 1653+00 ▪ Lengthen inlet and outlet of 6′ x 4′ RCBC at Sta. 1629+80 ▪ Lengthen inlet and outlet of 6′ x 6′ RCBC at Sta. 1661+85	$53,500,000
Extend SB auxiliary lane to KY 329		$1,500,000
KY 329 ALT 1 (conventional widening)	▪ Traditional Widening – 7 lanes plus 12' wide island for pier ▪ Design Speed: 45 MPH ▪ 4 – 12' through lanes ▪ Dual right turn from Ramp A (NB off ramp) ▪ Dual left turn from Ramp C (SB off ramp) ▪ Dual left turn to Ramp D (SB on ramp)	$8,200,000
Glenarm Rd ALT 2 (parallel structure)	▪ Construct proposed bridge parallel to existing ▪ Maintains traffic during construction	$2,600,000
KY 146 No Build plus signalization		$100,000
	TOTAL	$65,900,000

Section

3

Executive Summary

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Section 3 – Executive Summary

3.1 Background

A Value Engineering (VE) Study was conducted on the Preliminary Line and Grade documents for the **I-71 Widening, MP 14.1 to MP 18.0 Project** for the KYTC on January 10-14, 2022, for the project described in Section 2 – Project Description.

3.2 Workshop In-brief Meeting

KYTC and HMB (design team) representatives presented the project during the in-brief meeting on Monday, January 10, 2022. This included a virtual site tour using the storyboard webpages set-up specifically for this project at:

https://hmbpe.maps.arcgis.com/apps/MapSeries/index.html?appid=20338406b1a7493187b04bb0249997d4#

The workshop objectives were identified at the start of the workshop and were used to focus the VE Team's efforts:

- Identify value opportunities (function/resources)
- Review—
  - Sag near KY 329
  - Profile adjustment at KY 329
  - NB ramp at KY 146 (design exception)
  - KY 146 Interchange area (accommodate acceleration)

Also identified were the workshop constraints (e.g., standards, policies, resources, commitments made, etc.) that may be difficult, if not impossible, to change:

- Need to reconstruct bridges over the mainline to accommodate widening
- Do not touch CSX bridge and pedestrian bridge

3.3 Performance Criteria

During the Information Phase on Monday, January 10, 2022, the VE Team listed the criteria to evaluate the impact of the Value Engineering (VE) Proposals on the project's performance. The table below presents the list and description of these criteria.

Table 3-1: List of Performance Criteria

ID	Criteria	Description
A	Maintenance of Traffic (MOT)	Allow free-flow traffic movements during construction
B	Safety	Prevent serious injury and fatal crashes
C	Maintainability	Long-term maintenance considerations
D	Mobility	Long-term operations on the Interstate
E	Connectivity	Tie into I-MOVEKY; possibly extend TRIMARC system

These criteria were used in the evaluation and development of VE Proposals.

3.4 Workshop Results

Summary workshop results are shown in the table below.

Table 3-2: Summary Workshop Results

Workshop Outcome	Number	Section of Report/Result
Ideas Brainstormed	66	See Creative Idea List and Evaluation (Section 6 – Appendices, Appendix D)
Ideas Developed into Value Engineering (VE) Proposals, costed	10	See Section 4 – Summary Information and Section 5 – Value Engineering Proposals
Design Comments (DC), not developed	11	See Section 4 – Summary Information
All VE Proposals – Cost Avoid (Potentially reduces initial and/or O&M cost without sacrificing function and/or performance)	8	$13,054,000 (Section 5 – Value Engineering Proposals)
All VE Proposals – Cost Add (At a cost add to the project, potentially improves function and/or performance)	2	($259,000) (Section 5 – Value Engineering Proposals)

3.5 Value Engineering Packages

During the development of the VE Proposals and before the out-brief presentation, the value team considered how the VE Proposals could be applied to the project in concert with one another. The outcome of this discussion led to two VE packages as presented in the table below. The bottom of the table sums total potential first cost avoidance or first cost addition.

Table 3-3: Value Engineering Packages

	VE Package 1	**VE Package 2**
Preferred Alternative (Baseline)	**$65,900,000**	**$65,900,000**
Construct Class IV wall in lieu of Class V wall (VE Proposal No. 6)	($97,000)	($97,000)
Pavement design recommendations (VE Proposal No. 8): Add fibers to the asphalt base	($209,000)	($209,000)
Pour concrete on top of the existing culvert slab (VE Proposal No. 9)	($1,343,000)	($1,343,000)
Keep Glenarm Rd. at same location using existing substructures (VE Proposal No. 4)	($1,040,000)	($1,040,000)
Build new I-71 bridge over KY 329 with common I-71 median (VE Proposal No. 2)	($397,000)	($397,000)
Reduce vertical clearance on KY 329 from 16′ to 14′-6″ (VE Proposal No. 10)	($1,482,000)	($1,482,000)
Redesign the KY 329 Interchange: Build a dog-bone interchange at KY 329 (VE Proposal No. 1)	($2,693,000)	N/A
Construct short-term, low cost improvements at KY 329 (VE Proposal No. 5)	N/A	$4,000
Review capacity and safety option for KY 146 (VE Proposal No. 3)	$255,000	$255,000
Defer auxiliary lane construction to a future date (VE Proposal No. 7)	($5,142,000)	($5,142,000)
Adjusted (Total VE Impact)	**$53,752,000**	**$56,449,000**

3.6 Function Analysis

Function definition and analysis is the heart of Value Engineering. It is the primary activity that separates VE from all other "improvement" programs. The objective of this phase is to ensure the entire team agrees upon the purpose of the project elements. Furthermore, this phase assists with development of the most beneficial areas for continuing the study. The data supporting Function Analysis can be found in Section 6: Appendices, Appendix C.

The VE Team identified the functions using active verbs and measurable nouns. This process allowed the team to truly understand all of the functions associated with the project. The basic functions (the "purpose" of the Purpose and Need) were defined as **Increase Capacity** and **Improve Safety**. A Random Function Identification Worksheet was completed and is included in Appendix C.

3.7 Value Engineering Punchlist

This section includes a Value Engineering Punchlist that the decision makers can use to guide and track decisions as they determine the ultimate disposition of each VE Proposal. The Value Engineering Punchlist is included on the following page.

VALUE ENGINEERING PUNCH LIST

ITEM NO. 5-483.10 **PROJECT COUNTY:** Oldham **DATE OF STUDY:** January 10-14, 2022

VE Alternative Number	Description	Location (Item No., Segment, Alternate)	Activity (Y,N,UC-Date)	Implemented Life Cycle Cost Savings	Original Cost	Alternative Cost	Initial Cost Saving	Life Cycle Cost Savings (Total Present Worth)	FHWA Categories	Remarks
1	Redesign the KY 329 Interchange						$2,693,000	$2,940,000		
2	Build new I-71 bridge over KY 329 with common I-71 median						$397,000	$371,000		
3	Review capacity and safety options for KY 146						($255,000)	($255,000)		
4	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures						$1,040,000	$1,040,000		
5	Construct short-term, low cost improvements at KY 329						($4,000)	($4,000)		
6	Construct Class IV wall in lieu of Class V wall						$97,000	$97,000		
7	Defer auxiliary lane construction to a future date						$5,142,000	$5,572,000		
8	Pavement design recommendations						$209,000	$209,000		
9	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material						$1,343,000	$1,343,000		
10	Reduce vertical clearance on KY 329 from 16' to 14'-6"						$1,482,000	$1,482,000		

3.8 VE Team

Table 3-4: VE Team Participants

Name	Organization	Role in the Value Study	Level of Participation
Pat Miller	RHA	CVS Facilitator	Full Time
Colin Miller	RHA	VMA Workshop / Technical Assistant	Full Time
Jason Littleton, PE	American Engineers, Inc.	Geometric Designer	Full Time
Kenny Ott, PE	American Engineers, Inc.	Structures	Full Time
Andrew Brown, PE, PTOE	Palmer Engineering Company	Traffic & Safety Analysis	Full Time
Jamie Fielder	Palmer Engineering Company	Geometric Designer	Full Time
Rob Martin, PE	QK4	Constructability/MOT	Full Time
Brent Sweger, PE	KYTC	Quality Assurance Branch Manager	Part Time
Justin Harrod	KYTC	TET 3	Full Time

Figure 3-1: VE Team

Top Row (left to right): Justin Harrod, Pat Miller, Jamie Fielder, Brent Sweger

Bottom Row (left to right): Kenny Ott, Andrew Brown, Rob Martin, Jason Littleton, Colin Miller

3.9 Certification

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

Patrice Miller
CVS® No. 201410500
Facilitator

Section

4

Summary Information

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Section 4 – Summary Information

4.1 Introduction

The VE Team brainstormed 66 ideas. To shorten the list, the VE Team evaluated the ideas using a simultaneous two-step process (further described in Appendix D). A total of ten ideas were developed as Value Engineering Proposals with costs; and eleven ideas were identified as Design Comments.

The table below summarizes by function the total number of ideas brainstormed and developed.

Table 4-1: Summary of Ideas Brainstormed (by Function)

Function / Focus Area	Abbreviation	Total Number of Ideas Brainstormed	Total Number of VE Proposals (Developed)	Total Number of Design Comments (Not Developed)
Enhance Connectivity	EC	26	4	1
Separate Traffic	ST	15	2	0
Control Traffic	CT	6	1	2
Strengthen Sub-grade	SS	8	1	2
Elevate Road	ER	2	0	2
Miscellaneous	MI	9	2	4
TOTAL	**--**	**66**	**10**	**11**

4.2 Value Engineering Proposals - Summary

The table on the following two pages summarizes the 10 VE Proposals and their respective cost implications, if any. It's important to note that costs reflected in positive numbers indicate a cost savings and costs reflected in negative numbers (parentheses) indicate a cost add. It's also important to note that, due to the conceptual nature of the alternatives and the early level of the design metrics, most costs are high level estimations. As the project design progresses and harder metrics are generated, these costs will need to be refined. The VE Team has attempted to maintain a high level of conservatism when making the estimations in this report.

It is important to reiterate that the definition of value is as follows:

$$\text{Value} = \frac{\text{Function Performance}}{\text{Resources}}$$

Understanding Function Performance is key in the evaluation and later recommendation of an idea to become a VE Proposal.

Several of the proposals overlap or represent different ways of approaching the same issue. As a result, the cost avoid/cost add in the summary table is not cumulative.

The following pages list the VE Proposals in table format.

Table 4-2: Summary of Value Engineering Proposals

VE Proposal No.	Creative Idea No.	VE Proposal Title	Evaluation Score	VE PROPOSAL SYNOPSIS					Initial Cost Decrease / (Increase)	O&M Cost Decrease / (Increase)	Total Cost Life Cycle Decrease /(Increase)
				Proposal Synopsis	Reliability	Functionality	O&M	Schedule Impact			
1	EC-25	Redesign the KY 329 Interchange	4	Constructing a "dogbone" interchange at KY 329 will improve intersection delay at the ramp terminals while also improving safety performance in particular from a fatal and serious injury perspective. This will also decrease the total amount of asphalt pavement to be constructed and maintained long-term.	Improved	Improved	Improved	Maintained	$2,693,000	$247,000	$2,940,000
2	EC-26	Build new I-71 bridge over KY 329 with common I-71 median	4	Construct a 3-span bridge over KY 329 (no median pier). Proposed bridge is located midway between the existing twin bridges carrying both NB and SB I-71 over KY 329, using the common median section which now starts at begin bridge station 1545+50 instead of at Station 1574+89. The center span will span an 8-lane curb and gutter section with the multi-use path and sidewalk located behind the shoulder piers.	Maintained	Improved	Maintained	Improved	$397,000	($26,000)	$371,000
3	EC-24	Review capacity and safety options for KY 146	5	Provide low-cost improvement options which would improve capacity and prevent crashes by constructing a continuous Green-T intersection which includes a Partial Median U-Turn on KY 146 and square up turn radius involving I-71 northbound and southbound ramps onto KY 146. This would improve functionality along this section.	Improved	Improved	Maintained	Maintained	($255,000)	-	($255,000)
4	EC-19	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures	5	Glenarm Rd. will stay on a straight tangent within existing right-of-way, thus eliminates purchase of right-oif-way and reverse curves at each approach. Reduces project cost as existing substructures are used and eliminates construction of new approach roads. Schedule will be significantly improved as Glenarm Rd. should be closed to traffic for less than one month.	Maintained	Maintained	Maintained	Improved	$1,040,000	-	$1,040,000
5	ST-15	Construct short-term, low cost improvements at KY 329	4	Provide low-cost improvement options which would improve capacity and prevent crashes at the I-71 and KY 329 Interchange. These improvement options include constructing single lane roundabout, squaring up the right turn lane radius from ramps to KY 329, adding a right turn added lane onto KY 329 from I-71 Northbound off ramp, and access management along KY 329.	Improved	Improved	Maintained	Maintained	($4,000)	-	($4,000)
6	ST-04	Construct Class IV wall in lieu of Class V wall	4	In a scenario where full median shoulders are provided, it is suggested KYTC consider TL 4 concrete median barrier. The TDOT wall takes approximately 21% less concrete to construct. Reinforcement Steel was considered to be equivalent. Maintenance life cycle costs for either concrete median barrier are considered equal.	Maintained	Maintained	Maintained	Maintained	$97,000	-	$97,000

VE Proposal No.	Creative Idea No.	VE Proposal Title	Evaluation Score	VE PROPOSAL SYNOPSIS					Initial Cost Decrease / (Increase)	O&M Cost Decrease / (Increase)	Total Cost Life Cycle Decrease /(Increase)
				Proposal Synopsis	Reliability	Functionality	O&M	Schedule Impact			
7	CT-03	Defer auxiliary lane construction to a future date	5	Reconsider including auxiliary lanes in the project for I-71 based on additional information from cost benefit analysis updates.	Maintained	Maintained	Improved	Improved	$5,142,000	$430,000	$5,572,000
8	SS-08	Pavement design recommendations	4	Consider the use of fibers in the asphalt base lifts as a means to effectively reduce lift thickness needed (and cost) while maintaining the same level of performance.	Improved	Maintained	Maintained	Maintained	$209,000	-	$209,000
9	MI-06	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material	4	For I-71 step down culverts to be extended due to the roadway widening, place additional concrete and steel to reinforce existing culvert top slab in lieu of light weight fill material.	Maintained	Maintained	Maintained	Improved	$1,343,000	-	$1,343,000
10	MI-07	Reduce vertical clearance on KY 329 from 16′ to 14′-6″	4	KYTC policy allows for routes not on an interstate highway and not on the Strategic Highway Network to have bridge clearances as low as 14.5′. Eliminate the grade revision on I-71 meant to achieve 16.5′ clearance on KY 329 and instead widen near existing grade to achieve 14.5′ allowed by KYTC.	Maintained	Maintained	Maintained	Maintained	$1,482,000	-	$1,482,000

4.3 Design Comments (No Workbook Prepared)

The following table summarizes all those findings the VE Team identified during the preparation and performance of the VE Study that only comment about recommended corrections or concerns found in the project documents. Items such as errors, omissions, schedule corrections, estimate corrections, or document quality issues are examples of the elements listed in the following table and should be considered self-explanatory and do not require a formal response to accept or reject.

Table 4-3: Design Comments (No Workbook Prepared)

Proposal No.	Design Comment
Enhance Connectivity (EC)	
EC-13	Review safety performance width beneath structures at KY 146
Control Traffic (CT)	
CT-01	Install Advance Warning Flasher on KY 329 northbound in advance of the proposed traffic signal to warn drivers to "Be Prepared to Stop"
CT-04	Require trucks to use left lane during construction rather than shoulder lane
Strengthen Sub-grade (SS)	
SS-01	Consider alternative pavement designs for the contractor to bid as alternates
SS-07	Ensure pavement is able to drain using Paving Alternate 2. It appears the fabric wrapped aggregate is "capped" with DGA whereas in Paving Alternate 1, the Asphalt Treated Drainage Blanket is on top of the DGA layer
Elevate Road (ER)	
ER-01	Confirm that the phasing of construction still maintains a "balanced project"
ER-02	Verify that the project is a "balanced project"
Miscellaneous (MI)	
MI-02	Consider adjusting the superelevation transition location at 1662+50 to ensure adequate cross slope for drainage at the low point of the sag
MI-05	Consider reviewing $1M utility budget (appears low) due to development to the north along KY 329
MI-08	Drainage during MOT will create an issue as shown in the typicals; can be easily corrected with some wedging to pitch the other direction, but that needs to be accounted for in the price (there will be a lot)
MI-09	The VE Team reached out for additional information regarding an on-going KY 146 Planning Study. The team learned the Study Area is to the south of the current project, and to our knowledge was not intending to go any further north. The VE Team just wanted to make sure the Design and Project Team for 5-483.10 was aware of this

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Section

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Value Engineering Proposals

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Section 5 – Value Engineering Proposals

5.1 Introduction

During the Creativity Phase, the VE Team brainstormed 66 ideas. Of these, 10 were identified for further development into VE Proposals, including cost impacts. Several of the proposals overlap or represent different ways of approaching the same issue.

Cost savings are shown as positive costs, while any added costs are noted in parenthesis. Total Life Cycle Costs are the summation of the initial plus O&M costs as estimated by the VE Team.

The following pages detail the VE Proposals developed as part of the VE Team and include the following information:

- Value Engineering Proposal Number (1, 2, 3, 4, etc.)
- Creative Idea Number
- VE Proposal Title
- Function Identification
- VE Proposal Synopsis
- Baseline Concept
- VE Proposal Description
- Advantages and Disadvantages
- Cost Summary
- Sketches/Diagram (Baseline and Proposed)
- Discussion & Justification
- Cost Information (Initial Cost)
- Cost Information (Operations & Maintenance)

5.2 Cost Estimating for VE Proposals

The costs used are those provided by HMB. Where the VE Team has offered alternate costs, they are provided for information only, reflective of the short duration of the VE Study and should be evaluated by KYTC and HMB. Value Engineering Proposals are provided for their evaluation and implementation exclusively by KYTC and HMB.

VALUE ENGINEERING PROPOSAL NO. 1

EC-25

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Redesign the KY 329 Interchange
FUNCTION	**Enhance Connectivity**

VE PROPOSAL SYNOPSIS:

Constructing a "dogbone" interchange at KY 329 will reduce intersection delays at the ramp terminals while also improving safety performance in particular from a fatal and serious injury perspective. This will also decrease the total amount of asphalt pavement to be constructed and maintained long-term.

Reliability	**Improved**	**Functionality**	**Improved**	**$ Initial Cost Avoidance (Add)**
O&M	**Improved**	**Schedule Impact**	**Maintained**	**$2,693,000**

BASELINE CONCEPT DESCRIPTION:

KY 329 has two lanes in each direction with multiple turn lanes at the I-71 ramp terminals. Traffic signals will be constructed at the ramp terminals.

VE PROPOSAL DESCRIPTION:

Construct a "dogbone" interchange (with roundabouts at the ramp terminals). This would still maintain two lanes of traffic in each direction.

