Value Engineering Study Report

I-71 Improvements – 6-8910.00

GALLATIN COUNTY, KY

Workshop Dates: May 5 – 8, 2025

Final Report Date: August 1, 2025

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Disclaimer

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

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

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

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

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Introduction

This report summarizes the events and results of the Value Engineering (VE) study conducted by HDR Engineering, Inc. (HDR) for the Kentucky Transportation Cabinet (KYTC) on the I-71 Improvements from US 127 to MP 64 in Gallatin County (Item No. 6-8910.00). The VE study consisted of a 4-day workshop that was conducted virtually with a multidisciplinary team on May 5 – 8, 2025.

Baseline Project Overview

The project is the relocation and widening of a section of I-71 to improve geometrics, reduce crashes and accommodate future widening plans that will eventually join the 6-lane section at the Kentucky Speedway to I-75.

This baseline concept had an estimated construction cost of approximately $47.23 million.

VE Study Objectives and Timing

The primary objective of the study, through execution of the Value Methodology Job Plan (see Appendix A), was to evaluate the project scope and approach based on the hybrid preferred alternative and identify recommendations to accomplish the project functions to best meet the purpose and needs.

The VE study was conducted while the project was in the preliminary stage of project development.

VE Alternatives

The VE team generated 27 ideas for the project. These concepts were compared against the baseline project as it was developed at the time of the VE workshop. The concepts that performed the best were further developed by the VE team and resulted in 9 VE alternatives being developed. The VE alternatives consider multiple aspects of total value including assessing the impacts to performance, cost, time, and risk in comparison to the baseline concept. The cost and performance trade-offs for each VE alternative are summarized below in Table 1; the developed information about each is included in Section 7.

Table 1. Summary of Alternatives

Alt No.	Alternative Title	Cost Savings or (Cost Added)	Performance/Risk
Earthwork / Grading			
E-1	Flatten side slopes with excess roadway excavation material	$456,000	Improved (MO, M) Reduced (ROW/EI)
E-2	Construct grading for temporary diversions as permanent in lieu of removing	$330,000	Reduced (M)
E-3	Eliminate interceptor ditch	$180,000	Improved (M)
Typical Cross-Section / Project Limits			
XP-1	Reduce inside shoulders from 14.3' to 12.0'	$520,000	Improved (M) Reduced (MO)
XP-2	Drop/Add the 3rd lane at the Highway 127 ramps	$173,000	Improved (M, CI)
Tapering Point Road Structure			
S-1	Use single span structure at Tapering Point Road	$0	Improved (LO, M)
S-2	Increase height of pile caps and reduce bridge length	$460,000	No change
Construction / Maintainability			
C-1	Pave the surface course in echelon	($86,000)	Improved (M) Reduced (CI)
C-2	Install measures to reduce surface water runoff at barrier during select phases	($306,000)	Improved (CI, Risk) Reduced (M)

Note: Because the cost data depicted above represents savings, a number in parentheses represents a cost increase. Performance Attribute Legend: MO – Mainline Operations, LO – Local Operations, M – Maintainability, CI – Construction Impacts, EI – Environmental Impacts.

Implementation of VE Alternatives

Project Team representatives reviewed the information in the Draft VE Study Report and discussed the VE Alternatives to determine which should be accepted and implemented into the project.

Of the nine alternatives developed and presented in the Draft VE Study Report, seven were selected for either full or partial acceptance into the project. Please note that acceptance of alternatives denotes intent to implement based on current information in the given project development phase. It is recognized that future conditions may change this disposition.

The table below summarizes the implementation disposition of all the VE Alternatives, the rationale for the acceptance or rejection, and all comments received by the various project team reviewers and stakeholders. Additionally, to help document implementation discussions, a VE Implementation Form is included as Appendix E.

Table 2. Summary of Alternative Implementation

Alt No.	Alternative Title	Implement Status	Decision Rationale / Comments
E-1	Flatten side slopes with excess roadway excavation material	Accept	Since this area is prone to slides, flattening the side slopes will be very beneficial to the project and ensure that the excess roadway material can be utilized and reduce the amount of guardrail installed.
E-2	Construct grading for temporary diversions as permanent in lieu of removing	Accept	This recommendation will require additional work by the Consultant to incorporate into the plan set.
E-3	Eliminate interceptor ditch	Accept	Ther Project Design Team would like to accept this recommendation due to simplified construction, reduction in construction limits and reduction in quantity of channel lining. May require a special note to use straw/mesh to ensure vegetation establishment.
XP-1	Reduce inside shoulders from 14.3' to 12.0'	Reject	Because this recommendation will require a large re-design of this project, the team decided that they would not move forward with this recommendation. Although it is suggested to reduce the inside shoulders by almost 2 ft, additional pavement would be needed regardless due to the maintenance of traffic.
XP-2	Drop/Add the 3rd lane at the Highway 127 ramps	Reject	After much discussion they determined that this recommendation does not take into account the adjoining section of I-71 and when looking at both projects, it was determined that dropping/adding the 3rd lane would not provide an overall benefit for this project.
S-1	Use single span structure at Tapering Point Road	Accept	The Project Design Team would like to accept this recommendation.
S-2	Increase height of pile caps and reduce bridge length	Accept	The Project Design Team would like to accept this recommendation.
C-1	Pave the surface course in echelon	Accept	The Project Design Team would like to accept this recommendation and a special note will need to be included in the plan set.
C-2	Install measures to reduce surface water runoff at barrier during select phases	Accept	The Project Design Team would like to accept this recommendation. Additional work will be required. They will look into reducing surface water runoff by adding median barrier and box inlets.

VE Team Members

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

The VE team included the following. See Appendix B for additional details of all workshop attendees.

- Adam Ross, KYTC
- Kevin Kriete, HDR
- Wes Hagerman, HDR
- Scott Pennington, HDR
- Kevin Gearlds, HDR
- Mark Watson, HDR

Acknowledgements

The VE team wishes to express its appreciation to the KYTC project team members and the STV Inc. design team representatives for the excellent support they provided throughout the study. We hope that the alternatives and design considerations provided will assist in the management decisions necessary to move the project forward through the project delivery process.

1 Introduction

This VE report summarizes the events of the virtual VE study conducted for KYTC and facilitated virtually by HDR. The subject of the study was the I-71 Improvements in Gallatin County, KY. The VE study was conducted on May 5 – 8, 2025 while the project was in the preliminary stage of design development.

1.1 Scope of VE Study

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

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

- Conduct a thorough review and analysis of the key project functions using a multidiscipline, cross-functional team.
- Evaluate the project scope relative to updated budgetary information and project funding scenarios.
- Improve the value of the project through innovative measures aimed at improving the performance while reducing costs of the project.

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

1.2 Evaluation of the Baseline Concept

During the course of the VE study, a number of analytical tools and techniques were applied to develop a better understanding of the baseline concept. A major component of this analysis was Value Metrics which seeks to assess the elements of cost, performance, time, and risk as they relate to project value. As part of this process, the project team representatives identified a number of Performance Requirements, defined as the essential, non-discretionary aspects of the project, and Performance Attributes, those aspects of a project's scope that may possess a range of potential values. These were used throughout the study to identify, evaluate, and document alternatives.

The VE team identified and defined the following performance attributes for this project and then evaluated the baseline concept as it pertains to these attributes. The following performance attributes were used throughout the study to identify, evaluate, and document ideas and recommendations:

- Mainline Operations (MO) - An assessment of traffic operations and safety on the main line within the project limits.

- Local Operations (LO) - An assessment of traffic operations and safety on the local roadway infrastructure.
- Maintainability (M) - An assessment of the long-term durability, longevity, and maintainability of all roadway elements.
- Construction Impacts (CI) - An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to existing utilities; impacts to businesses and residents relative to access during construction.
- Environmental Impacts (EI) - An assessment of the permanent impacts to environmentally-sensitive resources. Attribute also considers the qualitative impacts of right of way (ROW) acquisition and other property impacts.

1.3 Value Opportunities and Focus Points

The primary opportunities for value improvement resulting from the VE team's analysis of the baseline project using the tools and techniques of the Value Methodology were as follows:

- Earthwork and Grading
  - Side slope grades and excess material vs. right of way
  - Removal of temporary diversion grading
  - Maintenance and function of Interceptor ditch
- Typical Cross Section & Project Limits
  - Potential cost savings while maintaining performance / operations
- Tapering Point Road Structure
  - Bridge area and substructure options
- Construction
  - Surface course paving operations vs. joints
  - Temporary drainage at median barriers during select phases

2 Information Phase

The VE team received the documentation and drawings from the project design team as shown in Table 3. The design team also introduced the project and its characteristics on the first day of the study. Project details and challenges as presented by the design team are summarized below.

2.1 Information Provided to VE Team

Table 3 lists the project documents provided to the VE team for use during the study.

Table 3. Information Provided to the VE Team

Document/Drawing/Schematic	Document Date
Preliminary Line and Grade Plans	5/5/2025
Cost Estimate	2/24/2025

2.2 Project Overview and Location

The project is the relocation and widening of a section of I-71 to improve geometrics, reduce crashes and accommodate future widening plans that will eventually join the 6-lane section at the Kentucky Speedway to I-75.

2.3 Project History / Information

I-71 is a north-south interstate that begins in Louisville at the I-64/I-65 (Kennedy) Interchange running through Northern Kentucky ending in Cleveland Ohio at I-90. This interstate corridor is a major truck corridor with 39.8% truck traffic, which is forecasted to maintain over the next 20 years. Existing I-71 is 4 lanes with a 60-foot depressed median and 12-foot outside shoulders (10-foot usable). Median cable guardrail exists throughout this segment of I-71.

This section of I-71 is characterized by sharp curves and steep grades. The original design speed for I-71 was 60 mph. Horizontally, there are reverse curves (3 and 4-degrees) approaching the bridge over Tapering Point Road followed by a curve in the opposite direction (3-degrees) on the bridge. There are 3 segments of 4% grades within the project limits which includes the reverse curves and the bridge. Superelevation is deficient, particularly on the bridge. The substandard geometry for the posted 70 mph speed limit combined with the heavy volume of traffic (2019 ADT of 35,200), particularly trucks (2019 Truck ADT of 39.8%), and has contributed to a high number of crashes.

2.4 Project Scope

The following summarizes the primary scope of work items for this project:

Beginning at the US 127 interchange, the alignment shifts to the west then crosses over existing I-71 prior to crossing Tapering Pointe Road and stays on the east side until it ties back to I-71 north of the vertical crest curve at approximate M.P. 65.

Figure 1. Preferred Alternative Exhibit

2.5 Project Cost Estimate

The VE team was provided a copy of the project's cost estimate prepared by American Engineers Inc. on February 24, 2025. The estimate includes 15% mark-ups for contingency and totaled $47,232,773.

The estimate used to estimate the costs for the VE Alternatives and allowed for a relative comparison against the baseline design.

An abbreviated estimate developed from these is shown in Table 4. See Appendix C for additional estimate and project cost assumptions.

Table 4. Cost Estimate – Baseline Concept

Cost Item	Cost	Percent of Total	Cumulative Percentage
Roadway Excavation	$12,694,525	28.1%	28%
Pavement	$11,975,598	26.5%	55%
Roadway & Traffic Items	$8,273,777	18.3%	73%
Bridge	$3,811,279	8.4%	81%
Median Barrier / Guard Rail	$3,374,398	7.5%	89%
Drainage	$2,565,243	5.7%	95%
Mob/Demob	$2,470,482	5.5%	100%

3 Project Analysis

3.1 VE Focus Points and Observations

Prior to the VE study and during the Information Phase, a number of activities were conducted to better understand the baseline concept. The following summarizes key focus points and observations identified during these sessions and during the VE team's initial analysis.

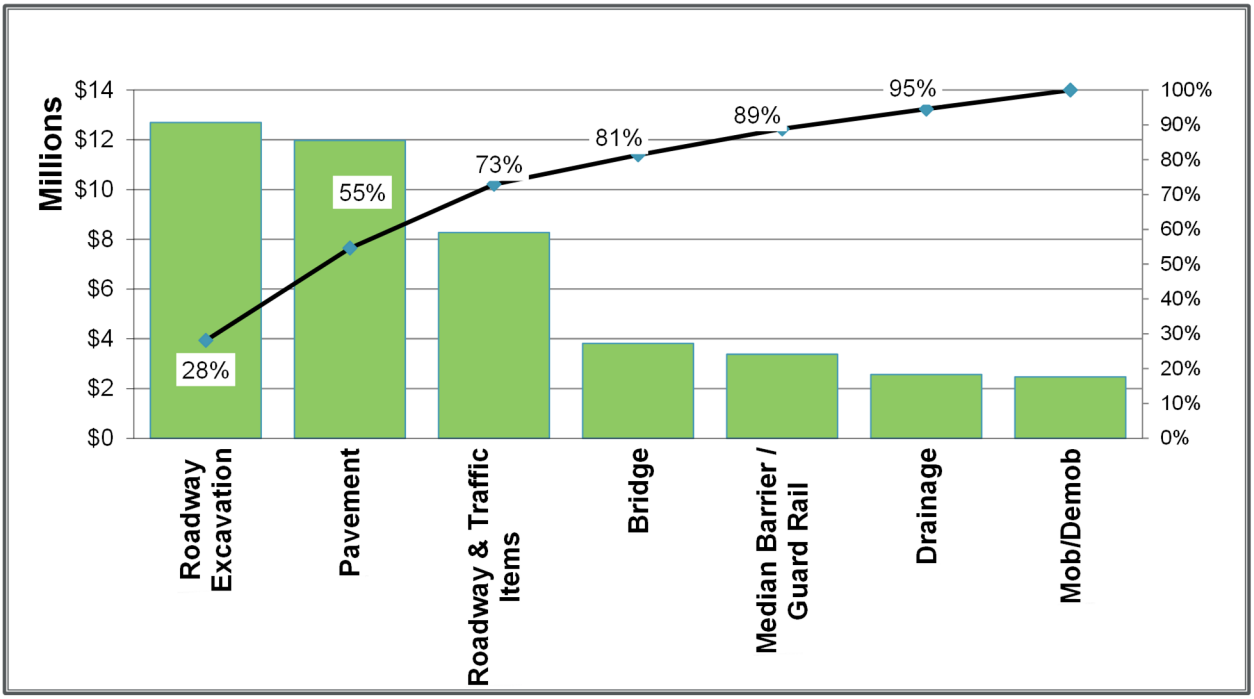
- Project will require disposal of large quantities of roadway excavation. Proposed fill locations are in abandoned existing roadway to support pollinators and landscaping. There may be impacts to phasing and availability.
    - Opportunity to dispose more material and reduce potential for slope stability issues vs. guard rail
- Project is assuming maintaining two lanes in each direction throughout construction with minor lane shifts and temporary construction
- Transition location from 6-lane to 4-lane at project limits may be optimized
- Potential reductions in project grades with excess material
- Potential impacts to existing bridge at KY 127 to accommodate 6-lane widened section
- Extension of existing culverts may have maintenance impacts with aged existing structures or may require modification to accommodate the widening
- Potential impacts to slope stability / landslides
- Grades require guard rail throughout most of the project (vs. flattening slopes)
- Rock lining drainage ditches for slope stability (vs. flattening or alternative erosion control)
- Maintenance implications of Interceptor Ditch
- Structure type at Tapering Point Road
- Inside shoulder widths of 14.3' may not be needed with revised median barrier widths
- Disposal of excavated material may require additional hauling / material handling from cut locations to fill locations across mainline.
- Potential issues with traffic conditions during winter of select phases / temporary conditions
- Potential for reuse / salvage for cable barrier
- Potential issues with maintaining the high friction surface (existing) during construction
- Potential issues with condition of existing drainage features to support widening / extensions
- Ability of excavation disposal to support plantings / pollinators

3.2 Cost Model

The VE facilitator prepared a cost model from the cost estimate, which was provided by the project team. The model was organized to identify major construction elements or trade categories, the design team's estimated costs, and the percent of total project cost for the significant cost items (Figure 2).

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

Figure 2. Cost Model



3.3 Value Metrics

The value metrics process was used as an analysis tool to evaluate the baseline project and the VE alternatives. Value metrics is a system of techniques predicated on the theory that value is an expression of the relationship between the performance of a function and the cost of acquiring it. It provides a standardized means of identifying, defining, evaluating, and measuring performance. Performance is quantified in terms of how well a set of attributes contribute to the overall functional purpose of a given project.

The basic equation used for calculating value is:

$$Value = \frac{Performance}{Cost + Time}$$

In other words, value is equivalent to the relationship of the resources needed to provide a certain level of performance for a given function. Performance is defined as a set of requirements and attributes of a project's scope that are pertinent to the project's purpose and need. Participant responses are elicited for a series of paired comparisons in which the performance of alternatives are compared, with consideration of the project purpose and need, while taking into account the relative intensity of preference of one criterion over another.

The following pages describe the steps in the value metrics process.

3.3.1 Performance Attributes

Performance attributes are an integral part of the value analysis process. The performance of each project must be properly defined and agreed on by the project team, VE team, and representatives at the beginning of the study. These attributes represent those aspects of a project's scope and schedule that possess a range of potential values.

Performance attributes can generally be divided between project scope components (highway operations, environmental impacts, maintainability, and system preservation) and project delivery components. It is important to make a distinction between performance *attributes* and performance *requirements*. Performance requirements are mandatory and binary in nature. All performance requirements must be met by any VE alternative concept being considered. Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives could be acceptable that had different durations.

The VE team, along with the project team, identified and defined the performance attributes for this project and then defined the baseline concept as it pertains to these attributes. The performance attributes shown in Table 5 were used throughout the study to identify, evaluate, and document ideas and alternatives.

Typical standardized project performance attributes are shown below. The VE team, along with the project team, identified and defined the performance attributes for this project and then defined the baseline concept as it pertains to these attributes (Table 5). The following performance attributes were used throughout the study to identify, evaluate, and document ideas and alternatives.

Table 5. Performance Attributes and Description

Performance Attribute	Description of Attribute	Baseline Concept
Main Line Operations	An assessment of traffic operations and safety on the main line within the project limits. Operational considerations include level of service relative to the 20-year traffic projections, as well as geometric considerations such as design speed, sight distance, and lane and shoulder widths.	• Improves alignment and sight distances at mainline curves • Reduce runoffs / shutdowns during winter conditions • Provides additional capacity and separation to accommodate slow moving vehicles • Widening to 6-lane cross-section through project limits • Transition back to 4-lane section occurs after interchange at southern limits • Median barrier separation throughout to prevents crossovers • 14' inside shoulders with median barriers
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure. Local Operations include frontage roads as well as cross roads. Operational considerations include level of service relative to the 20-year traffic projections; geometric considerations such as design speed, sight distance, lane and shoulder widths; bicycle and pedestrian operations and access.	• Maintains continuity of Taper Point Road with a grade separation • No other connections or access to mainline provided within project limits

Table 5. Performance Attributes and Description

Performance Attribute	Description of Attribute	Baseline Concept
Maintainability	An assessment of the long-term maintainability of the facilities and equipment. Maintenance considerations include the overall durability, longevity, and maintainability of structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.	• New structure at Taper Point Road with two spans • Concrete median barrier provided throughout • Full depth asphalt concrete (AC) pavement section in new alignment segments • Overlay existing pavement at connection / transition locations • Extension of existing drainage culverts in select locations • 2:1 slopes for embankments at bridge abutments • Benching fill slopes for slope stability • Class 2 ditch lining of existing drainage ditches in select locations • Disposal of excavated material to abandoned roadway alignment / ROW
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to existing utilities; impacts to businesses and residents relative to access, visual effects, noise, vibration, dust, and construction traffic; environmental impacts.	• Maintain two lanes of traffic in each direction throughout construction • Assume maintaining Tapering Point Road operation throughout construction • Temporary pavement required at connection points • Reduced separation from barrier walls during select phases
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts; impacts to shore edge; impacts to cultural, recreational and historic resources.	• ROW acquisition balanced to each side of existing due to center alignment of new roadway • New drainage culverts at select crossing locations • Extending existing culverts at select locations • Disposal of excavated material may require additional area / easements

3.3.2 Performance Attribute Matrix

The performance attribute matrix was used to determine the relative importance of the performance attributes for the project. The project and VE team evaluated the relative importance of the performance attributes that would be used to evaluate the creative ideas.

These attributes were compared in pairs asking the question: “Which one is more important to the purpose and need of the project?” (e.g., A or B, A or C, A or D, etc.) The letter code (e.g., “A”) was entered into the matrix for each pair. After all pairs were discussed they were tallied (after normalizing the scores by adding a point to each attribute) and the percentages calculated. These scores were then used to calculate the value of each alternative during the VE team’s performance evaluation scoring.

Figure 3. Performance Attribute Matrix

Performance Attributes Criteria Matrix								
Paired Comparison								
							Total points	% of Total
Main Line Operations	A	A	A	A	A		5.0	33%
Local Operations		B	C	D	E		1.0	7%
Maintainability			C	D	E		2.0	13%
Environmental Impacts				D	D		4.0	27%
Construction Impacts					E		3.0	20%
						Total	15.0	100%
Without emphasis on preference								
A = A is of greater importance								
A/B = A and B are of equal importance								

4 Function Analysis Phase

4.1 Overview

Function analysis results in a unique view of the project. It transforms project elements into functions, which help guide the VE team in considering the functional concepts of the project–independent of the current design. Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level (Table 6). Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions.

The primary functions identified by the VE team for the project were to **Improve operations** and **Safety** by **Straightening Alignment** and **Increasing Capacity** while **accommodating future demand**. Key secondary functions include **Create Space** (for widening), **Establish Grades** (earthwork) and **Dispose Material**.

Table 6. Random Function Identification

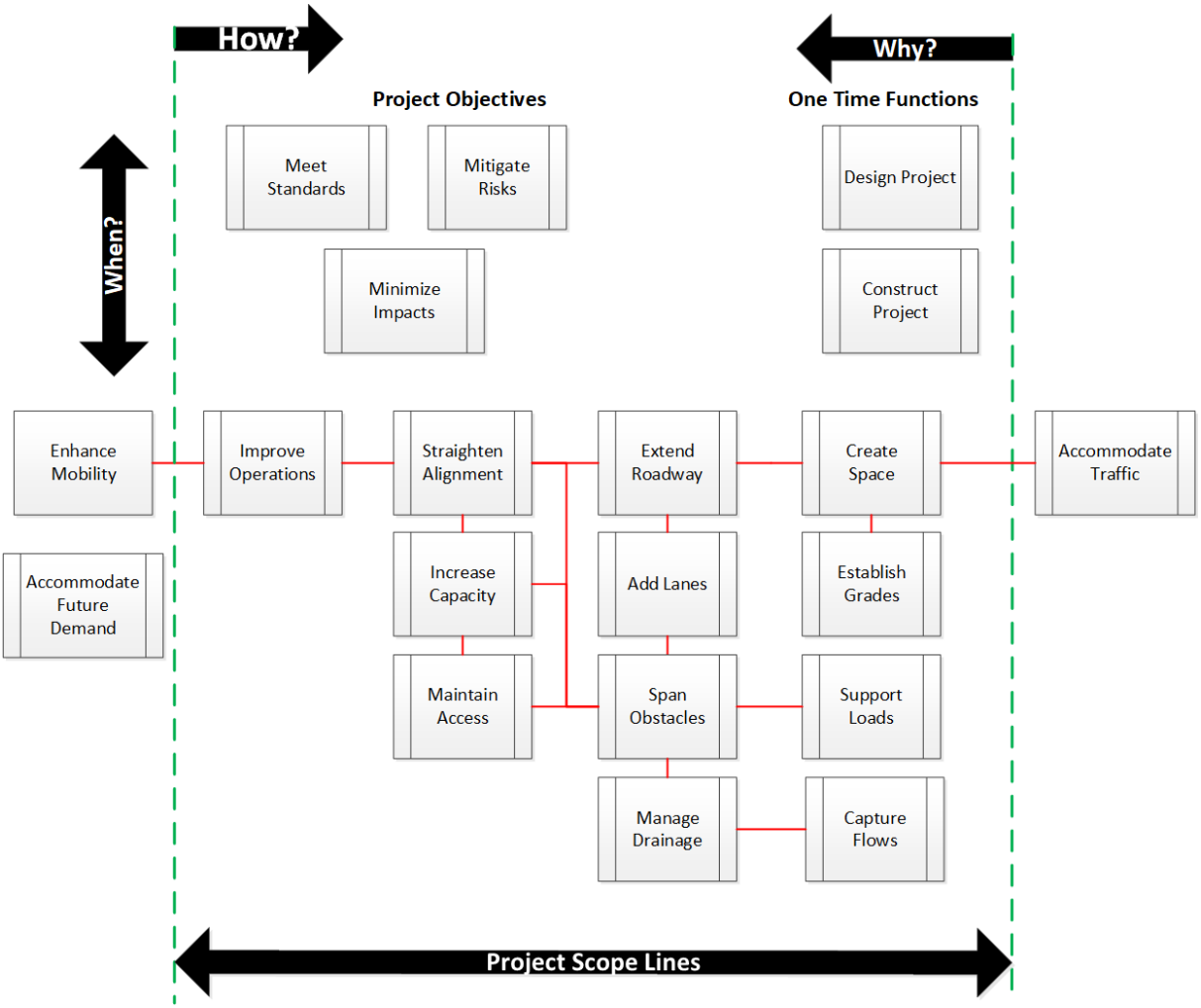
Project Element	Functions	
Purpose and Need	Improve	Safety
	Straighten	Alignment
	Meet	Standards
	Accommodate	Grades
	Reduce	Conflicts
	Accommodate	Future Demand/Growth
	Increase	Capacity
	Minimize	Impacts
	Minimize	Maintenance
Bridge	Span	Obstacle
	Separate	Traffic
	Maintain	Continuity (Local Road)
	Support	Loads
	Maintain	Existing (Local Road)
	Accommodate	Grades/Profiles
Drainage	Convey	Flows
	Reduce	Maintenance
	Reuse	Existing
	Accommodate	Widening
	Remove	Sediment
	Control	Erosion
	Minimize	Disturbance (to Existing)
Roadway	Accommodate	Grades
	Minimize	Earthwork
	Minimize	Environmental Impacts
	Accommodate	Geotechnical
	Stabilize	Soil
	Reuse	Existing

Project Element	Functions	
Right of Way (ROW)	Create	Space
	Acquire	Properties
	Remove	Obstacles
	Minimize	Relocations
	Establish	Habitat / Plantings
Earthwork / Roadway Excavation	Remove	Material
	Establish	Grades
	Accommodate	Grades
	Minimize	Impacts
	Dispose	Material (Onsite)
Barriers / Guard Rail	Separate	Traffic
	Prevent	Runoffs
	Minimize	Footprint

4.2 Function Analysis System Technique Diagram

The Function Analysis System Technique or “FAST” diagram arranges the functions in logical order so that when read from left to right, the functions answer the question “How?” If the diagram is read from right to left, the functions answer the question “Why?” Functions connected with a vertical line are those that happen at the same time as, or are caused by, the function at the top of the column. The FAST diagram (Figure 4) provided the VE team with an understanding of which functions offer the best opportunity for cost or performance improvement.

Figure 4. FAST Diagram



5 Creativity Phase

During the Creativity Phase, the VE team generated ideas on how to perform the various functions. The idea list was grouped by function or major project element. All of the ideas generated are recorded in Table 7. The final disposition of each idea is included at the end of Section 6.

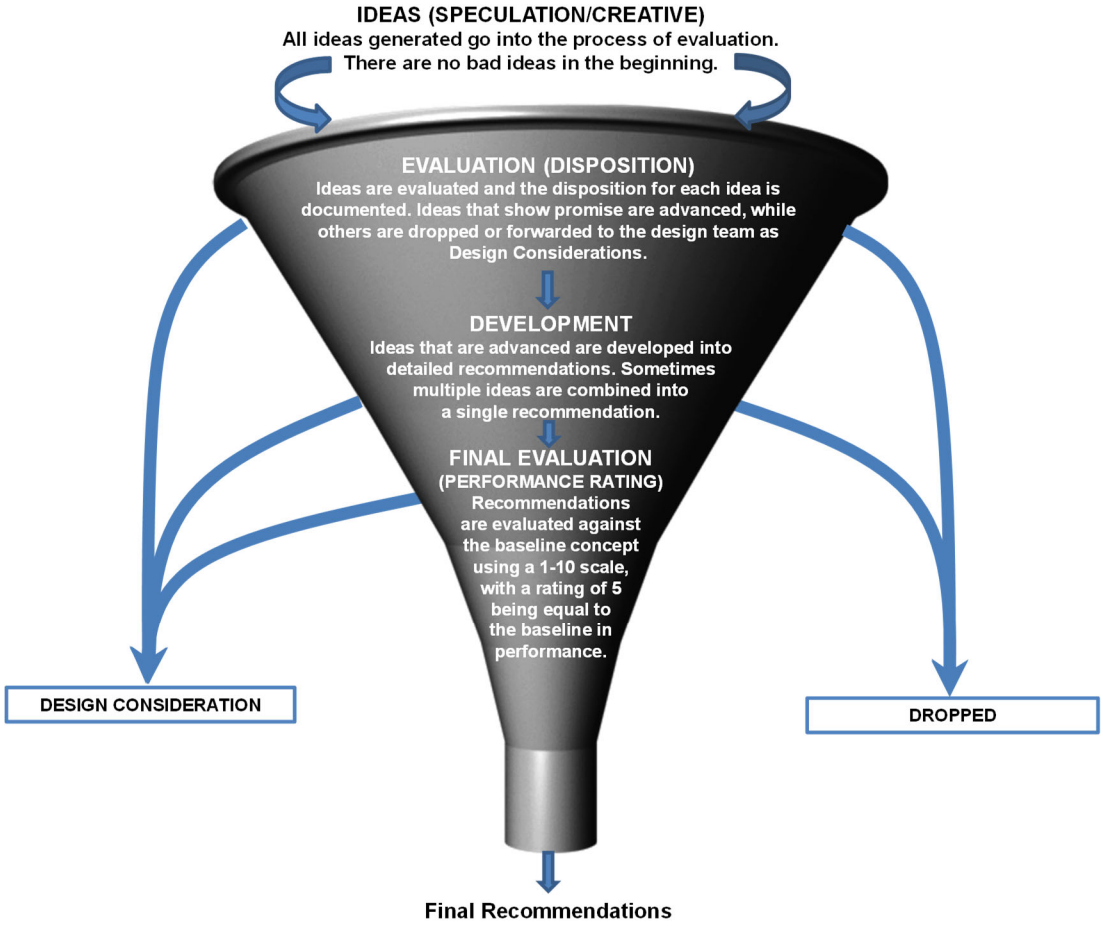
Table 7. Creative Idea List

Idea No.	Description
1	Pave the surface course in echelon
2	Drop/Add the 3rd lane at the Highway 127 ramps
3	Flatten side slopes with excess roadway excavation material
4	Ensure specifications account for shale embankment construction
5	Relocate NB limit to start after Highway 127 bridge
6	Verify condition of existing drainage culverts to support extensions
7	Provide lightweight fill over existing culverts to support extensions
8	Revise alignment of new culverts into perpendicular and reduce length
9	Eliminate interceptor ditch
10	Flatten drainage ditches to reduce / eliminate ditch lining
11	Reduce inside shoulders to 12.0' in lieu of 14.3'
12	Revise grades to reduce sliver fills / cuts
13	Use single span structure at Tapering Point Road
14	Provide arch-supported tunnel at Tapering Point Road in lieu of bridge
15	Increase height of pile caps and reduce bridge length
16	Revise slopes of disposal areas to maximize capacity
17	Eliminate salvage assumptions of existing cable barrier
18	Provide additional temporary width to increase separation from barrier
19	Install measures to reduce surface water runoff at barrier during select phases
20	Increase temporary storage of disposal and demo/use existing alignment
21	Provide high friction surface in temporary pavement for NB lane diversion
22	Provide 4-lane section in interim and defer widening for 6 lanes until future
23	Provide 1 lane in each direction during temporary construction (weekend closure) at transition locations with existing
24	Construct grading for temporary diversions as permanent in lieu of removing
25	Reserve topsoil / organics to support pollinator plantings
26	Revise pavement section to combine subbase layers (DGA and Crushed Stone)
27	Expand typical cross-section to eliminate median barrier

6 Evaluation Phase

Although each project is different, the evaluation process for each VE effort can be thought of in its simplest form as a way of combining, evaluating, and narrowing ideas until the VE team agrees on the alternatives to be forwarded. Figure 5 depicts the typical information flow for this part of the Value Methodology Job Plan.

Figure 5. VE Process Information Flow



6.1 Evaluation Process

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

The VE team also compared each idea with its baseline concept to determine whether the performance of the attribute (as introduced in Section 3.3) was better than, equal to, or worse than the baseline concept.

Each idea was then carefully evaluated, with the VE team reaching consensus on the overall ranking of the idea as defined below:

Develop = Advance for further development

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

Dismiss = Poor Opportunity/dropped from further development

Combine = Concept is similar to another idea

This ranking resulted in the initial disposition of the idea. Those ideas selected for development were taken into the next phase of the VE workshop; low-ranking ideas were dropped from further consideration.

Once ideas were evaluated, the VE facilitator held a mid-point review to validate the evaluation results and ensure the ideas moving forward aligned with the goals and objectives of the project. Some ideas that were originally selected for development were dropped from further consideration as they did not meet the long-term vision of the project.

Table 8. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating
1	Pave the surface course in echelon	• Reduced maintenance • Reduced construction time	• Increased MOT	Develop
2	Drop/Add the 3rd lane at the Highway 127 ramps	• Eliminates merge at Hwy 127 / curves • Improve safety / driver expectation • Reduce pavement quantity • Reduce potential for impacts to existing bridge/shoulders/crash cushions	• Increase overhead signage	Develop
3	Flatten side slopes with excess roadway excavation material	• Simplifies disposal of excess material • Reduces guard rail • Improves safety • Reduces maintenance / improved slope stability	• Increased ROW • May extend culvert lengths • Increased environmental impact	Develop
4	Ensure specifications account for shale embankment construction	• Improved construction oversight • Reduce risk		Comment
5	Relocate NB limit to start after Highway 127 bridge			Combine with 2
6	Verify condition of existing drainage culverts to support extensions	• Reduce risk		Comment
7	Provide lightweight fill over existing culverts to support extensions	• Reduce risk • Reduce impacts to existing culverts		Combine with 6
8	Revise alignment of new culverts into perpendicular and reduce length	• Reduced culvert lengths	• Flow restrictions and topography challenges	Dismiss
9	Eliminate interceptor ditch	• Reduced earthwork / ditch lining • Reduces maintenance		Develop
10	Flatten drainage ditches to reduce / eliminate ditch lining	• Simplifies disposal of excess material • Reduces maintenance / improved slope stability	• Increased ROW • May extend culvert lengths • Increased environmental impact	Combine with 3

Table 8. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating
11	Reduce inside shoulders to 12.0' in lieu of 14.3'	• Reduces footprint and related impacts • Reduces pavement	• Complicates transition to existing / requires lane shift • Reduces separation of traffic from barrier	Develop
12	Revise grades to reduce sliver fills / cuts	• Reduces roadway excavation / disposal • Reduce impacts / disturbance		Dismiss
13	Use single span structure at Tapering Point Road	• Improves clearspan over local road / removes obstacles • Improved constructability		Develop
14	Provide arch-supported tunnel at Tapering Point Road in lieu of bridge	• Supports additional material disposal onsite • Eliminates bridge deck maintenance	• Tunnel maintenance • May require lighting and ventilation	Dismiss
15	Increase height of pile caps and reduce bridge length	• Reduce bridge area	• Increase substructure scope/cost	Develop
16	Revise slopes of disposal areas to maximize capacity	• Reduces material disposal hauling	• May require additional material handling • Temporary slope stability issues	Comment
17	Eliminate salvage assumptions of existing cable barrier	• Reduce cost estimate assumptions		Comment
18	Provide additional temporary width to increase separation from barrier		• Increase ROW / footprint	Dismiss
19	Install measures to reduce surface water runoff at barrier during select phases	• Improve safety • Reduce risk • Increase drainage capacity	• Increase drainage scope for temporary • Potential maintenance impacts	Develop
20	Increase temporary storage of disposal and demo/use existing alignment	• Reduces material disposal hauling		Combine with 16
21	Provide high friction surface in temporary pavement for NB lane diversion	• Improves safety • Reduce risk • Improves wet/winter weather operations	• Adds pavement costs	Comment

Table 8. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating
22	Provide 4-lane section in interim and defer widening for 6 lanes until future	• Reduce interim scope / cost	• Reduces roadway capacity • Increase cost during future widening • Reduces separation with slow moving traffic	Dismiss
23	Provide 1 lane in each direction during temporary construction (weekend closure) at transition locations with existing	• Increases separation from barrier during temporary phase	• Increased delays during temporary closures	Dismiss
24	Construct grading for temporary diversions as permanent in lieu of removing	• Reduce earthwork scope / costs	• May increase ROW / footprint • May require benching of existing	Develop
25	Reserve top soil / organics to support pollinator plantings	• Improves planting establishment	• May add earthwork cost / handling	Comment
26	Revise pavement section to combine subbase layers (DGA and Crushed Stone)	• Reduce pavement costs		Comment
27	Expand typical cross-section to eliminate median barrier	• Reduces maintenance • Increases separation of traffic	• Increase footprint / ROW impacts • Increase environmental impacts • May require cable barrier	Dismiss

7 Development Phase

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

In the case of this project, of the 27 ideas that were generated during the Creativity Phase, 9 of those ideas were evaluated high enough to be taken forward, combined, and developed further. Some of the ideas were deemed more appropriate as a design consideration for the project team, rather than developed into a VE alternative (Section 7.3). For the Development Phase, narratives, drawings, calculations, and cost estimates were prepared for each alternative.

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

7.1 Summary of VE Alternatives

The alternatives developed by the VE team are shown in the table below. The table summarizes each alternative's cost impact and performance trade-offs. The alternatives are organized by category based on the project feature/project location or aspect of the project being addressed.

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

- Initial Cost Savings Potential – A quantified indication of the alternative's impact to the project's initial cost in comparison with the baseline concept. Initial cost savings are conceptual and reflective of the VE team's parametric estimation of possible savings and represent orders of magnitude cost impact of the VE alternative. Because the cost data depicted represent savings, a number in parentheses represents a cost increase.]
- Performance/Risk – A qualitative summary of the performance impacts of the VE alternative in comparison with the baseline concept. Performance attributes include the following: MO – Main Line Operations, LO – Local Operations, M – Maintainability, CI – Temporary Construction Impacts, and EI – Environmental Impacts. Refer to the Project Analysis section of this report for additional explanation of the performance attributes identified. Certain alternatives include a qualitative summary of the result of VE alternative to change the probability or degree of magnitude/impact on the project's total risk exposure relative to the baseline concept.

Table 9. Summary of Alternatives

Alt No.	Alternative Title	Cost Savings or (Cost Added)	Performance/Risk
Earthwork / Grading			
E-1	Flatten side slopes with excess roadway excavation material	$456,000	Improved (MO, M) Reduced (ROW/EI)
E-2	Construct grading for temporary diversions as permanent in lieu of removing	$330,000	Reduced (M)
E-3	Eliminate interceptor ditch	$180,000	Improved (M)
Typical Cross-Section / Project Limits			
XP-1	Reduce inside shoulders from 14.3' to 12.0'	$520,000	Improved (M) Reduced (MO)
XP-2	Drop/Add the 3rd lane at the Highway 127 ramps	$173,000	Improved (M, CI)
Tapering Point Road Structure			
S-1	Use single span structure at Tapering Point Road	$0	Improved (LO, M)
S-2	Increase height of pile caps and reduce bridge length	$460,000	No change
Construction / Maintainability			
C-1	Pave the surface course in echelon	($86,000)	Improved (M) Reduced (CI)
C-2	Install measures to reduce surface water runoff at barrier during select phases	($306,000)	Improved (CI, Risk) Reduced (M)

VE ALTERNATIVE E-1
Flatten side slopes with excess roadway excavation material

Description of Baseline Concept: Construct embankment slopes on either a 2:1 or 2.5:1 slope per geotechnical recommendation.

Description of Alternative Concept: Construct embankment slopes on 3:1 or preferably 4:1 slopes to eliminate guardrail and use excess material from cut slopes. In areas with temporary widened slopes, construct to required stable slope configuration and leave in place.

Advantages:

- Increase in safety by eliminating guardrail from many locations.
- Increase safety by placing excess excavation on right of way reducing the need for transporting with on-road trucks.
- Increase slope stability and reduce potential landslides by flattening the embankment slopes.
- Reduce the need for “waste areas” by using the excess excavation on right of way.

Disadvantages:

- Increases the footprint of the project that may then require purchase of more right of way.
- Lengthen drainage structures increasing total cost for these items.
- May require more environmental clearance due to larger disturbed area.

Discussion:

This project has a large amount of excess excavation due to the large cuts through the new alignment. Widening current and proposed embankments to flatter slopes could be a safe and economical way to dispose of this excess material. The non-durable shale in this area is prone to embankment and cut slope failures so flatter slopes provide increased stability safety factors. This also allows the contractor to use off-road equipment to transport most of the material to the locations without impacting traffic.

Embankment slopes that are traversable (3:1) do not require guardrail and ones that are recoverable (4:1) are always to be considered when possible. Since many of the proposed slopes require a 2.5:1 slope to be stable increasing to a 3:1 or a 4:1 slope should be considered. This will allow for placement of the excess material within the roadway template and eliminate the need for guardrail.

This will require changes to the drainage system as ditches will need to be moved and some pipes and culverts will need to be extended. The flatter slopes may allow for the ditches to be flatter and lessen the need for as much channel lining or the use of smaller channel lining. Additional right of way may need to be purchased to accommodate the wider embankments. This will also change the disturbed area so the environmental documents will need to be updated.

Schedule Impacts:

The contract schedule should be accelerated slightly by placing more material within the roadway embankments compared to off-site locations. Using the embankments reduces the haul distances and allows for more of the material to be hauled by off-road trucks and not by on-road trucks hauling to “waste” areas. This will also slightly increase safety as less construction traffic will be using mainline I-71 reducing the potential for accidents.

VE ALTERNATIVE E-1
Flatten side slopes with excess roadway excavation material

Risk:

Environmental approval is delayed due to larger disturbance area requiring additional investigations and fees.

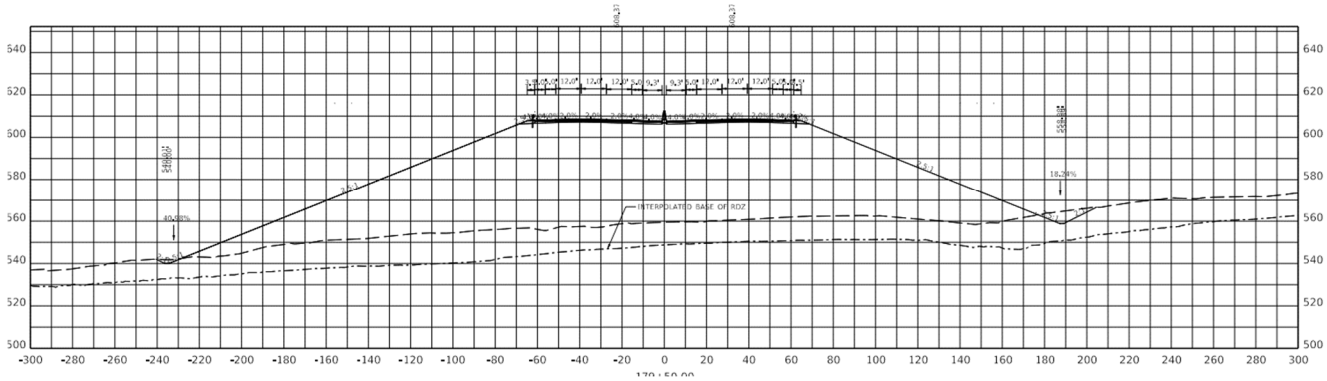
Performance Assessment:

Attributes and Rating Rationale
Mainline Operations Provide more stable roadway embankments. Provide a safer roadway by reducing guardrail.
Local Operations No effect on local operations.
Maintainability Increasing stability and reduce chances of landslides on embankments. Also decrease maintenance of guardrail.
Construction Impacts Increase ease of construction by reducing length of haul routes for excess material and reduce the need for on-road trucks as more material would be placed within roadway template. Increase in the total length of drainage structures to be installed.
Right of Way / Environmental Impacts Increase the amount of right of way needed. Increase the disturbed limits and require changes to the environmental documents.

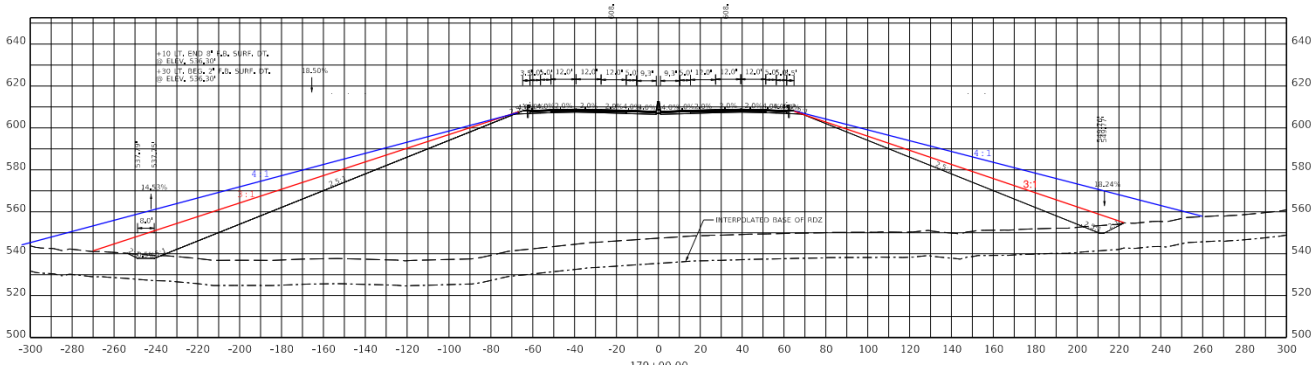
VE ALTERNATIVE E-1

Flatten side slopes with excess roadway excavation material

Baseline Concept Sketch



VE Alternative Concept Sketch



Assumptions and Calculations: Assumed 15% increase in area needed and 15% increase in cost for a 4:1 slope. Additional quantities of pipe and channeling was estimated based on length added for a 4:1 slope. Additional quantities of steel reinforcement and concrete class A were based on extending the total culvert lengths by about 20% from as designed. A slight reduction in the roadway excavation item was considered as the contractor will be able to place more material in the roadway template and not be required to find a waste area. Bid item cost was based on the higher value between the project estimate and the 2024 Average Unit Bid Prices.

Flattening embankments to a 4:1 slope at the below locations provides storage for approximately 175,500 CUYD of excavated material: RT and LT STA. 174+00 to STA. 181+50, LT STA 185+00 to RT STA 190+00, STA 189+50 to 195+25, RT STA 196+50 to STA 200+00. These 4:1 slopes also eliminates the need for guardrail in these locations resulting in a reduction in guardrail by approximately 2,550 LF and improves safety for the corridor. The flatter slopes will allow some of the channel lining to be reduced to smaller sized channel lining or erosion control blanket. I reduced 33% of the added channel length as erosion control blanket.

VE ALTERNATIVE E-1

Flatten side slopes with excess roadway excavation material

Initial Cost Estimate

CONSTRUCTION ELEMENT		*BASELINE CONCEPT*			*ALTERNATIVE CONCEPT*		
Description	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Roadway excavation	CY	1,197,485	$ 17.19	$ 20,584,767	1,197,485	$ 16.50	$ 19,758,503
Channel Lining Class III	TON	12,090	$ 68	$ 819,218	12,095	$ 68	$ 819,557
Right of way purchase	each	1	$ 1,786,000	$ 1,786,000	1	$ 2,053,900.00	$ 2,053,900
Culvert pipe 18 in	LF	71	$ 213	$ 15,101	106	$ 213	$ 22,545
Concrete Class A	CUYD	935	$ 1,012	$ 945,728	1,122	$ 1,012	$ 1,134,873
Steel Reinforcement	LB	112,698	$ 2	$ 191,587	135,238	$ 2	$ 229,904
Culvert pipe 66 in	LF	252	$ 449	$ 113,244	287	$ 449	$ 128,972
Gaurdrail steel W beam S face	LF	14,625	$ 35	$ 512,460	12,075	$ 35	$ 423,108
Erosion control blanket	SQYD	0	$ 2	$ -	500	$ 2	$ 1,235
PROJECT MARK-UPS	15%			$3,745,216			$3,685,890
TOTAL (Rounded)				$28,713,000			$28,258,000
						SAVINGS	**$455,000**

VE ALTERNATIVE E-2
Construct grading for temporary diversions as permanent in lieu of removing

Description of Baseline Concept:

In the project plans, additional fill material will be installed along with the new roadway fills to construct the I-71 NB and SB diversions. Once the diversions are no longer needed, the fill for the diversions is removed and wasted.

Description of Alternative Concept:

In lieu of removing the diversion fills after use, the VE team proposes leaving the fills in place and incorporating into the permanent construction. As the project currently has a significant amount of waste, this will reduce the amount of material to be wasted and will eliminate a significant amount of work to re-handle the material to remove from the area.

Advantages:

- Reduce earthwork scope/costs

Disadvantages:

- May increase ROW/project footprint
- May require benching of existing slope

Discussion:

Using the MOT cross-sections for the I-71 NB and SB diversions, the following quantities were calculated to determine the amount of “temporary” fill material that could be incorporated into the permanent project embankment slopes.

It is assumed the diversion embankment areas are still in development as some cross-sections detail the permanent embankment over sections of the diversion embankment. In addition, some diversion fill areas are shown on top of existing ground. It is assumed benching will be required for these areas.

Diversion embankment areas are being constructed as 2:1 slopes which do match permanent embankment slopes in some areas. If deemed flatter permanent slopes are required, additional ROW may be necessary.

Additional measures may be needed to ensure proper drainage.