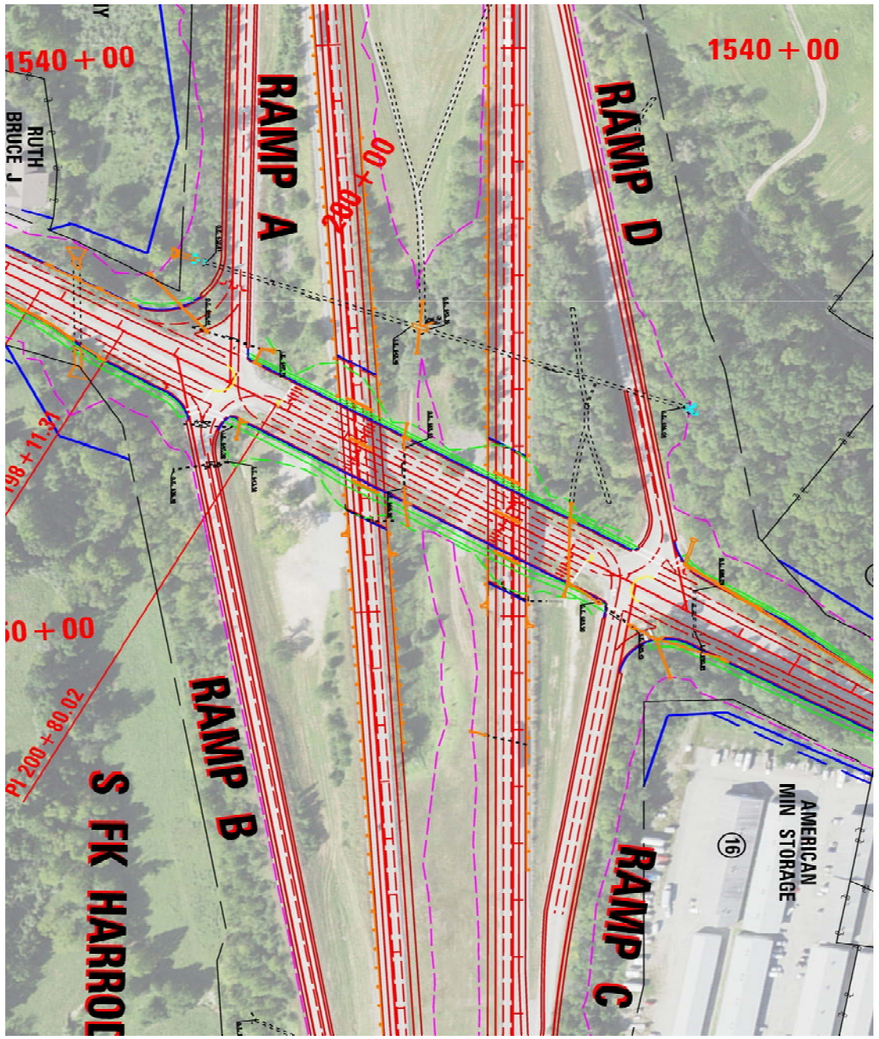
VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Reduces traffic delay at ramp terminals	● Public acceptance
● Reduces pavement need	●
● Improves safety performance at the ramp terminals	●
● Reduces roadway footprint	●
● Shorter bridge span reduces long-term maintenance costs	●
●	●
●	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$9,418,000	$634,000	$10,052,000
VE PROPOSAL:	$6,725,000	$387,000	$7,112,000
TOTAL (Baseline less Proposed)	$2,693,000	$247,000	$2,940,000

AVOID COST

TITLE	Redesign the KY 329 Interchange

SKETCH/DIAGRAM: BASELINE CONCEPT



VALUE ENGINEERING PROPOSAL NO. 1

EC-25

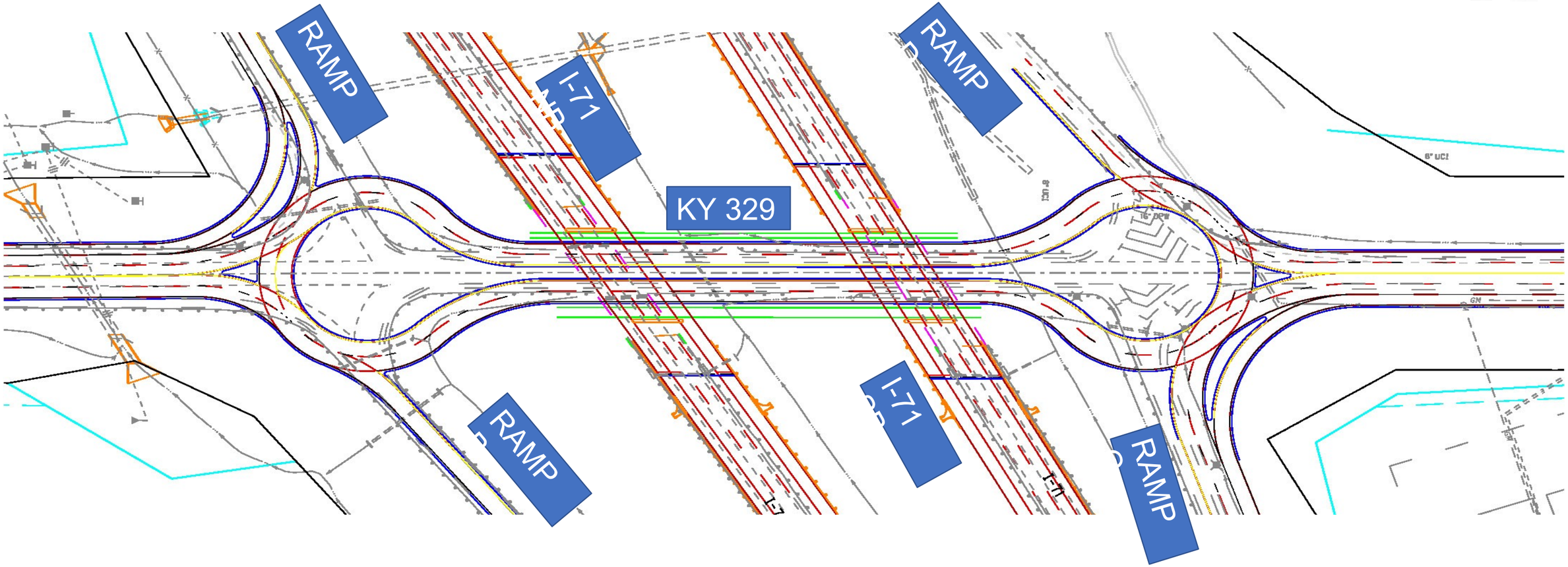
Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Redesign the KY 329 Interchange

SKETCH/DIAGRAM: VE PROPOSAL



VALUE ENGINEERING PROPOSAL NO. 1

EC-25

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Redesign the KY 329 Interchange

DISCUSSION & JUSTIFICATION:

Considering the impending development immediately adjacent to the KY 329 interchange, the value team proposes reconsideration of the Diverging Diamond Interchange (DDI) as well as investigating the feasibility of constructing a "dogbone" interchange (with roundabouts at the ramp terminals). Both options provide a narrower footprint for KY 329 with the DDI carrying 3 lanes of traffic in each direction under the bridges and the dogbone alternate carrying two lanes of traffic in each direction under the bridges. This propagates beyond the ramp terminals as well as lanes are added and dropped approaching the terminals.

Based on our initial study, the value team proposes to construct a dogbone interchange. This alternate will allow the design team to reduce the typical section through the interchange from 8 total lanes (2 in each direction with a dual left headed north on KY 329 and a single left headed south on KY 329 as well as excess pavement for a center pier for the I-71 overpass) to 4 total lanes of pavement plus a raised median to separate the two directions of traffic. This will reduce the initial construction cost as well as the long-term maintenance costs on KY 329 by requiring less pavement, although you would have the additional cost of the raised median.

The baseline assumption, KY 329 Alternate 1, also proposes to install traffic signals at the ramp terminals. Traffic signals increase the likelihood of higher severity crashes over stop conditions. By constructing a roundabout at the ramp terminals, you decrease the severity of any potential crashes in addition to allowing "free-flow" of the ramps to KY 329. Based on the value team's initial HCS investigation into the function of the dogbone interchange compared to DDI and the baseline, the delay per vehicle is lowest with the roundabouts (see attached table).

TITLE	Redesign the KY 329 Interchange

DISCUSSION & JUSTIFICATION (continued):

I - 71
OLDHAM COUNTY
ITEM 5-483.10
TRAFFIC ANALYSIS SUMMARY

ALTERNATIVE DESCRIPTION	2019 LEVEL OF SERVICE		2045 LEVEL OF SERVICE		2019 DELAY / VEH (sec/veh)		2045 DELAY / VEH (sec/veh)	
RAMPS / PEAK HOUR	NB RAMPS	SB RAMPS	NB RAMPS	SB RAMPS	AM	PM	AM	PM
KY 329 NO BUILD	F	F	F	F	304	26	1608	1456
KY 329 NO BUILD - INSTALL SIGNALS AT RAMP TERMINI	C	D	F	F	233	64	1423	1240
KY 329 ALT 1 - WIDEN KY 329 TO 7 LANES	B	B	B	C	20	20	106	120
KY 329 ALT 2 - WIDEN KY 329 AND RECONFIGURE TO DIVERGING DIAMOND	B	A	B	A	16	18	49	62
VE IDEA #1 - CONSTRUCT DOUBLE ROUNDABOUT AT I-71 AND KY 329 INTERCHANGE	A	B	A	D	15	19	36	18

NOTES:
FURTHER ANALYSIS OF THE DOUBLE ROUNDABOUT INCLUDED IN THE ENTIRE NETWORK IS RECOMMENDED TO VALIDATE VE STUDY INITIAL TRAFFIC ANALYSIS USING HCS METHODOLOGY.

TITLE	Redesign the KY 329 Interchange

DISCUSSION & JUSTIFICATION (continued):

In addition to the capacity and traffic flow that the DDI and Double Roundabouts offer, these two options have a safety benefit as well when compared to signalized intersection. Using the Safety Performance for Intersection Control Evaluation (SPICE), the DDI is predicted to prevent 33% of Total Crashes when compared to Traffic Signal. The DDI is predicted to prevent Fatal and Serious Injury Crashes by 41% when compared to Traffic Signals. The 2-lane roundabout is predicted to prevent 46% of Total Crashes when compared to Traffic Signal. SPICE tool does not include SPF for predicting fatal and injury crashes on 2-lane roundabouts, but a 2-lane roundabout is expected to prevent fatal and injury crashes compared to the Traffic Signal due to the traffic calming effect of traveling through a roundabout and also since the roundabout reduces high severity angle crashes such as when a vehicle runs a red light or doesn't yield to an oncoming vehicle.

There are constructability concerns with the baseline alternate in particular with constructing the new I-71 center pier in the middle of existing KY 329. From a MOT perspective, the design team can design KY 329 such that one direction of KY 329 would run on the existing lanes and the opposite direction would be new construction allowing a potential center pier (in the middle of the proposed raised median) to be constructed to the side of existing KY 329 (alternately, KY 329 clear spanned and piers constructed between the pedestrian facilities and the roadway). The value team would propose to shift KY 329 and have the SB lanes be new construction as this would provide additional room for the construction of the roundabout at the SB I-71 ramp terminal—in particular to minimize right of way impacts to the storage facility.

The dogbone interchange, if constructed would be a first in Louisville, although there is one off I-265 just north of the Ohio River in Indiana. Public involvement and public education efforts would be recommended to enhance the likelihood of acceptance by users. Acceptance of interchange users can be mitigated by showing them how the interchange would operate and how it will ultimately save them time and potential serious collisions when compared to the traditional interchange.

This proposal can be combined with others such as reducing the bridge clearance over KY 329 to provide further cost savings.

It should be noted that any cost avoidance/add with this proposal does not consider possible reduction of the I-71 mainline bridges. These could be reduced by approximately 25% due to the reduced roadway width over which they must span.

The value team recommends the design team run further traffic simulation on the dogbone interchange to verify the results of the value team's HCS analysis.

VALUE ENGINEERING PROPOSAL NO. 1

EC-25

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Redesign the KY 329 Interchange
Assumptions & Calculations	For the purpose of estimating Baseline Concept and Value Engineering Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
DGA	Ton	9,820	$25	$245,500	7,180	$25	$179,500
Asph Base PG64-22	Ton	6,730	$75	$504,750	2,630	$75	$197,250
Asph Base PG76-22	Ton	7,130	$80	$570,400	3,400	$80	$272,000
Asph Surf PG76-22	Ton	2,840	$88	$249,920	1,700	$88	$149,600
Rdwy Exc	CY	86,370	$15	$1,295,550	56,300	$15	$844,500
Embankment in Place	CY	35,500	$15	$532,500	28,750	$15	$431,250
Signals	Inter-section	2	$100,000	$200,000	0	$100,000	$0
Std. Barrier Median	SY	0	$60	$0	4,780	$60	$286,800
I71 NB Bridge (est. 25% reduction)	SF	16,714	$180	$3,008,520	12,536	$180	$2,256,390
I71 SB Bridge (est. 25% reduction)	SF	15,616	$180	$2,810,880	11,712	$180	$2,108,160
TOTAL				$9,418,000			$6,725,000
						Impact to Initial Cost (Baseline Less Proposed)	**$2,693,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 1

EC-25

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Redesign the KY 329 Interchange

Assumptions				
Interest/Discount Rate(%):	**4.0%**		**Economic Life (yrs):**	40

LIFE CYCLE COST ANALYSIS

Salvage & Replacement Costs			**Baseline Concept**		**VE Proposal**	
Item	**Description**	**Yr**	**Est Cost**	**Pres Worth**	**Est Cost**	**Pres Worth**
1	KY 329 Resurfacing	10	$250,000	$168,891	$150,000	$101,335
2	KY 329 Resurfacing	20	$250,000	$114,097	$150,000	$68,458
3	KY 329 Resurfacing	30	$250,000	$77,080	$150,000	$46,248
4	Traffic Signal Replacement	20	$100,000	$45,639	$0	$0
5	Bridge Deck Replacement	20	$500,000	$228,193	$375,000	$171,145
6						
7						
8						
9						
10						
Total Salvage & Replacement Costs			**$1,350,000**	**$633,900**	**$825,000**	**$387,186**

Annual Costs (pres worth calculated over 40 yrs)		**Baseline Concept**		**VE Proposal**	
Item	**Description**	**Est Cost**	**Pres Worth**	**Est Cost**	**Pres Worth**
1					
2					
3					
4					
5					
Total Annual Costs		**$0**	**$0**	**$0**	**$0**

SUMMARY	**Baseline Present Worth**	**Proposed Present Worth**
Total Present Worth (salvage+annual pres worth)	**$634,000**	**$387,000**
RESULTS (Proposed less Baseline)	**AVOID COST of $247,000**	

Notes: 1) Total Present Worth is rounded to the nearest thousand dollars, 2) Initial costs are covered in the Detail sheet.

Assumptions & Calculations: Any assumptions made or support calculations that were developed to support the quantities used in the LCC should be included.

VALUE ENGINEERING PROPOSAL NO. 2

EC-26

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Build new I-71 bridge over KY 329 with common I-71 median
FUNCTION	**Enhance Connectivity**

VE PROPOSAL SYNOPSIS:

Construct a 3-span bridge over KY 329 (no median pier) where the center span will span an 8-lane curb and gutter section with the multi-use path and sidewalk located behind the shoulder piers

Reliability	**Maintained**	**Functionality**	**Improved**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Improved**	**$397,000**

BASELINE CONCEPT DESCRIPTION:

Bifurcated along existing NB and SB, widened to the inside using part-width bridge construction. Proposed 4-span (60-70-70-60) twin bridges. Each twin bridge is 61-ft wide with 24-ft raised median in KY 329 for median pier.

VE PROPOSAL DESCRIPTION:

Shift mainline roadway alignment from the bifurcated section to a common median resulting in a new single 3-span bridge carrying both directions of traffic over KY329.

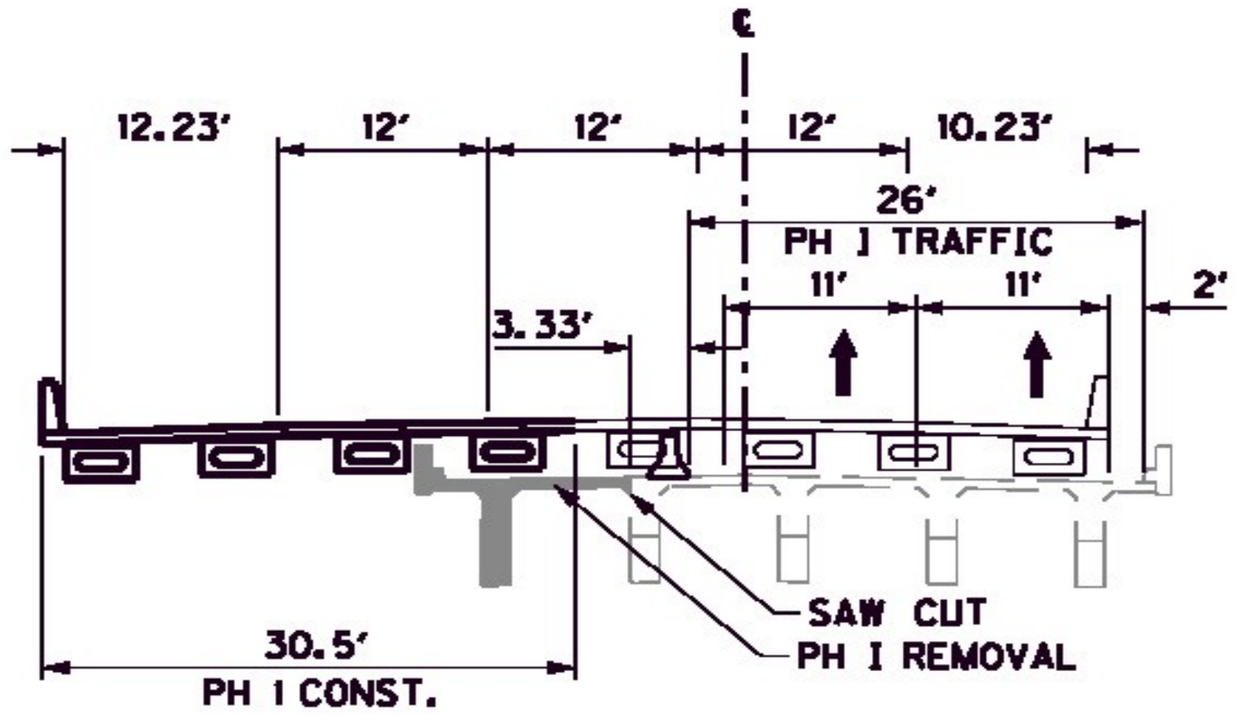
VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Eliminates part-width bridge construction	● Part of I-MOVEKY is reconstructed
● KY 329 including all 4 ramps can remain exactly as is today	● Adds cut and fill
● Interchange options are greatly expanded and can be constructed in the future	● Cut is mostly rock as seen in the median on the west/I-MOVEKY side
● Produces excess right-of-way that will be highly valuable to the future adjacent planned developments	●
● Construction of one bridge instead of two twin bridges	●
● Bridge and bridge approaches are constructed offline	●
● Expensive temporary shoring for substructure construction is eliminated	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$9,665,000	$369,000	$10,034,000
VE PROPOSAL:	$9,268,000	$395,000	$9,663,000
TOTAL (Baseline less Proposed)	$397,000	($26,000)	$371,000

AVOID COST

TITLE	Build new I-71 bridge over KY 329 with common I-71 median

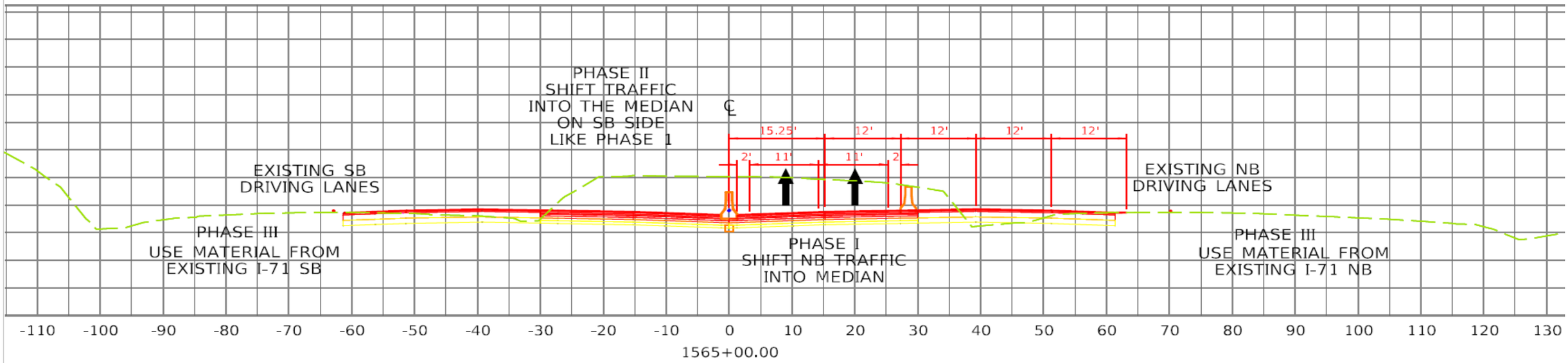
SKETCH/DIAGRAM: BASELINE CONCEPT



I–71 NORTHBOUND BRIDGE OVER KY 329
ALTERNATE 1
PHASE I MOT

TITLE	Build new I-71 bridge over KY 329 with common I-71 median

SKETCH/DIAGRAM: VE PROPOSAL



VALUE ENGINEERING PROPOSAL NO. 2

EC-26

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

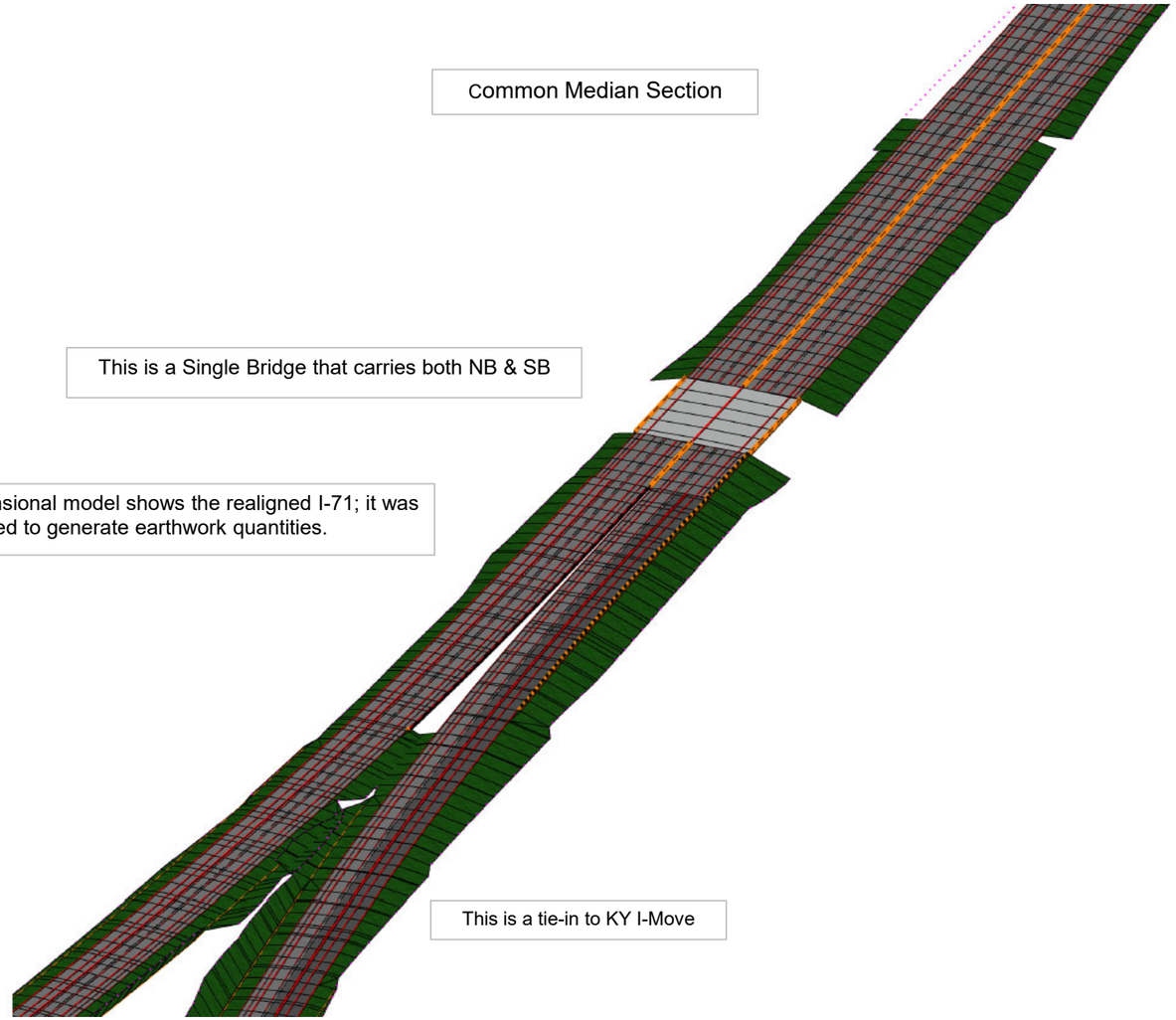
Oldham County, Item No. 5-483.10

TITLE	Build new I-71 bridge over KY 329 with common I-71 median

SKETCH/DIAGRAM: VE PROPOSAL

TITLE	Build new I-71 bridge over KY 329 with common I-71 median

SKETCH/DIAGRAM: VE PROPOSAL



VALUE ENGINEERING PROPOSAL NO. 2

EC-26

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Build new I-71 bridge over KY 329 with common I-71 median

DISCUSSION & JUSTIFICATION:

The baseline requires partial removal of the existing twin bridges and part-width construction of the proposed twin bridges at 3-4 ft higher and immediately adjacent. This will be extremely hard to accomplish as new shoulder piers will be on top of the existing end bents that will need to be partially removed and a 30-ft deep vertical excavation alongside them to construct the new shoulder piers. The temporary shoring to accomplish will be extremely expensive and does not appear to be included in the baseline cost estimate. The cost to construct this temporary shoring could easily be in the million dollar range. Conservatively we have used a $500,000 cost for this temporary shoring. Also, most of the fill will come from the adjacent NB and SB fill and moved just a short distance so the embankment cost could be half the $15 dollars per cubic yard, so we have used an embankment cost of $8 dollars per cubic yard. Lastly, lowering the clearance to 14.5' minimum would further reduce the amount of fill/cost. The risk to interstate traffic next to a 30-ft deep hole is also extremely high. The additional 3-4 ft height of the new bridge will require the existing I-71 pavement north and south of these twin bridges to be fully removed and reconstructed, so there is no advantage to construct these as a pavement widening and bridge widening.