VE ALTERNATIVE E-2

Construct grading for temporary diversions as permanent in lieu of removing

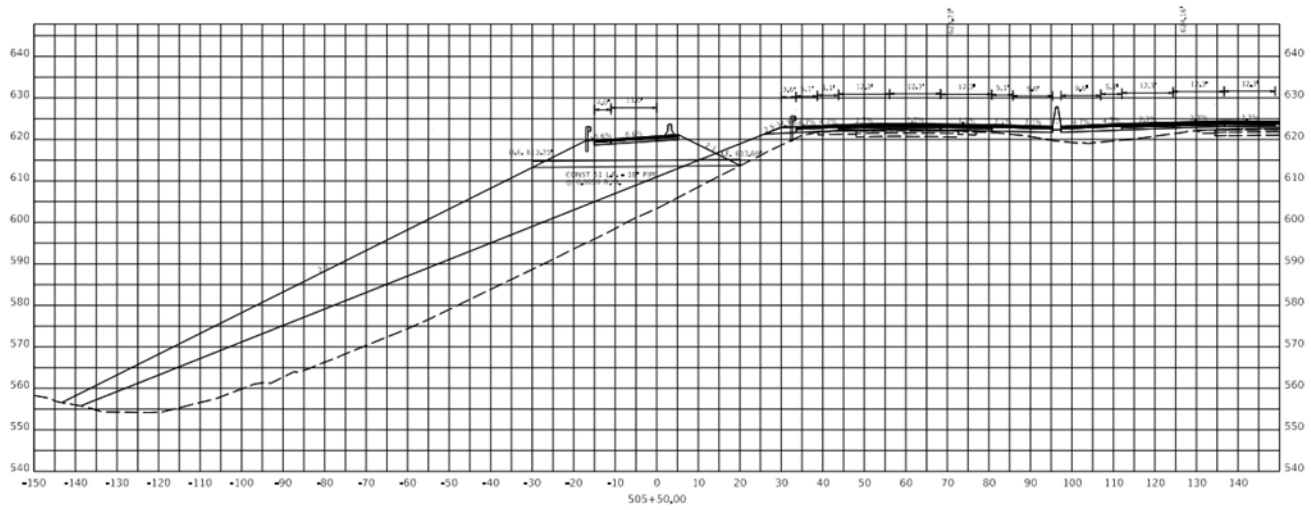
Performance Assessment:

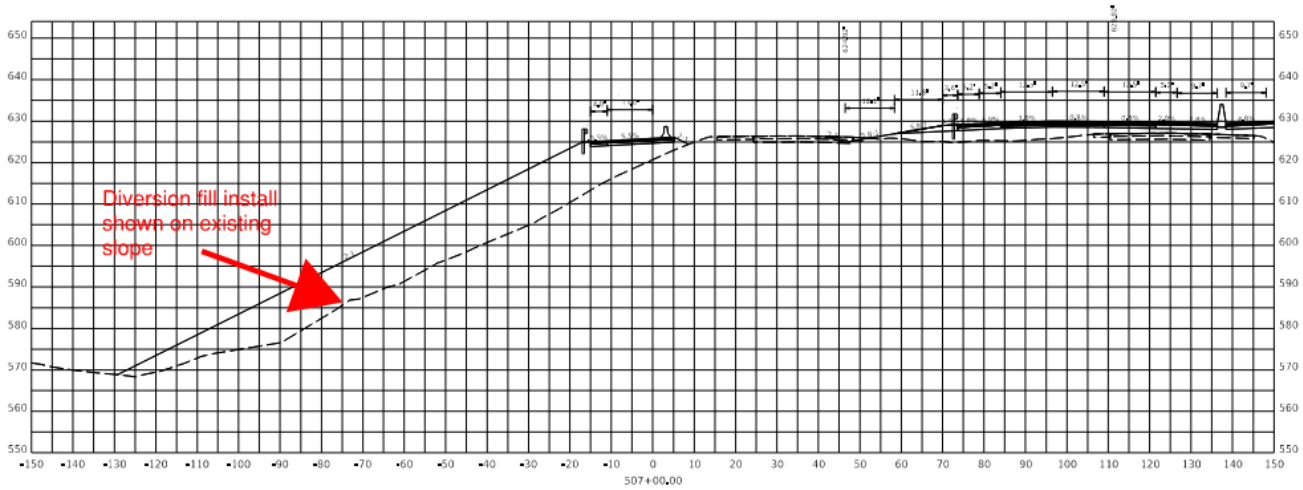
Attributes and Rating Rationale
Mainline Operations No change.
Local Operations No change.
Maintainability Diversion embankment slopes are being constructed as 2:1 slopes which may be steeper than some permanent fill slopes.
Construction Impacts Allowing the diversion embankments to remain in place will require less work as the fill material will not need to be handled a second time. In addition, on an already large waste project, less material will need to be wasted on/off site.
Right of Way / Environmental Impacts If concerns about 2:1 slopes for diversion embankments, flatter slopes may require additional ROW and thus leading to additional environmental impacts.

VE ALTERNATIVE E-2

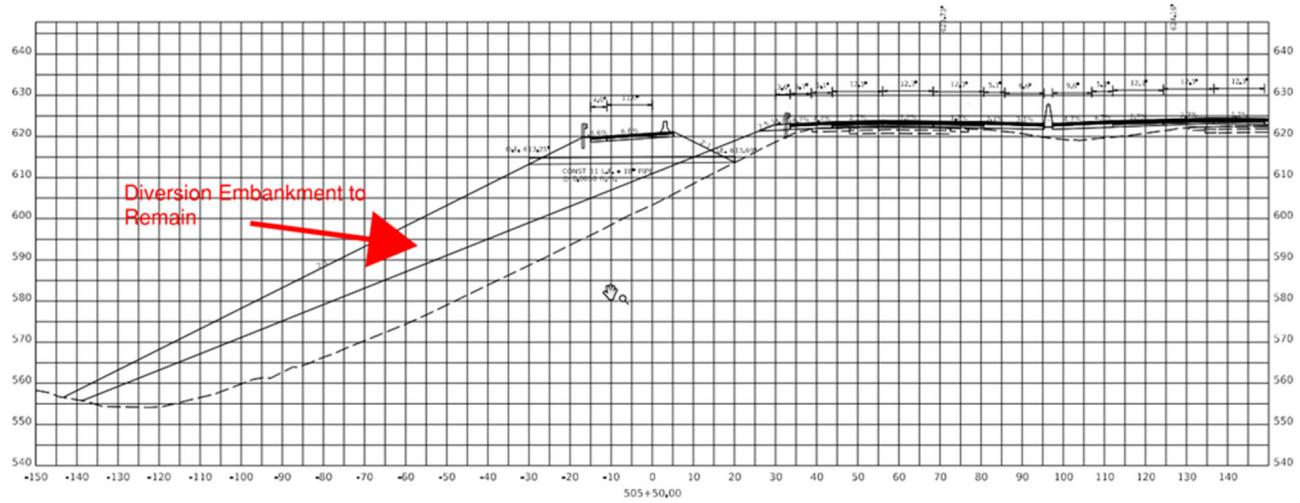
Construct grading for temporary diversions as permanent in lieu of removing

Baseline Concept Sketch



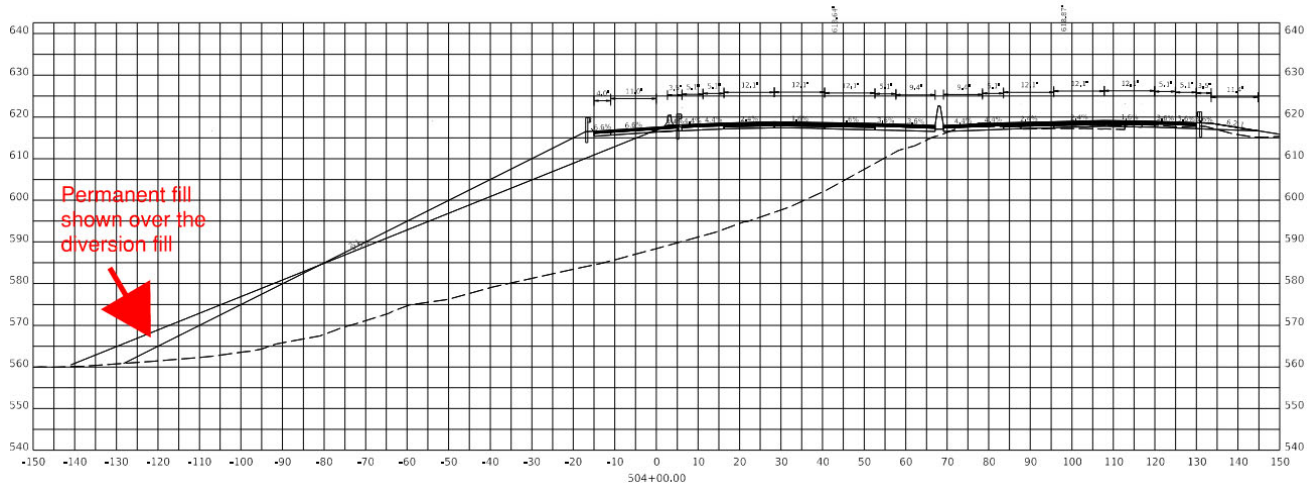


VE Alternative Concept Sketch



VE ALTERNATIVE E-2

Construct grading for temporary diversions as permanent in lieu of removing



Assumptions and Calculations:

Diversion Earthwork Quantities:

NB Diversion
600+00 Begin diversion
600+50 – 0 Sq Ft
601+50 – 0 Sq Ft
602+00 – 125 Sq Ft
532 CY
602+50 – 450 Sq Ft
1250 CY
603+00 – 900 Sq Ft / 1713 CY
603+50 – 950 Sq Ft / 1644 CY
604+00 – 825 Sq Ft / 1343 CY
604+50 – 625 Sq Ft / 856 CY
605+00 – Shows add'l fill over diversion – 300 Sq Ft / 417 CY
605+50 – Shows add'l fill over diversion – 150 Sq Ft / 486 CY
606+00 – Toe of diversion slope on new cut area – 375 Sq Ft / 463 CY
606+50 – Toe of diversion slope on new cut area – 125 Sq Ft / 185 CY
607+00 – Toe of diversion slope on new cut area – 75 Sq Ft / 93 CY
607+50 – 25 Sq Ft- / 139 CY
608+00 – 125 Sq Ft / 86 CY
608+37.23 – End diversion

9207 CY Total Embankment NB Diversion

SB diversion
500+00 – Begin diversion
500+50 – 0 Sq Ft
501+00 – 0 Sq Ft / 23 CY
501+50 – 25 Sq Ft / 93 CY
502+00 – 75 Sq Ft / 93 CY
502+50 – Shows add'l fill over diversion – 25 Sq Ft / 93 CY
503+00 – Shows add'l fill over diversion – 75 Sq Ft / 162 CY
503+50 – Shows add'l fill over diversion – 100 Sq Ft / 370 CY

504+00 – Shows add'l fill over diversion – 300 Sq Ft / 833 CY
504+50 – Shows add'l fill over diversion – 600 Sq Ft / 1366 CY
505+00 – Shows add'l fill over diversion – 875 Sq Ft / 2153 CY
505+50 – 1450 Sq Ft / 3102 CY
506+00 – Top of diversion fill on existing slope – 1900 Sq Ft / 3241 CY
506+50 – Diversion fill on existing slope – 1600 Sq Ft / 2616 CY
507+00 – Diversion fill on existing slope – 1225 Sq Ft / 2060 CY
507+50 – Diversion fill on existing slope – 1000 Sq Ft / 1458 CY
508+00 – Diversion fill on existing slope – 575 Sq Ft / 810 CY
508+50 – Diversion fill on existing slope – 300 Sq Ft / 394 CY
509+00 – Diversion fill on existing slope – 125 Sq Ft / 116 CY
509+50 – 0 Sq Ft
509+63.76 – End diversion

18,983 CY Total Embankment SB Diversion

28,190 CY Total Embankment NB & SB Diversions

Initial Cost Estimate

CONSTRUCTION ELEMENT		*BASELINE CONCEPT*			*ALTERNATIVE CONCEPT*		
Description	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Roadway Excavation	CY	28,190	$ 10.18	$ 286,974			$ -
SUB-TOTAL				$286,974			$0
PROJECT MARK-UPS	15%			$43,046			$0
TOTAL (Rounded)				$330,000			$0
						SAVINGS	**$330,000**

VE ALTERNATIVE E-3
Eliminate interceptor ditch

Description of Baseline Concept:

Between stations 115+00 and 126+00 along the north side of the westbound lanes there is an interceptor ditch located mid-slope near the top of the planned slope excavation. The ditch catches runoff from the hillside above the proposed new excavation and should help to limit erosion of the newly excavated hillside and silting of the lower ditch which parallels to the interstate offset 18’ from the edge of shoulder.

Review of the roadway cross sections through this area shows a slight swale, or likely existing interceptor ditch, at the same location on the slope.

Description of Alternative Concept:

From discussions, interceptor ditches tend to silt in overtime and their location up on the slope makes them difficult to maintain. As the ditch silts in, the trapped water creates saturated slope areas that are then more prone to sloughing and slides. Resulting in significant maintenance repairs. The goal in this case would be to simply remove the interceptor ditch and rely on proper erosion control measures to limit erosion on the disturbed slopes. There are other large slope cuts in the project limits that will utilize this same approach and not utilize an interceptor ditch.

Advantages:

- Simplifies construction by removing difficult ditch excavation on 2:1 slope
- Removes rock placement for protecting the interceptor ditch
- Reduced maintenance concerns with interceptor ditch up on a steep slope
- Reduced concern with over saturation of slope which can lead to sloughing/slides from water trapped in interceptor ditch due to inability to properly maintain.

Disadvantages:

- Some increase in silting of the main ditch parallel to I-71, typical of other locations along the project limits. This material is easily accessed and removed.

Discussion:

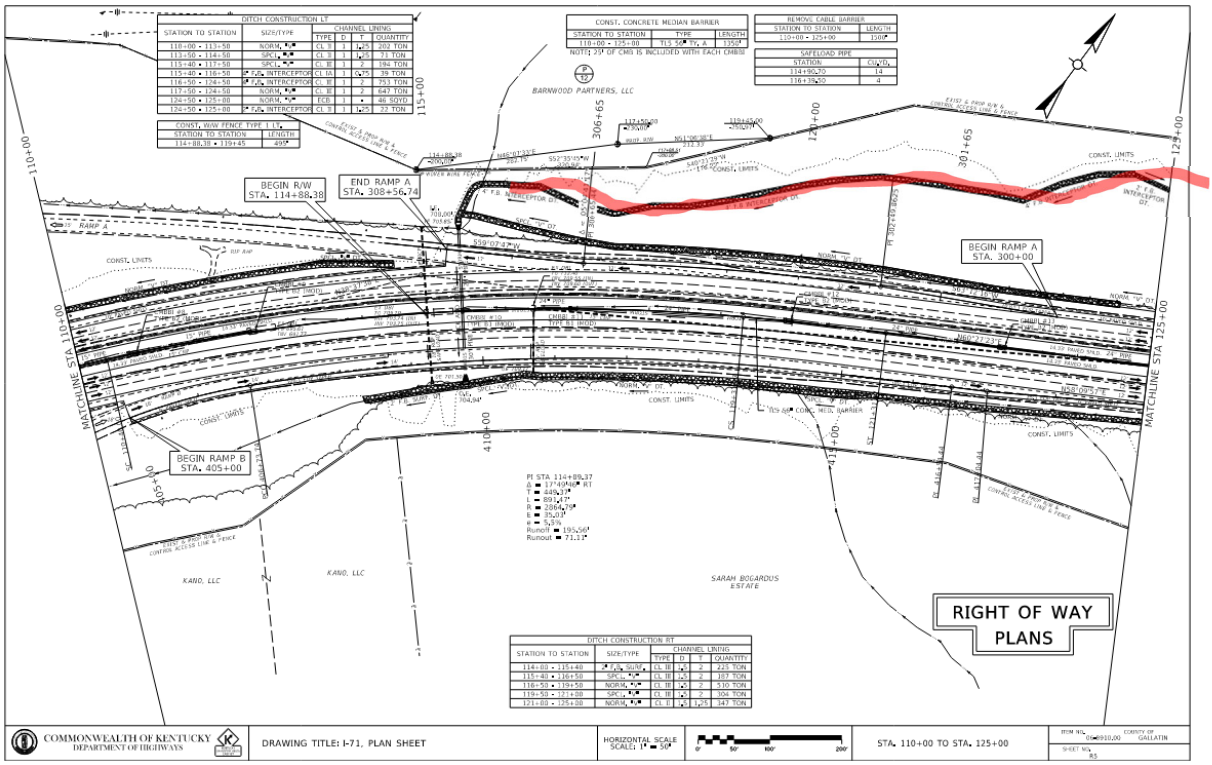
Removal of the interceptor ditch results in a cost savings of roughly $180,000.

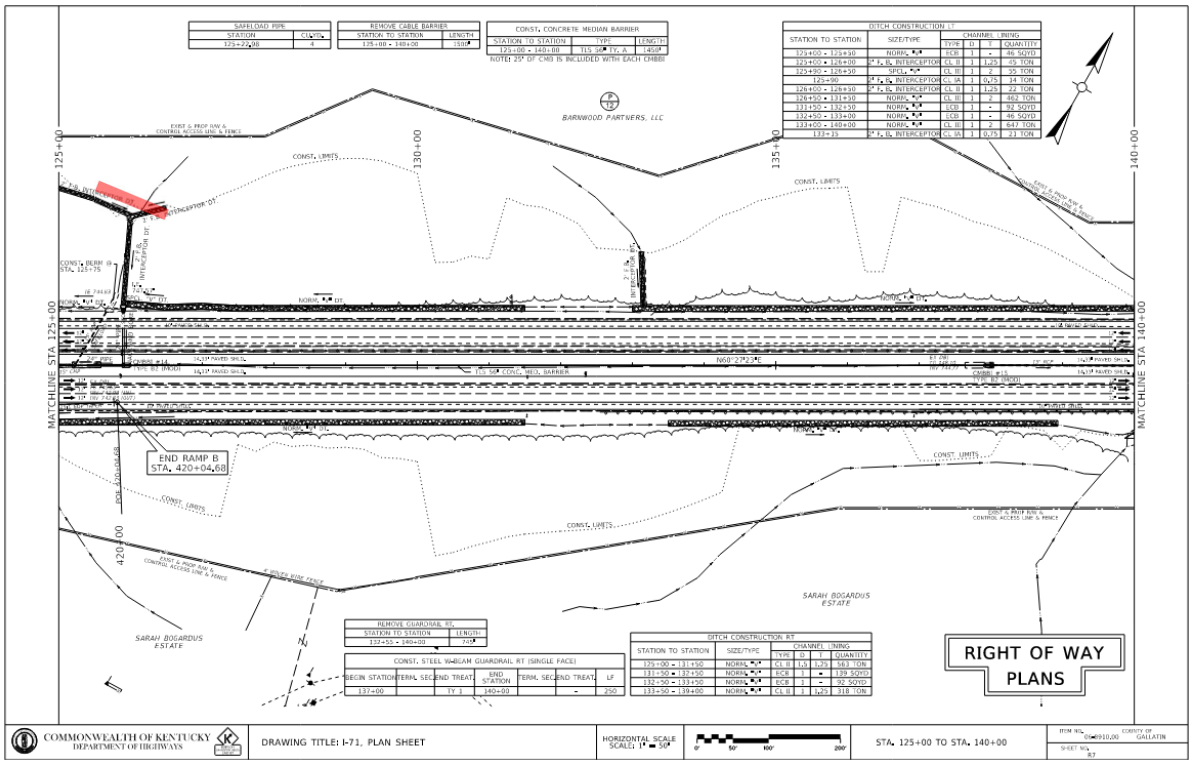
VE ALTERNATIVE E-3
Eliminate interceptor ditch

Performance Assessment:

Attributes and Rating Rationale
Mainline Operations No impacts to mainline operations
Local Operations No impacts to local operations
Maintainability Decreased long term maintenance concerns. From discussions, interceptor ditches tend to silt in over time and their location up on the slope makes them difficult to maintain. As the ditch silts in, the trapped water creates saturated slope areas that are then more prone to sloughing and slides. Resulting in significant maintenance repairs. There is a possible increase in/silting of the main ditch parallel to I-71 which could lead to drainage issues adjacent to the pavement. These are easily visible and addressed. Maintaining proper erosion control on the disturbed slopes until vegetation is reestablished is important.
Construction Impacts Simplifies construction by removing ditching and rock placement on the slope and reduces the extend of disturbed soil.
Right of Way / Environmental Impacts Reduced construction limits and resulting environmental impacts

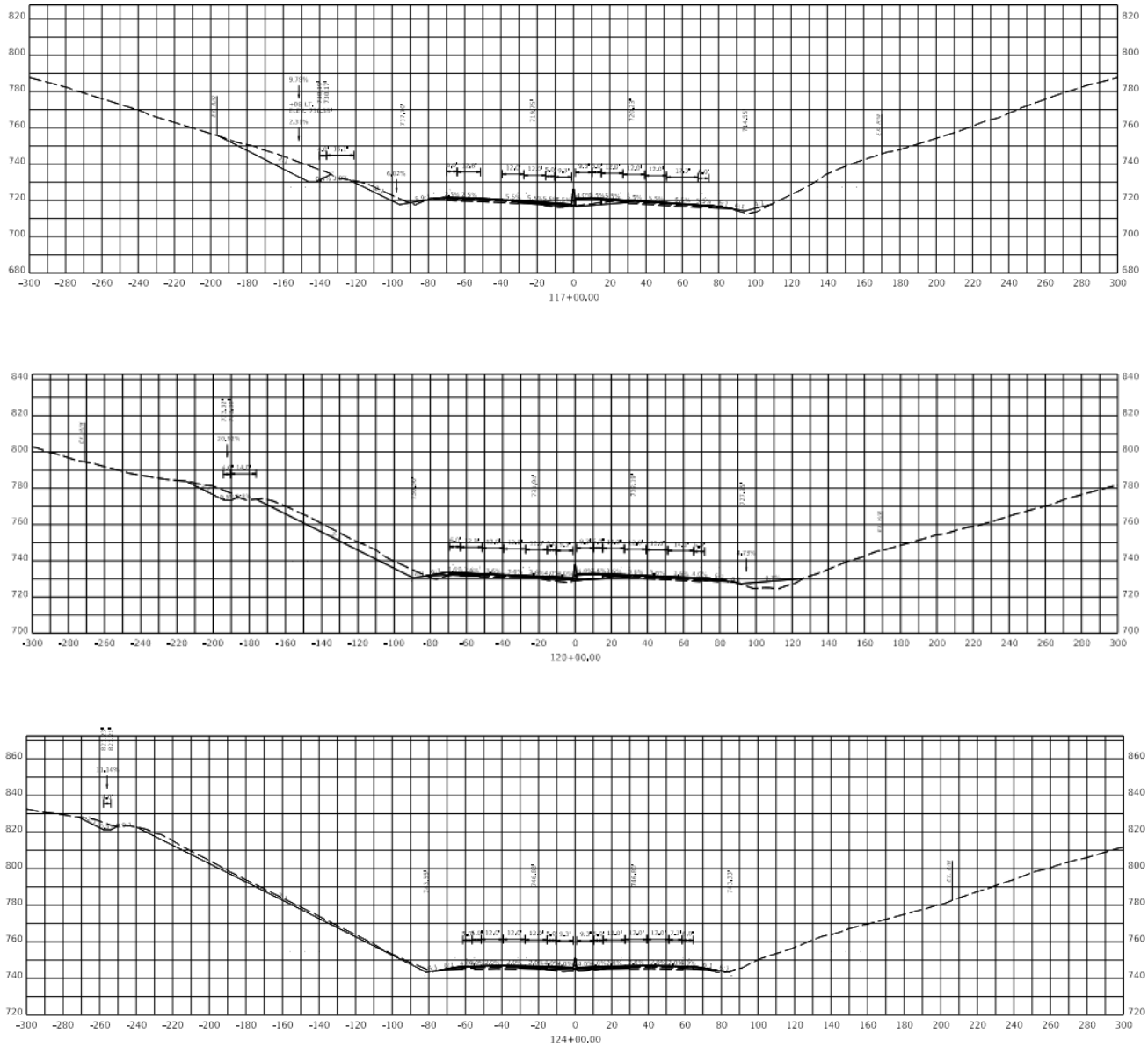
Baseline Concept Sketch





Plan Views of Interception Ditch

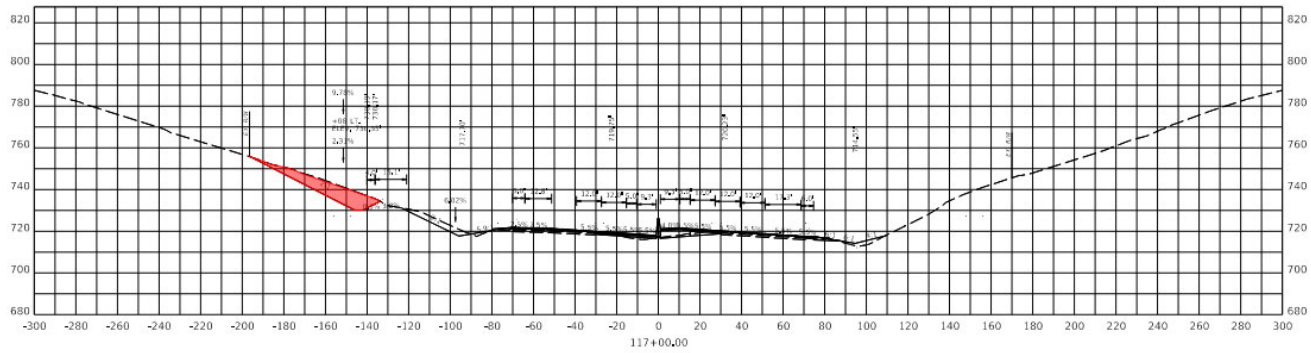
VE ALTERNATIVE E-3
Eliminate interceptor ditch

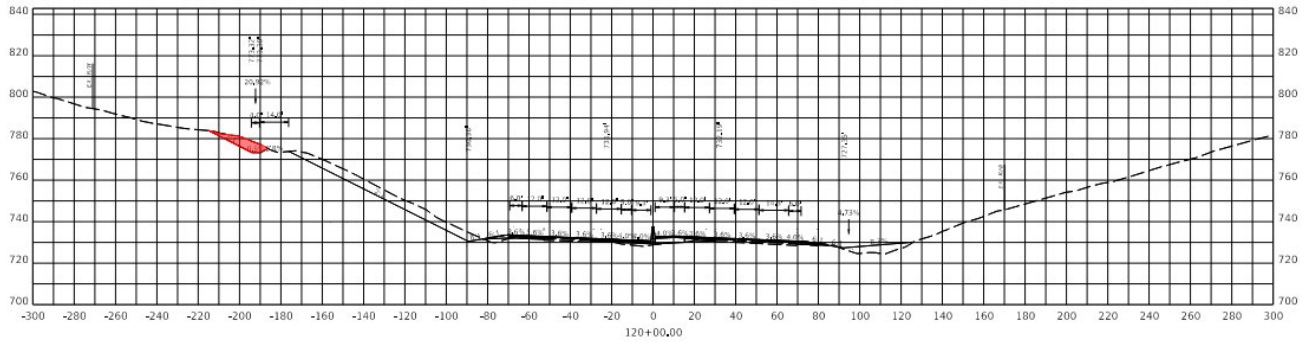


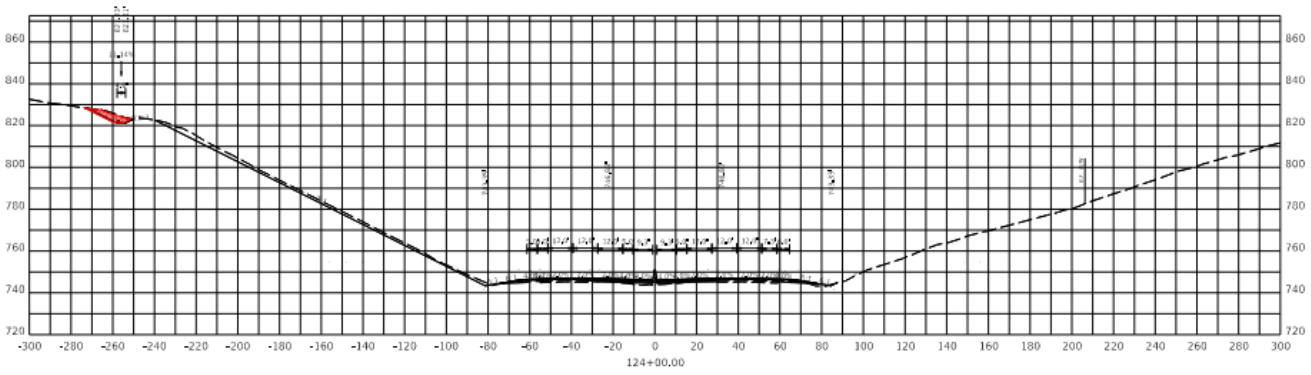
Cross Sections Showing Interception Ditch

VE ALTERNATIVE E-3
Eliminate interceptor ditch

VE Alternative Concept Sketch







Cross Sections Showing Reduction in Excavation (Red Highlight)

Quantity Reductions

Roadway Excavation 4810 CY; (exclude red area in cross section above for affected stations)

Channel Lining 39 Tons Type IA (quantities taken from plan sheets)
89 Tons Type II
753 Tons Type III

Assumptions and Calculations:

Reduce Roadway Excavation for interceptor ditch (red highlighted areas on previous sheets, examples stations)

Remove Channel Lining quantity for Interceptor ditch parallel to the interstate along the top of slope disturbance. Assume the interceptor ditches perpendicular to the interstate will remain.

Doubled the unit bid price for roadway excavation ($20.00) from the cost estimate document ($10.18) to account for the localized and difficult nature of the ditch excavation up on the slope versus the general roadway excavation.

Utilized the cost estimate unit bid prices for Channel Lining.

Roadway Excavation							
Station		Excavation (SF)	CY	Unit Prive (/CY)			
116+00		51	94.4	$ 20.00			
116+50		347	642.6				
117+00		299	553.7				
117+50		145	268.5				
118+00		189	350.0				
118+50		94	174.1				
119+00		91	168.5				
119+50		124	229.6				
120+00		97	179.6				
120+50		127	235.2				
121+00		178	329.6				
121+50		210	388.9				
122+00		224	414.8				
122+50		125	231.5				
123+00		50	92.6				
123+50		44	81.5				
124+00		52	96.3				
124+50		38	70.4				
125+00		36	66.7				
125+50		16	29.6				
126+00		46	85.2				
126+50		13	24.1				
127+00							
			4810	CY			**$ 96,200.00**
Channel Lining (Interceptor Ditch)							
Ditch Type	Station		Lining Type	Quantity (Ton)	Unit Price (/ Ton)		
4' FB	115+40	116+50	IA	39	$ 138.00	$	5,382.00
4' FB	116+50	124+50	III	753	$ 67.76	$	51,023.28
2' FB	124+50	126+00	II	67	$ 42.83	$	2,869.61
2' FB	126+00	126+50	II	22	$ 42.83	$	942.26
						$	**60,217.15**
					Total Savings =	**$**	**160,000.00**

VE ALTERNATIVE E-3
Eliminate interceptor ditch

Initial Cost Estimate

CONSTRUCTION ELEMENT		*BASELINE CONCEPT*			*ALTERNATIVE CONCEPT*		
Description	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Roadway Excavation	CY	4,810	$ 20.00	$ 96,200			$ -
Channel Lining							
-Type IA	Ton	39	$ 138.00	$ 5,382			$ -
-Type III		753	$ 67.76	$ 51,023			$ -
-Type III		67	$ 42.83	$ 2,870			$ -
-Type III		22	$ 42.83	$ 942			$ -
SUB-TOTAL				$156,417			$0
PROJECT MARK-UPS	15%			$23,463			$0
TOTAL (Rounded)				$180,000			$0
						SAVINGS	**$180,000**

VE ALTERNATIVE XP-1
Reduce inside shoulders from 14.3' to 12.0'

Description of Baseline Concept:

14’-4” is the proposed width for both inside shoulders (larger than normal).

Description of Alternative Concept:

Reduce the width of both inside shoulders to 12’-0”.

Advantages:

- Reduces cost of pavement

Disadvantages:

- Reduced distance between live traffic and a vehicle that has pulled over to the shoulder
- Complicates transitions back to the existing pavement at each terminus of the project

Discussion:

It seems likely the inside shoulder widths were initially set to 14’-0” during preliminary design, and that was based on an older, wider KYTC standard for a concrete median barrier. Recent updates to the KYTC standards have a median barrier that is 8” narrower at its base.

Costs can be reduced by changing the inside shoulders widths to 12’-0” while still meeting AASHTO/KYTC design standards.

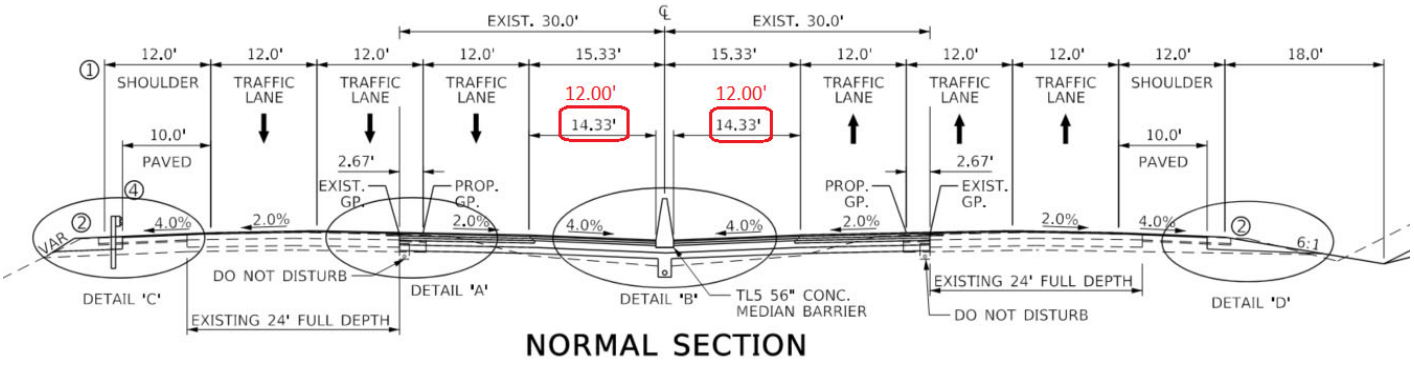
VE ALTERNATIVE XP-1
Reduce inside shoulders from 14.3' to 12.0'

Performance Assessment:

Attributes and Rating Rationale
Mainline Operations Slight reduction in refuge space for vehicles pulled over on inside shoulder Slight reduction in drainage area
Local Operations No effect
Maintainability Slightly reduces future milling and re-paving quantities
Construction Impacts Slightly reduces construction schedule
Right of Way / Environmental Impacts No significant effect

VE ALTERNATIVE XP-1

Reduce inside shoulders from 14.3' to 12.0'



NORMAL SECTION

Change Inside Shoulders from 14'-4" to 12'-0"		
Beg. Sta.	9988.75	
End Sta.	26900	
Length (ft)	16911	
Width of Reduction (ft)	4.666	(total for both shoulders)
Thickness of Asphalt Surface (in)	1.5	INSIDE PAVED SHOULDER NEW CONSTRUCTION
Thickness of Asphalt Base (in)	6	1.50" CL3 ASPH SURF 0.38D PG64-22 3.00" CL3 ASPH BASE 1.00D PG64-22 3.00" CL3 ASPH BASE 1.00D PG64-22 9.50" CRUSHED STONE BASE
Thickness of CSB (in)	9.5	
Volume of Asphalt Surface (CF)	9863	
Volume of Asphalt Base (CF)	39454	
Volume of CSB (CF)	62469	
Weight of Asphalt Surface (Tons)	725.0	density: 110 lbs /SY/in
Weight of Asphalt Base (Tons)	2899.9	
Weight of CSB (Tons)	3592.0	density: 115 pcf
Cost of Asphalt Surface (Tons)	$ 85,611	
Cost of Asphalt Base	$ 241,704	
Cost of CSB (Tons)	$ 124,784	
Subtotal	$ 452,099	
Estimated Cost Savings	**$ 519,914**	with 15% contingency

VE ALTERNATIVE XP-2
Drop/Add the 3rd lane at the Highway 127 ramps

Description of Baseline Concept:

The project is currently showing extending the widened three-lane section through the interchange with Highway 127. The striping plans show the transition/merge for the SB lanes starting at approximately Station 115+00. The transition/addition of the third lane in the NB direction begins at approximately Station 101+55.

Description of Alternative Concept:

Revise the project limits to begin and end the widened three-lane section at the ramps for the Highway 127 interchange.

Advantages:

- Reduces pavement scope and costs
- Improves driver expectations
- Eliminates merge with high-speed lanes (NB)
- Promotes use of ramp and interchange for emergency/wet weather diversion
- Reduces risk of impacts existing Highway 127 bridge and related elements

Disadvantages:

- Increases scope/costs of future I-71 widening
- Reduces area for merge from Highway 127 NB ramp with I-71 NB traffic

Discussion:

This alternative suggests utilizing the Highway 127 ramps as the logical southern termini of the widened section instead of extending through the interchange. The widened section was extended through the interchange in an attempt to simplify future I-71 widening. The VE team identified a possible risk that the future widening may require replacement of the Highway 127 overcrossing and interchange reconstruction. Additionally, the existing bridge has a medium condition rating and may be ready for replacement at the time of the future widening project. As such, there may be limited benefits of this project extending the widened section to support the future project.

Existing bridge shows 18’ vertical clearance, but has variable depth beams that may reduce that clearance to 16’.

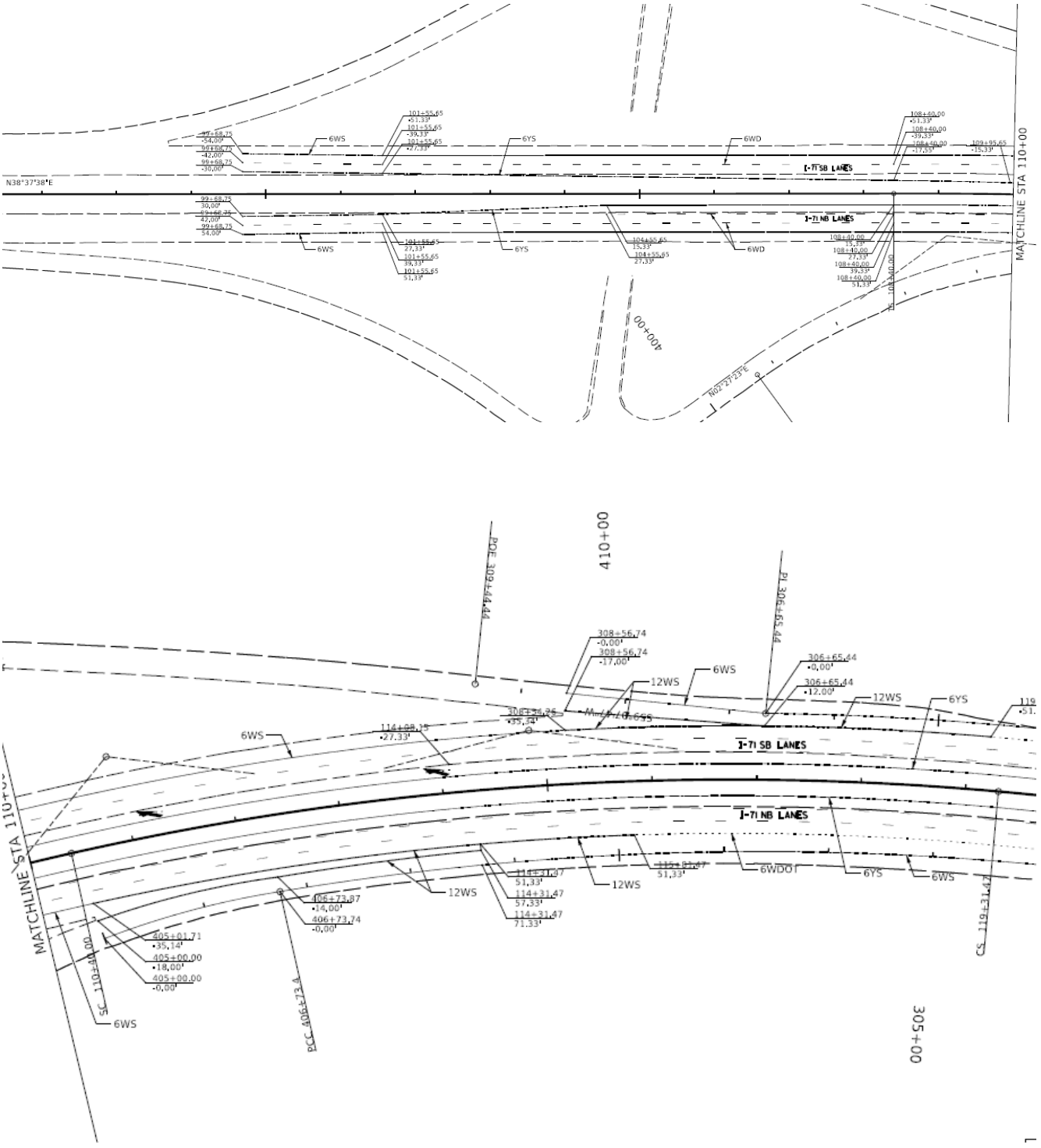
VE ALTERNATIVE XP-2
Drop/Add the 3rd lane at the Highway 127 ramps

Performance Assessment:

Attributes and Rating Rationale
Mainline Operations Assume similar operation to baseline concept. Driver expectations are improved and eliminates SB merge condition from the left into high-speed lanes. Reduces merge area for NB lanes with the NB Highway 127 ramp.
Local Operations No significant change.
Maintainability Reduced pavement requiring overlay / maintenance in the interim.
Construction Impacts Reduces time and impacts to existing roadway and increases amount of work that can be completed offline of traffic.
Right of Way / Environmental Impacts No significant change.

VE ALTERNATIVE XP-2
Drop/Add the 3rd lane at the Highway 127 ramps

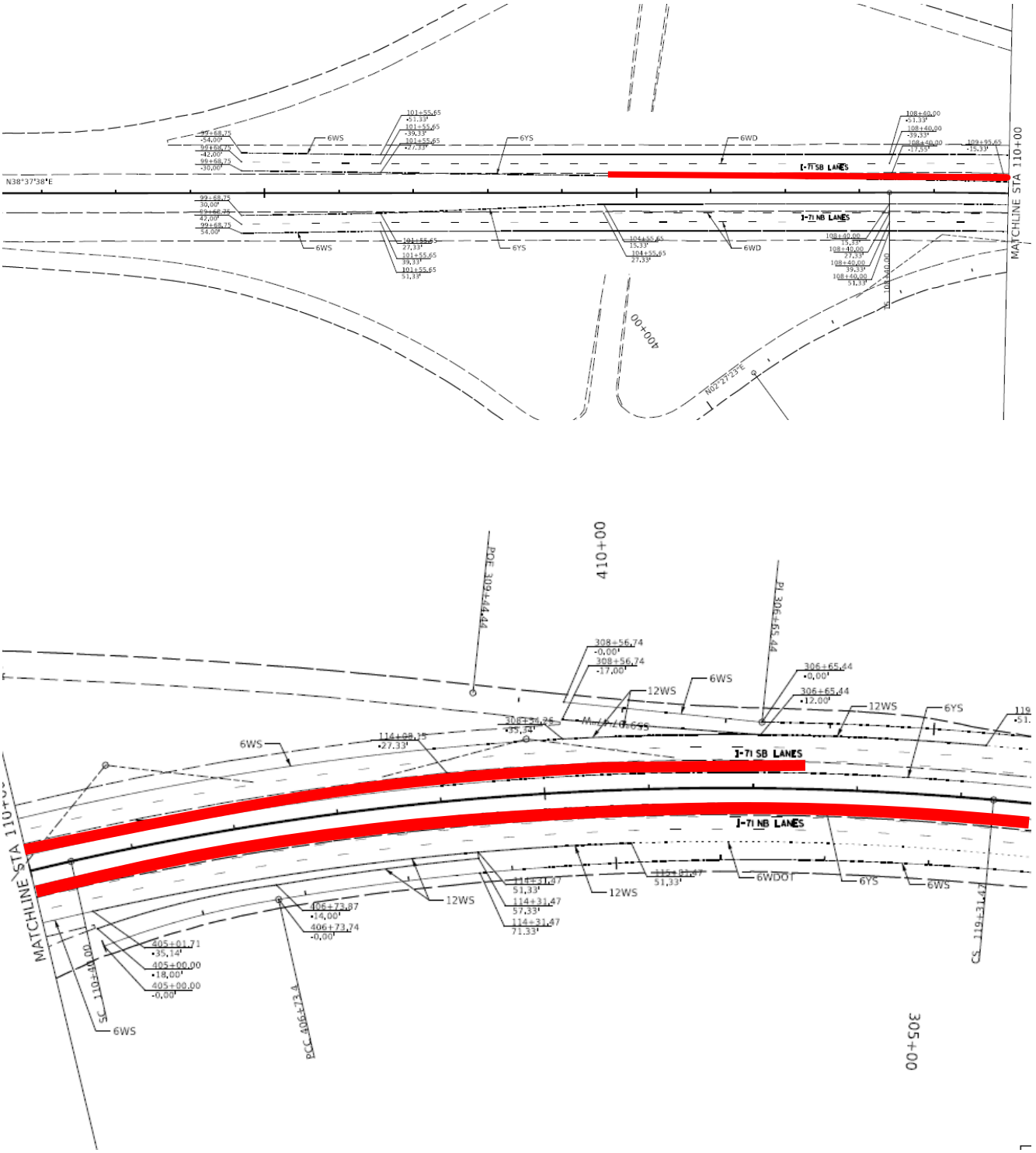
Baseline Concept Sketch



VE ALTERNATIVE XP-2

Drop/Add the 3rd lane at the Highway 127 ramps

VE Alternative Concept Sketch



VE ALTERNATIVE XP-2

Drop/Add the 3rd lane at the Highway 127 ramps

Initial Cost Estimate

CONSTRUCTION ELEMENT		*BASELINE CONCEPT*			*ALTERNATIVE CONCEPT*		
Description	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Crushed Stone Base	Ton	650	$ 32.03	$ 20,820			$ -
Lime Stablized Roadbed	SY	533	$ 3.79	$ 2,021			$ -
Asphalt Base	Ton	1,200	$ 69.03	$ 82,836			$ -
Asphalt Surfacing	Ton	600	$ 97.66	$ 58,596			$ -
Median Barrier	LF	100	$ 115.50	$ 11,550			$ -
Overhead Sign				$ -	1	$ 25,000	$ 25,000
SUB-TOTAL				$175,823			$25,000
PROJECT MARK-UPS	15%			$26,373			$3,750
TOTAL (Rounded)				$202,000			$29,000
						SAVINGS	**$173,000**

VE ALTERNATIVE S-1
Use single span structure at Tapering Point Road

Description of Baseline Concept:

2 span, unsymmetrical bridge with a pier located near the shoulder of KY 3002 (Tapering Point Rd.)

Precast, prestressed concrete beam superstructure

Description of Alternative Concept:

1 span bridge

Same type of superstructure, but with deeper beams

Advantages:

- Improves safety by removing a pier from the clear zone beneath the bridge
- Reduces time for construction
- Raises profile grade of I-71, allowing for excess material to be stored in this area

Disadvantages:

- Larger crane needed for setting beams during construction

Discussion:

This alternative suggests revisiting the single span option for this structure. It seems to have several advantages, including cost savings, reduced time for construction, and improvement in safety for the state road beneath.

VE ALTERNATIVE S-1

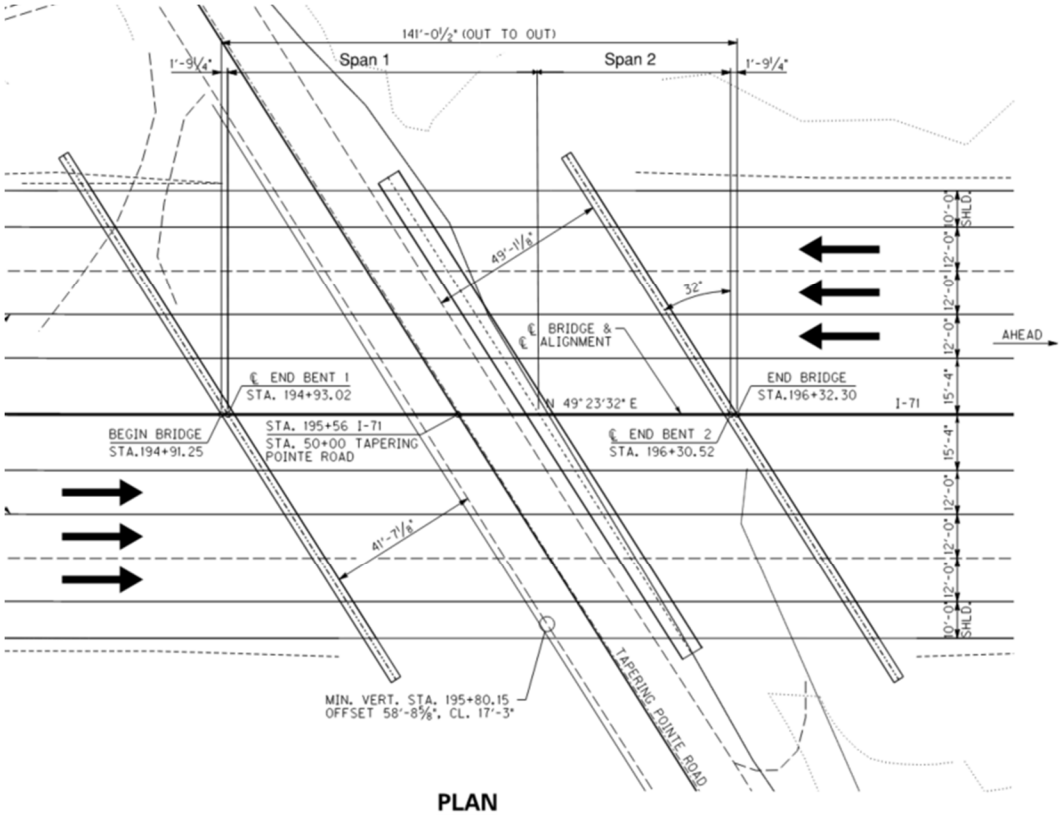
Use single span structure at Tapering Point Road

Performance Assessment:

Attributes and Rating Rationale
Mainline Operations No change
Local Operations Improves operations for KY 3002 by eliminating pier from clear zone below.
Maintainability Future routine inspections will be shorter for a single-span bridge No pier to repair or rehabilitate during life of the bridge
Construction Impacts • Reduces time for construction (+) • Larger crane needed for setting heavier beam (-)
Right of Way / Environmental Impacts • Raises profile grade of I-71 increases disturb limits slightly

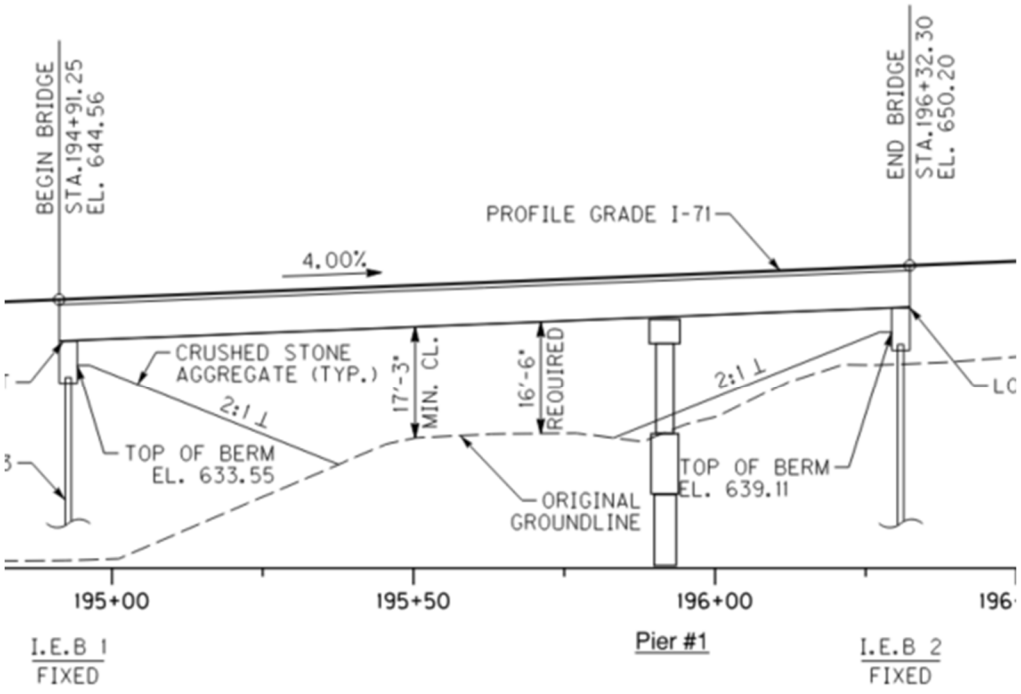
VE ALTERNATIVE S-1
Use single span structure at Tapering Point Road