The value team proposal is to extend the common median from station 1574+89 to the south/west side of our proposed bridge over KY 329, approximately station 1546+30. This will place construction of the new single, 3-span bridge well away from either of the existing bridges so the new bridge and approaches to the new bridge can be fully constructed with no disruption to existing traffic and eliminates complex phasing and expensive shoring. Even the approach roads in the baseline alternate will require expensive shoring to construct the first phase as they will be next to and 3 to 4 feet higher than the existing road. Eliminating the complex and expensive phasing will have a significant benefit to both MOT and schedule.

One offshoot to this concept is that the proposed bridge can also be constructed as twin bridges such that each twin bridge is far enough away from the existing bridge to eliminate shoring. etc. Doing this will allow transitioning back into the I-MOVE section much quicker, thus reducing the length of added roadway to construct to tie back into I-MOVE and the amount of fill required could be greatly reduced.

VALUE ENGINEERING PROPOSAL NO. 2

EC-26

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Build new I-71 bridge over KY 329 with common I-71 median
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB. The Baseline cost does not appear to include the added difficulty of partial width construction which will be more difficult than normal due to the 3-4 foot difference in profile grade which will add at least 25% and most likely 50% to the unit bridge cost including bridge removal; the VE team used 35% as a mark-up to quantify the difficulty.

DESIGN ELEMENT	Mark-up	BASELINE CONCEPT				VE PROPOSAL		
Description	%	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
NB Bridge	35.00%	SF	16,714	$180	$4,061,502			
SB Bridge	35.00%	SF	15,616	$180	$3,794,688			
Remove NB Bridge	35.00%	LS	1	$120,000	$162,000			
Remove SB Bridge	35.00%	LS	1	$120,000	$162,000			
Proposed Median Bridge		SF				34,650	$180	$6,237,000
Remove NB Bridge		LS				1	$120,000	$120,000
Remove SB Bridge		LS				1	$120,000	$120,000
Added Roadway Length NB (see NOTE 1 below)		Miles				0.15	$ 2,179,915	$326,987
Added Roadway Length SB (see NOTE 1 below)		Miles				0.29	$ 2,179,915	$632,175
Embankment from beginning to 1574+89		CY	65,685	$15	$985,275	229,000	$8	$1,832,000
Temporary Shoring		LS	1	$500,000	$500,000	0	$500,000	$0
NOTE 1: Baseline Pavement Cost = $20,622,000; Project Length = 4.72 miles; Cost per mile = $4,359,831; Cost per mile NB or SB = **$2,179,915**								
TOTAL					$9,665,000			$9,268,000
							Impact to Initial Cost (Baseline Less Proposed)	**$397,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 2

EC-26

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Build new I-71 bridge over KY 329 with common I-71 median

Assumptions				
Interest/Discount Rate(%):	**4.0%**		**Economic Life (yrs):**	40

LIFE CYCLE COST ANALYSIS

Salvage & Replacement Costs			Baseline Concept		VE Proposal	
Item	**Description**	**Yr**	**Est Cost**	**Pres Worth**	**Est Cost**	**Pres Worth**
1	Bridge Deck Replacement	20	$808,250	$368,875	$866,250	$395,345
2						
3						
4						
5						
6						
7						
8						
9						
10						
Total Salvage & Replacement Costs			**$808,250**	**$368,875**	**$866,250**	**$395,345**

Annual Costs (pres worth calculated over 40 yrs)		Baseline Concept		VE Proposal	
Item	**Description**	**Est Cost**	**Pres Worth**	**Est Cost**	**Pres Worth**
1					
2					
3					
4					
5					
Total Annual Costs		**$0**	**$0**	**$0**	**$0**

SUMMARY	Baseline Present Worth	Proposed Present Worth
Total Present Worth (salvage+annual pres worth)	**$369,000**	**$395,000**
RESULTS (Proposed less Baseline)	**ADD COST of $26,000**	

Notes: 1) Total Present Worth is rounded to the nearest thousand dollars, 2) Initial costs are covered in the Detail sheet.

Assumptions & Calculations: Any assumptions made or support calculations that were developed to support the quantities used in the LCC should be included.

VALUE ENGINEERING PROPOSAL NO. 3

EC-24

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Review capacity and safety options for KY 146
FUNCTION	**Enhance Connectivity**

VE PROPOSAL SYNOPSIS:

Provide low cost improvement options which would improve capacity, functionality, and prevent crashes by constructing a continuous Green-T intersection which includes a Partial Median U-Turn on KY 146 and square up turn radius involving I-71 northbound and southbound ramps onto KY 146.

Reliability	**Improved**	**Functionality**	**Improved**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Maintained**	**($255,000)**

BASELINE CONCEPT DESCRIPTION:

A No-Build with Install Signal at Southbound Ramp Terminal alternate at the I-71 @ KY 146 intersection. This alternate includes installing a signal at the I-71 Southbound Ramps at KY 146 intersection which is currently stop controlled on the ramps. The I-71 Northbound Ramps at KY 146 is currently signalized.

VE PROPOSAL DESCRIPTION:

The value team analyzed five options for the I-71 @ KY 146 Intersection: (Option A) constructing a Continuous Green-T intersection, (Option B) constructing a Partial Median U-Turn, (Option C) tightening and square up the right turn radius for the right turns from the I-71 Northbound and Southbound Off Ramps, (Option D) install oversized "Do Not Enter" and "Wrong Way" Signs with Red Reflective Panel strips on posts, and (Option E) constructing a double roundabout.

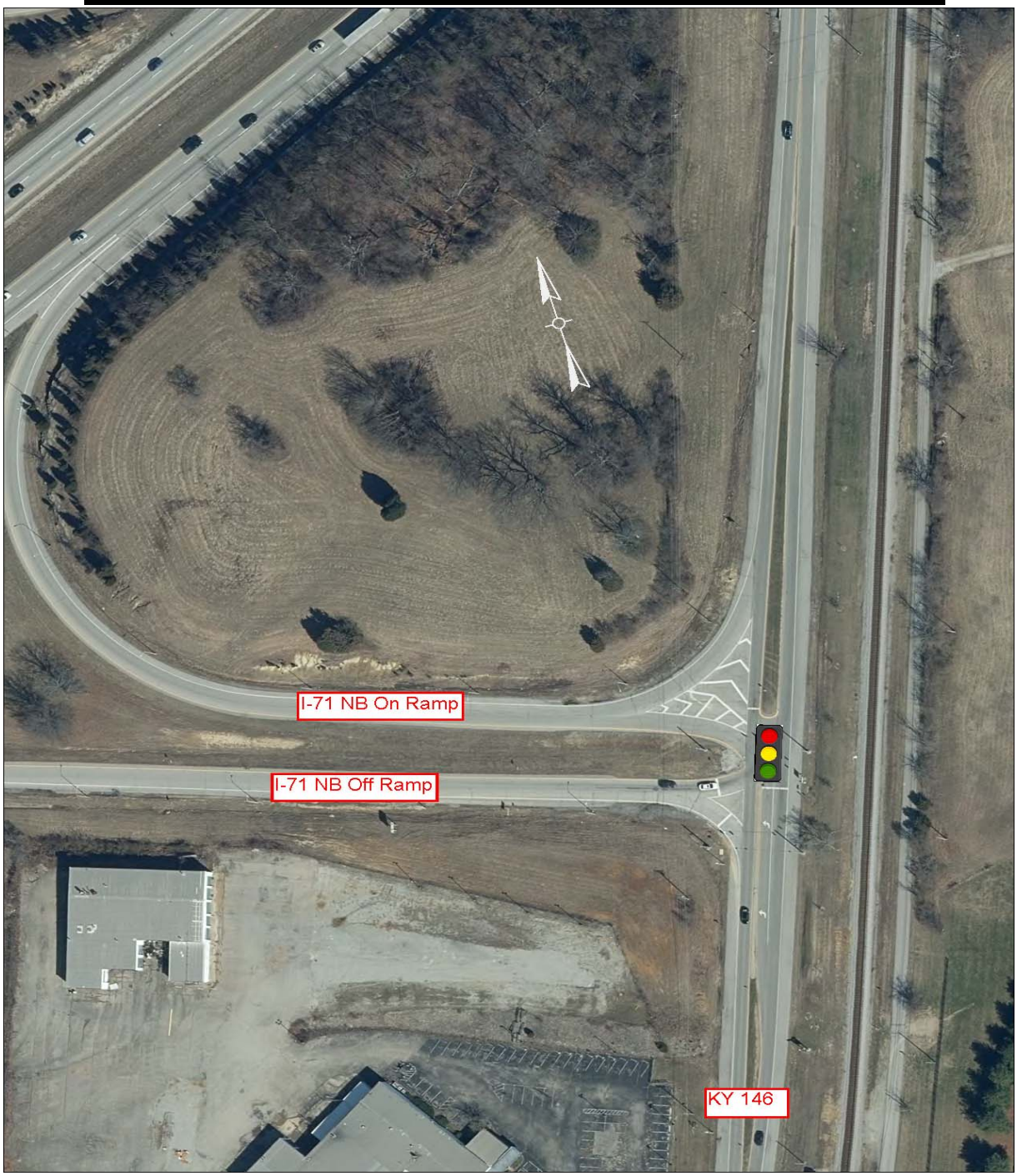
VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
• Increased safety by reducing serious injuries and potential fatal crashes	• Public Perception regarding the partial median U-turn (Atypical movement)
• Potential increase to capacity	• Potential impacts to utilities
• High Function vs Low cost value	• Potential impacts contributed to the partial median U-turn
•	• Creates a merge/weave traffic pattern
•	•
•	•
•	•

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$0	$0	$0
VE PROPOSAL:	$255,000	$0	$255,000
TOTAL (Baseline less Proposed)	($255,000)	$0	($255,000)

ADD COST

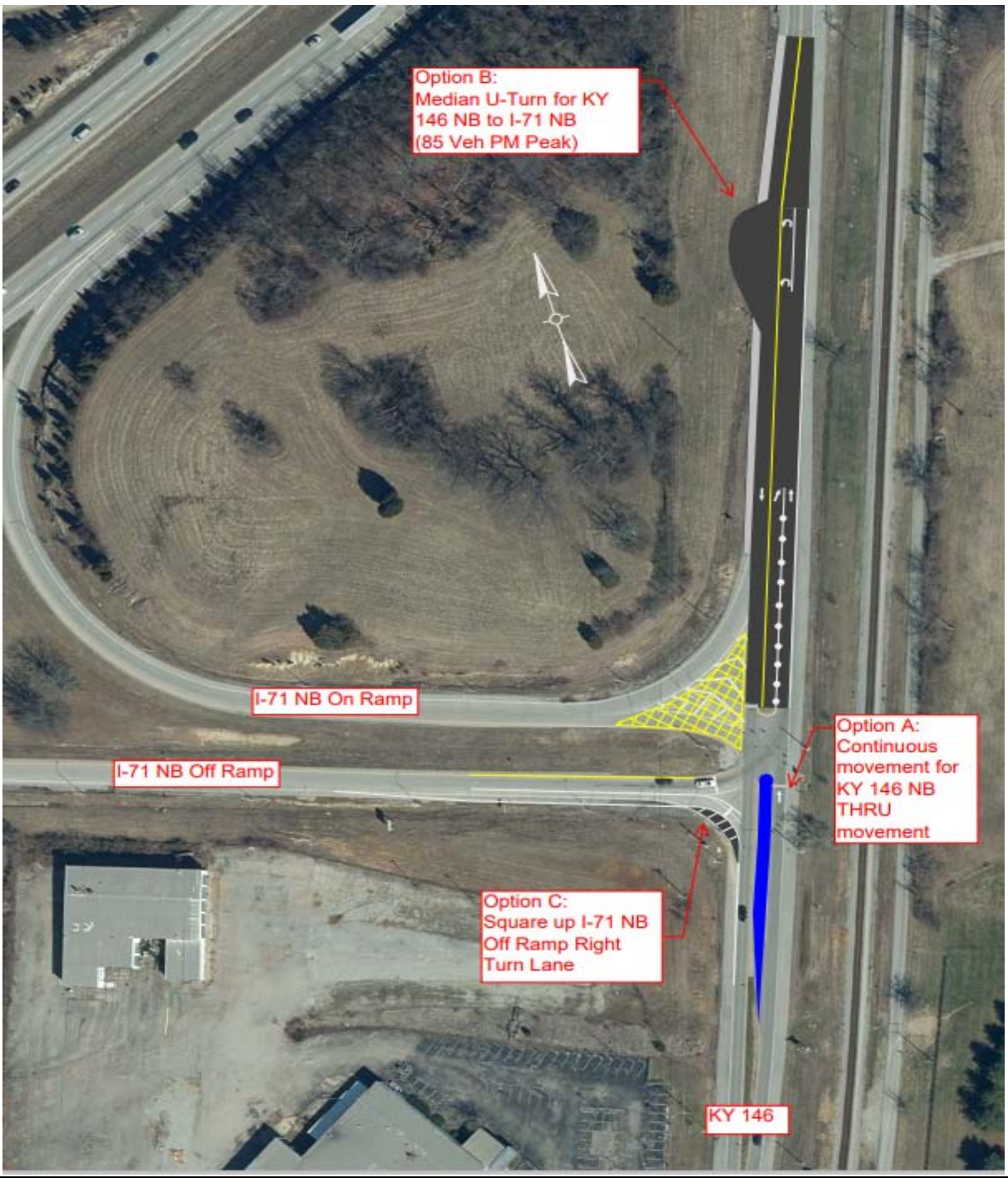
TITLE	Review capacity and safety options for KY 146

SKETCH/DIAGRAM: BASELINE CONCEPT



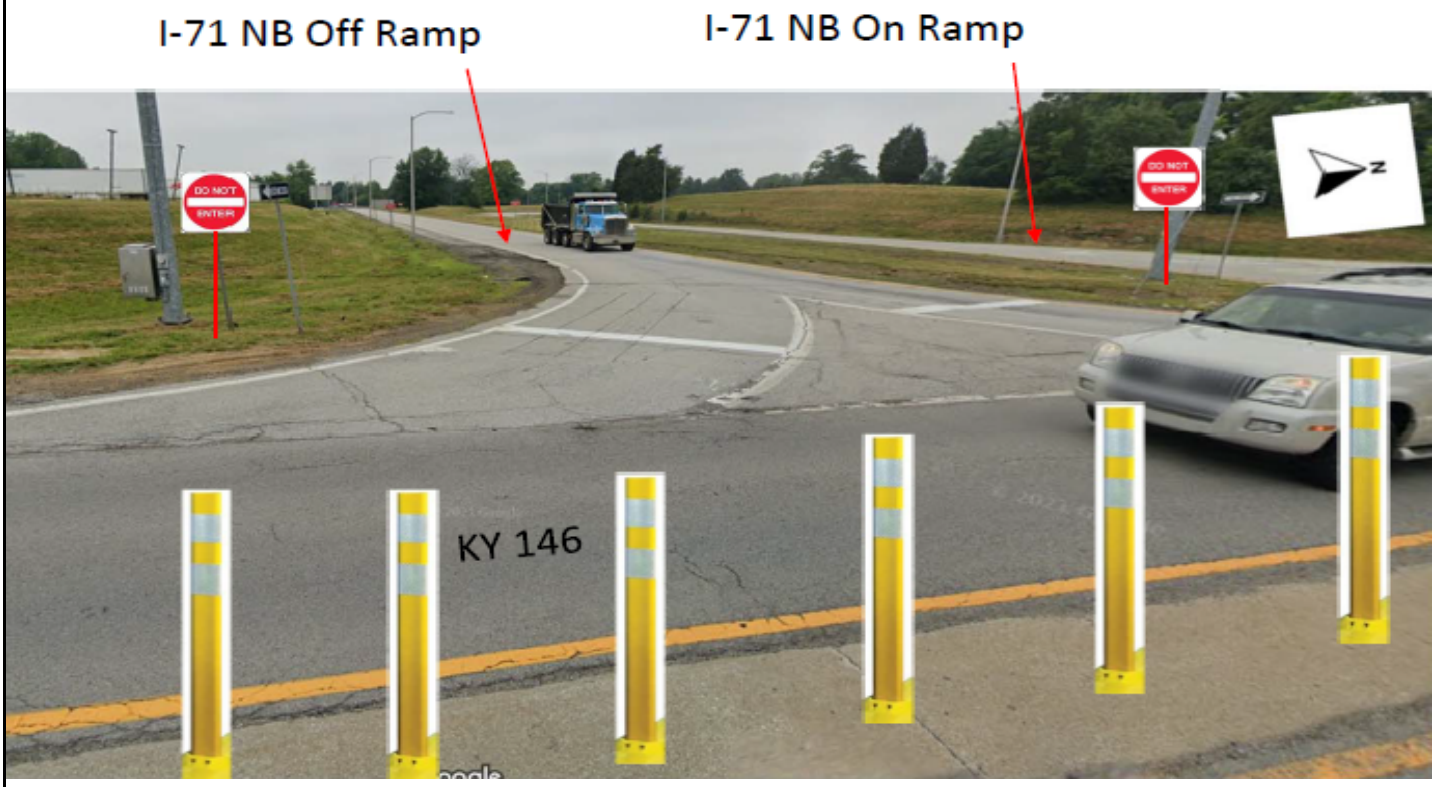
TITLE	Review capacity and safety options for KY 146

SKETCH/DIAGRAM: VE PROPOSAL



TITLE	Review capacity and safety options for KY 146

SKETCH/DIAGRAM: VE PROPOSAL



Option D

VALUE ENGINEERING PROPOSAL NO. 3

EC-24

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Review capacity and safety options for KY 146

DISCUSSION & JUSTIFICATION:

Baseline: The VE Team recognizes the Design and Project Teams selected a No-Build with Install Signal at Southbound Ramp Terminal alternate at the I-71 @ KY 146 intersection. The I-71 Northbound Ramps at KY 146 is currently signalized. Further improvements are being postponed due to cost constraints of the project.

I-71 Northbound at KY 146 intersection currently operates at LOS C for 2019 and is expected to operate at LOS E for the design year 2045. I-71 Southbound at KY 146 Intersection would operate at LOS C under signalized control and is expected to operate at LOS C for the design year 2045. The I-71 Northbound at KY 146 intersection experienced 14 total crashes during 5-year crash history with 2 of those crashes involving an injury collision. The I-71 Southbound at KY 146 intersection experienced 19 total crashes with 1 of those crashes involving an injury.

Recommendation: The VE Team believes we may be able to provide low cost improvement options which would improve capacity and prevent crashes. The value team analyzed the following options within this general concept:

Option A – Construct a Continuous Green-T (CGT) intersections for I-71 Northbound @ KY 146 Intersection
Option B – Construct a Partial Median U-Turn for KY 146 Northbound Left Turns onto I-71 Northbound
Option C – Tighten and square up the right turn radius for the right turns onto KY 146 from the I-71 Northbound and Southbound Off Ramps
Option D – Install oversized "Do Not Enter" and "Wrong Way" Signs with Red Reflective Panel strips on posts.
Option E – Construct a double roundabout at the KY 146 Interchange, utilizing a single-lane roundabout

The recommended concept as mentioned above shows five different options to consider at this intersection.