Base Case (2 Spans)



PLAN

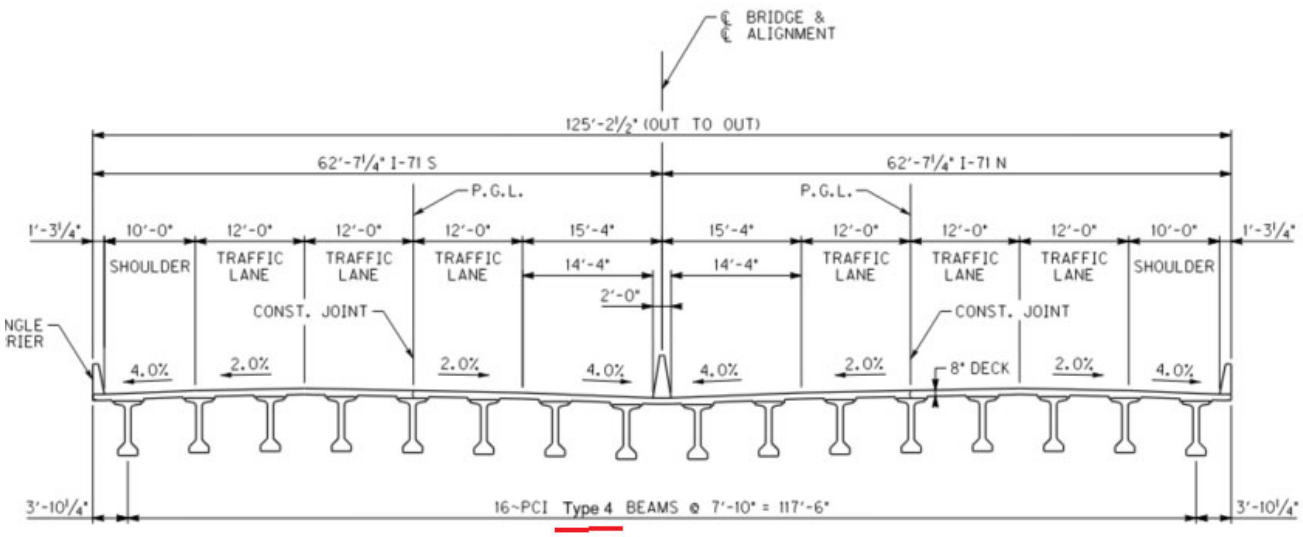
~SUPERSTRUCTURE NOT SHOWN~



ELEVATION

VE ALTERNATIVE S-1

Use single span structure at Tapering Point Road

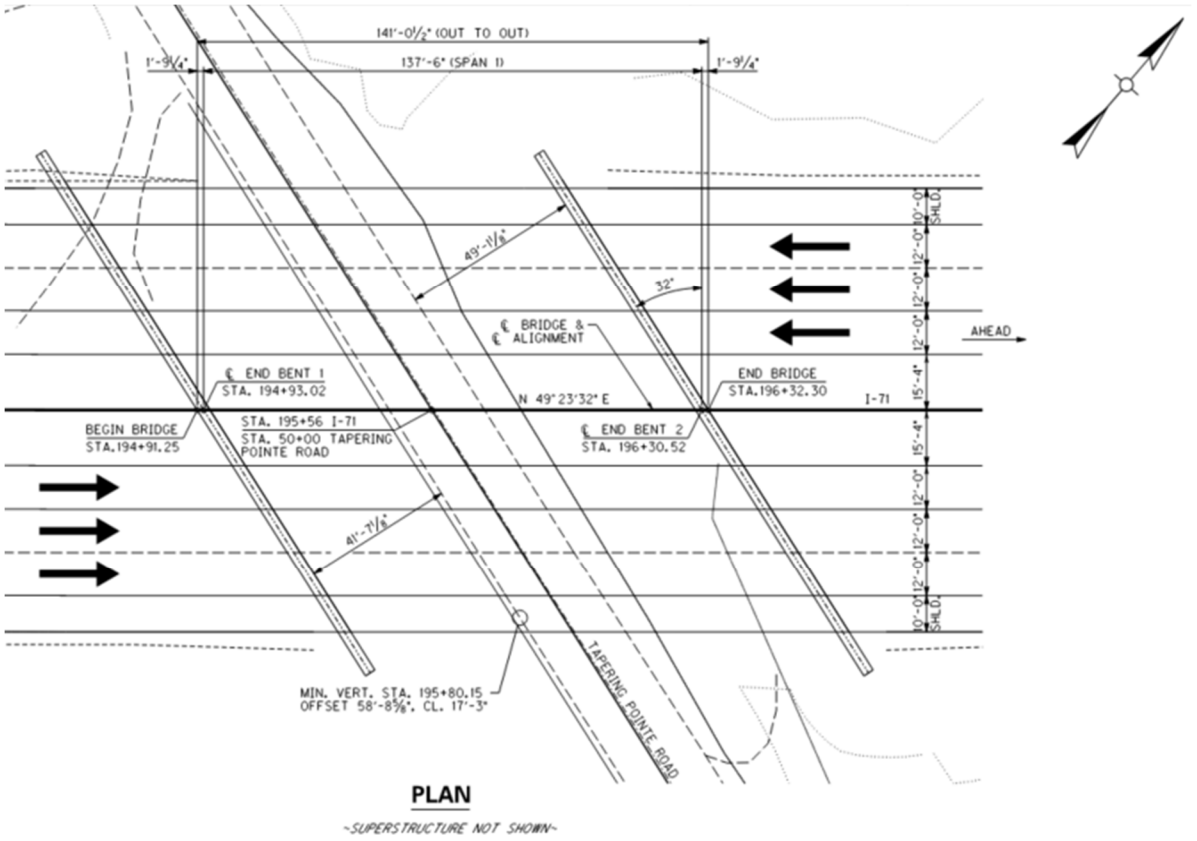


TYPICAL SECTION

(LOOKING AHEAD)

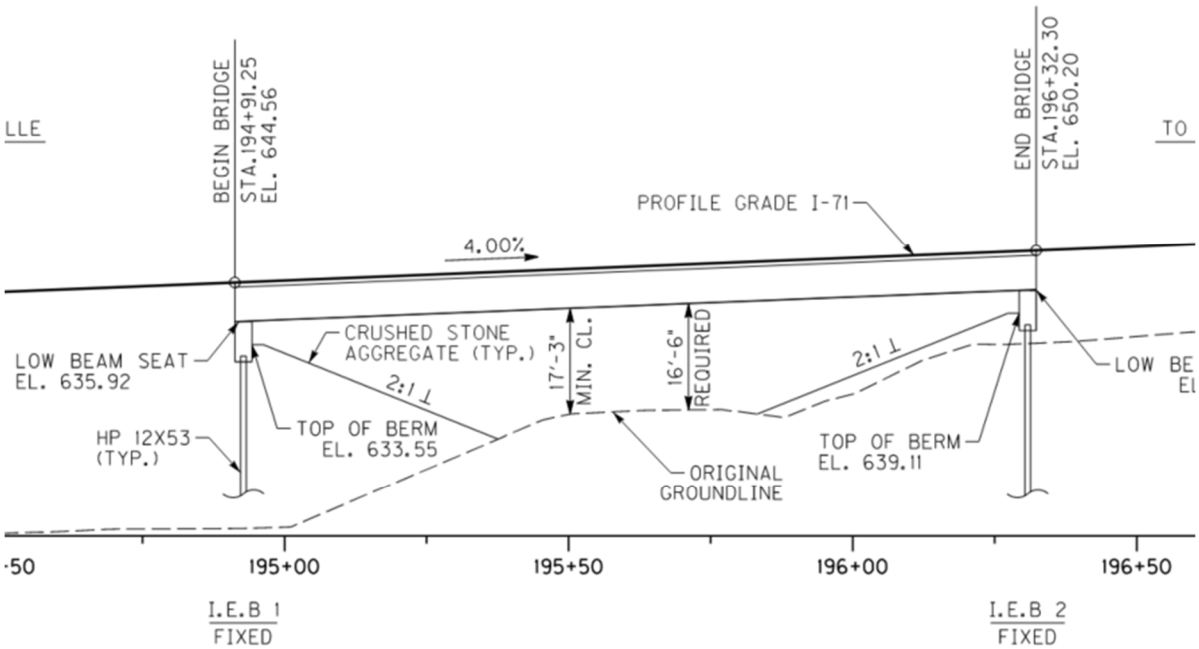
VE ALTERNATIVE S-1
Use single span structure at Tapering Point Road

VE Alternative (1 Span)



PLAN

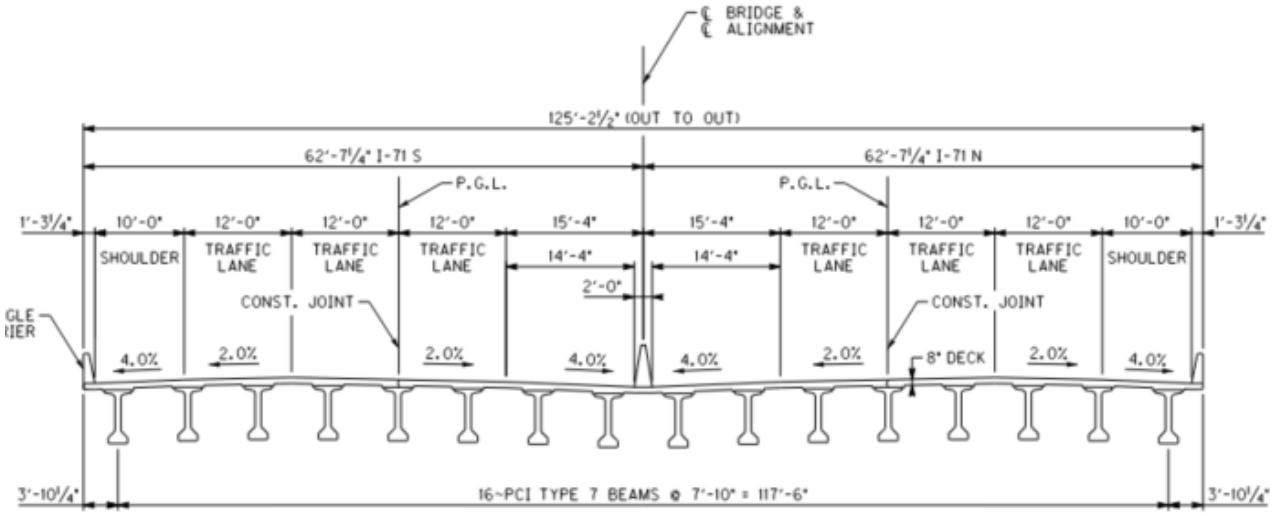
~SUPERSTRUCTURE NOT SHOWN~



ELEVATION

VE ALTERNATIVE S-1

Use single span structure at Tapering Point Road



TYPICAL SECTION

(LOOKING AHEAD)

VE ALTERNATIVE S-1
Use single span structure at Tapering Point Road

Cost Estimate for Base Case (2 Spans)

Note: only consider precast beams, pier, and extra rebar in superstructure for neg. moment at pier (i.e. key differences between 1 span)

DIVISION OF STRUCTURAL DESIGN
SUMMARY OF BRIDGE DESIGN DATA

COUNTY	Gallatin
ROAD	I-71
STATUS REPORT ITEM	
STATE PROJECT NO.	
FEDERAL PROJECT NO	
CROSSING	KY 3002
DESIGNER	HDR Design Section
DRAWING NO.	
STATION	
SKEW	32.0 deg Lt.
DESIGN LOAD	KY HL-93
ROAD ALIGNMENT	Straight
BRIDGE ROADWAY	
BRIDGE WIDTH	
TOTAL LENGTH	
DECK AREA	
BRIDGE TYPE	PCI Beam Type 4

ABUTS: ABUT. TYPE 1: IEB, 2: IEB; ABUT. HEIGHT 1: 3.0 ft, 2: 3.0 ft

SPANS: 1: 90.0 ft, 2: 47.5

PIERS: 1: 24.0 ft

COMPARISON of Estimate vs. Final Bid: Final Plan Total $2,287,825; Final Bid Total $-; Contractor UNDER By: $ 2,287,825; 100.0 %

FRAMING: Continuous for LL
MATERIAL: PCI Beam Type 4
SPECIAL FEATURES:

Item	Units	FINAL PLANS ESTIMATE 5/8/25 Unit Price	Superstructure		Substructure		Bridge	BID Unit Price	Letting: TBD Superstructure		Awarded: TBD Substructure	Bridge
Concrete Class A	CY	1,214.03			157.7	191,452.22	191,452.22				157.7	
Concrete Class AA	CY	1,617.46			70.0	113,221.92	113,221.92				70.0	
Steel Reinforcement Epoxy Coated	LB	2.23	15139	33,790.02			33,790.02		15139			
Drilled Shaft 54" Common	LF	2,760.00			126	347,760.00	347,760.00				126	
Drilled Shaft Rock 48"	LF	2,640.00			56	147,840.00	147,840.00				56	
Precast PC I Beam Type 4	LF	660.00	2202.7	1,453,760.35			1,453,760.35		2202.7			
Total for Additional Items												
TOTAL COST				1,487,550.38		800,274.14	2,287,824.51					

VE Alternative (1 Span)
(only consider precast beams)

DIVISION OF STRUCTURAL DESIGN
SUMMARY OF BRIDGE DESIGN DATA

COUNTY	Gallatin
ROAD	I-751
STATUS REPORT ITEM	
STATE PROJECT NO.	
FEDERAL PROJECT NO	
CROSSING	KY 3002
DESIGNER	HDR Design Section
DRAWING NO.	
STATION	
SKEW	32.0 deg Lt.
DESIGN LOAD	KY HL-93
ROAD ALIGNMENT	Straight
BRIDGE ROADWAY	
BRIDGE WIDTH	
TOTAL LENGTH	
DECK AREA	
BRIDGE TYPE	PCI Beam Type 7

ABUTS: ABUT. TYPE 1: IEB, 2: IEB; ABUT. HEIGHT 1: 3.0 ft, 2: 3.0 ft

SPANS: 1: 137.5 ft

PIERS:

COMPARISON of Estimate vs. Final Bid: Final Plan Total $1,770,944.43; Final Bid Total $-; Contractor UNDER By: $ 1,770,944.43; 100.0 %

FRAMING: Single, Simple
MATERIAL: PCI Beam Type 7
SPECIAL FEATURES:

Item	Units	FINAL PLANS ESTIMATE 5/8/25 Unit Price	Superstructure		Substructure	Bridge	BID Unit Price	Letting: TBD Superstructure		Awarded: TBD Substructure	Bridge
Precast PC I Beam Type 7	LF	804.00	2202.7	1,770,944.43		1,770,944.43		2202.7			

VE ALTERNATIVE S-2
Increase height of pile caps and reduce bridge length

Description of Baseline Concept:

Minimum height of pile cap for integral end bents (3 feet tall at lowest beam seat).

Description of Alternative Concept:

Using a 6’ tall pile cap at each end bent lowers the berm heights at the top of the spill slopes. As a result, the bridge’s *perpendicular* span length is reduced by 12 feet (compared to a 3’ tall pile cap). For every 1 foot of increase in end-bent height, you get a corresponding decrease in the *perpendicular* bridge span length of 4 feet (assuming 2:1 spill slopes under the bridge). After accounting for the 32° skew, the proposed bridge length reduction would be around 14 feet (measured along CL I-71).

Advantages:

- Reduces cost of the superstructure by reducing the length of the bridge ($368K)
- If same beam depth is kept, *fewer beams* can be used at a larger spacing
- Applies to either 2 Span option or single-span option

Disadvantages:

- Increased wing lengths and disturb limits
- Increased substructure costs

Discussion:

The VE team calculations show this simple change saves $368K without any impacts to utilities, ROW, safety, or serviceability. It also does not add to the design effort. The KYTC Guidance Manul for Bridge Design states that if the height of the end bent is 6’ or less at the lowest beam seat, the designer need not perform any refined analysis to account for force effects from lateral loads (e.g. earth pressure).

VE ALTERNATIVE S-2

Increase height of pile caps and reduce bridge length

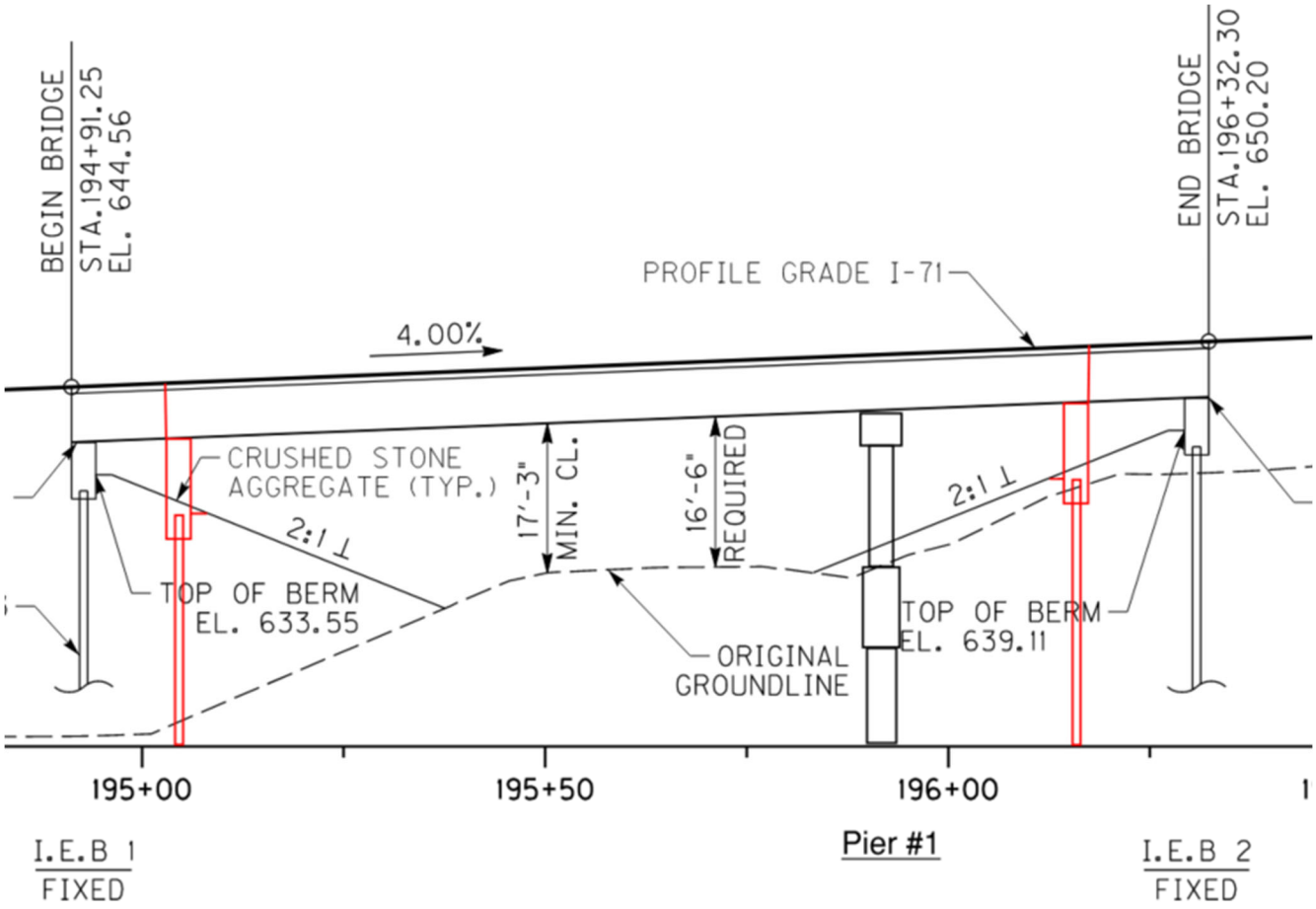
Performance Assessment:

Attributes and Rating Rationale
Mainline Operations No effect
Local Operations No effect
Maintainability No effect
Construction Impacts No effect
Right of Way / Environmental Impacts No effect

VE ALTERNATIVE S-2

Increase height of pile caps and reduce bridge length

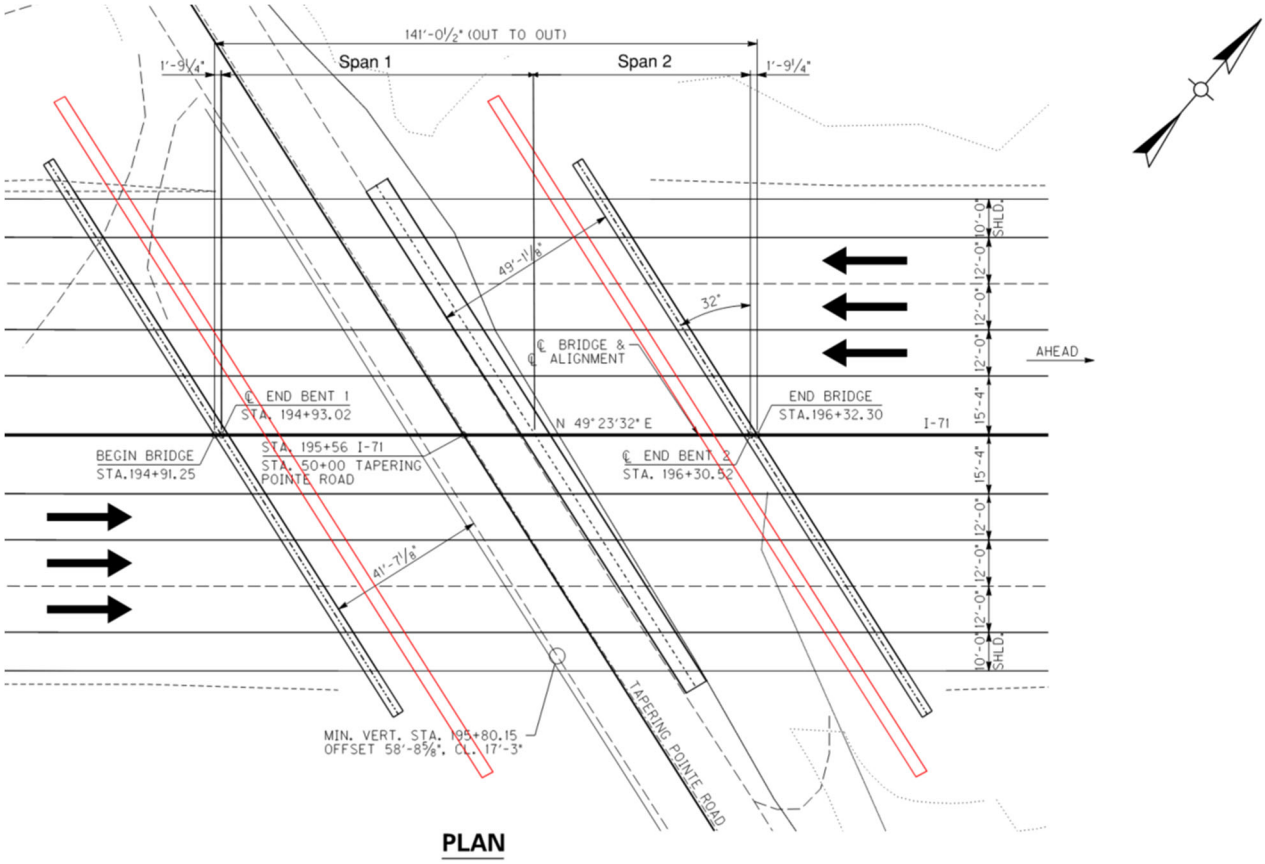
Sketches



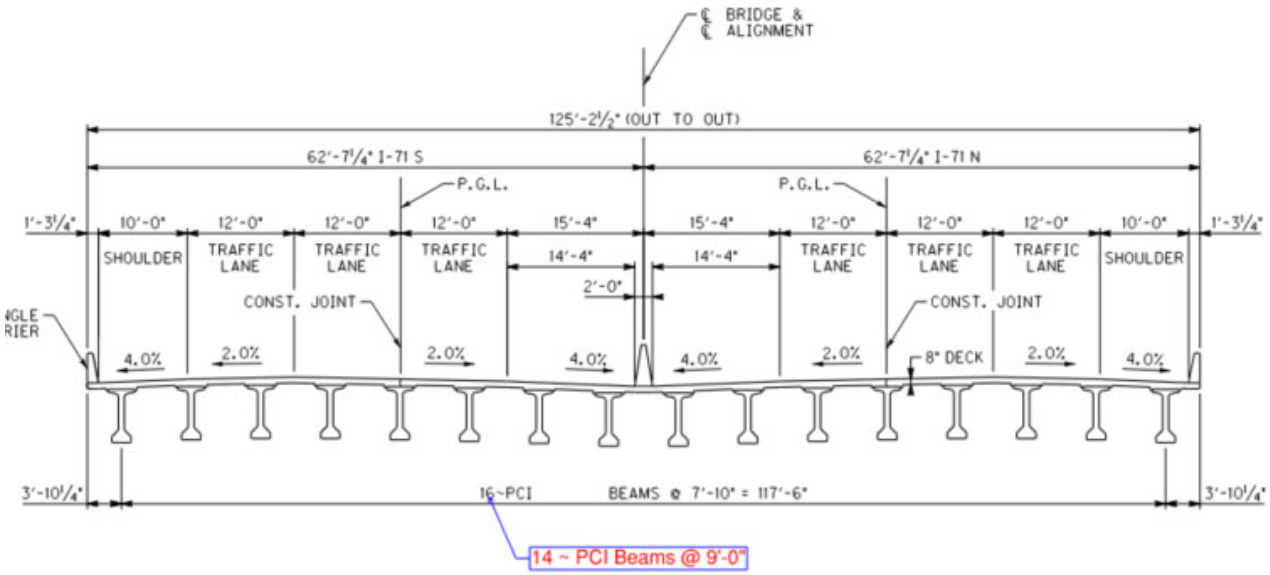
ELEVATION

VE ALTERNATIVE S-2

Increase height of pile caps and reduce bridge length



PLAN



TYPICAL SECTION

(LOOKING AHEAD)

VE ALTERNATIVE S-2

Increase height of pile caps and reduce bridge length

Base Case: 3’ Tall End Bent Pile Caps (concrete, rebar, piles, and bridge rail only)

DIVISION OF STRUCTURAL DESIGN
SUMMARY OF BRIDGE DESIGN DATA

COUNTY	Gallatin
ROAD	I-71
STATUS REPORT ITEM	
STATE PROJECT NO.	
FEDERAL PROJECT NO	
CROSSING	KY 3002 (Tapering Point Rd)
DESIGNER	HDR Design Section
DRAWING NO.	
STATION	
SKEW	32.0 deg Lt.
DESIGN LOAD	KY HL-93
ROAD ALIGNMENT	Straight
BRIDGE ROADWAY	
BRIDGE WIDTH	
TOTAL LENGTH	
DECK AREA	
BRIDGE TYPE	PCI Beam Type 7

ABUTS: ABUT. TYPE 1: IEB, 2: IEB; ABUT. HEIGHT 1: 3.0 ft, 2: 3.0 ft

SPANS: 1: 137.5 ft

PIERS

FRAMING: Simple
MATERIAL: PCI Beam Type 7
SPECIAL FEATURES:

COMPARISON of Estimate vs. Final Bid

Final Plan Total	$3,199,213	Contractor UNDER By:	100.0 %
Final Bid Total	$-	$	3,199,213

FINAL PLANS ESTIMATE 5/8/25 | **BID** Letting: TBD | Awarded: TBD

Item	Units	Unit Price	Superstructure		Substructure		Bridge	Unit Price	Superstructure		Substructure		Bridge
Concrete Class A	CY	1,214.03			108.4	131,600.64	131,600.64				108.4		
Concrete Class AA	CY	1,617.46	436.0	705,275.51	32.2	52,082.08	757,357.60		436.0		32.2		
Steel Reinforcement Epoxy Coated	LB	2.23	86532	193,139.42	6390	14,262.48	207,401.90		86532		6390		
Piles - Steel HP 12 X 53	LF	99.71			2200	219,357.60	219,357.60				2200		
Precast PC I Beam Type 7	LF	804.00	2216.0	1,781,664.00			1,781,664.00		2216.0				
Rail System Single Slope 40"	LF	180.55	282.0	50,915.66			50,915.66		282.0				
Total for Additional Items				50,915.66			50,915.66						
TOTAL COST				2,781,910.27		417,302.80	3,199,213.06						

VE Alternative: 6’ Tall End Bent Pile Caps (Savings of $368K)

DIVISION OF STRUCTURAL DESIGN
SUMMARY OF BRIDGE DESIGN DATA

COUNTY	Gallatin
ROAD	I-751
STATUS REPORT ITEM	
STATE PROJECT NO.	
FEDERAL PROJECT NO	
CROSSING	KY 3002
DESIGNER	HDR Design Section
DRAWING NO.	
STATION	
SKEW	32.0 deg Lt.
DESIGN LOAD	KY HL-93
ROAD ALIGNMENT	Straight
BRIDGE ROADWAY	
BRIDGE WIDTH	
TOTAL LENGTH	
DECK AREA	
BRIDGE TYPE	PCI Beam Type 7

ABUTS: ABUT. TYPE 1: IEB, 2: IEB; ABUT. HEIGHT 1: 6.0 ft, 2: 6.0 ft

SPANS: 1: 123.5 ft

PIERS

FRAMING: Simple
MATERIAL: PCI Beam Type 7
SPECIAL FEATURES:

COMPARISON of Estimate vs. Final Bid

Final Plan Total	$2,831,373.14	Contractor UNDER By:	100.0 %
Final Bid Total	$-	$	2,831,373.14

FINAL PLANS ESTIMATE 5/8/25 | **BID** Letting: TBD | Awarded: TBD

Item	Units	Unit Price	Superstructure		Substructure		Bridge	Unit Price	Superstructure		Substructure		Bridge
Concrete Class A	CY	1,214.03			206.8	251,060.99	251,060.99				206.8		
Concrete Class AA	CY	1,617.46	392.8	635,336.72	41.0	66,315.70	701,652.41		392.8		41.0		
Steel Reinforcement Epoxy Coated	LB	2.23	77943	173,968.78	8136	18,159.55	192,128.33		77943		8136		
Piles - Steel HP 12 X 53	LF	99.71			2400	239,299.20	239,299.20				2400		
Precast PC I Beam Type 7	LF	804.00	1743.0	1,401,372.00			1,401,372.00		1743.0				
Rail System Single Slope 40"	LF	180.55	254.0	45,860.21			45,860.21		254.0				
Total for Additional Items													
TOTAL COST				2,256,537.70		574,835.44	2,831,373.14						

VE ALTERNATIVE C-1
Pave the surface course in echelon

Description of Baseline Concept:

Paving each driving lane separately with a cold joint between each lane.

Description of Alternative Concept:

Pave the surface lifts in echelon. Eliminating a cold joint by paving all or at least 2 lanes at the same time.

Advantages:

- Elimination of cold joints between driving lanes in the asphalt surface.
- Reduce maintenance costs as the joints between lanes are generally the first failure point in pavements. Providing longer lasting pavements.

Disadvantages:

- Increased demand for construction equipment and contractor scheduling.
- Increased maintenance of traffic to accommodate lane closures.

Discussion:

Asphalt pavement rehabilitation is one of the largest maintenance costs affecting KYTC each year. Any method that can eliminate or reduce pavement deterioration and reduce the need for costly and dangerous repair operations is beneficial. By changing the paving sequence such that a minimum of 2 lanes is paved in echelon will eliminate at least one cold joint between lanes. This joint is one of the first modes of failure for pavements. Repairs to this area include spot patching or milling and repaving a thin strip of asphalt. Each of these are only temporary fixes and one adds additional cold joints to the pavement.

The new sections of roadway can easily be paved all 3 driving lanes in echelon for the top layer of base. The final surface can be paved as all 3 lanes in echelon or with the outside shoulder and lane paved in echelon 22.5-23.0 feet in width to offset the base and surface joints without placing the joint in the wheel path. Then pave either the 2 remaining lanes 24.0-25.0 feet wide to offset the shoulder joint or pave both lanes and inside shoulder in echelon to limit the total joints in the surface to only 1.

Schedule Impacts:

Overall time on the schedule should not be affected as the same amount of paving will be required. However, sequencing the equipment and material needs to pave multiple lanes at once will require additional coordination with suppliers, public information outlets, and others. If the entire length of the project is paved in echelon as part of a separate final phase, some additional time may be required on the schedule.

Risk

This construction technique does induce some risk over conventional construction. Any equipment malfunction, material supply, or traffic flow disruption can impact the schedule more adversely due to the amount of scheduling and coordination required.

VE ALTERNATIVE C-1

Pave the surface course in echelon

Performance Assessment:

Attributes and Rating Rationale
Mainline Operations More uniform top asphalt surface layer.
Local Operations N/A
Maintainability Less maintenance for spalling joints.
Construction Impacts More coordination required with material, equipment, and workforce needed.
Right of Way / Environmental Impacts N/A

VE ALTERNATIVE C-1
Pave the surface course in echelon

Baseline Concept Sketch

VE Alternative Concept Sketch

VE ALTERNATIVE C-1
Pave the surface course in echelon

Assumptions and Calculations:

Cost is assumed to be slightly higher due to scheduling and coordination requirements. Assumed a 5% increase in MOT cost and a $2.00 cost per ton for asphalt surface. I also changed the estimated cost to match 2024 average unit bid price.

This proposal does increase the initial cost of the project, but the value is realized by less maintenance costs and worker exposure during the life cycle of the pavement.

Initial Cost Estimate

CONSTRUCTION ELEMENT		*BASELINE CONCEPT*			*ALTERNATIVE CONCEPT*		
Description	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Maintain & Control Traffic	each	1	$ 1,000,000.00	$ 1,000,000	1	$ 1,050,000.00	$ 1,050,000
CL4 ASPH SURF 0.38A PG76-22	ton	11,353	$ 109	$ 1,240,656	11,353	$ 112	$ 1,265,860
SUB-TOTAL				$2,240,656			$2,315,860
PROJECT MARK-UPS	15%			$336,098			$347,379
TOTAL (Rounded)				$2,577,000			$2,663,000
						SAVINGS	**($86,000)**

VE ALTERNATIVE C-2
Install measures to reduce surface water runoff at barrier during select phases

Description of Baseline Concept:

During construction, traffic is operating 2' off of the median barrier wall gutter line during particular MOT phases. During heavy rainfall events, surface water runoff may extend into the wheel path contributing to hydroplaning vehicles.

Description of Alternative Concept:

Install measures to expedite drainage of surface water runoff along the median barrier wall gutter line during heavy rainfall events where traffic is operating 2' off of the gutter line during particular MOT phases. Additional drainage structures may assist w/ clearing surface water/ice/snow in a more timely manner in this accident prone area.

Advantages:

- Improve safety
- Reduce risk
- Increase drainage capacity

Disadvantages:

- Increase drainage scope for temporary condition
- Potential maintenance impacts

Discussion:

At the following times/locations, traffic will be operating 2' off of the newly installed median barrier wall gutter line:

- Per MOT Plan Sheets
    - Phase 2 – I-71 SB Sta 150+00 – 155+00 (See Sheet R79)
    - Phase 6 – I-71 SB Sta 164+50 – 223+50 (See Sheet R94, R95 & R96)
    - Phase 6 – I-71 NB Sta 150+00 – 223+50 (See Sheet R94, R95 & R96)

In order to exit surface water from the median gutter more efficiently during the noted MOT phases, we recommend installing additional CMBBI's at the noted locations and draining downgrade to the next designed CMBBI.

- Add CMBBI at Sta 152+50 – Install 15" pipe (375') to existing DBI at Sta 156+25 – Safeload along w/ DBI once no longer needed
- Add CMBBI at Sta 163+00 – Install 15" pipe (550') to new CMBBI at Sta 168+50
- Add CMBBI at Sta 171+25 – Install 15" pipe (275') to new CMBBI at Sta 174+00
- Add CMBBI at Sta 177+00 – Install 15" pipe (260') to new CMBBI at Sta 179+60
- Add CMBBI at Sta 191+00 – Install 15" pipe (600') to new CMBBI at Sta 185+00
- Add CMBBI at Sta 202+00 – Install 15" pipe (493') to new CMBBI at Sta 197+07
- Add CMBBI at Sta 212+00 – Install 15" pipe (500') to new CMBBI at Sta 207+00
- Add CMBBI at Sta 221+00 – Install 15" pipe (427') to new CMBBI at Sta 216+73

New drainage structures/pipe may be kept in place permanently to assist w/ stormwater removal or may be safeloaded to eliminate an additional stormwater system that will require long term maintenance. In lieu of new pipe under the median barrier wall, the new CMBBI's could be drained to the outside via a bore/jack pipe.

VE ALTERNATIVE C-2

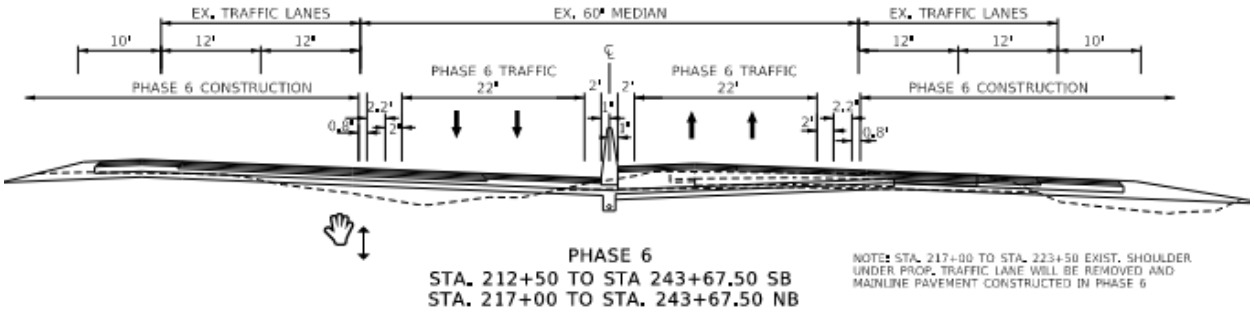
Install measures to reduce surface water runoff at barrier during select phases

It was also discussed that there may be other options such as cutting a slot/trench along the median barrier wall gutter line to carry an additional flow of surface water during these temporary conditions. With further analysis by the designer, other more cost-effective options may be available.

Performance Assessment:

Attributes and Rating Rationale
Mainline Operations No change.
Local Operations No change.
Maintainability Maintainability may have an increase if the new drainage structures/pipe remain part of the permanent drainage system.
Construction Impacts Will add time to install additional drainage structures and pipe. Will improve safety during the MOT phases where traffic is running 2’ off of the median barrier wall gutter line.
Right of Way / Environmental Impacts No change.

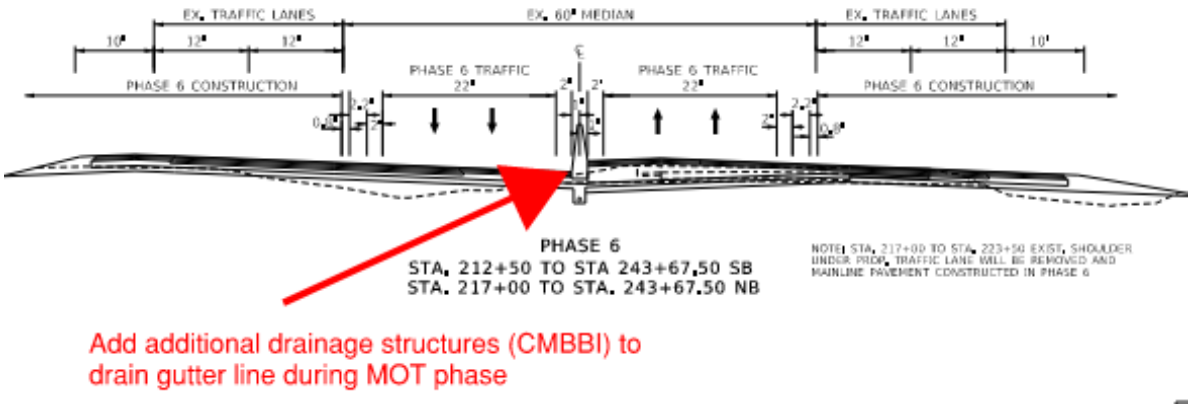
Baseline Concept Sketch



VE ALTERNATIVE C-2

Install measures to reduce surface water runoff at barrier during select phases

VE Alternative Concept Sketch



Assumptions and Calculations:

Line Item #9960 Conc Med Barrier Box Inlet – Mod

8 Each at $6000/Each = $48,000

Line Item #1978 Conc Median Barrier Type A

8 x 25 LF at $115.50/LF = $23,100 Savings

Line Item #0521 Storm Sewer Pipe – 15 IN

3480 LF at $97.03/LF = $337,664

Initial Cost Estimate

CONSTRUCTION ELEMENT		*BASELINE CONCEPT*			*ALTERNATIVE CONCEPT*		
Description	**Unit**	**Qty**	**Cost/Unit**	**Total**	**Qty**	**Cost/Unit**	**Total**
Concrete Median Barrier Box Inlet	Ea	8	$ 6,000	$ 48,000			$ -
Concrete Median Barrier Type A	LF	200	$ 116	$ 23,100			$ -
Storm Sewer Pipe - 15 in	LF			$ -	3,480	$ 97	$ 337,664
SUB-TOTAL				$71,100			$337,664
PROJECT MARK-UPS	15%			$10,665			$50,650
TOTAL (Rounded)				$82,000			$388,000
						SAVINGS	**($306,000)**

7.2 VE Strategy

VE studies result in the development of a number of alternatives to a baseline concept. While each alternative is developed as an independent and unique concept, typically the cumulative impact of a selected combination of alternatives provides the best value solution for the project. This is due to the fact that some alternatives may be competing ideas or different ways to address the same issue. Some alternatives are developed to answer a question raised by a decision maker or to resolve an open issue and found not to be beneficial to the ultimate project.

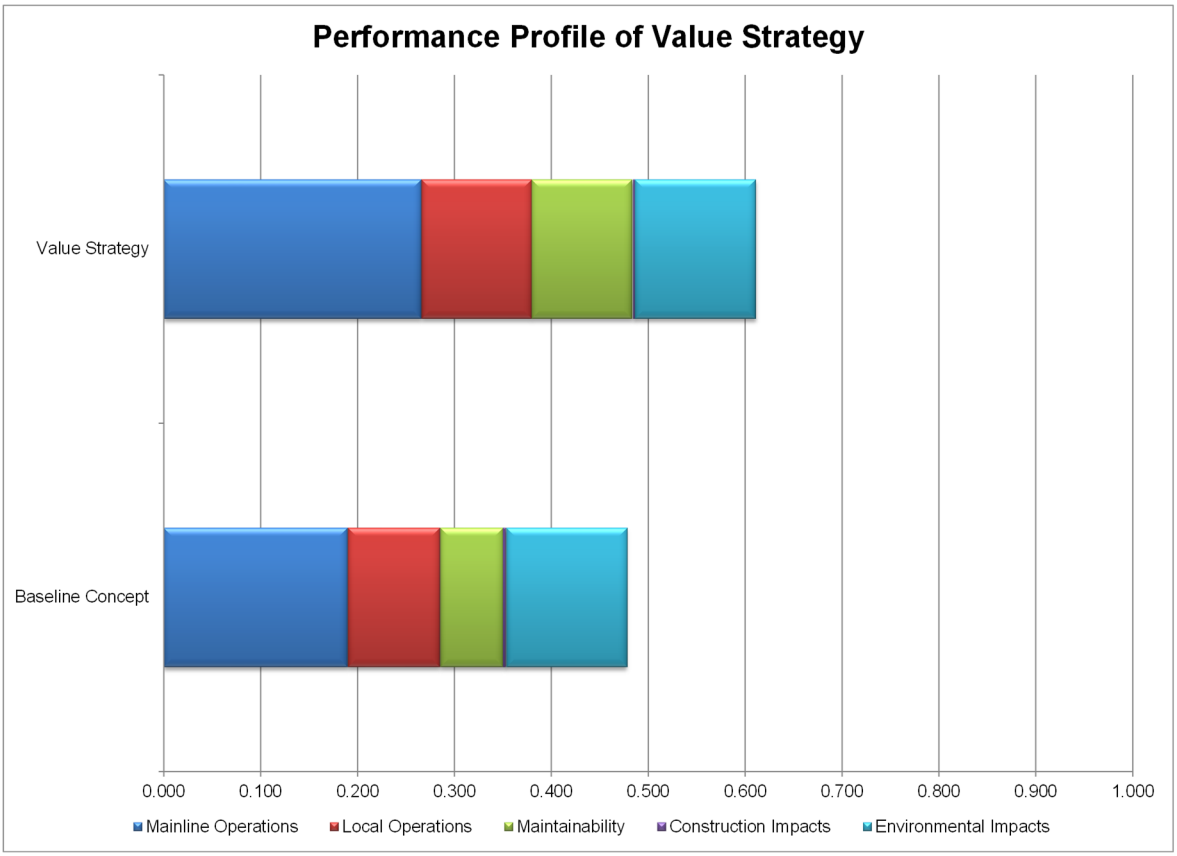
As a result of these factors, the VE team developed a VE strategy that represents a possible combination of the developed alternatives to assist the decision makers in their evaluation of them and the overall results of the VE study. The VE strategy is based on factors that include improved performance, likelihood of implementation, cost savings, or any combination of project's performance attributes. This information is a guide and is not intended to reject the other alternatives from stakeholder consideration.

Table 10. Summary of VE Strategy

Strategy Description	Cumulative Cost Savings	Schedule Savings	Cumulative Performance Change	Cumulative Value Change
VE Team Selected Combination (VE Alts E-1, E-2, E-3, XP-2, S-1, S-2, C-1)	~$1.5M	TBD	+4%	+58%

7.2.1 Compare Performance – Baseline Concept and VE Strategies

The VE team compared Baseline Concept to the VE strategy using the performance attributes. The total performance scores reflect the performance rating for each attribute multiplied by its overall priority (weight) expressed using a ratio scale. The chart below compares the total performance scores for the baseline concept and VE strategy.



7.2.2 Rating Rationale

The rating rationale for the performance of the baseline concept as compared to the VE strategy developed by the VE team is provided below.

Table 11. VE Strategy Performance Rating Rationale

VE Strategy 1	Includes VE Alts:		
VE Team Selected Combination	E-1, E-2, E-3, XP-2, S-1, S-2, C-1		
PERFORMANCE MEASURES	*Performance*	*Baseline*	*Recommendation*
Attributes and Rating Rationale for Recommendation			
Main Line Operations	*Rating*	5	7
Flattening side slopes reduces guard rail and provides recoverable slopes.	*Weight*	33.3	
	Contribution	166.5	233.1
Local Operations	*Rating*	5	6
Removes pier adjacent to Tapering Point Road with a single span structure	*Weight*	6.6	
	Contribution	33	39.6
Maintainability	*Rating*	5	8
Flatter slopes should reduce potential for slides and erosion. Improves pavement longevity with elimination of joints. Single span structure and pile caps reduces bridge area.	*Weight*	13.3	
	Contribution	66.5	106.4
Environmental Impacts	*Rating*	5	4
Requires additional Right of Way to accommodate the flatter slopes. May require modification of environmental document for the additional impacts.	*Weight*	26.6	
	Contribution	133	106.4
Construction Impacts	*Rating*	5	5
Increases amount of offline work at the southern termini will reduce impacts to traffic. Paving in eschelon may require additional traffic management and temporary delays.	*Weight*	20.0	
	Contribution	100	100
Total Performance		499	586
Net Change in Performance			17%

7.2.3 Compare Value

The cost and elements were compared and normalized for the Baseline Concept and the VE Strategy using the following tables. These tables illustrate how cost scores were derived. In this comparison, a lower score is desirable as the project will benefit from lower costs.

Table 12. Comparison of Cost Values

Strategy Description	Cost		Cost Score
Baseline Concept	$	47,232,773.47	0.508
VE Strategy	$	45,719,773.47	0.492
Totals	$	92,952,546.94	1.000

Once relative scores for Performance and Cost have been derived, the next step is to synthesize a value index for the Baseline Concept and the VE strategy. A Value Matrix was prepared which facilitated the comparison of the Baseline and the VE strategy by

organizing and summarizing this data into a tabular format. The performance scores for the Strategy were divided by the total schedule and cost scores for the Strategy to derive a value index. The value indices for the VE strategy were then compared against the value index of the Baseline Concept and the difference is expressed as a percent (±%) deviation.

Table 13. Value Matrix

Strategy Description	Performance Score	Change in Performance	Cost Score	Schedule Score	Value Index
Baseline Concept	0.478	N/A	0.508	TBD	N/A
VE Strategy	0.611	+17%	0.492	TBD	+32%

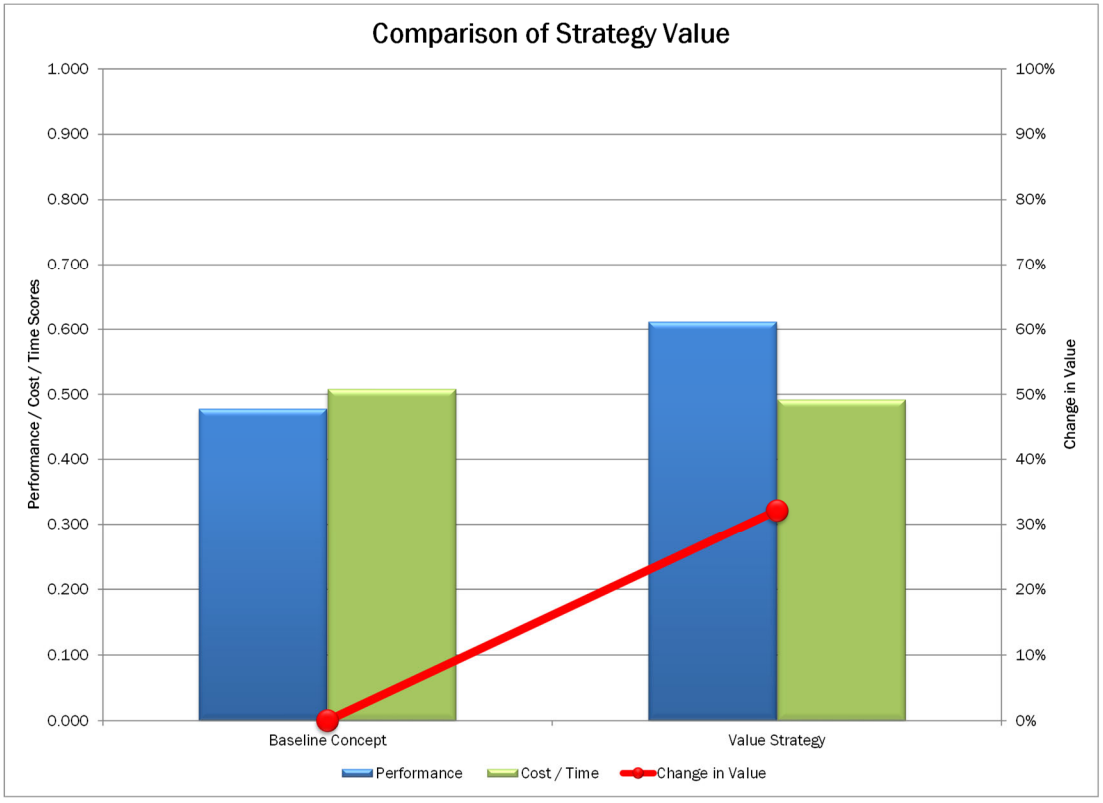


Figure 6. Comparison of Value - Baseline Concept and VE Strategy

7.3 Additional Design Considerations

The VE team generated the following design suggestions for the project design team's consideration. These items represent ideas that were generated during the Creative Phase of the VE study but were not chosen for development as VE alternatives. However, they may provide additional value improvement for the project in the form of risk mitigations or document clarifications.