Option A was considered because the value team believed this proposal would help increase capacity and improve safety at the I-71 Northbound and KY 146 Intersection. Constructing a CGT intersection would allow KY 146 Northbound Thru vehicles (375 vehicles for 2019 PM Peak Hour) to have a continuous green signal and become free flow movement. Using the Capacity Analysis for Planning of Junctions (CAPx), constructing CGT intersection would improve volume to capacity ratio from 0.58 for the existing signal to 0.43 for the CGT in 2019 Design Year. For the 2045 Design Year, the volume to capacity ratio for the signal is 1.01 and the CGT is 0.81. Using the Safety Performance for Intersection Control Evaluation (SPICE), the CGT is predicted to reduce Fatal and Serious Injury Crashes by 15%.

TITLE	Review capacity and safety options for KY 146

DISCUSSION & JUSTIFICATION (continued):

Option B was considered because the value team believed this proposal would help increase capacity and improve safety at the I-71 Northbound and KY 146 Intersection. Constructing a partial median U-turn would eliminate KY 146 Northbound left turn vehicles (85 vehicles for 2019 PM Peak Hour) from turning left onto I-71 NB on ramp at the signalized intersection. The left turning vehicles would travel thru the intersection and utilize a median U-turn to then travel southbound on KY 146 and turn right onto the I-71 NB on ramp. Using the Capacity Analysis for Planning of Junctions (CAPx), constructing partial median U-turn would improve volume to capacity ratio from 0.58 for the existing signal to 0.49 for the partial median U-turn in 2019 Design Year. For the 2045 Design Year, the volume to capacity ratio for the signal is 1.01 and the partial median U-turn is 0.87. Using SPICE, the partial median U-turn is predicted to reduce Fatal and Serious Injury Crashes by 22%.

Option C was considered because the value team believed this proposal would help improve safety at the I-71 Northbound and Southbound Off Ramps onto KY 146, specifically for the right turns. The improvement involves tightening up the right turn radius to prevent rear end collisions caused the stop-and-go maneuvers of vehicles turning right and looking over their shoulder. This improvement has a minimal effect on capacity, as vehicles will still be able to turn right on red. There were 2 crashes at the I-71 Northbound off ramp right turn and 7 crashes at the I-71 Southbound off ramp right turn.

Option D Install oversized "Do Not Enter" and "Wrong Way" Signs with Red Reflective Panel strips on posts. Install FG 300 Curb System on existing median to help delineate the left turns and provide visual barrier to prevent wrong way left turns on the Off Ramp.

Option E was considered because the value team believed this proposal would help improve safety at the I-71 and KY 146 Interchange. This option includes constructing a single lane roundabout at each ramp terminal. Using the Capacity Analysis for Planning of Junctions (CAPx), constructing roundabout at I-71 Northbound Intersection results in 0.66 volume to capacity ratio and 1.12 for the I-71 Southbound Intersection. The baseline alternate of installing a signal at the I-71 southbound intersection yields a 0.75 volume to capacity ratio, it is not recommended to construct the double roundabout at the KY 146 interchange.

TITLE	Review capacity and safety options for KY 146

DISCUSSION & JUSTIFICATION (continued):

The VE Team recommends further evaluation of the Option A, Option B, Option C, and Option D.

The VE Team did not specifically analyze the I-71 Southbound at KY 146 intersection, but some of these improvement options can be implemented at that intersection. Such as squaring up the right turn lanes on the off ramp and preventing wrong way drivers

Cost:

Cost Considerations with recommending Option A, Option B, Option C, Option D show a total estimating $255,000. The four main cost factors in this total includes: Full depth pavement-BASE, removing and replacing light poles, FG 300 Curb System, and miscellaneous costs associated with striping, signing, and removal (which can be seen below). All other costs included are relatively minor in the grand scheme of overall costs.

Full Depth Pavement-BASE = 770 TONS x $75/TON= $57,750

Remove/Relocate Light Poles= 2 poles at $25,000 each= $50,000

FG 300 Curb System= 405 LF x $100/LF= $40,500

Miscell - Striping, Signing, and Removal= 1 LS x $50,000 LS= $50,000

Implementation Considerations:

The VE team would like to mention the following implementation considerations when assessing Option B:

- Freight (Semi-trucks) Traffic when considering the median U-turn consideration for traffic
- Any utilities which might be impacted by these proposed options

VALUE ENGINEERING PROPOSAL NO. 3

EC-24

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Review capacity and safety options for KY 146
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Full Depth Pavement - BASE	TON				770	$75	$57,750
DGA BASE	TON				604	$25	$15,094
Resurface	TON				139	$88	$12,233
Raised Median	SY				239	$60	$14,333
FG 300 Curb System	LF				405	$100	$40,500
Remove and Relocate Light Pole	EA				2	$25,000	$50,000
Earthwork	CY				1,000	$15	$15,000
Miscell. - Striping, Signing, Remove Pavement, etc.	LS				1	$50,000	$50,000
TOTAL				$0			$255,000
						Impact to Initial Cost (Baseline Less Proposed)	**($255,000)**

Note: Total costs are rounded to the nearest thousand dollars.

ADD COST

VALUE ENGINEERING PROPOSAL NO. 4

EC-19

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures
FUNCTION	**Enhance Connectivity**

VE PROPOSAL SYNOPSIS:

Reconstruct the Glenarm Rd. overpass (superstructure only) on the existing tangent alignment reusing existing substructures.

Reliability	**Maintained**	**Functionality**	**Maintained**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Improved**	**$1,040,000**

BASELINE CONCEPT DESCRIPTION:

Glenarm Rd. is relocated on a new parallel alignment so piers and end bents are fully reconstructed and new approach roads are needed, with each constructed along reverse curves. Right-of-way purchase is required to construct the new approach roads.

VE PROPOSAL DESCRIPTION:

Reconstruct superstructure on existing piers and end bents, raising the cap elevations to achieve 16'-6" minimum vertical clearance. Accelerated Bridge Construction (ABC) will be utilized to minimize Glenarm Rd. closure time due to 8-mile detour.

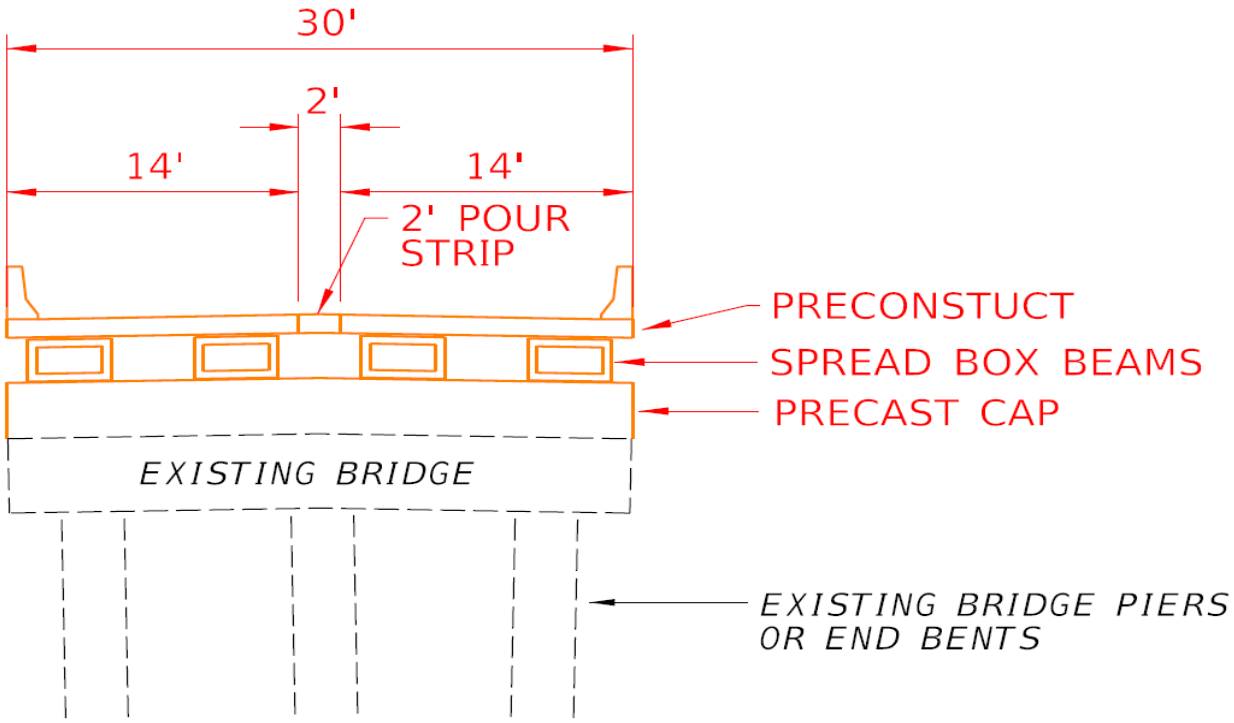
VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Reduces cost	● Traffic will need to detour for about a month
● Improves schedule	●
● Tangent alignment is better than reverse curves at each end	●
● Stays within existing right-of-way	●
● Utilizes existing piers and end bents, greatly improves MOT on I-71	●
● Removes existing superstructure only as baseline also removes 3 piers and 2 end bents	●
●	●

$ COST SUMMARY	**Initial Costs**	**O&M Costs**	**Total Life Cycle Cost**
BASELINE CONCEPT:	$1,922,000	$0	$1,922,000
VE PROPOSAL:	$882,000	$0	$882,000
TOTAL (Baseline less Proposed)	$1,040,000	$0	$1,040,000

AVOID COST

TITLE	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures

SKETCH/DIAGRAM: BASELINE CONCEPT & VE PROPOSAL



VALUE ENGINEERING PROPOSAL NO. 4

EC-19

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures

DISCUSSION & JUSTIFICATION:

The existing 240-ft, 4-span (50'-70'-70'-50') RCDG bridge has haunched girders that do not allow adequate clearance for the widened I-71 template so the bridge needs to be reconstructed to provide the required clearance. The primary reason for the baseline alternate to reconstruct Glenarm Rd. along a new alignment is due to the 8-mile detour .if constructed along the existing alignment, the user cost/inconvenience could be significant due to the bridge having to be closed for a long time.

Therefore to minimize impact on the traffic this proposal uses Accelerated Bridge Construction to minimize the road closure time and reconstruct the superstructure as required to achieve the necessary clearance. It also uses the existing 3 piers and end bents which greatly expedites the construction time and thus minimizes road closure. Using the existing piers also eliminates the lengthy disruption and MOT issues related to constructing these 3 piers adjacent to I-71 traffic.

The primary concept is to raise the cap elevations of the 3 piers and use standard concrete I or spread box beams to achieve adequate clearance. Precast concrete caps are proposed that can be placed on top of the existing pier caps to achieve the required pier cap elevations and fixed to the existing cap using grouted dowels. The superstructure construction can be expedited by constructing spans offline before closing traffic so each span can be lifted and set into place. The proposed sketch shows a 4-beam typical where 2 beams with the concrete deck are constructed offline and is connected to the other half using a CIP pour strip

VALUE ENGINEERING PROPOSAL NO. 4

EC-19

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB. Bridge removal for VE Proposal is superstructure only, no substructures so we used half of the full bridge removal cost which included 3 piers and 2 endbents.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
New Bridge (see **NOTE 1**)	SF	8,184	$160	$1,309,440	7,200	$100	$720,000
Bridge Removal	LS	1	$90,000	$90,000	1	$45,000	$45,000
Earthwork	LS	1	$305,773	$305,773	0		
Pavement	LS	1	$216,488	$216,488	1	$117,000	$117,000
NOTE 1: The baseline concept cost includes the cost to completely construct the substructures whereas the VE proposal cost reuses the existing substructures.							
TOTAL				$1,922,000			$882,000
						Impact to Initial Cost (Baseline Less Proposed)	**$1,040,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 5

ST-15

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Construct short-term, low cost improvements at KY 329
FUNCTION	**Separate Traffic**

VE PROPOSAL SYNOPSIS:

Provide short-term, low cost improvement options which would improve capacity and prevent crashes at the I-71 and KY 329 Interchange. These improvement options include constructing single lane roundabout, squaring up the right turn lane radius from ramps to KY 329, adding a right turn added lane onto KY 329 from I-71 Northbound off ramp, and access management along KY 329.

Reliability	**Improved**	**Functionality**	**Improved**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Maintained**	**($4,000)**

BASELINE CONCEPT DESCRIPTION:

KY 329 has two lanes in each direction with multiple turn lanes at the I-71 ramp terminals. Traffic signals will be constructed at the ramp terminals.

VE PROPOSAL DESCRIPTION:

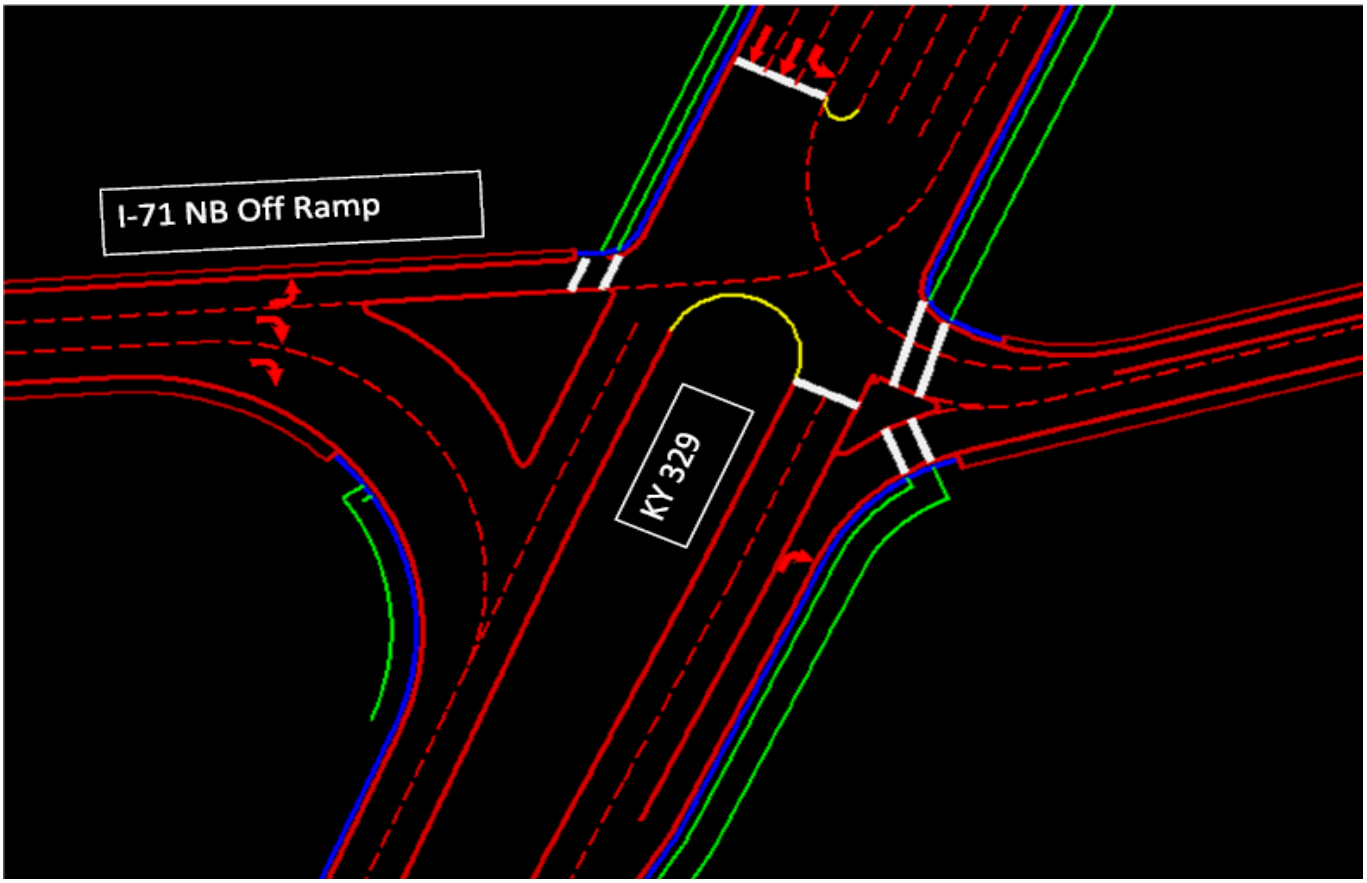
Construct low cost improvements to KY 329 interchange. Squaring up the right turns, added a right turn lane from the off ramp, and access management can all be incorporated with the Baseline Concept. The single lane roundabout may be implemented for the design year until the traffic exceeds what the single lane roundabout can handle.

VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Improves sight lines at right turns	● None apparent
● Reduces angle collisions along the entrances on KY 329	●
● Allows longer term plan for KY 329 corridor to be developed	●
●	●
●	●
●	●
●	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$0	$0	$0
VE PROPOSAL:	$4,000	$0	$4,000
TOTAL (Baseline less Proposed)	($4,000)	$0	($4,000)
			ADD COST

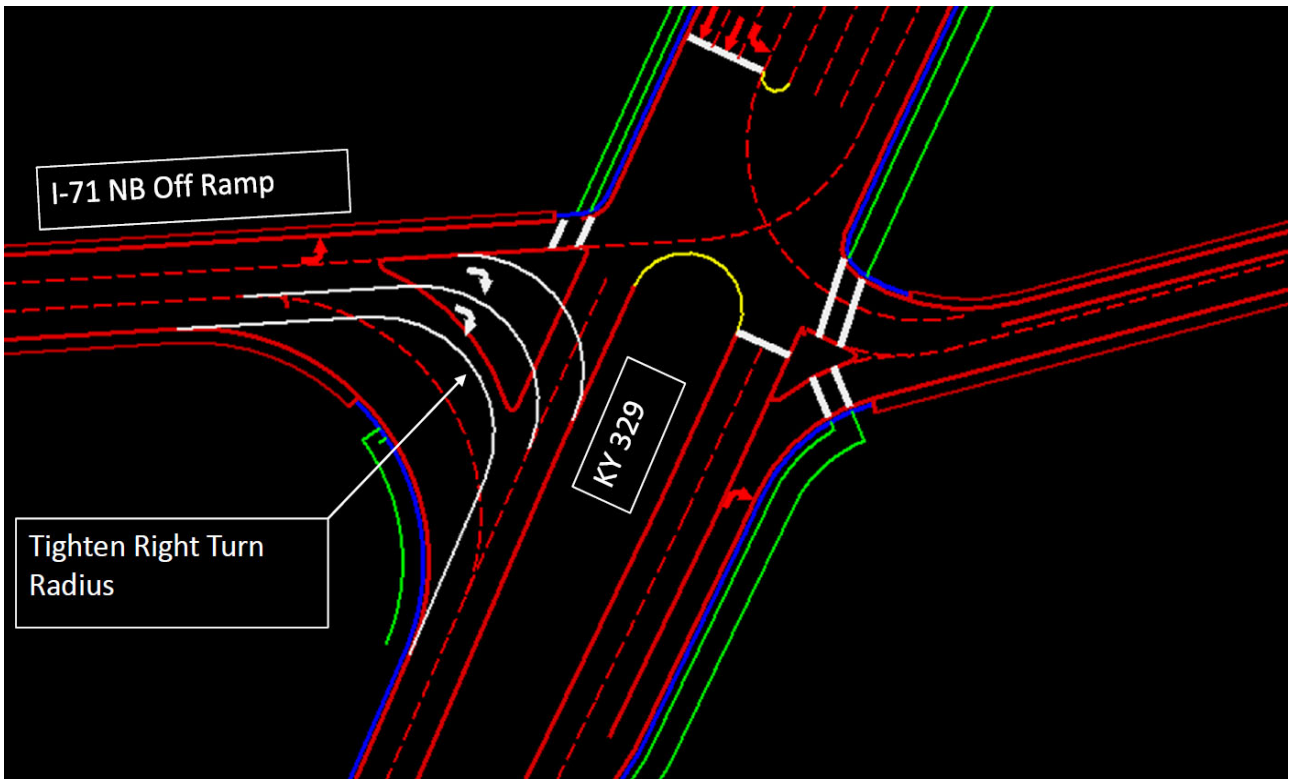
TITLE	Construct short-term, low cost improvements at KY 329

SKETCH/DIAGRAM: BASELINE CONCEPT



TITLE	Construct short-term, low cost improvements at KY 329

SKETCH/DIAGRAM: VE PROPOSAL



VALUE ENGINEERING PROPOSAL NO. 5

ST-15

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

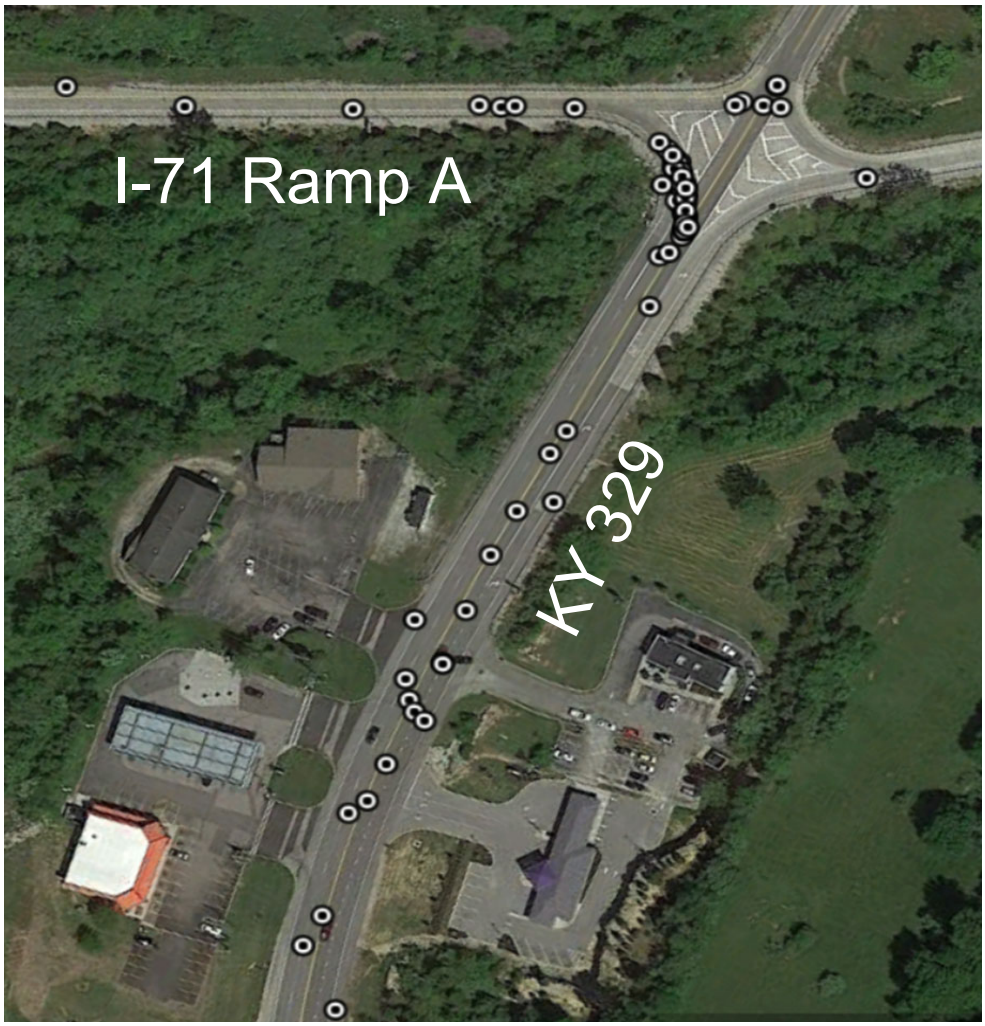
Oldham County, Item No. 5-483.10

TITLE	Construct short-term, low cost improvements at KY 329

DISCUSSION & JUSTIFICATION:

This value proposal includes multiple small cost safety improvements to the baseline.

I-71 at KY 329 intersection currently operates at LOS F for 2019 and is expected to operate at LOS C/D if signals are installed at the ramps with no build alternative. The I-71 Northbound at KY 329 intersection experienced a high number of crashes during 5-year crash history. There are approximately 42 rear end crashes on the right turn slip ramp from I-71 NB onto KY 329. See the graphic below showing the cluster of crashes along the right turn slip ramp. The graphic also shows the 15 angle crashes along KY 329 that involve vehicles entering and exiting entrances along KY 329.



TITLE	Construct short-term, low cost improvements at KY 329

DISCUSSION & JUSTIFICATION (continued):

Option A: Square up the off ramp right turn at I-71 northbound at KY 329 Ramp A.

By pulling the right turn radii in closer to the proposed signals, you improve the angle at which the right turn driver must look for oncoming traffic. As the angle becomes more obtuse, the driver must look further over their shoulder prior to beginning their turn. This leads to an increase in anticipated collisions.

The VE Team proposes to tighten the radius for the right turns. This can be achieved with the existing pavement footprint by installing hatching to force vehicles to use the tighter radius while still allowing for truck tracking in the hatched area.

This proposal will improve intersection reliability by reducing the number of anticipated collisions while not increasing project costs. The maintenance of traffic and long term maintenance is unchanged with the exception of maintenance associated with the hatching areas.

Option B: Build a single lane roundabout at each ramp terminus in lieu of conventional diamond interchange (Alt 1).

The VE Team ran a HCS analysis on the effectiveness of a single lane roundabout. The analysis showed that a single lane roundabout would perform at Level of Service A/B in the design year. However, this is only an interim solution as a single lane roundabout fails before the design year.

Based on the limited functional lifespan of a single lane roundabout combined with the relatively high implementation cost, the VE Team anticipates construction of single lane roundabouts may not have a favorable benefit/cost ratio compared to other options. Because of this, a cost estimate was not developed for this option.

Based on the cursory review of the two alternates, the VE Team recommends implementation of **Option A** with this VE Proposal.

VALUE ENGINEERING PROPOSAL NO. 5

ST-15

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Construct short-term, low cost improvements at KY 329
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Thermo Hatching							
KY 329 Ramp A	SF	0	$5	$0	450	$5	$2,250
KY 329 Ramp C	SF	0	$5	$0	140	$5	$700
KY 146 Ramp A	SF	0	$5	$0	70	$5	$350
KY 146 Ramp C	SF	0	$5	$0	70	$5	$350
TOTAL				$0			$4,000
						Impact to Initial Cost (Baseline Less Proposed)	**($4,000)**

Note: Total costs are rounded to the nearest thousand dollars.

ADD COST

VALUE ENGINEERING PROPOSAL NO. 6

ST-04

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Construct Class IV wall in lieu of Class V wall
FUNCTION	**Separate Traffic**

VE PROPOSAL SYNOPSIS:

In a scenario where full median shoulders are provided, it is suggested KYTC consider TL 4 concrete median barrier. The TDOT wall takes approximately 21% less concrete to construct. Reinforcement steel was considered to be equivalent. Maintenance life cycle costs for either concrete median barrier are considered equal.

Reliability	**Maintained**	**Functionality**	**Maintained**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Maintained**	**$97,000**

BASELINE CONCEPT DESCRIPTION:

KYTC has indicated to use KYTC Barrier wall 12C per the standard drawings in the cost estimates provided, but the shape of this wall is not MASH compliant. It has been mentioned in previous projects that a 56-inch tall TL 5 concrete median barrier should be used to take the place of Type 12C.

VE PROPOSAL DESCRIPTION:

Consider use of 51-inch tall TL 4 concrete median barrier, especially in areas with wider medians and shoulders.

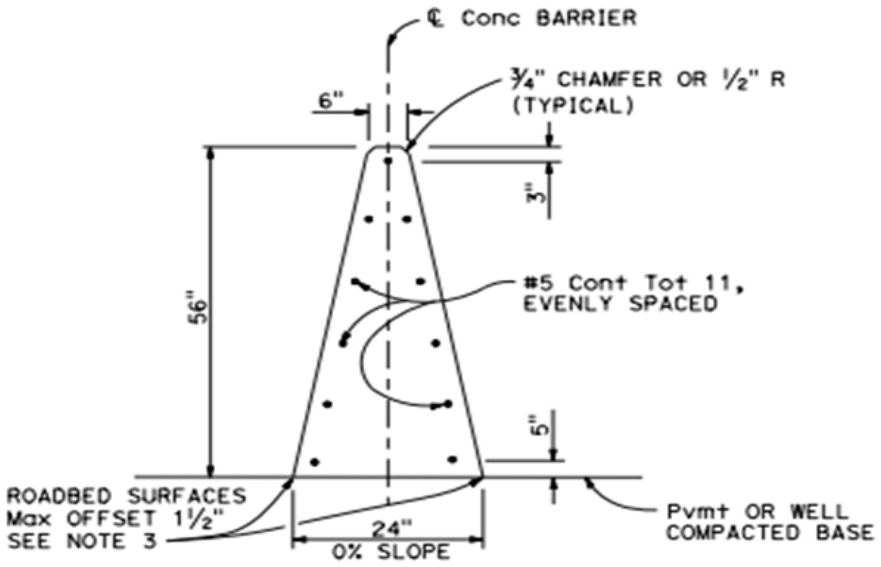
VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Cost savings for materials	● Minor reduction in crash performance
●	●
●	●
●	●
●	●
●	●
●	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$539,000	$0	$539,000
VE PROPOSAL:	$442,000	$0	$442,000
TOTAL (Baseline less Proposed)	$97,000	$0	$97,000

AVOID COST

TITLE	Construct Class IV wall in lieu of Class V wall

SKETCH/DIAGRAM: BASELINE CONCEPT



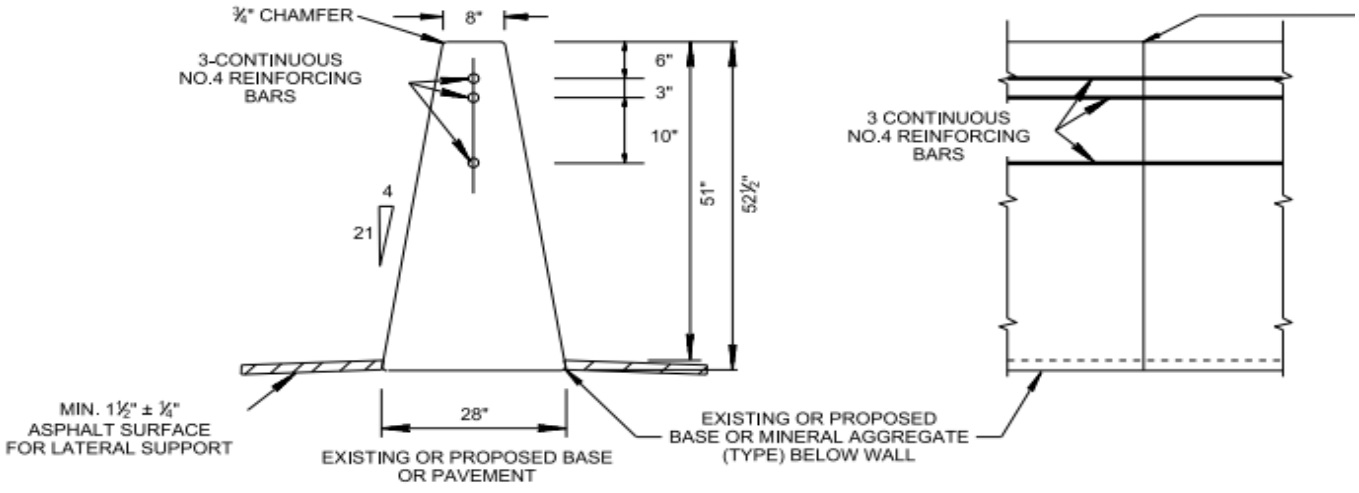
CONCRETE BARRIER TYPE 60MG

(Monolithic concrete
glare screen/barrier)

Detail from Caltrans Standard Plans. The Type B wall as detailed in the Preliminary line and grade plans has a base of 32" wide and a top projected to be 10.75" wide (based on constant slope of TDOT wall).

TITLE	Construct Class IV wall in lieu of Class V wall

SKETCH/DIAGRAM: VE PROPOSAL



51" HEIGHT WALL

(J) MIN. SAFETY PERFORMANCE OF 51" SINGLE SLOPE WALL IS ACCEPTABLE ACCORDING TO THE TL-4 EVALUATION CRITERIA SPECIFIED IN NCHRP REPORT 350.

(K) IF GRADE SEPARATION EXCEEDS 2' USE S-SSMB-9 INSTEAD.

VALUE ENGINEERING PROPOSAL NO. 6

ST-04

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Construct Class IV wall in lieu of Class V wall

DISCUSSION & JUSTIFICATION:

KYTC has indicated in the cost estimates provided that KYTC Barrier Wall Type 12C is to be used on the project. The shape of this wall presently is not compliant with the AASHTO Manual for Assessing Safety Hardware (MASH) so it is expected this will have to be changed. The value team recommends that a barrier wall meeting TL 4, similar to the 51" TDOT barrier wall currently being used on the adjacent I-71 widening project, be used for this project.

In general, research and common practice from other states, including TN, indicates that a concrete median with TL 4 is acceptable for use on the interstate. It was determined that the suggestion to KYTC be made that a TL 4 concrete median barrier be used in areas where full median shoulders are to be in place. In this situation, with a 12- to 14-foot median shoulder along with median barrier width itself, establishes a width between opposing traffic lanes of 26 to 30 feet. With the full shoulder, a larger vehicle will have more width to recover and if does strike the wall, there is a greater chance that the vehicle will not be on as severe a crash angle, keeping the vehicle on their side of the median wall.

To summarize, in a scenario where full median shoulders are provided, it is suggested KYTC consider TL 4 concrete median barrier. The TDOT wall takes approximately 21% less concrete to construct than a TL 5 wall, similar to the Caltrans wall used for comparison purposes. Reinforcement steel was considered to be equivalent. Maintenance life cycle costs for either concrete median barrier are considered equal. While the proposal of the TL-4 wall will yield a higher cost than the original estimate of the 12C wall, the 12C wall is not MASH compliant and would require the use of a different wall. As stated above, the TL-5 wall would be the typical replacement for this wall based on previous project conversations. The original estimate should be updated to include the price of a TL-5 wall in lieu of the 12C wall and the VE proposal would be to use the TL-4 wall in the place of the TL-5 wall.

VALUE ENGINEERING PROPOSAL NO. 6

ST-04

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Construct Class IV wall in lieu of Class V wall
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
CONCRETE MEDIAN BARRIER-56" (MATERIALS ONLY), vs TL 4 51"	CY	3,990	$135	$538,650	3,277	$135	$442,395
TOTAL				$539,000			$442,000
						Impact to Initial Cost (Baseline Less Proposed)	**$97,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 7

CT-03

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Defer auxiliary lane construction to a future date
FUNCTION	**Control Traffic**

VE PROPOSAL SYNOPSIS:

Reconsider including auxiliary lanes in the project for I-71 based on additional information from cost benefit analysis updates.

Reliability	**Maintained**	**Functionality**	**Maintained**	**$ Initial Cost Avoidance (Add)**
O&M	**Improved**	**Schedule Impact**	**Improved**	**$5,142,000**

BASELINE CONCEPT DESCRIPTION:

Auxiliary lanes for both I-71 NB and SB from KY 329 to KY 146. Inclusion of this work is based upon cost benefit analysis provided.

VE PROPOSAL DESCRIPTION:

Consider eliminating the construction of the auxiliary lanes as part of this project based on additional parameters to be considered in the cost benefit analysis.

VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Reduces cost	● Small reduction in capacity
● Reduces footprint and right-of-way	● Small reduction in safety crash prediction
● Reduces long term maintenance and guardrail lengths	●
●	●
●	●
●	●
●	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$56,102,000	$430,000	$56,532,000
VE PROPOSAL:	$50,960,000	$0	$50,960,000
TOTAL (Baseline less Proposed)	$5,142,000	$430,000	$5,572,000
			AVOID COST

VALUE ENGINEERING PROPOSAL NO. 7

CT-03

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Defer auxiliary lane construction to a future date

SKETCH/DIAGRAM: VALUE PROPOSAL

During Preliminary Design, the below table was used that shows Benefit Cost Summary for the alternates. The "benefit" is a combination of the travel time savings and crash reduction savings. The additional cost to construct auxiliary lanes is $5.1 million.

SECTION	ALTERNATIVE DESCRIPTION	20 YEAR TRAVEL TIME SAVINGS	20 YEAR CRASH REDUCTION SAVINGS	20 YEAR TOTAL TRAVEL TIME AND CRASH REDUCTION SAVINGS	COST OF IMPROVEMENTS	COMBINED BENEFIT / COST RATIO
MAINLINE	MAINLINE ALT 1 - 14' MED SHOULDER	$75,750,000	$123,580,000	$199,330,000	$50,960,000	3.9
	MAINLINE ALT 1A - 14' MED SHOULDER, AUX LANES	$80,730,000	$162,740,000	$243,470,000	$56,102,000	4.3

Additionally, the 20 Year Crash Reduction Savings was further explored. The below table was provided in the I-71 Benefit Cost Summary ("Safety" sheet in Excel). This table was used to calculate the 20-year safety benefit based on crash reduction.

SECTION	ALTERNATIVE DESCRIPTION	5-YEAR NO. OF CRASHES	CMF ITEM	CMF FACTOR	CRASH REDUCTION PER 5 YEARS	CRASH REDUCTION PER YEAR	SAFETY BENEFIT PER YEAR	TOTAL 20-YEAR SAFETY BENEFIT	COST OF IMPROVEMENTS	SAFETY B/C RATIO
MAINLINE	**MAINLINE ALT 1 - 14' MED SHOULDER**	829	Inside Shoulder	0.977	339.6	67.9	$6,179,000	$123,580,000	$50,960,000	2.4
			Extend Accel Lane	0.89						
			Extend Decel Lane	0.93						
			Widening	0.73						
	MAINLINE ALT 1A - 14' MED SHOULDER, AUX LANES	829	Widening	0.73	447.3	89.5	$8,137,000	$162,740,000	$56,102,000	2.9
			Extend Accel Lane	0.89						
			Extend Decel Lane	0.93						
			Inside Shoulder	0.977						
			Auxiliary	0.78						

TITLE	Defer auxiliary lane construction to a future date

SKETCH/DIAGRAM: VALUE PROPOSAL

The Preliminary Safety Analysis by the Design Team resulted in a 32% reduction in crashes when analyzing Alternate 1A compared to Alternate 1. Using ISATe, ALT 1A is expected to reduce crashes by 8% and only reduce Fatal and Injury Crashes by 0.5%. The following table shows the 20-year potential crash cost savings when comparing ALT 1A to ALT 1.

Safety Benefit of construction Auxillary Lane compared to Alt 1						
Existing Crashes along the Auxillary Lane		% Crash Reduction of Alt. 1A vs Alt 1	Reduced # of Crashes	Crash Cost	5-year Potential Crash Cost Savings	20-year Lifetime Potential Crash Cost Savings
# of KABC	59	0.5%	0.29	$ 329,565	$95,628	$382,512
# of PDO	283	7.8%	21.99	$ 9,689	$213,034	$852,135
						$1,235,000

The Preliminary Safety Analysis resulted in 20 Year Crash Reduction Savings of $39,160,000. This benefit is significantly larger than the Safety Benefit expected using ISATe analysis. Part of the reasoning is since the 0.78 Auxiliary Lane CMF was combined with the other CMF's and applied over the total 829 mainline crashes, and not the 352 total crashes that occurred along the limits of the proposed auxiliary lanes.

Based on the updated Crash Reduction Savings, the minimal benefit based on the 20-year travel time savings, and the added cost of construction the auxiliary lane, the Benefit Cost Ratio shows that the Mainline Alternate 1 has a higher B/C Ratio of 3.9 when compared to Alternate 1A B/C Ratio of 3.7.

NOTE: The below table does not reflect any updates to Alternate 1 – 20-year crash reduction savings. This table is just showing Alternate 1 as the baseline and adding the $1.2 million crash reduction savings based the updated ISATe analysis for auxiliary lanes.

SECTION	ALTERNATIVE DESCRIPTION	20 YEAR TRAVEL TIME SAVINGS	20 YEAR CRASH REDUCTION SAVINGS	20 YEAR TOTAL TRAVEL TIME AND CRASH REDUCTION SAVINGS	COST OF IMPROVEMENTS	COMBINED BENEFIT / COST RATIO
MAINLINE	MAINLINE ALT 1 - 14' MED SHOULDER	$75,750,000	$123,580,000	$199,330,000	$50,960,000	3.9
	MAINLINE ALT 1A - 14' MED SHOULDER, AUX LANES	$80,730,000	$124,815,000	$205,545,000	$56,102,000	3.7
	The 20 Year Crash Reduction Savings was updated to reflect the ISATe expected crash analysis that resulted in 20 Year Crash Reduction Saving of $1,235,000					

VALUE ENGINEERING PROPOSAL NO. 7

CT-03

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Defer auxiliary lane construction to a future date

DISCUSSION & JUSTIFICATION:

Alternate 1 involves widening the existing 4-lane interstate to a 6-lane section with 3 lanes in both directions. Each direction of travel has three 12’ travel lanes, 12’ outside shoulder (10’ paved), and 14’ inside shoulder paved in common median. This alternate involves extending the acceleration lanes at the entrance ramps and the deceleration lanes at the exit ramps.

Alternate 1A is an off shoot of Alternate 1. The number of lanes, lane widths, and shoulder widths remain the same. Alternate 1A provides auxiliary lanes between the KY 329 and KY 146 entrance and exit ramps in both the northbound and southbound directions on I-71.

The Design Team’s analysis yielded a 20-year safety benefit of adding auxiliary lanes to be $39 million. Upon review, the VE Team reevaluated and determined that the auxiliary lanes might only yield an expected 20-year safety benefit of $1.2 million, based on analysis using the Enhanced Interchange Safety Analysis Tool (ISATe). Therefore, the benefit to cost ratio was updated to reflect the updated safety benefit, and Alt 1A is lower than Alt 1. Further details on how this was determined and evaluated during the value study is described in the narrative and tables provided in the Proposed Sketches page(s).

TITLE	Defer auxiliary lane construction to a future date

DISCUSSION & JUSTIFICATION (continued):

Below is a summary of items for the Design Team to review and validate:

• When using multiple Crash Modification Factors (CMFs), the CMF Clearinghouse recommends using methods such as the Dominant Effect, Dominant Common Residuals, or Additive Method. When multiple CMFs are multiplied together to get a combined CMF, you are multiplying the effectiveness of the CMFs. There is potential overlap of the effectiveness of the CMFs and it is recommended to use applications of combining CMFs in accordance with the CMF Clearinghouse.
• The Crash Reduction was calculated using all the combined CMFs and multiplied by the total mainline number of crashes. It is recommended to only apply CMFs to the crashes the proposed improvement targets to reduce. For instance, the auxiliary lane improvement and associated CMF should only be applied to crashes that occur within the existing entrance and exit ramps. During the value study, it was determined that within the auxiliary lane section, there are approximately 352 total crashes with 59 of those crashes involving an injury.
• Reevaluate the Crash Modification Factor (CMF) Clearinghouse for the most applicable CMF for the improvements. For instance; following a search on CMF Clearinghouse, there is a CMF for extend deceleration lane of 0.93 that appears to be based on site conditions where the deceleration lane was extended by 100'. There may be a CMF that applies more closely to Alternate 1 where the proposed improvement of extending deceleration lane involves extending the KY 146 Ramp D by approximately 700'.