Table 14. Design Considerations

Comment No.	Description
DC-1	Ensure specifications account for shale embankment construction
DC-2	Verify condition of existing drainage culverts to support extensions
DC-3	Revise slopes of disposal areas to maximize capacity
DC-4	Eliminate salvage assumptions of existing cable barrier
DC-5	Provide high friction surface in temporary pavement for NB lane diversion
DC-6	Reserve topsoil / organics to support pollinator plantings
DC-7	Revise pavement section to combine subbase layers (DGA and Crushed Stone)

Appendix A. Value Methodology Process

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

The primary objective of a Value Engineering (VE) study is value improvement. Value improvements might relate to scope definition, functional design, constructability, coordination (both internal and external), or the schedule for project development.

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

Pre-VE Study

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

- Initiate study – Identify study project and define study goals
- Organize study – Conduct pre-VE study meeting and select team members
- Prepare data – Collect and distribute data and prepare cost models.

Workshop Phases

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

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

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

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

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

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

Post-Study

Implementation Phase - The project team is then charged with reviewing the report and may hold a Disposition Meeting with management and other stakeholders, to determine which alternatives will be implemented in the design. The project team then tracks their implementation into the plans.

Performance-Based Value Engineering

The following is a general discussion and overview of the Performance-Based VE process. Ideas that have been introduced and warrant further consideration, will be documented with their advantages and disadvantages; each idea will then be carefully evaluated against project-specific attributes.

Performance measures an integral part of the VE process. It provides the cornerstone of the VE process by giving a systematic and structured way of considering the relationship of a project's performance and cost as they relate to value. Project performance must be properly defined and agreed on by the stakeholders at the beginning of the VE study. The performance attributes and requirements that are developed are then used throughout the study to identify, evaluate, and document alternatives.

Introduction

Value engineering has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that VE can play related to improving project performance. Project costs are relatively easy to quantify and compare through traditional estimating techniques. Performance is not so easily quantifiable.

The VE facilitator will lead the team and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialogue that develops forms the basis for the VE teams understanding of the performance requirements of the project and to what degree the current design concept is meeting those requirements. From this baseline, the VE team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

Performance-based VE yields the following benefits:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives
- Develops a baseline understanding of how the project is meeting performance goals and objectives
- Identifies areas where project performance can be improved through the VE process
- Develops a better understanding of a VE alternative's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value
- Uses value as the true measurement for the basis of selecting the right project or design concept
- Provides decision-makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions.

Methodology

The application of Performance-based VE consists of the following steps:

1. Identify key project (scope and delivery) performance attributes and requirements for the project.

Establish the hierarchy and impact of these attributes on the project.

Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts.

Identify the change in performance of alternative project concepts generated by the study.

Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement.

The primary goal of value engineering is to improve the value of the project. A simple way to think of value in terms of an equation is as follows:

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

Assumptions

Before embarking on the details of this methodology, some assumptions need to be identified. The methodology described in the following steps assumes the project functions are well established. Project functions are defined as what the project delivers to its users and stakeholders; a good reference for the project functions can be found in the environmental document's purpose and need statement. Project functions are generally well defined prior to the start of the VE study. If project functions have been substantially modified, the methodology must begin anew (Step 1).

Step 1 – Determine the Major Performance Attributes

Performance attributes can generally be divided between project scope components (highway operations, environmental impacts, and system preservation) and project delivery components. It is important to make a distinction between performance *attributes* and performance *requirements*. Performance requirements are mandatory and binary in nature. All performance requirements MUST be met by any VE alternative concept being considered. Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge meets all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives could be acceptable that had different durations.

The VE facilitator will initially request representatives from project team and external stakeholders identify performance attributes that they feel are essential to meeting the overall need and purpose of the project. Usually, four to seven attributes are selected. It is important that all potential attributes be thoroughly discussed. The information that comes out of this discussion will be valuable to both the VE team and the project owner. It is important that each attribute be discretely defined and be quantifiable in some form. Most performance attributes that typically appear in transportation VE studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required.

Typical standardized project performance attributes are shown below. Specific definitions of each attribute can be found below.

- Main Line Operations
- Local Operations
- Maintainability
- Construction Impacts

- Environmental Impacts

Step 2 – Determine the Relative Importance of the Attributes

Once the group has agreed on the project's performance attributes, the next step is to determine their relative importance in relation to each other. This is accomplished using an evaluative tool termed in this report as the "Performance Attribute Matrix." This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?"

A letter code (e.g., "A") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is of essentially equal importance, both letters (e.g., "A/B") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed. When all pairs have been discussed, the number of "votes" for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any "votes." If this occurs, the attribute is given a token "vote," as it made the list in the first place and should be given some degree of importance.

An example of this exercise is shown below.

PERFORMANCE ATTRIBUTE MATRIX

[Project Name]

Which attribute is more important to the project?							**TOTAL**	**%**
Main Line Operations	A	B	A	A		A	5.0	**23.8%**
Local Operations		B		B	B	B/F	5.5	**26.2%**
Maintainability			C		E	F	2.0	9.5%
Construction Impacts			D		E	D/F	1.5	7.1%
Environmental Impacts				E		E	4.0	19.0%
Project Schedule						F	3.0	14.3%
						Total	21.0	100%

Without emphasis on preference

A = A is of greater importance

A/B = A and B are of equal importance

For the example project above, the project owner, design team, and stakeholders determined that Main Line Operations, followed by Environmental, gave the greatest improvement relative to the projects purpose and need, while Construction Impacts and Project Schedule gave the least improvement.

Step 3 – Establish the Performance Baseline for the Original Design

The next step in the process is to document the project-specific elements for the performance attributes developed in Step 1. This step establishes a baseline against which the VE alternative concepts can be compared. An example of project-specific elements is shown below.

Once the baseline definitions for the various attributes have been established, their total performance should be calculated by multiplying the attribute's weight (which was developed in Step 2) by its rating. While one could assign a 0 to 10 rating for each attribute, using the definitions and scales developed in Step 1, a baseline rating of 5 is typically used as a mid-point so that alternatives can be evaluated – better than or worse than the baseline.

Total baseline performance is calculated by multiplying the attribute's weight (which was developed in Step 2) by its rating (5). The baseline design's total performance of 500 points can be calculated by adding all of the scores for the attributes. This numerical expression of the original designs performance forms the baseline against which all alternative concepts will be compared.

Step 4 – Evaluate the Performance of the VE Alternative Concepts

Once the performance of the baseline has been established for the original design concept, it can be used to help the VE team develop performance ratings for individual VE alternative concepts as they are developed during the study.

It is important to consider the alternative concept's impact on the entire project (rather than on discrete components) when developing performance ratings for the alternative concept.

Proposals are evaluated against the baseline for all attributes to compare the potential for value improvement. As discussed in Step 3, the baseline is given a rating of 5. The following ratings were used to evaluate the performance of the alternative concepts relative to the baseline concept.

Rating	Performance Attribute Scale
10	Alternative concept is extremely preferred
9	Alternative concept is very strongly preferred
8	Alternative concept is strongly preferred
7	Alternative concept is moderately preferred
6	Alternative concept is slightly preferred
5	*Baseline*
4	Baseline concept is slightly preferred
3	Baseline concept is moderately preferred
2	Baseline concept is strongly preferred
1	Baseline concept is very strongly preferred
0	Baseline concept is extremely preferred

Step 5 – Compare the Performance Ratings of Alternative Concepts to the Baseline Project

As the VE team develops alternatives, the performance of each is rated against the original design concept (baseline). Changes in performance are always based on the overall impact to the total project. Once performance and cost data have been developed by the VE team, the net change in value of the VE alternatives can be compared to the baseline design concept. The resulting "Value Matrix" provides a summary of these changes and allows a way for the Project Team to assess the potential impact of the VE alternatives on total project value.

The VE team groups the VE alternatives into a strategy (or strategies) to provide the decision-makers a clear picture of how the alternatives fit together into possible solutions. At least one strategy is developed to present the VE team's consensus of what should be implemented. Additional strategies are developed as necessary to present other combinations to the decision-makers that should be considered. The strategy(s) of VE alternatives are rated and compared against the baseline concept. The performance ratings developed for the VE strategies are entered into the matrix, and the summary portion of the Value Matrix is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations:

- % Performance Improvement = Δ Performance VE Strategy/Total Performance Original Concept
- Value Index = Total Performance/Total Cost
- % Value Improvement = ΔValue Index VE Strategy/Value Index Original Concept.

Appendix B. VE Workshop Agenda and Attendees

Day 1	May 5, 2025 Objective for the day: Learn about VE and the project	
9:00 AM (EDT)	**Workshop Kick-off Meeting** • Study kickoff • Team introductions • Workshop objectives	**All Audiences:** Project owner, management, stakeholders, designers, etc.
9:15 AM *Information Phase*	**VE Process Overview** • An instructional presentation on the principles of value Engineering and their application to the project	**VE Facilitator**
9:30 AM *Information Phase*	**Project Overview** • Goals and objectives of the project • Key project drivers, decisions, and constraints • Project Scope / Design Overview • Project challenges and VE focus areas • Areas for discussion: ○ Roadway Design ○ Traffic Analysis ○ Structures ○ Drainage/Hydraulics ○ Utilities ○ Environmental Conditions ○ Staging/Phasing	**Project Team/ Designer**
11:00 AM	**Break**	
11:15 AM	**Project Issues and Concerns**	**KYTC/Designer**
11:30 AM	**Define and Prioritize Performance Attributes**	**All Audiences**
12:00 AM	**Risk Assessment & Risk Register Updates**	**All Audiences**
Noon	**Lunch**	
1:00 PM	**VE Project Engineering and Documentation Review** • Review Available Project Documents • Review Project schedule, including construction phasing/sequencing, work windows • Cost Estimate / Cost Model Review and contingency assumptions • Preliminary List of Project Issues and Value Opportunities	**VE Team (offline)**
2:00 PM	**Value Metrics and Baseline Performance Rating** • Rate performance attributes of baseline project **Risk Assessment & Risk Register** • Assign probabilities and impact ratings to risks **Discuss Project Issues and Value Opportunities**	**VE Team**
5:00 PM	**Adjourn for the day**	

Day 2	**May 6, 2025** **Objective for the day: Function Engineering, Brainstorming Ideas, and Evaluation**	
8:00 AM *Function Phase*	**Function Analysis** • Random Function Identification • Build / Review FAST diagram	**VE Team**
9:00 AM *Creative Phase*	**Brainstorming Ideas** • Brainstorm alternative ways to perform key functions	**VE Team**
Noon	**Lunch**	
1:00 PM *Evaluation Phase*	**Evaluation of Ideas** • Score/Rate ideas based on predetermined criteria	**VE Team**
5:00 PM	**Adjourn for the day**	
Day 3	**May 7, 2025** **Objective for the day: Midpoint Review and Begin Developing**	
8:00 AM	**Develop Ideas into VE Alternatives** • Select ideas to develop further into Alternatives • Individual/team assignments • Review VE Alternative Development Process	**VE Team**
9:00 AM	**Midpoint Review**	**KYTC / Designer Reps**

10:00 AM
Development Phase
	Develop Ideas into Recommendations
	• Individual/team assignments
	• Development of recommendations:
	  ○ Test design feasibility
	  ○ Design Engineering
	  ○ Technical narratives
	  ○ Further discussion on advantages and disadvantages
	  ○ Cost Estimating
		VE Team (offline individual assignments)

5:00 PM	**Adjourn for the day**	

Day 4	**May 8, 2025** **Objective for the day: Continue Development of VE Alternatives**	
8:00 AM *Development Phase*	**Continue Development of recommendations:** • Technical narratives • Drawings/Sketches • Cost Estimating	**VE Team**
9:00 AM *Development Phase*	**VE Team Review of VE Alternative Development** • Peer review of recommendations • Outbrief Presentation Preparation/Review	**VE Team**
1:00 PM	**Presentation of VE Findings** • Team presents VE Study Results and Value Proposals • Questions and answers	**All Audiences:** Project owner, management, stakeholders, designers, etc.
3:00 PM	**Adjourn**	

Appendix C. Project Estimate

Estimate 06-8910.00

Estimated Cost:$41,071,976.93

Contingency: 15.00%

Estimated Total: $47,232,773.47

Base Date: 02/24/25

Spec Year: 08

Unit System: E

Work Type: ASPHALT SURFACE WITH BRIDGE

Highway Type: INTERSTATE

Urban/Rural Type: RURAL

Season: SUMMER

County: GALLATIN

Latitude of Midpoint: 384519

Longitude of Midpoint: 844826

District: 06

Federal Project Number: FD52 039 0071 062-065

State Project Number: STP 0713 067

Prepared by American Engineers Inc. on 02/24/25

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
Group 0001: PAVING					
0001	00001 DGA BASE	5,273.000	TON	$34.94	$184,238.62
0003	00003 CRUSHED STONE BASE	103,225.000	TON	$32.03	$3,306,296.75
0013	00013 LIME STABILIZED ROADBED	165,401.000	SQYD	$3.79	$626,869.79
0014	00014 LIME	3,305.000	TON	$164.32	$543,077.60
0100	00100 ASPHALT SEAL AGGREGATE	274.000	TON	$125.42	$34,365.08
0103	00103 ASPHALT SEAL COAT	33.000	TON	$1,067.44	$35,225.52
0214	00214 CL3 ASPH BASE 1.00D PG64-22	24,881.000	TON	$69.03	$1,717,535.43
0217	00217 CL4 ASPH BASE 1.00D PG64-22	31,839.000	TON	$61.70	$1,964,466.30
0219	00219 CL4 ASPH BASE 1.00D PG76-22	14,577.000	TON	$84.24	$1,227,966.48
0339	00339 CL3 ASPH SURF 0.38D PG64-22	7,470.000	TON	$97.66	$729,520.20
0342	00342 CL4 ASPH SURF 0.38A PG76-22	11,353.000	TON	$126.20	$1,432,748.60
0356	00356 ASPHALT MATERIAL FOR TACK	79.000	TON	$5.22	$412.38
0358	00358 ASPHALT CURING SEAL	166.000	TON	$853.55	$141,689.30
2702	02702 SAND FOR BLOTTER	414.000	TON	$38.93	$16,117.02
9500	20071EC JOINT ADHESIVE	16,931.250	LF	$0.89	$15,068.81

Total for Group 0001:$11,975,597.88

Group 0002: ROADWAY

0078	00078 CRUSHED AGGREGATE SIZE NO 2	19.000	TON	$76.20	$1,447.80
1005	01005 PERFORATED PIPE EDGE DRAIN-4 IN	11,593.600	LF	$7.17	$83,126.11
1006	01006 PERFORATED PIPE EDGE DRAIN-6 IN	8,793.700	LF	$5.40	$47,485.98
1007	01007 PERFORATED PIPE EDGE DRAIN-8 IN	157.000	LF	$32.80	$5,149.60

Line #	Item Number Description *Supplemental Description*	Quantity	Units	Unit Price	Extension
1010	01010 NON-PERFORATED PIPE-4 IN	168.000	LF	$24.74	$4,156.32
1011	01011 NON-PERFORATED PIPE-6 IN	12.000	LF	$31.74	$380.88
1020	01020 PERF PIPE HEADWALL TY 1-4 IN	11.000	EACH	$987.34	$10,860.74
1021	01021 PERF PIPE HEADWALL TY 1-6 IN	2.000	EACH	$570.00	$1,140.00
1022	01022 PERF PIPE HEADWALL TY 1-8 IN	4.000	EACH	$530.99	$2,123.96
1028	01028 PERF PIPE HEADWALL TY 3-4 IN	2.000	EACH	$1,280.33	$2,560.66
1310	01310 REMOVE PIPE	1,623.000	LF	$14.77	$23,971.71
1740	01740 CORED HOLE DRAINAGE BOX CON-4 IN	35.000	EACH	$244.98	$8,574.30
1741	01741 CORED HOLE DRAINAGE BOX CON-6 IN	38.000	EACH	$283.33	$10,766.54
1978	01978 CONC MEDIAN BARRIER TYPE A TL5 56 IN	15,922.000	LF	$115.50	$1,838,991.00
1982	01982 DELINEATOR FOR GUARDRAIL MONO DIRECTIONAL WHITE	213.000	EACH	$13.93	$2,967.09
1985	01985 DELINEATOR FOR BARRIER - YELLOW	504.000	EACH	$16.27	$8,200.08
2003	02003 RELOCATE TEMP CONC BARRIER	42,077.000	LF	$3.04	$127,914.08
2091	02091 REMOVE PAVEMENT	44,439.000	SQYD	$8.85	$393,285.15
2159	02159 TEMP DITCH	12,952.000	LF	$0.39	$5,051.28
2160	02160 CLEAN TEMP DITCH	6,476.000	LF	$0.83	$5,375.08
2200	02200 ROADWAY EXCAVATION	1,197,485.000	CUYD	$10.18	$12,190,397.30
2242	02242 WATER	642.000	MGAL	$0.53	$340.26
2262	02262 FENCE-WOVEN WIRE TYPE 1	6,085.000	LF	$6.71	$40,830.35
2351	02351 GUARDRAIL-STEEL W BEAM-S FACE	14,625.000	LF	$27.43	$401,163.75
2367	02367 GUARDRAIL END TREATMENT TYPE 1	15.000	EACH	$4,113.32	$61,699.80
2369	02369 GUARDRAIL END TREATMENT TYPE 2A	13.000	EACH	$1,247.51	$16,217.63

Line #	Item Number Description *Supplemental Description*	Quantity	Units	Unit Price	Extension
2381	02381 REMOVE GUARDRAIL	20,471.000	LF	$2.71	$55,476.41
2397	02397 TEMP GUARDRAIL	1,487.500	LF	$21.36	$31,773.00
2429	02429 RIGHT-OF-WAY MONUMENT TYPE 1	26.000	EACH	$209.68	$5,451.68
2432	02432 WITNESS POST	3.000	EACH	$206.03	$618.09
2482	02482 CHANNEL LINING CLASS IA	854.000	TON	$138.13	$117,963.02
2483	02483 CHANNEL LINING CLASS II	5,414.000	TON	$42.83	$231,881.62
2484	02545 CLEARING AND GRUBBING 121 ACRES at $3000 per acre	1.000	LS	$363,000.00	$363,000.00
2519	02484 CHANNEL LINING CLASS III	12,090.000	TON	$67.76	$819,218.40
2555	02555 CONCRETE-CLASS B	138.000	CUYD	$683.33	$94,299.54
2558	02585 EDGE KEY	527.000	LF	$12.85	$6,771.95
2562	02562 TEMPORARY SIGNS	629.250	SQFT	$6.45	$4,058.66
2603	02603 FABRIC-GEOTEXTILE CLASS 2	44,445.000	SQYD	$2.02	$89,778.90
2607	02607 FABRIC-GEOTEXTILE CLASS 2 FOR PIPE	7,890.000	SQYD	$2.00	$15,780.00
2650	02650 MAINTAIN & CONTROL TRAFFIC	1.000	LS	$1,000,000.00	$1,000,000.00
2671	02671 PORTABLE CHANGEABLE MESSAGE SIGN	4.000	EACH	$3,224.33	$12,897.32
2676	02676 MOBILIZATION FOR MILL & TEXT	1.000	LS	$50,000.00	$50,000.00
2690	02690 SAFELOADING	43.000	CUYD	$381.45	$16,402.35
2697	02697 EDGELINE RUMBLE STRIPS	67,992.000	LF	$0.18	$12,238.56
2701	02701 TEMP SILT FENCE	12,952.000	LF	$2.51	$32,509.52
2703	02703 SILT TRAP TYPE A	122.000	EACH	$212.78	$25,959.16
2704	02704 SILT TRAP TYPE B	122.000	EACH	$145.35	$17,732.70
2705	02705 SILT TRAP TYPE C	122.000	EACH	$163.06	$19,893.32

Line #	Item Number	Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
2706	02706	CLEAN SILT TRAP TYPE A	122.000	EACH	$5.00	$610.00
2707	02707	CLEAN SILT TRAP TYPE B	122.000	EACH	$5.00	$610.00
2708	02708	CLEAN SILT TRAP TYPE C	122.000	EACH	$5.00	$610.00
2726	02726	STAKING	1.000	LS	$570,111.18	$570,111.18
2731	02731	REMOVE STRUCTURE BRIDGE	2.000	LS	$175,000.00	$350,000.00
2898	02898	RELOCATE CRASH CUSHION	13.000	EACH	$2,783.87	$36,190.31
2929	02929	CRASH CUSHION TYPE IX	2.000	EACH	$8,640.62	$17,281.24
3171	03171	CONCRETE BARRIER WALL TYPE 9T	21,688.000	LF	$27.84	$603,793.92
5950	05950	EROSION CONTROL BLANKET	100,806.000	SQYD	$1.40	$141,128.40
5952	05952	TEMP MULCH	392,986.000	SQYD	$0.24	$94,316.64
5953	05953	TEMP SEEDING AND PROTECTION	294,284.000	SQYD	$0.26	$76,513.84
5963	05963	INITIAL FERTILIZER	24.600	TON	$1,139.04	$28,020.38
5964	05964	MAINTENANCE FERTILIZER	41.000	TON	$1,088.40	$44,624.40
5985	05985	SEEDING AND PROTECTION	694,284.000	SQYD	$0.28	$194,399.52
5992	05992	AGRICULTURAL LIMESTONE	430.000	TON	$74.41	$31,996.30
6401	06401	FLEXIBLE DELINEATOR POST-M/W	48.000	EACH	$77.35	$3,712.80
6511	06511	PAVE STRIPING-TEMP PAINT-6 IN	192,977.000	LF	$0.26	$50,174.02
6542	06542	PAVE STRIPING-THERMO-6 IN W	49,979.000	LF	$1.20	$59,974.80
6543	06543	PAVE STRIPING-THERMO-6 IN Y	33,547.000	LF	$1.22	$40,927.34
6546	06546	PAVE STRIPING-THERMO-12 IN W	1,678.000	LF	$3.45	$5,789.10
6556	06556	PAVE STRIPING-DUR TY 1-6 IN W	474.000	LF	$8.46	$4,010.04
6557	06557	PAVE STRIPING-DUR TY 1-6 IN Y	316.000	LF	$9.10	$2,875.60

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
6578	06578 PAVE MARKING-THERMO MERGE ARROW	4.000	EACH	$333.78	$1,335.12
9921	10020NS FUEL ADJUSTMENT	483,200.000	DOLL	$1.00	$483,200.00
9931	10030NS ASPHALT ADJUSTMENT	20,615.000	DOLL	$1.00	$20,615.00
9951	20738NS112 TEMP CRASH CUSHION	9.000	EACH	$4,088.24	$36,794.16
9961	23148EN END ANCHORS	2.000	EACH	$5,250.00	$10,500.00
9971	24255EC REMOVE CABLE GUARDRAIL BARRIER SYSTEM	16,615.300	LF	$21.00	$348,921.30
9981	24489EC INLAID PAVEMENT MARKER	879.000	EACH	$28.09	$24,691.11
9991	25078ED THRIE BEAM GUARDRAIL TRANSITION TL-3	6.000	EACH	$4,044.88	$24,269.28
9995	20191ED OBJECT MARKER TY 3	15.000	EACH	$76.88	$1,153.20

Total for Group 0002:$21,627,030.65

Group 0003: DRAINAGE

0461	00461 CULVERT PIPE-15 IN	126.000	LF	$136.67	$17,220.42
0462	00462 CULVERT PIPE-18 IN	71.000	LF	$212.69	$15,100.99
0464	00464 CULVERT PIPE-24 IN	238.000	LF	$192.94	$45,919.72
0468	00468 CULVERT PIPE-36 IN	16.000	LF	$457.65	$7,322.40
0469	00469 CULVERT PIPE-42 IN	16.000	LF	$296.20	$4,739.20
0473	00473 CULVERT PIPE-66 IN	252.000	LF	$449.38	$113,243.76
0521	00521 STORM SEWER PIPE-15 IN	357.000	LF	$97.03	$34,639.71
0522	00522 STORM SEWER PIPE-18 IN	1,053.000	LF	$111.34	$117,241.02
0524	00524 STORM SEWER PIPE-24 IN	1,288.000	LF	$119.66	$154,122.08
0526	00526 STORM SEWER PIPE-30 IN	74.000	LF	$210.66	$15,588.84
1202	01202 PIPE CULVERT HEADWALL-15 IN	3.000	EACH	$1,832.64	$5,497.92