During the VE Study review, the Enhanced Interchange Safety Analysis Tool (ISATe) was used to calculate the expected number of the crashes for Alternate 1 and Alternate 1A within the vicinity of the auxiliary lane. The various highway design configurations were entered in the analysis along with the proposed entrance and exit ramp improvements for Alternate 1 and the auxiliary lanes for Alternate 1A. Inputs included ramp entrance and exit lengths, guardrail lengths, AADT volumes, existing crash history, horizontal curve information, cross section date, and roadside data. After entering the inputs into ISATe, the calculations were performed and the below table is a summary of the output results.

ISATe - Expected Crash Prediction					
	Total Crashes	Fatal and Injuries KABC	% Reduction compated to Alt 1	Property Damage PDO	% Reduction compated to Alt 1
ALT 1	312.2	61.0		249.7	
ALT 1A	292.5	60.7	0.49%	230.3	7.77%

VALUE ENGINEERING PROPOSAL NO. 7

CT-03

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Defer auxiliary lane construction to a future date
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
ALT 1A (PREFERRED) Total Cost Estimate	LS	1	$56,102,000	$56,102,000			
ALT 1 Total Cost Estimate					1	$50,960,000	$50,960,000
TOTAL				$56,102,000			$50,960,000
						Impact to Initial Cost (Baseline Less Proposed)	**$5,142,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 7

CT-03

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Defer auxiliary lane construction to a future date

Assumptions				
Interest/Discount Rate(%):	**4.0%**		**Economic Life (yrs):**	40

LIFE CYCLE COST ANALYSIS

Salvage & Replacement Costs			Baseline Concept		VE Proposal	
Item	**Description**	**Yr**	**Est Cost**	**Pres Worth**	**Est Cost**	**Pres Worth**
1	Joint Sealing	10	$31,752	$21,451		
2	Resurfacing of Aux Lane (includes joint sealing)	20	$251,013	$114,559		
3	Joint Sealing	30	$31,757	$9,791		
4						
5						
6						
7						
8						
9						
10						
Total Salvage & Replacement Costs			**$314,522**	**$145,801**	**$0**	**$0**

Annual Costs (pres worth calculated over 40 yrs)		Baseline Concept		VE Proposal	
Item	**Description**	**Est Cost**	**Pres Worth**	**Est Cost**	**Pres Worth**
1	6" Durable Stripe every 2 years	$14,350	$284,026		
2					
3					
4					
5					
Total Annual Costs		**$14,350**	**$284,026**	**$0**	**$0**

SUMMARY	Baseline Present Worth	Proposed Present Worth
Total Present Worth (salvage+annual pres worth)	**$430,000**	**$0**
RESULTS (Proposed less Baseline)	**AVOID COST of $430,000**	

Notes: 1) Total Present Worth is rounded to the nearest thousand dollars, 2) Initial costs are covered in the Detail sheet.

Assumptions & Calculations: Any assumptions made or support calculations that were developed to support the quantities used in the LCC should be included.

VALUE ENGINEERING PROPOSAL NO. 8

SS-08

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Pavement design recommendations
FUNCTION	**Strengthen Sub-grade**

VE PROPOSAL SYNOPSIS:

Consider the use of fibers in the asphalt base lifts as a means to effectively reduce lift thickness needed (and cost) while maintaining the same level of performance.

Reliability	**Improved**	**Functionality**	**Maintained**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Maintained**	**$209,000**

BASELINE CONCEPT DESCRIPTION:

Use CL 4 Asphalt Base 1.00 D and CL4 Asphalt Base CK using both PG64-22 and PG 76-22 with various thickness.

VE PROPOSAL DESCRIPTION:

Consider the use of fibers in the asphalt base lifts as a means to effectively reduce lift thickness needed (and cost) while maintaining the same level of performance. The fibers are proving to be an effective measure to reduce stresses and cracking within the asphalt layers utilizing minimal pavement thicknesses.

VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Performance equal to baseline	● None apparent
● Reduces cost	●
●	●
●	●
●	●
●	●
●	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$4,827,000	$0	$4,827,000
VE PROPOSAL:	$4,618,000	$0	$4,618,000
TOTAL (Baseline less Proposed)	$209,000	$0	$209,000

AVOID COST

TITLE	Pavement design recommendations

DISCUSSION & JUSTIFICATION:

The use of Kevlar fibers in the asphalt base layers as a means to address thermal cracking and both top down and bottom up fatigue cracking in the pavements without adding thickness is becoming an increasingly valuable tool for pavement designers. KYTC has performed several pilot projects in this regard and information shared with the value team indicates the results have been favorable. To accurately predict the exact amount of asphalt base that could be reduced from the proposed asphalt base thicknesses, would require analysis with AASHTOWARE Pavement ME, which the value team did not have time to provide. However, for discussion purposes, based on recent projects where this analysis approach has been utilized, the value team believes the overall lift thicknesses can be reduced a total of 1.0".

Example for evaluation with AASHTOWARE Pavement ME:
Baseline Pavement Alt 2:Proposed with Fibers

Item	Thickness (IN)	Item	Thickness (IN)
Asph. Surf CL 4 PG 76-22	1.5	Asph. Surf CL 4 PG 76-22	1.5
Asph. Base CL 4 1.0D PG 76-22	3	Asph. Base CL 4 1.0D PG 76-22 (fibers)	3
Asph. Base CL 4 1.0D PG 64-22	3.5	Asph. Base CL 4 1.0DPG 64-22 (fibers)	3
Asph. Base CL 4 CK PG 64-22	4.5	Asph. Base CL 4 1.0D PG 64-22	4

If Baseline Pavement Alt 1 is pursued, additional opportunities for minimizing the pavement lifts can be explored since this pavement alternate has additional asphalt base lifts.

This value proposal has no impacts to project schedule, risks, implementation challenges, or additional MOT considerations. This value proposal primarily is cost oriented.

VALUE ENGINEERING PROPOSAL NO. 8

SS-08

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Pavement design recommendations
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB. The quantities would differ if fibers are used. The use of fibers will reduce the pavement thickness needed. In discussion page 1, it is estimated that at least 1" of material can be saved. Under cost element 1, the baseline concept includes 64,000 tons of material. By utilizing the fibers, the unit cost is driven up by $3 a ton, but the quantity is reduced. This results in a cost savings using the VE without sacrificing the end product.

DESIGN ELEMENT	BASELINE CONCEPT				VE PROPOSAL		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Pavement without fibers	Ton	64,355	$75	$4,826,625			
Pavement with fibers	Ton				59,206	$78	$4,618,068
TOTAL				$4,827,000			$4,618,000
						Impact to Initial Cost (Baseline Less Proposed)	**$209,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 9

MI-06

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material
FUNCTION	**Miscellaneous**

VE PROPOSAL SYNOPSIS:

For I-71 step down culverts to be extended due to the roadway widening, place additional concrete and steel to reinforce existing culvert top slab in lieu of light weight fill material.

Reliability	**Maintained**	**Functionality**	**Maintained**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Improved**	**$1,343,000**

BASELINE CONCEPT DESCRIPTION:

Based on the cost estimate for the project, light weight fill is to be used to address additional loading to be applied to existing step down culverts that are extended as part of the roadway widening.

VE PROPOSAL DESCRIPTION:

Place additional concrete and steel to reinforce existing culvert top step down slab in lieu of light weight fill material.

VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Reduces cost	● None apparent
● Expedites schedule	●
●	●
●	●
●	●
●	●
●	●

$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$1,415,000	$0	$1,415,000
VE PROPOSAL:	$72,000	$0	$72,000
TOTAL (Baseline less Proposed)	$1,343,000	$0	$1,343,000

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 9

MI-06

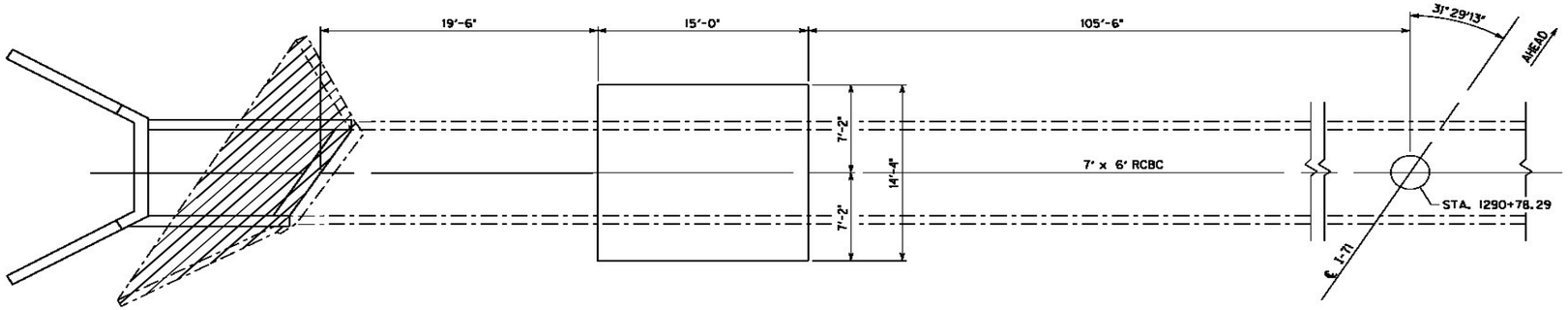
Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

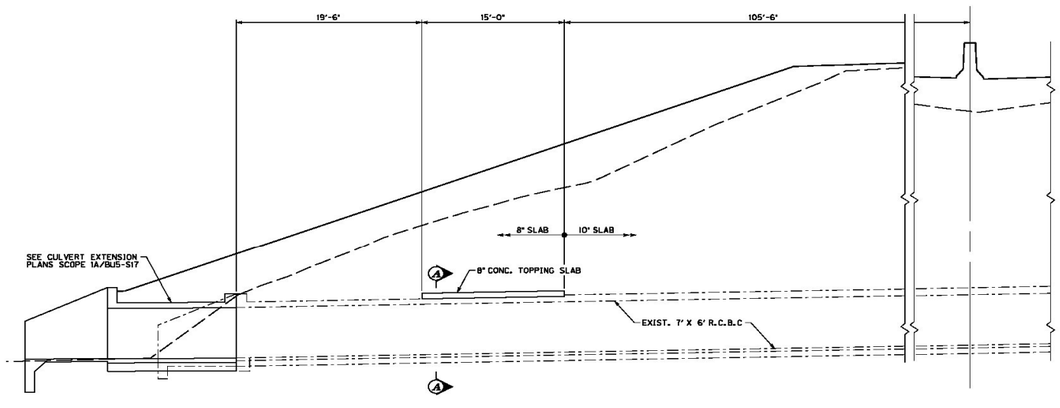
TITLE	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material

SKETCH/DIAGRAM: VE PROPOSAL

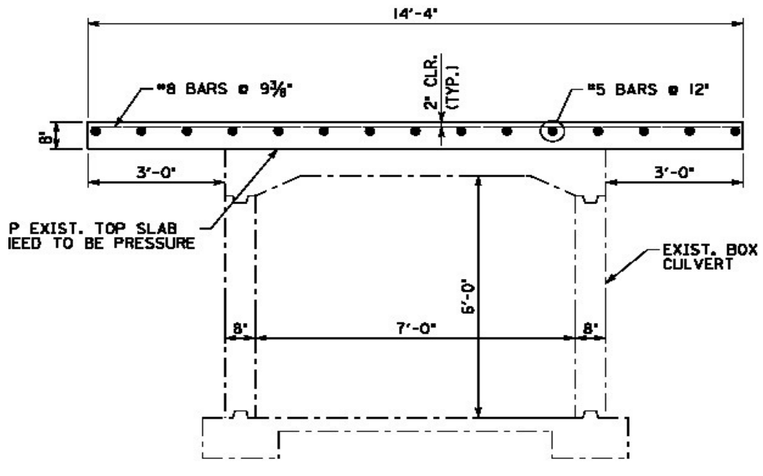


PLAN

There is no baseline sketch for the culvert extension detail provided with the documents. This level of detail really is a final design item. However, from the VE team review of the cost estimates, it appears the project team intended to use lightweight fill for the culvert extensions due to the thinner top and wall sections of the existing culverts on the ends. The VE Team believes that it will be more economical to reinforce the culvert per the "Proposed" detail provided. If there is some question about the cost, as detailed in the VE proposal, the VE suggests that KYTC consider bidding alternates for this and let contractor price out best way to accomplish this item.



LONGITUDINAL SECTION ALONG ℄ CULVERT



TITLE	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material

DISCUSSION & JUSTIFICATION:

Existing concrete box culverts within the project corridor will need to be extended as part of the roadway widening for I-71. These culverts were originally constructed with a step down culvert top slab (reduced thickness) in the areas of shallower fills as a cost saving measure. With the additional load to be placed in the step down section of the culvert top as part of the roadway widening, measures need to be taken to address this.

The baseline cost estimate for the project includes a contingency for light weight fill to be used in the area of the culvert top step down. The use of light weight fill lessens the load from the roadway widening on the culvert top and allows the culvert to remain in place. One of the challenges with this is that the existing material over the culvert top needs to be removed in order to place the light weight fill, effectively exposing the existing culvert top.

The second challenge with this relates to the cost of the light weight fill itself. The limits of the light weight fill material needed to effectively reduce the loading on the culvert top can be significant, once slopes are laid back to perform the work. Light weight material has been priced at $100 per CY for recent projects.

The value proposal is to consider doing a culvert top slab modification via placing additional concrete and steel to reinforce the existing top slab such that it will meet loading requirements from conventional fill. Minimal additional earthwork is anticipated for this operation, since it is necessary to expose the existing culvert top with the baseline option or the value proposal. Further, the culvert top reinforcement potentially eliminates the need for a specialty material supplier or possibly a specialty sub-contractor needed to place the light weight fill, thus limiting construction costs.

One possible contracting mechanism to consider for this item is to bid alternates: 1) Use light weight fill or 2) Reinforce the existing culvert top slab. This approach would allow the contractor to establish the most competitive way to accomplish this.

This value proposal potentially has a positive impact to project schedule with the elimination of the need for specialty suppliers or subcontractors and no additional risks, implementation challenges, or additional MOT considerations are anticipated.

Volume Concrete= 15'x14'-4"x8"/27= 6 CY (for one slab on one culvert end)

Volume Lightweight Fill: Volume Fill-Culvert
[(26'+15'+26') x 26.5' x 20')/27] -[(26'+15'+26') x 8' x 6'-10")/27]= 1179 CY (amount of lightweight fill required based on excavating to the bottom of the culvert in the area of the stepped slab using 1:1 excavation slopes in all directions and then backfilling the excavation with lightweight fill). The quantity of concrete/lightweight fill shown is for one end of one culvert. This will need to be done for both NB and SB widenings at each of the six culverts so these numbers are multiplied by 12 in the cost estimate.

VALUE ENGINEERING PROPOSAL NO. 9

MI-06

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Light Weight Fill (6 culverts AVG)	CY	14,148	$100	$1,414,800			
Concrete CL A with Reinforcement (6 culverts AVG)	CY				72	$1,000	$72,000
TOTAL				$1,415,000			$72,000
						Impact to Initial Cost (Baseline Less Proposed)	**$1,343,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

VALUE ENGINEERING PROPOSAL NO. 10

MI-07

Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Oldham County, Item No. 5-483.10

TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"
FUNCTION	**Miscellaneous**

VE PROPOSAL SYNOPSIS:

KYTC policy allows for routes not on an interstate highway and not on the Strategic Highway Network to have bridge clearances as low as 14.5'. Eliminate the grade revision on I-71 meant to achieve 16.5' clearance on KY 329 and instead widen near existing grade to achieve 14.5' allowed by KYTC.

Reliability	**Maintained**	**Functionality**	**Maintained**	**$ Initial Cost Avoidance (Add)**
O&M	**Maintained**	**Schedule Impact**	**Maintained**	**$1,482,000**

BASELINE CONCEPT DESCRIPTION:

Adjust grade of bifurcated section of I-71 at the interchange with KY 329 to achieve a desired 16.5' vertical clearance at the bridge over KY 329.

VE PROPOSAL DESCRIPTION:

`

VE PROPOSAL ADVANTAGES:	VE PROPOSAL DISADVANTAGES:
● Simplifies maintenance of traffic	● Lower bridge clearance
● Reduces leveling and wedging need	●
● Reduces embankment needed	●
●	●
●	●
●	●
●	●

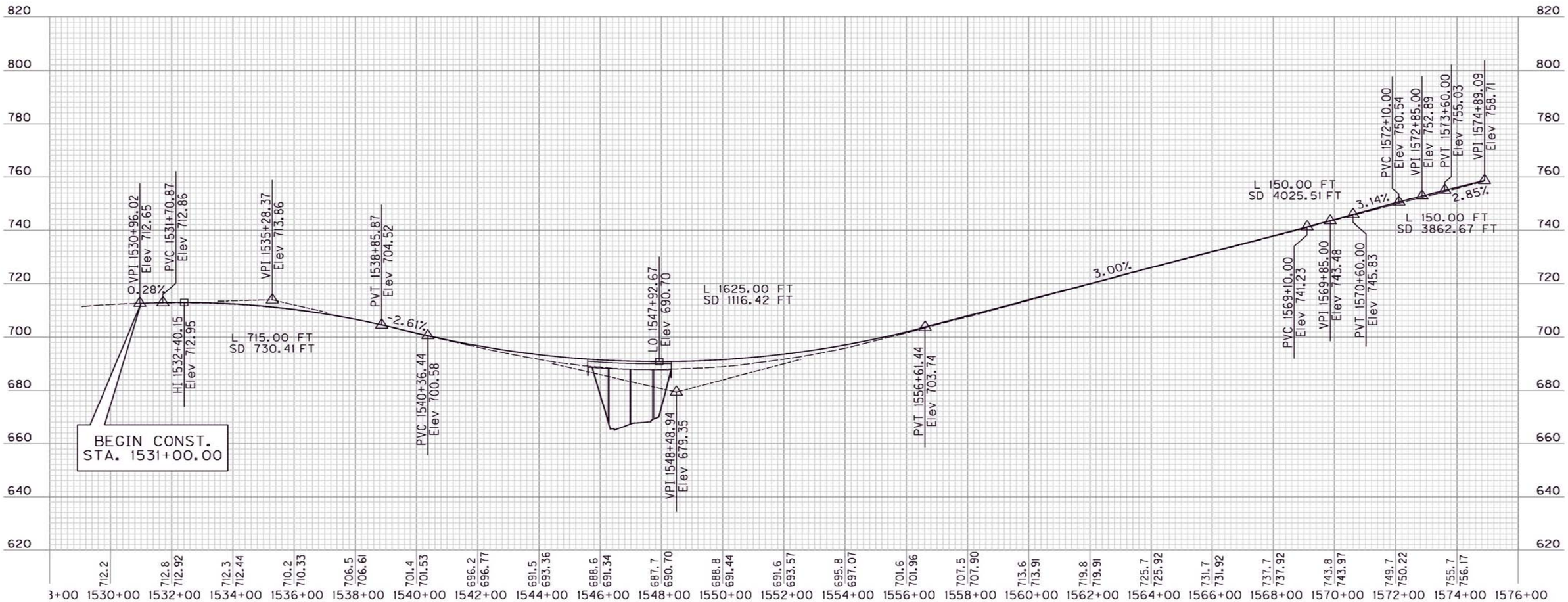
$ COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE CONCEPT:	$2,845,000	$0	$2,845,000
VE PROPOSAL:	$1,363,000	$0	$1,363,000
TOTAL (Baseline less Proposed)	$1,482,000	$0	$1,482,000

AVOID COST

TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"

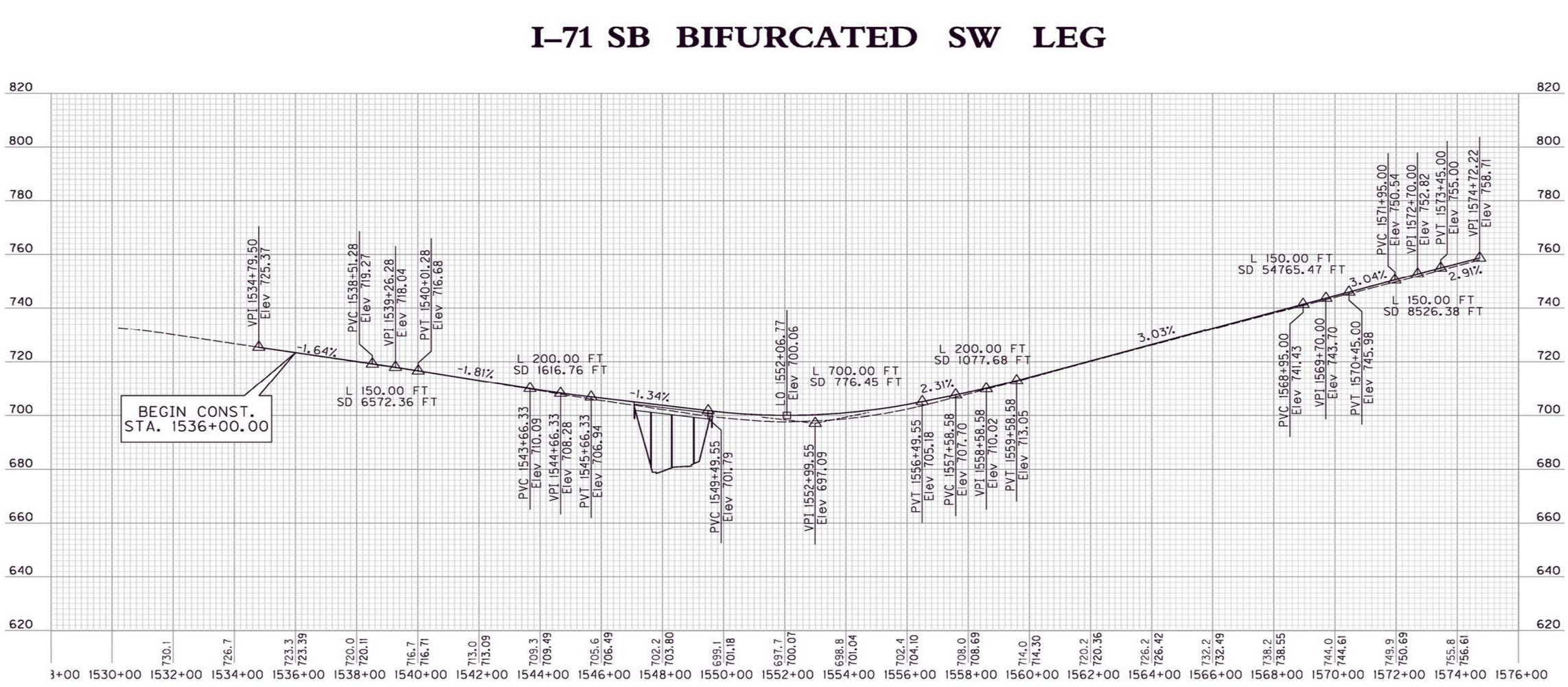
SKETCH/DIAGRAM: BASELINE CONCEPT

I–71 NB BIFURCATED SE LEG



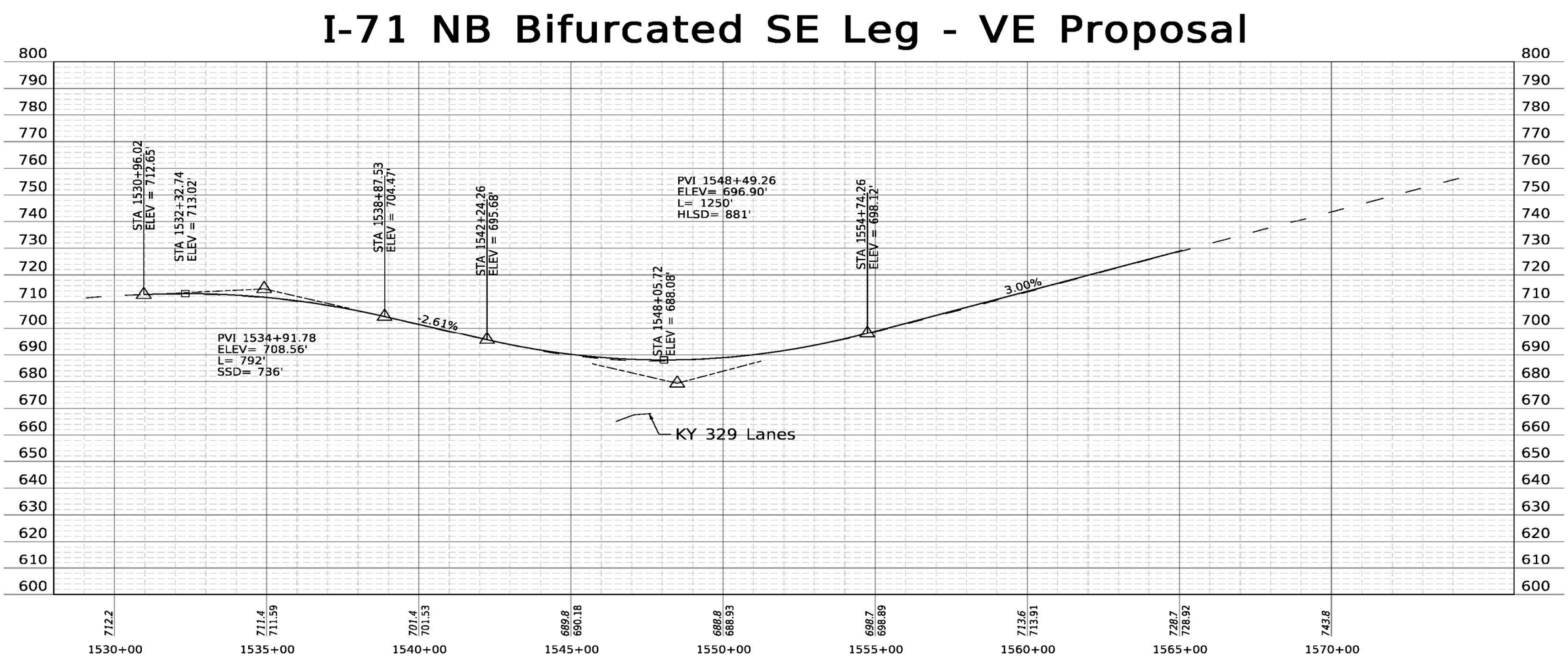
TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"

SKETCH/DIAGRAM: BASELINE CONCEPT



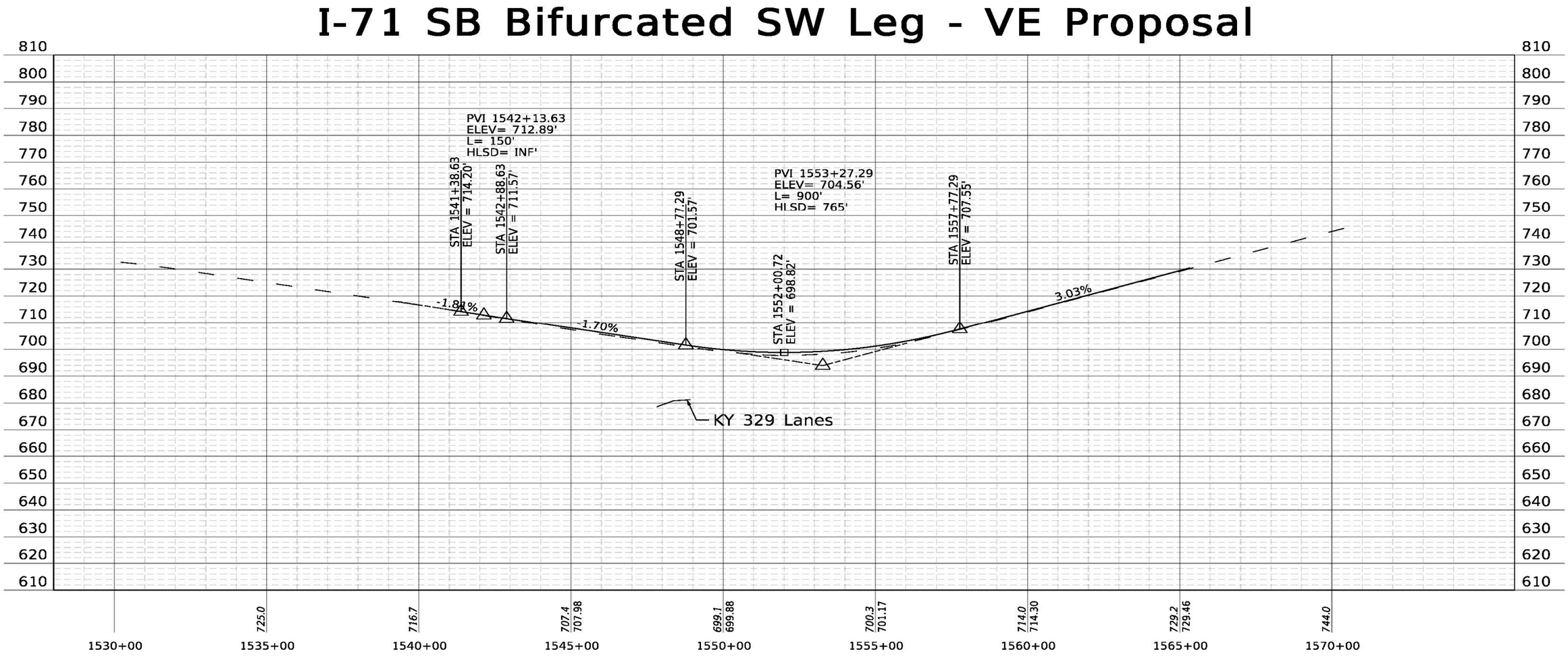
TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"

SKETCH/DIAGRAM: VE PROPOSAL



TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"

SKETCH/DIAGRAM: VE PROPOSAL



VALUE ENGINEERING PROPOSAL NO. 10

MI-07

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"

DISCUSSION & JUSTIFICATION:

The baseline design proposes to improve the sag vertical curves on I-71 at KY 329 to provide 16.5’ of clearance on KY 329. The current clearance on KY 329 is 13.5’ with haunched girder bridges carrying I-71 over KY 329. The value team proposes to reduce this clearance to 14.5’.

Per the KYTC Highway Design Manual, 14.5’ clearance is allowed for routes that aren’t interstates and not on the Strategic Highway Network. KY 329 is neither an interstate nor on the Strategic Highway Network. Furthermore, this route has operated for many years with low clearance without issue. Other interchanges within the immediate vicinity such as at KY 146 or KY 393 can service over-height loads without excessive additional mileage driven.

By reducing the proposed clearance, the constructability of mainline I-71 will be improved. The current baseline may prove difficult to maintain traffic on existing I-71 while raising the grade by 3’-4’. By reducing the amount of grade difference, the amount of shift needed to construct the new bridge is decreased. This will also reduce the total amount of pavement structure needed over the existing I-71 travel lanes to construct the grade change. It was unclear what material was being used to accomplish this grade change over the existing pavement. An assumption was made, based on the CAD files provided, that asphalt level and wedge would be utilized. By reducing the amount of grade change, a cost savings of over $1,250,000 can be realized.

It also appears the proposed bridges on I-71 are wider than necessary to accommodate MOT in later phases when traffic is shifted onto the newly constructed bridge and approaches and work begins to complete construction of the new bridge and raise the existing lanes to the final grade. Additionally, the reduction of grade change will greatly simplify MOT schemes and provide additional cost savings that can be realized but are difficult to quantify in this proposal. MOT savings have not been included in this proposal.

This value proposal may be coupled with others, such as constructing a dogbone interchange, to provide more cost savings with minimal impact to functionality.

VALUE ENGINEERING PROPOSAL NO. 10

MI-07

Kentucky Transportation Cabinet

I-71 Widening, MP 14.1 to MP 18.0

Oldham County, Item No. 5-483.10

TITLE	Reduce vertical clearance on KY 329 from 16' to 14'-6"
Assumptions & Calculations	For the purpose of estimating Baseline Concept and VE Proposal, cost estimate data was derived from information provided by HMB.

DESIGN ELEMENT	**BASELINE CONCEPT**				**VE PROPOSAL**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway Excavation	CY	33,885	$15	$508,275	33,885	$15	$508,275
Embankment in Place	CY	65,685	$15	$985,275	48,355	$15	$725,325
Leveling & Wedging	Ton	18,014	$75	$1,351,050	1,730	$75	$129,750
TOTAL				$2,845,000			$1,363,000
						Impact to Initial Cost (Baseline Less Proposed)	**$1,482,000**

Note: Total costs are rounded to the nearest thousand dollars.

AVOID COST

Section

6

Appendices

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Appendix A – VE Study Participants

A copy of the workshop attendee list is included for reference.

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Workshop Attendee List

January 10-14,2021										Name	Organization	Position
10		11		12		13		14				
am	pm	am	pm	am	pm	am	pm	am	pm			
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Patrice Miller, CVS	RHA	Team Leader
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Colin Miller, VMA	RHA	Technical Assistant
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Jason Littleton, PE, PMP, LSIT	American Engineers, Inc.	Geometric Designer
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Kenny Ott, PE, PMP	American Engineers, Inc.	Structures
☑	☑	☑	☑	☑	☑	☑	☑	☐	☐	Andrew Brown	Palmer Engineering Company	Traffic & Safety Analysis
☑	☑	☑	☑	☑	☑	☑	☑	☐	☐	Jamie Fielder	Palmer Engineering Company	Geometric Designer
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Rob Martin	QK4	
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Brent Sweger	KYTC	Quality Assurance Branch Manager
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Justin Harrod	KYTC	Transportation Engineering Technologist III
☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	Karl B Sawyer	KYTC	Location Engineer
☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	Matt Sipes	HMB	Water Design
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	Phillip Howard	KYTC	Project Manager
☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	Joey Mosley	HMB	Structures
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	Andre Johannes	KYTC	Project Manager
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	Matt A Bullock	KYTC	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	Eileen Vaughn	FHWA	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	Patrick Matheny	KYTC - D05	
☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	Brad Johnson	HMB	Traffic & Safety Analysis
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	Tim Layson		Director of Highway Design
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	Ross Mills	KYTC	
☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	Michael Loyselle	FHWA	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	John W Moore		
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	Jarrod Johnson		

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Appendix B – Cost Model & Pareto Model

B.1 Introduction

A cost model was prepared by RHA, LLC for this project. It was based on the cost estimate data provided by HMB. The cost model clearly illustrates the cost drivers for the project and was used to guide the VE Team during the workshop.

The cost model reflects the costs for the selected alternatives ("baseline concept"), as described below:

Table B-1: Selected Alternatives ("Baseline Concept") Costs

Alternative	**Construction Total**
I-71 Mainline ALT 1A (14' inside shoulder and auxiliary lane)	$53,500,000
Extend Southbound Auxiliary Lane to KY 329	$1,500,000
KY 329 ALT 1 (conventional widening)	$8,200,000
Glenarm Rd ALT 2 (parallel structure)	$2,600,000
KY 146 No Build plus signalization	$100,000
KY 393 Install signals (separate project)	N/A
TOTAL	**$65,900,000**

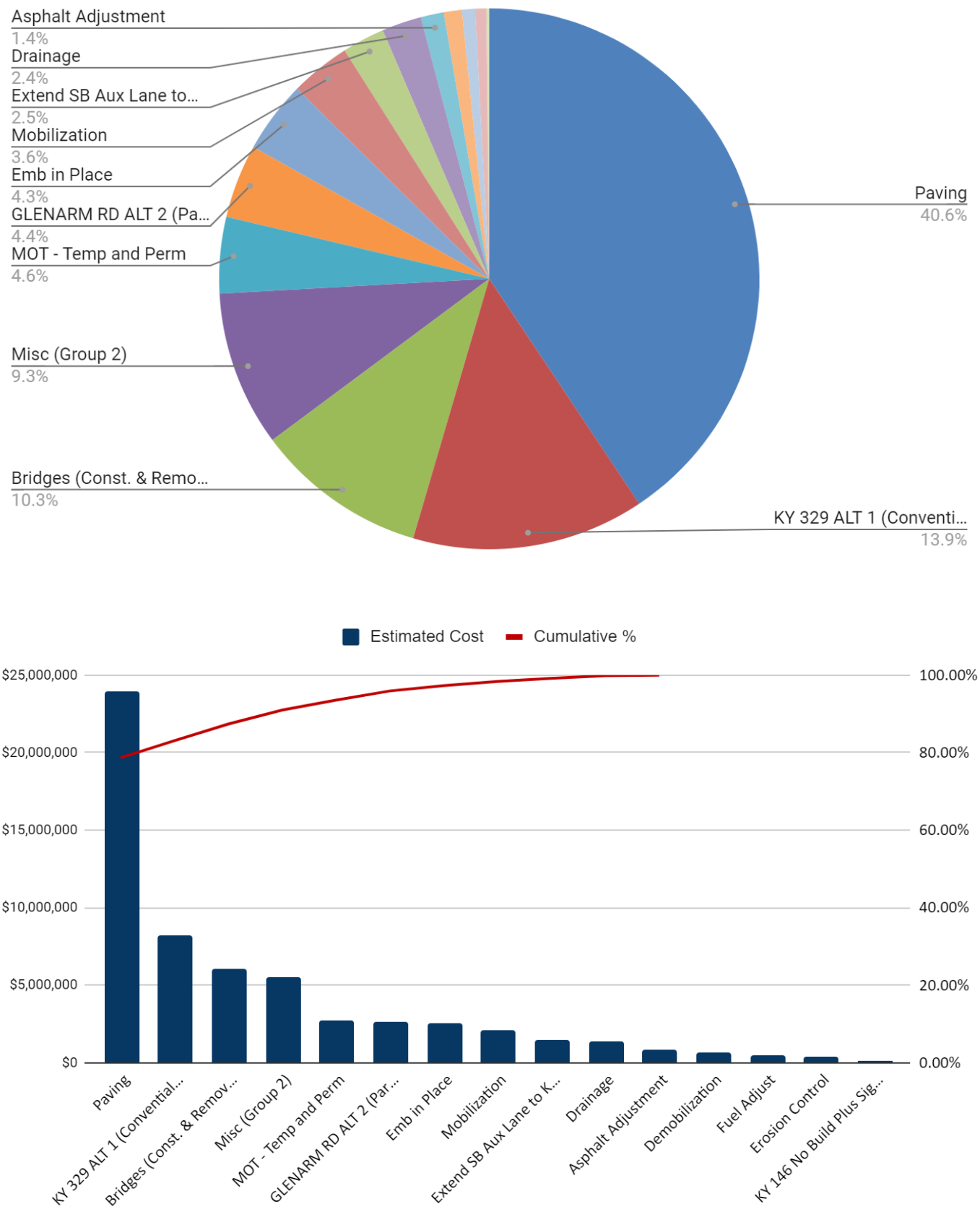
Overall, the current estimate is approximately $66M (without design, right-of-way, and utilities). The project budget has not yet been set in the Six-Year Highway Plan.

Table B-2: Cost Model (Construction Costs without Contingency)

Description	Estimated Cost	% Total	% Cumulative
Paving	$23,944,931	40.63%	40.63%
KY 329 ALT 1 (Convential Widening)	$8,200,000	13.91%	54.55%
Bridges (Const. & Removal)	$6,059,400	10.28%	64.83%
Misc (Group 2)	$5,477,115	9.29%	74.12%
MOT - Temp and Perm	$2,685,300	4.56%	78.68%
GLENARM RD ALT 2 (Parallel Structure)	$2,600,000	4.41%	83.09%
Emb in Place	$2,535,863	4.30%	87.40%
Mobilization	$2,124,696	3.61%	91.00%
Extend SB Aux Lane to KY 329	$1,500,000	2.55%	93.55%
Drainage	$1,396,122	2.37%	95.92%
Asphalt Adjustment	$810,937	1.38%	97.29%
Demobilization	$637,409	1.08%	98.37%
Fuel Adjust	$462,853	0.79%	99.16%
Erosion Control	$395,185	0.67%	99.83%
KY 146 No Build Plus Signalization	$100,000	0.17%	100.00%
Total	**$58,929,810**	100.00%	

The shaded rows represent approximately 80% of the total project cost.

Figure B-3: Cost Model Charts (Pie and Pareto)



B.2 Cost Estimate Observations

There were a few Cost Estimate Observations identified and discussed during the VE Workshop.

- Consider reviewing $1M utility budget (appears low) due to development to the north along KY 329
- Drainage during MOT will create an issue as shown in the typicals but can be easily corrected with some wedging to pitch to the other direction; may need to be accounted for in the project estimate.
- Earthwork volume seems low for this project; may impact project estimate.

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Appendix C – Function Analysis

C.1 Introduction

Function definition and analysis is the heart of Value Engineering. It is the primary activity that separates VE from all other "improvement" programs. The objective of this phase is to ensure the entire team agrees upon the purposes for the project elements. Furthermore, this phase assists with development of the most beneficial areas for continuing study.

C.2 Random Function Identification

The VE team identified the functions of the I-71 Widening, MP 14.1 to MP 18.0 Project using active verbs and measurable nouns. This process allowed the team to truly understand the functions associated with the project. A Random Function Identification Worksheet is provided below.

Table C-1: Random Function Identification Worksheet

Element Description	Identify Functions		Classify Functions	Prioritize Functions
Item	Active Verb	Measurable Noun	Higher-Order Basic Secondary	Selected for the Creativity Phase
Project	Support	Load	Secondary	YES
Project	Reduce	Conflict-points	Secondary	YES
Project	Improve	Mobility	Higher-Order	
Project	Improve	Reliability	Higher-Order	
Project	Enhance	Connectivity	Secondary	YES
Project	Increase	Capacity	Basic	
Project	Allow	Access	Secondary	
Project	Create	Free-flow	Secondary	
Project	Reduce	Delay	Higher-Order	
Project	Meet	Standards	Secondary	YES
Project	Improve	Safety	Basic	
Project	Reduce	Crash-severity	Secondary	
Project	Separate	Traffic	Secondary	YES
Project	Span	Space	Secondary	
Project	Separate	Grade	Secondary	
Project	Convey	Drainage	Secondary	
Project	Transport	Stormwater	Secondary	
Project	Convey	Information	Secondary	
Project	Direct	Traffic-flow	Secondary	YES
Project	Control	Traffic	Secondary	YES
Project	Strengthen	Subgrade	Secondary	YES
Project	Mitigate	Noise	Secondary	
Project	Avoid	Utilities	Secondary	
Project	Transport	Gas	Secondary	

Element Description	Identify Functions		Classify Functions	Prioritize Functions
Item	Active Verb	Measurable Noun	Higher-Order Basic Secondary	Selected for the Creativity Phase
Project	Transport	Electricity	Secondary	
Project	Transport	Water	Secondary	
Project	Allow	Space	Secondary	
Project	Elevate	Road	Secondary	YES

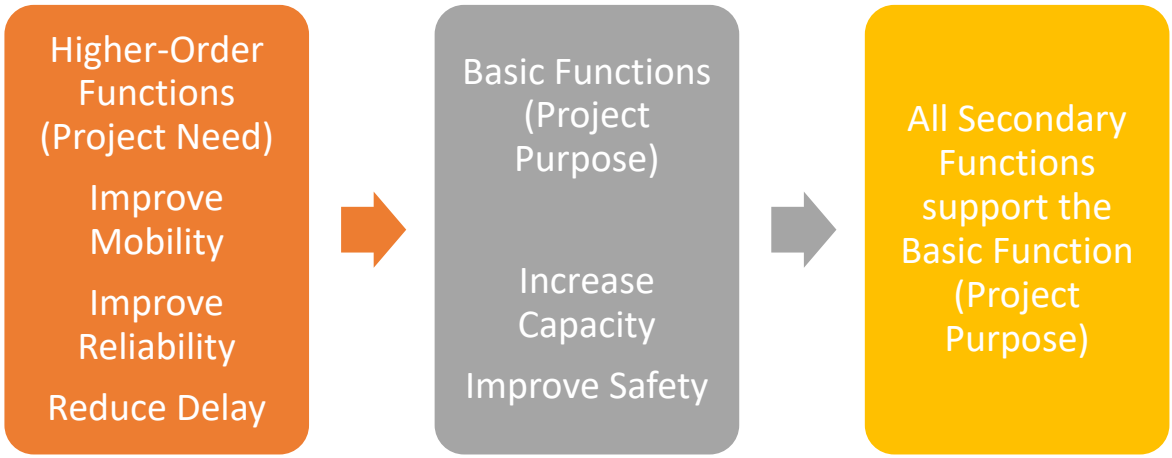
After these were listed and discussed, the functions were classified as described in the following classifications:

- **Higher-Order Function:** The specific goals or needs for which the basic function exists and is outside the scope of the subject under study.
- **Basic Function:** The specific purpose(s) for which a project exists and answers the question, "what must it do?"
- **Secondary Function:** A function that supports the basic function or required secondary functions and results from the specific design approach to achieve the basic function.

Functions were identified and prioritized using the previously identified risks, available cost data, and the VE Team's expertise. A function model, or Function Analysis System Technique (FAST) diagram, was not developed for this project. The VE Team identified "Increase Capacity" and "Improve Safety" as the basic functions of the project.

Please note that the Basic and Higher-Order functions relate directly to the project's Purpose and Need as illustrated in Figure C-1.

Figure C-1: Function Analysis and Purpose & Need



Appendix D – Creative Idea List and Evaluation

D.1 Introduction

The objective of the Creativity Phase is to generate a large number of ideas on alternate ways to perform each function selected for the value engineering study. It uses standard brainstorming techniques, including ideation that is unconstrained by habit, tradition, negative attitudes, assumed restrictions, and specific criteria. No judgment takes place during this phase of the study, though ideas are discussed for clarification purposes.

What makes the Creativity Phase of the Value Methodology successful is for the team not to conceive ways to design a project but to develop ways to perform the functions selected for the study. Past experience is combined and recombined to form new combinations that will perform the desired functions, regardless of what is included in the original project concept, and improve the value of the project compared to what was originally considered attainable.

D.2 Evaluation Techniques Used

The VE Team members evaluated the ideas using a two-step process. The first step, to shorten the list, identified ideas that scored as follows:

Table D-1: Evaluation Key (Step 1)

Score	Description
5	Great Value (Workbook prepared)
4	Good Value (Workbook prepared)
3	Moderate Value (No workbook prepared)
2	Poor Value (No workbook prepared)
DS	Design Suggestion, More than a DC, requires further explanation
DC	Design Comment, Stand-alone comment that needs no further explanation; a list of these will be given to the design team
ABC	Already Being Considered/Done, Included in the baseline concept
OS	Out of Scope, Not a part of this project
FF	Fatal Flaw, Violates a code or standard

This first step evaluation scored the ideas as appropriate to eliminate them from further evaluation.

The second step scored the remaining ideas using the Value Relationship Key along with the idea's alignment with previously identified project goals, functions, and performance criteria. The prioritization for further development and documentation is as follows:

Table D-2: Rating (Step 2)

Value Relationship Key	*Value =* Function / Resource					
5 Great Value	*F*	*F+*	*F++*	*F++*	*F++*	*F++*
	R--	*R--*	*R*	*R-*	*R--*	*R+*
4 Good Value	*F-*	*F*	*F+*	*F+*	*F+*	
	R--	*R-*	*R*	*R-*	*R+*	
3 Moderate Value	*F--*	*F-*	*F+(*)*	*F++(*)*		
	R--	*R-*	*R++*	*R++*		
2 Poor Value	*F--*	*F-*	*F*	*F*		
	R	*R--*	*R+*	*R++*		
1 Fatal Flaw	*Unacceptable Impacts, violates a code or standard*					

**Is the Function improved to the point that it overcomes the high cost?*

Figure D-1: Value Cue Key (Magnitude of Change)

Value Cue Key – Magnitude of Change	
F++ = Large increase in function	R-- = Large decrease in resources used
F+ = Small increase in function	R- = Small decrease in resources used
F = No impact in function	R = No impact in resources used
F- = Small negative impact in function	R+ = Small increase in resources used
F-- = Large negative impact in function	R++ = Large increase in resources used

D.3 List of Scored Ideas Organized by Function

The list of scored ideas is shown on the following pages. During the Creativity and Evaluation Phases of the workshop, VE Team members were actively engaged in the brainstorming and evaluation of ideas. During the Evaluation Phase, some ideas were combined with others and are designated as such by the nomenclature "w/" (with another idea).

Table D-4: "Scored" Creative Idea List

Idea No.	Idea Title	Score*
*Key: **5 = Great Value** (Workbook prepared), **4 = Good Value** (Workbook prepared), **3 = Moderate Value** (No workbook prepared), **2 = Poor Value** (No workbook prepared), **FF = Fatal Flaw**, Violates a code or standard, **DS = Design Suggestion**, More than a DC, requires further explanation, **DC = Design Comment**, Stand-alone comment that needs no further explanation; a list of these will be given to the design team, **ABC = Already Being Considered/Done**, Included in the baseline concept, **OS = Out of Scope**, Not a part of this project		
Enhance Connectivity (EC)		
EC-01	Build a Diverging Diamond Interchange (DDI) at KY 329 (Alt 2) in lieu of conventional diamond interchange (Alt 1)	w/EC-25
EC-02	Build a dog-bone interchange at KY 329 in lieu of conventional diamond interchange (Alt 1)	w/EC-25
EC-03	Build a single-lane roundabout at each ramp terminus in lieu of convential diamond interchange (Alt 1)	w/EC-02
EC-04	Build a new interchange off-line to the south by realigning KY 329; take I-71 over KY 329	w/EC-26
EC-05	Build a new interchange off-line to the south by realigning KY 329; take I-71 under KY 329	w/EC-26
EC-06	Build the new bridges for I-71 off-line toward the median	2
EC-07	Extend the tie-in to the north of KY 329 (roughly 1,000') to end at station PT 229	3
EC-08	Build sidewalks through the KY 146 interchange area	2
EC-09	Begin common median to the southwest of the existing KY 329 interchange	w/EC-04, EC-05
EC-10	Construct Single Point Urban Interchange (SPUI) at KY 329	w/EC-04, EC-05
EC-11	North of KY 329: have the lane drop be at the 2nd potential entrance to the hospital (station 222.50)	w/EC-07
EC-12	Construct roundabout at northbound exit termini ingress/egress with KY 146 (allowing for northbound KY 146 on-ramp to be shifted further to the south increasing acceleration lane length)	w/EC-24
EC-13	Review safety performance width beneath structures at KY 146	DC
EC-14	Combine EC-12 and EC-13 to potentially achieve optimum acceleration lane length	3
EC-15	Construct a Continuous Green-T (CGT) at KY 146	w/EC-24
EC-16	Add a dog-bone interchange at KY 146	w/EC-24
EC-17	Utilize all the existing right-of-way to the west of KY 146 to construct a complete new interchange	2
EC-18	Construct median U-Turn at KY 146 for KY 146 northbound left turns onto Ramp B towards I-71 northbound	w/EC-24
EC-19	Utilize ABC Construction to keep Glenarm Rd. at same location using existing substructures	5
EC-20	Close northbound on-ramp at KY 146; require movement to go to KY 393 (next exit north)	3
EC-21	Partial width construction to keep Glenarm Rd. at same location using existing substructures	w/EC-19
EC-22	Extend Ramp A (northbound off-ramp at KY -146) 1000' to allow for more queuing; M Ramp B (northbound on ramp at KY 146) to be moved west some to stay clear of CSX RR and Ped Bridge	2

Idea No.	Idea Title	Score*
*Key: **5 = Great Value** (Workbook prepared), **4 = Good Value** (Workbook prepared), **3 = Moderate Value** (No workbook prepared), **2 = Poor Value** (No workbook prepared), **FF = Fatal Flaw**, Violates a code or standard, **DS = Design Suggestion**, More than a DC, requires further explanation, **DC = Design Comment**, Stand-alone comment that needs no further explanation; a list of these will be given to the design team, **ABC = Already Being Considered/Done**, Included in the baseline concept, **OS = Out of Scope**, Not a part of this project		
EC-23	Construct the KY 146 northbound to I-71 northbound as an elevated ramp over RR and Ped and then tie back in on I-71	2
EC-24	Review capacity and safety for KY 146 options	5
EC-25	Redesign the KY 329 Interchange	4
EC-26	Build new I-71 bridge over KY 329 with common I-71 median	4
Separate Traffic (ST)		
ST-01	Modify the typical to use a depressed median separated via cable barrier	3
ST-02	Add ramp metering at on-ramps	2
ST-03	Add enhanced ITS at interchanges	ABC
ST-04	Construct Class IV wall in lieu of Class V wall	4
ST-05	Install oversized wrong-way messaging signage at the KY 146 interchange	w/EC-24
ST-06	Extend raised median to help delineate travel lanes at the KY 146 interchange	2
ST-07	Install curb system on top of the raised median to help delineate travel lanes at the KY 146 interchange	w/ST-05
ST-08	Clear span KY 329 improvements; eliminate center pier in the median	w/EC-26
ST-09	Shallow the beams - hybrid beams	w/ST-08
ST-10	Shallow the beams - build sidewalks behind the shoulder piers	ABC
ST-11	Square up the off-ramp right turn at I-71 southbound at KY 146 Ramp C	w/EC-24
ST-12	Square up the off-ramp right turn at I-71 northbound at KY 329 Ramp A	w/ST-15
ST-13	Construct an added lane for the off-ramp right-turn at I-71 northbound at KY 329 Ramp A	w/ST-15
ST-14	Construct access management on KY 329 from old KY 329 to the interchange	3
ST-15	Low-cost improvements at KY 329	4
Control Traffic (CT)		
CT-01	Install Advance Warning Flasher on KY 329 northbound in advance of the proposed traffic signal to warn drivers to "Be Prepared to Stop"	DC
CT-02	Shrink the footprint of KY 329 (width) 96' of pavement plus sidewalk and trail is excessive for this level of traffic	w/others
CT-03	Defer auxiliary lane construction to a future date	5
CT-04	Require trucks to use left lane during construction rather than shoulder lane	DC
CT-05	Separate Ramp B at KY 146 with reinforced earth walls to raise grade to fly over KY 146, RR and Ped Bridge	2
CT-06	Stripe left-turn lanes on KY 329 for entrances	3
Strengthen Sub-grade (SS)		
SS-01	Consider alternative pavement designs for the contractor to bid as alternates	DC
SS-02	Construct the new widening with cement stabilized subgrade	w/SS-08
SS-03	Construct the new widening with geogrid	w/SS-08

Idea No.	Idea Title	Score*
*Key: **5 = Great Value** (Workbook prepared), **4 = Good Value** (Workbook prepared), **3 = Moderate Value** (No workbook prepared), **2 = Poor Value** (No workbook prepared), **FF = Fatal Flaw**, Violates a code or standard, **DS = Design Suggestion**, More than a DC, requires further explanation, **DC = Design Comment**, Stand-alone comment that needs no further explanation; a list of these will be given to the design team, **ABC = Already Being Considered/Done**, Included in the baseline concept, **OS = Out of Scope**, Not a part of this project		
SS-04	Add fibers to the asphalt base to reduce thickness on mainline	w/SS-08
SS-05	Add fibers to the asphalt base at the intersections to address rutting	w/SS-08
SS-06	Construct exit ramp terminals with concrete	w/SS-08
SS-07	Ensure pavement is able to drain using Paving Alternate 2. It appears the fabric wrapped aggregate is "capped" with DGA whereas in Paving Alternate 1, the Asphalt Treated Drainage Blanket is on top of the DGA layer	DC
SS-08	Pavement design recommendations	4
Elevate Road (ER)		
ER-01	Confirm that the phasing of construction still maintains a "balanced project"	DC
ER-02	Verify that the project is a "balanced project"	DC
Miscellaneous (MI)		
MI-01	Do not improve the vertical curve at 1662+50	3
MI-02	Consider adjusting the superelevation transition location at 1662+50 to ensure adequate cross slope for drainage at the low point of the sag	DC
MI-03	Review safety cost/benefit analysis (CMF)	w/CT-03
MI-04	Review existing pipe culverts for liner need	ABC
MI-05	Consider reviewing $1M utility budget (appears low) due to development to the north along KY 329	DC
MI-06	Pour concrete on top of the existing culvert slab in lieu of placing lightweight material	4
MI-07	Reduce vertical clearance on KY 329 from 16′ to 14′-6″	4
MI-08	Drainage during MOT will create an issue as shown in the typicals; can be easily corrected with some wedging to pitch the other direction, but that needs to be accounted for in the price (there will be a lot)	DC
MI-09	The VE Team reached out for additional information regarding an on-going KY 146 Planning Study. The VE Team learned the Study Area is to the south of the current project, and to our knowledge was not intending to go any further north. The VE Team just wanted to make sure the Design and Project Team for 05-483.10 was aware of this	DC

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Appendix E – Supporting Data

E.1 Risk Identification

Risk is a measure of future uncertainties in achieving program and/or project performance goals and objectives within defined cost, schedules and performance constraints. Risk can be associated with all aspects of a program/project (e.g., threat, technology maturity, supplier capability, design maturation, performance against plan) as these aspects relate across the project's cost and schedule. Risk addresses the potential variation in the planned approach and its expected outcome. Risks may also represent opportunities within a project that could be exploited to the benefit of the project.

During the preparation for the VE workshop and after reviewing project documentation, the VE Team identified project risks on their Key Issue Memos. The following risks were reviewed at the workshop and addition risks were added to the list, as follows:

- During Maintenance of Traffic (MOT) on I-71, is it necessary to require trucks to use the left lane to avoid excessive wear and tear to the existing shoulder? Or would the existing shoulder need to be reconstructed after Phase I?
- There is mention of extending existing culverts in the meeting minutes; however given the age of the existing pipes (not necessarily the culverts), it is likely that a liner may be required for some of them to ensure they continue to function.
- While utilities don't appear to impact the project significantly, there are developments to the north along KY 329. The VE Team is not sure where the water/electric/fiber optic/etc. will be coming from, and currently there is no indication they pass through the interchange, but with only $1,000,000 listed as the utility phase that could be problematic.
- Funding may not be available to do the Diverging Diamond Interchange (DDI).
- Public Involvement - communicating with the public on how this project will accomplish the purpose and need. How do we communicate that more lanes or simply installing a traffic signal is not always the answer?
- Step slabs on the culverts - not designed for extra fill (cost associated with mitigating this).
- The north part of KY 329 is a major collector; the south part of KY 329 is a minor arterial. Green Book says for major collector vertical clearance should be at least 14′. For arterials, should be at least 16′ (key word on each is "should," not shall); standard semi-trailer height is 13′- 6″.

The VE Team considered these risks during the Creativity Phase; these have the potential of impacting the project budget, schedule and performance.

E.2 VE Team Observations

During the preparation for the VE workshop and after reviewing the project documentation, the VE Team identified observations on their Key Issue Memos. The following were reviewed at the workshop and additional observations were added to the list, as follows:

- Crash history along mainline and at the interchanges. There are a high number of crashes observed at KY 329 Interchange that is under stop controlled for ramps and at the KY 146 Interchange that is signalized for northbound ramps and stop controlled for southbound ramps. These two interchanges have great opportunities for safety improvements that do not involve just installing signals.
- Verify how the Benefit Cost was calculated regarding the safety analysis. The crash reduction calculation appears to be combining all CMFs and applying the combined CMF to all crashes along the mainline. As an example, the CMF for extending the acceleration lane should only be applied to the crashes that occurred in the acceleration lane vicinity. Similar comment for the crash reduction benefit calculation used at the Interchanges.
- Construction of the Mainline will be tight around the bridges. Based on saw cut locations and lane widths, the VE Team is not confident that we have the adequate distance required behind the barrier. Adjustments may need to be made, but when sawing a bridge deck this isn't always simple, it may require moving to the next beam.
- Drainage during MOT will create an issue as shown in the typicals. Can be easily corrected with some wedging to pitch the other direction, but that needs to be accounted for in the price. There will be a lot.
- Initial phase shifting to the outside will cause issues at KY 146 NB for the on ramp. Subphases here may be warranted.
- Pay close attention to the superelevation transition near 1662+50. This occurs as you are approaching a sag vertical curve. May consider adjusting the superelevation transition location to ensure adequate cross slope for drainage at the low point of the sag.
- Assume that Highway Plan budget will be $67M.
- Not anticipating dealing with utilities with a $1M line item; unsure if $1M will cover utility impacts.
- Earthwork volume seems low for this project.
- In the area's 20-year long range transportation plan, there are NO planned improvements to KY 329 at or near the interchange.
- Account for the traffic growth for the future development; data needs to be collected and analyzed.
- For this project, the money is in the pavement and is dependent on increasing to 4 lanes.
- For the VE studies, opportunities may be at the interchanges.

E.3 Agenda

A copy of the workshop agenda is included on the following pages for reference.

Value Engineering (VE) Workshop Agenda

Project Name: Kentucky Transportation Cabinet
I-71 Widening, MP 14.1 to MP 18.0
Item Nos. 5-48.10 and 5-557.00, Oldham County

Dates: VE Workshop
January 10-14, 2022 (see detailed times below)

Study Location: "Hybrid" (In-person / Virtual)

Day 1: Monday, January 10, 2022, 9:00 AM – 5:00 PM ET

MS Teams Invitation Link – Day 1: (CLICK HERE)

Or call in (audio only) +1 323-484-8978 - Phone Conference ID: 619 998 583#

Time EST	VE Activity	Participants	Comments
9:00	Welcome & Introductions Brief Overview of Value Engineering Process & VE Agenda Review (CVS Facilitator)	All	
	INFORMATION PHASE		
9:20	Project Overview, Presentation & Virtual Site Tour (KYTC Project Manager, Consultant Design Lead/s)	All	
10:30	Short Break		
10:45	Identify/Review: ▪ Project Goals ▪ VE Study Objectives (Focus of VE Study) ▪ VE Study Constraints ▪ Identify, Define & Rank Performance Attributes	All	
12:00	Conclusion of In-brief meeting / Long Break		
1:00	Discuss Team Observations, Project Risks Review Cost Model, Schedule, Other	VE Team	
	FUNCTION ANALYSIS PHASE		
2:00	Function Identification of Project Elements ▪ Identify/Classify Project Functions ▪ Apply Risks/Resources to Functions ▪ Select Specific Functions for Study	VE Team	
3:00	Short Break		
	CREATIVE PHASE		
3:15	Brainstorm Ideas / Alternatives		
5:00	Adjourn		

Day 2: Tuesday, January 11, 2022, 9:00 AM – 5:00 PM ET

MS Teams Invitation Link – Day 2: (CLICK HERE)

Or call in (audio only) +1 323-484-8978 - Phone Conference ID: 619 998 583#

Time EST	VE Activity	Participants	Comments
9:00	Check-in	VE Team	
CREATIVE PHASE - continued			
9:05	Brainstorm Ideas / Alternatives	VE Team	
10:30	Short Break		
10:45	Brainstorm Ideas / Alternatives	VE Team	
12:00	Long Break		
EVALUATION PHASE			
1:00	Evaluation of Ideas – Team Assignments for Development	VE Team	
3:00	Short Break		
DEVELOPMENT PHASE			
3:15	Review Workbook Template & Process Flow Develop / Cost Alternatives	VE Team	
5:00	Adjourn		

Day 3: Wednesday, January 12, 2022, 9:00 AM – 5:00 PM ET

MS Teams Invitation Link – Day 3: (CLICK HERE)

Or call in (audio only) +1 323-484-8978 - Phone Conference ID: 619 998 583#

Time EST	VE Study Activity	Participants	Comments
9:00	Check-in	VE Team	
DEVELOPMENT PHASE - continued			
9:05	Develop / Cost Alternatives	VE Team	
10:45	Develop / Cost Alternatives	VE Team	
11:30	Check-in	VE Team	
12:00	Long Break		
1:00	Develop / Cost Alternatives	VE Team	
4:30	Check-in	VE Team	
5:00	Adjourn		

Day 4: Thursday, January 13, 2022, 9:00 AM – 5:00 PM ET

MS Teams Invitation Link – Day 4: (CLICK HERE)

Or call in (audio only) +1 323-484-8978 - Phone Conference ID: 619 998 583#

Time EST	VE Study Activity	Participants	Comments
9:00	Check-in	VE Team	
DEVELOPMENT PHASE - continued			
9:10	Develop / Cost Alternatives - Complete	VE Team	
11:30	Check-in		
12:00	Long Break		
1:00	Alternatives to Present Peer Review Workbooks Prepare Presentation	VE Team	
4:00	Run-through Presentation	VE Team	
5:00	Adjourn		

Day 5: Friday, January 14, 2022, 8:00 AM – Noon ET

MS Teams Invitation Link – Day 5: (CLICK HERE)

Or call in (audio only) +1 323-484-8978 - Phone Conference ID: 639 369 078#

Time EST	VE Study Activity	Participants	Comments
8:00	Check-in	VE Team	
DEVELOPMENT PHASE - continued			
8:05	Peer Review Workbooks – Complete Practice Presentation	VE Team	
9:30	Short Break		
9:45	Ready to present	VE Team	
PRESENTATION PHASE			
10:00	Presentation of Key Finding/VE Alternatives to Stakeholders/Decision-makers	All	
11:30	Workshop Close-out	VE Team	
12:00	Adjourn	VE Team	

All: Decision-makers, Design Team, Stakeholders, VE Team (Shaded rows)
VE Team: Subject Matter Experts and others serving as full-time VE Team members