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
1204	01204 PIPE CULVERT HEADWALL-18 IN	4.000	EACH	$2,101.91	$8,407.64
1208	01208 PIPE CULVERT HEADWALL-24 IN	1.000	EACH	$4,324.68	$4,324.68
1210	01210 PIPE CULVERT HEADWALL-30 IN	2.000	EACH	$3,441.07	$6,882.14
1212	01212 PIPE CULVERT HEADWALL-36 IN	1.000	EACH	$4,073.24	$4,073.24
1214	01214 PIPE CULVERT HEADWALL-42 IN	1.000	EACH	$5,408.34	$5,408.34
1222	01222 PIPE CULVERT HEADWALL-66 IN	1.000	EACH	$10,300.00	$10,300.00
1433	01433 SLOPED BOX OUTLET TYPE 1-18 IN	3.000	EACH	$2,975.04	$8,925.12
1451	01451 S & F BOX INLET-OUTLET-24 IN	4.000	EACH	$4,791.33	$19,165.32
1452	01452 S & F BOX INLET-OUTLET-30 IN	2.000	EACH	$7,478.72	$14,957.44
1480	01480 CURB BOX INLET TYPE B	2.000	EACH	$7,264.86	$14,529.72
1502	01502 DROP BOX INLET TYPE 5A	1.000	EACH	$5,966.00	$5,966.00
1771	01771 FRAME AND LID TY 1	3.000	EACH	$925.00	$2,775.00
9950	21799EN BORE AND JACK PIPE-24 IN	256.000	LF	$551.51	$141,186.56
9960	21337NS710 CONC MED BARRIER BOX INLET-MOD	31.000	EACH	$6,000.00	$186,000.00
9970	21800EN BORE AND JACK PIPE-30 IN	235.000	LF	$705.33	$165,752.55
9980	23126EN BORE AND JACK PIPE-18 IN	84.000	LF	$462.71	$38,867.64
9990	23952EC DRAINAGE JUNCTION BOX TY B	3.000	EACH	$4,041.40	$12,124.20
9998	24814EC PIPELINE INSPECTION	2,686.000	LF	$2.72	$7,305.92

Total for Group 0003:$1,187,587.57

Group 0004: BRIDGE

2403	02403 REMOVE CONCRETE MASONRY	40.300	CUYD	$666.71	$26,868.41
8003	08003 FOUNDATION PREPARATION	1.000	LS	$60,000.00	$60,000.00

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
8100	08100 CONCRETE-CLASS A	934.800	CUYD	$757.93	$708,512.96
8150	08150 STEEL REINFORCEMENT	112,698.000	LB	$1.70	$191,586.60
9999	x BRIDGE	1.000		$2,824,311.07	$2,824,311.07

Total for Group 0004:$3,811,279.04

Group 0019: DEMOBILIZATION &/OR MOBILIZATION

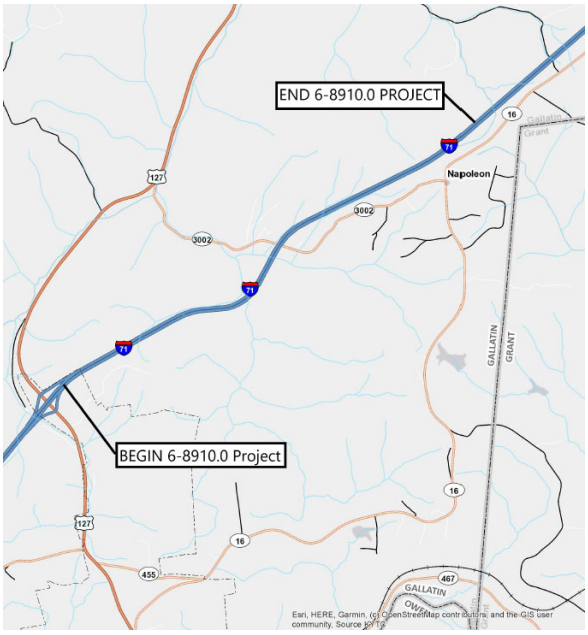
0136	02568 MOBILIZATION 5.0%	1.000	LS	$1,900,370.61	$1,900,370.61
0137	02569 DEMOBILIZATION 1.5%	1.000	LS	$570,111.18	$570,111.18

Total for Group 0019:$2,470,481.79

Appendix D. Closing Presentation

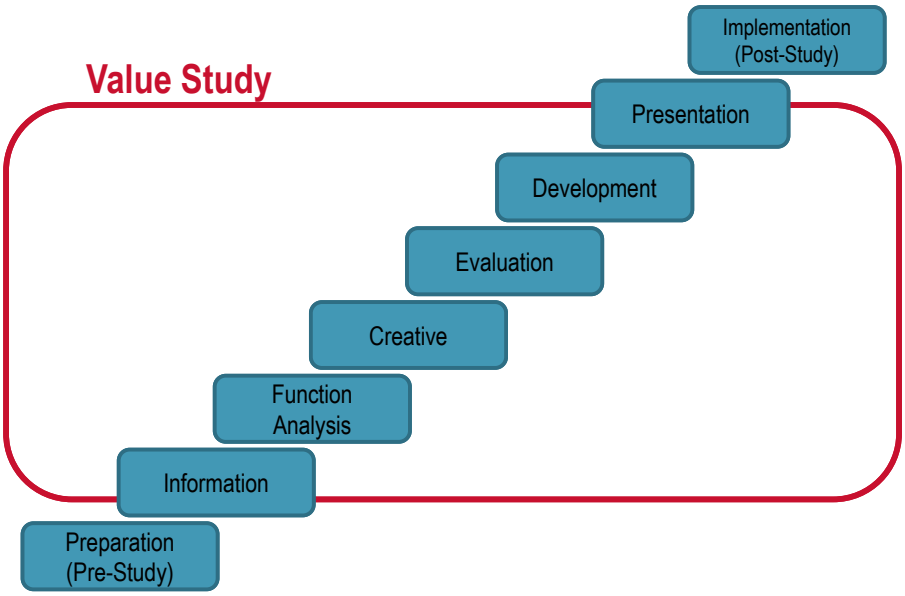
VALUE ENGINEERING STUDY

I-71
(KY 127 to MP 65.0)
6-8910.0
Gallatin Co.



1

VE JOB PLAN



2

VE Study Objectives – Key Functions

THROUGH APPLICATION OF THE VE JOB PLAN, THE OBJECTIVE OF THE VE STUDY WAS TO ASSESS AND/OR IMPROVE THE PROJECT FOCUSING ON FUNCTIONS:

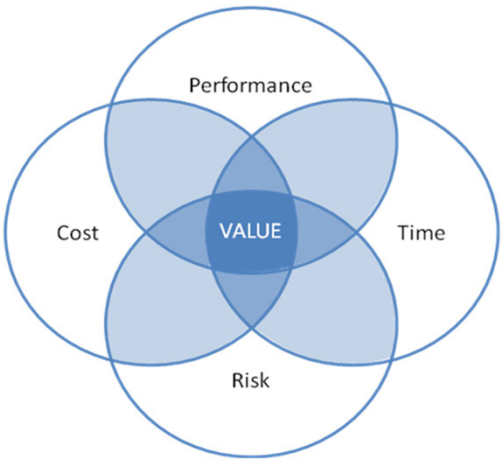
IMPROVE OPERATIONS *AND* ***SAFETY*** BY ***STRAIGHTENING ALIGNMENT*** *AND* **INCREASING CAPACITY** WHILE **ACCOMMODATING FUTURE DEMAND**.

Key secondary functions include **CREATE SPACE** (for widening), **ESTABLISH GRADES** (Earthwork) AND **DISPOSE MATERIAL**.

3

VE Study Overview – Value Metrics

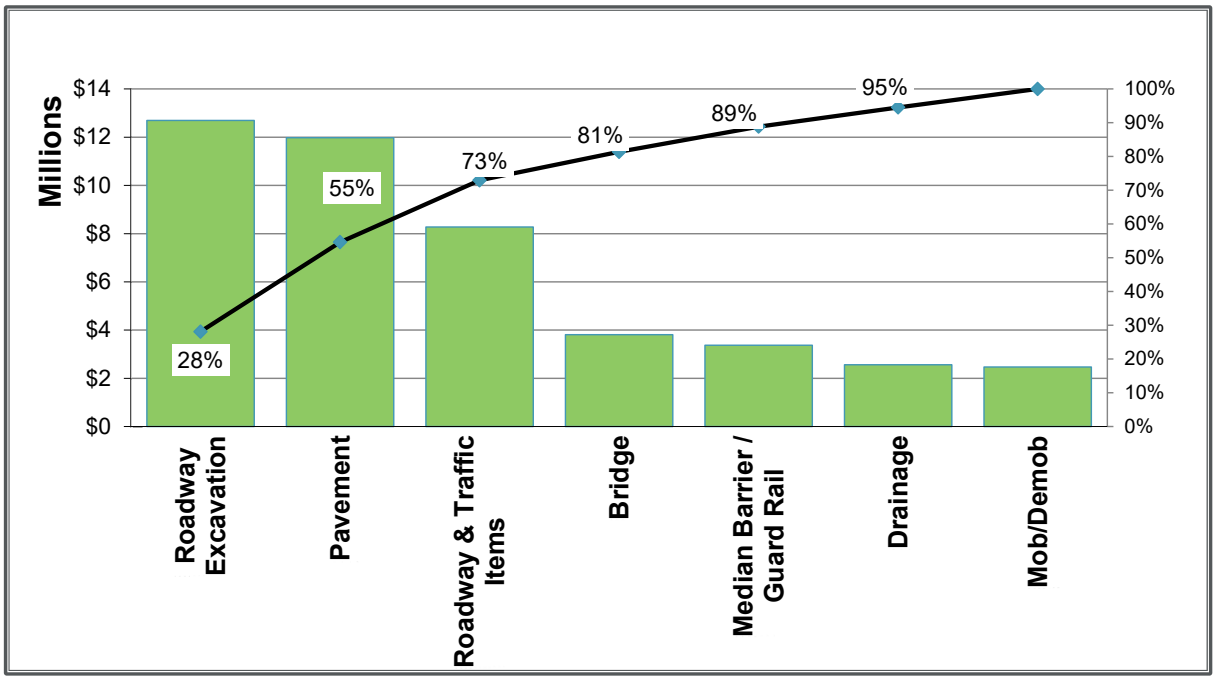
Value Engineering has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that VE can play with regard to improving project performance.



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

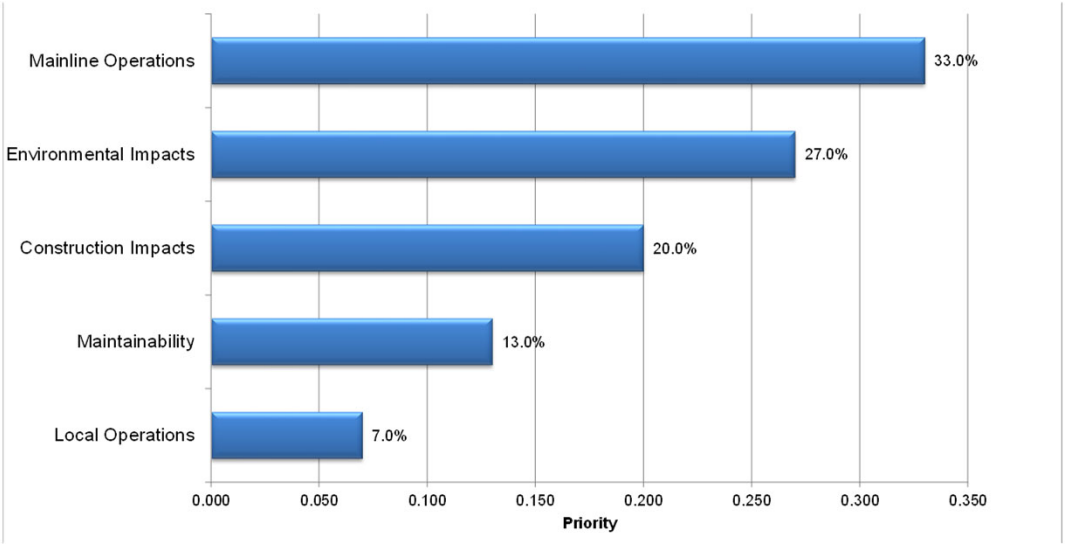
4

PARETO COST MODEL



5

PERFORMANCE ATTRIBUTES AND PRIORITIES

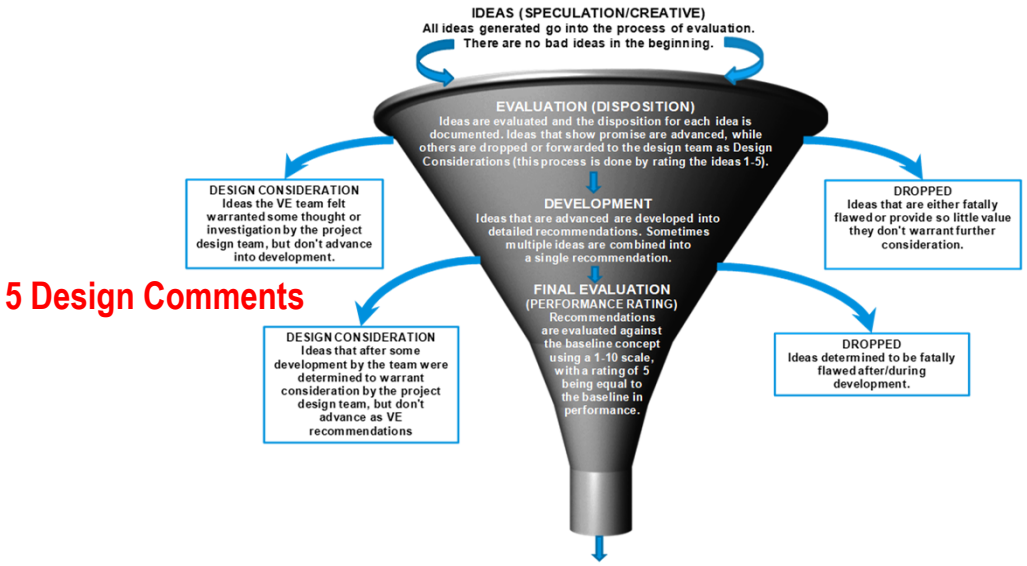


An improvement to which attribute will provide the greatest benefit relative to the project's need and purpose?

6

Evaluation Process – Tiered Approach

30 Brainstormed Ideas



9 Developed VE Alternatives

7

VALUE OPPORTUNITIES / VE FOCUS POINTS

- **Earthwork and Grading**
  - Side slope grades and excess material vs. Right of Way
  - Removal of Temporary Diversion Grading
  - Maintenance and Function of Interceptor Ditch
- **Typical Cross Section & Project Limits**
  - Potential cost savings while maintaining performance / operations
- **Tapering Point Road Structure**
  - Bridge area and substructure options
- **Construction**
  - Surface course paving operations vs. joints
  - Temporary drainage at median barriers during select phases

8

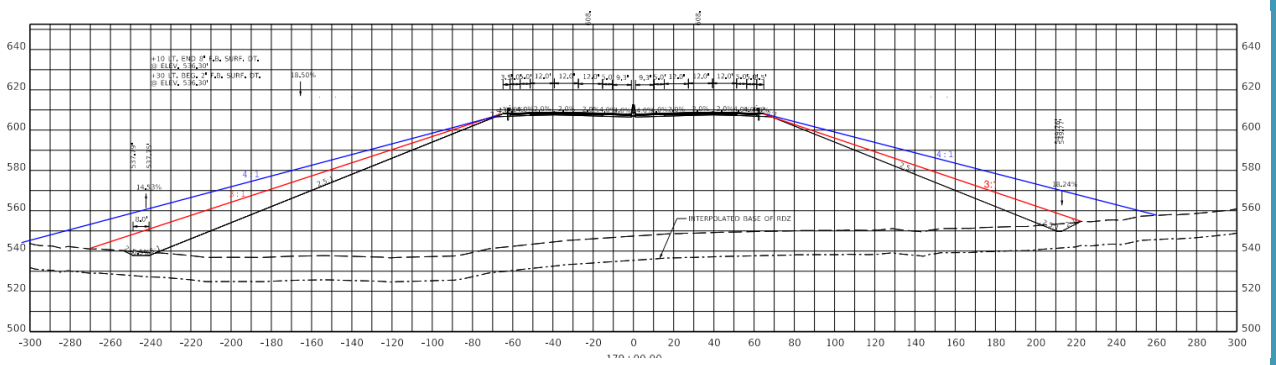
DEVELOPMENT PHASE

VE Alternative Development Content

- Baseline and Alternative Concept Narratives
- Advantages/Disadvantages
- Discussion/Justification
- Schedule and Risk Impacts
- Performance Attribute Comparison
- Sketches & Calculations
- Cost Estimates

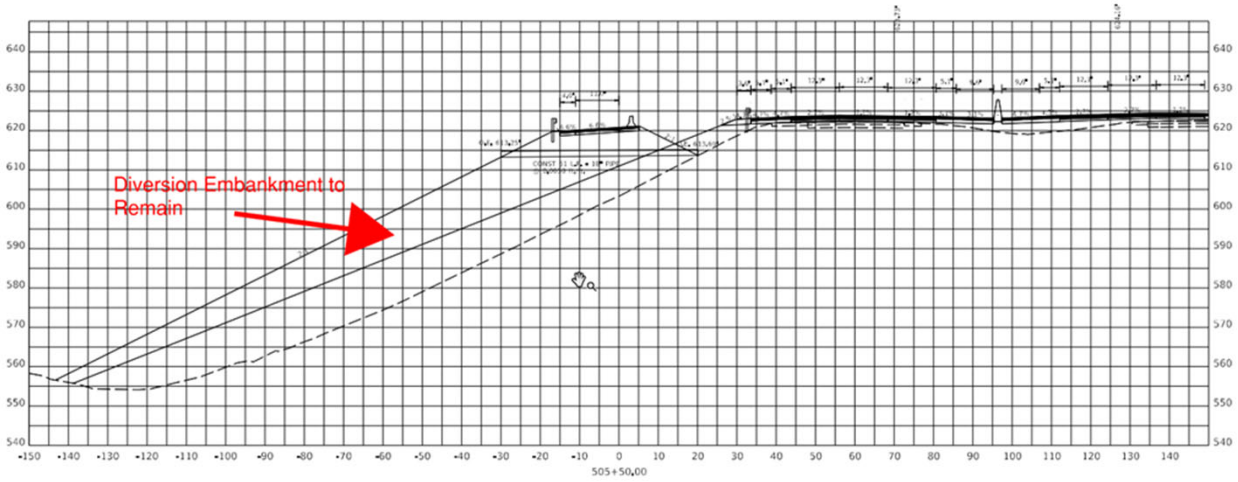
9

FLATTEN SIDE SLOPES WITH EXCESS ROADWAY EXCAVATION MATERIAL



10

CONSTRUCT GRADING FOR TEMPORARY DIVERSIONS AS PERMANENT IN LIEU OF REMOVING



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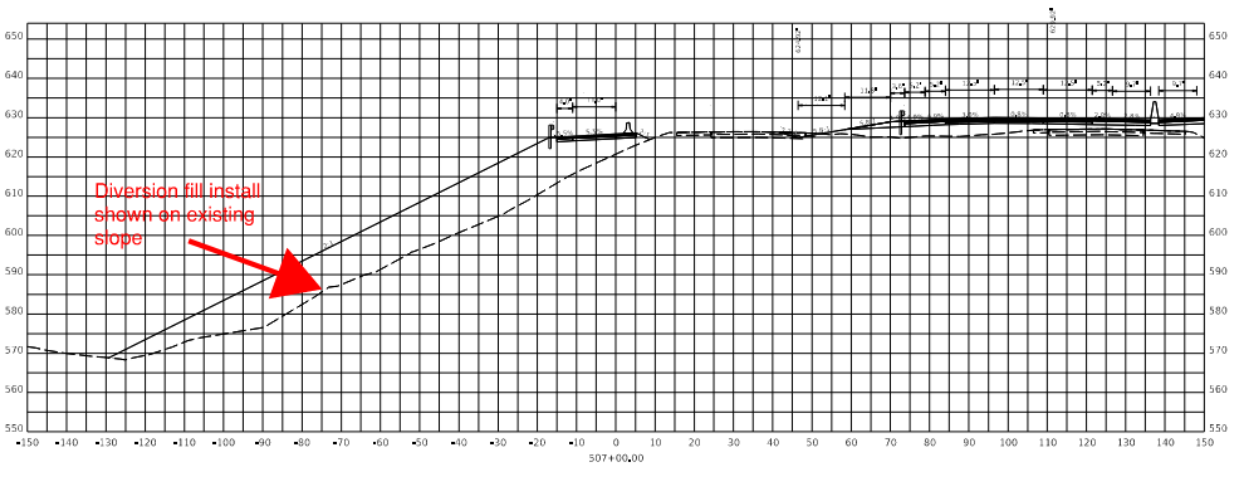
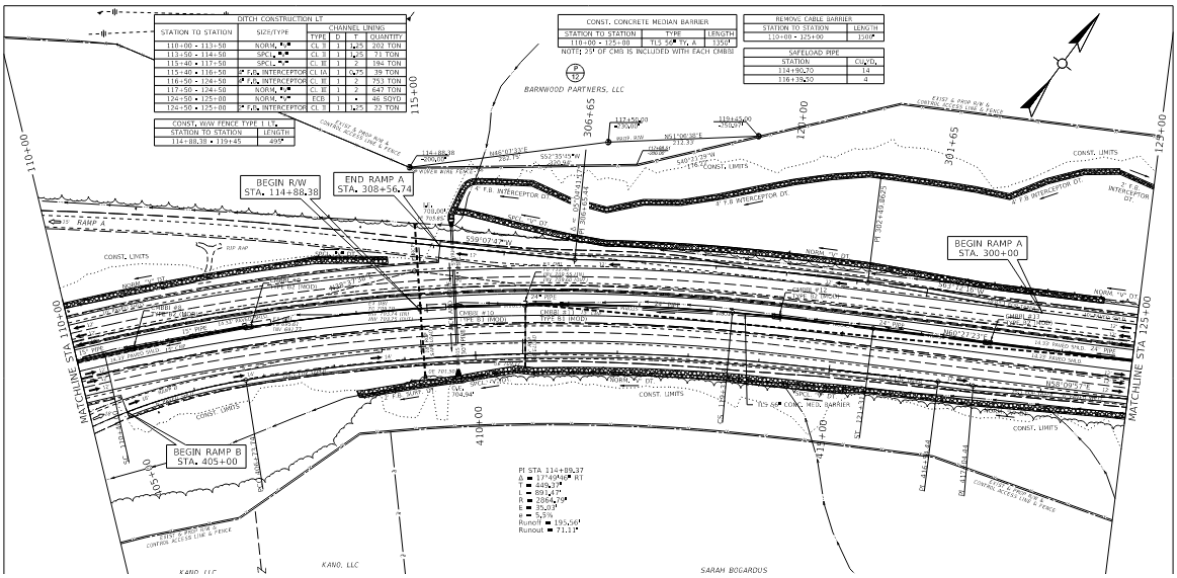
CONSTRUCT GRADING FOR TEMPORARY DIVERSIONS AS PERMANENT IN LIEU OF REMOVING



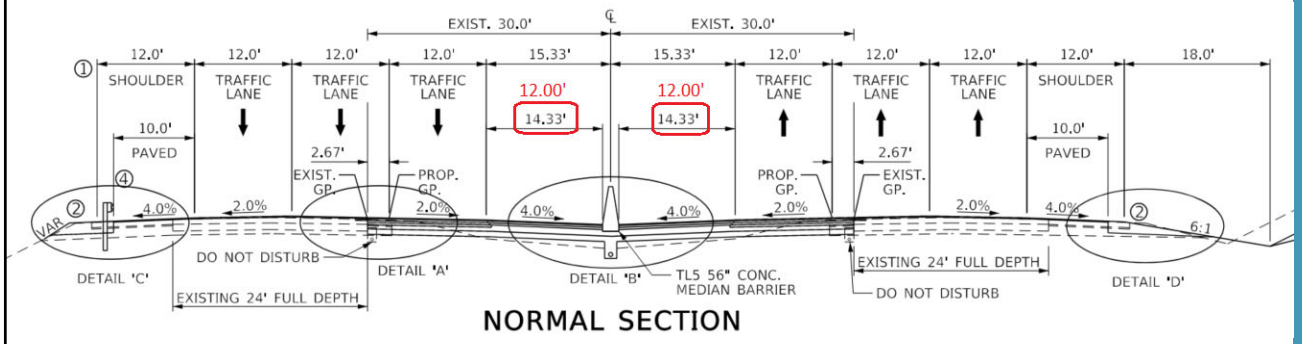
12

ELIMINATE INTERCEPTOR DITCH



13

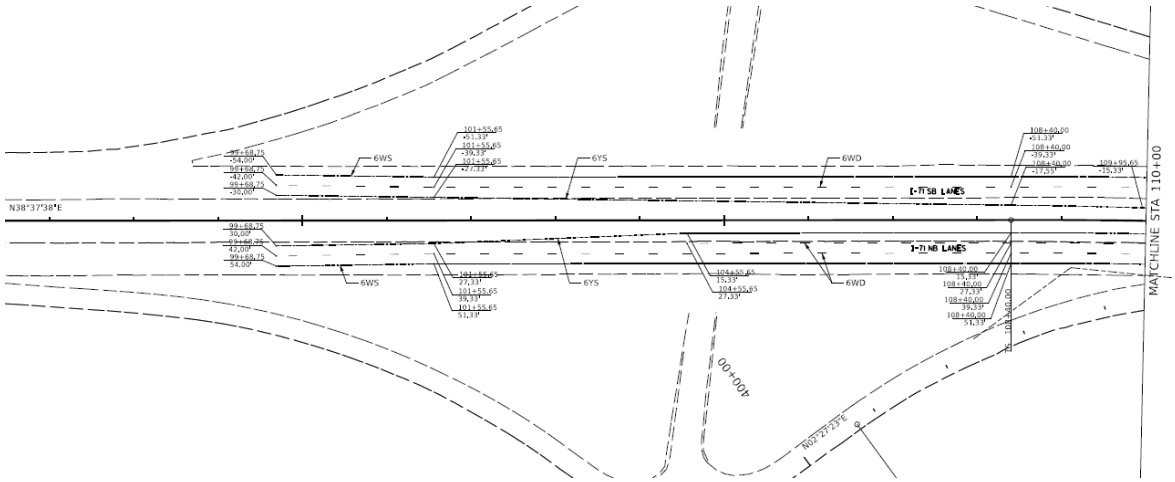
REDUCE INSIDE SHOULDER WIDTH



NORMAL SECTION

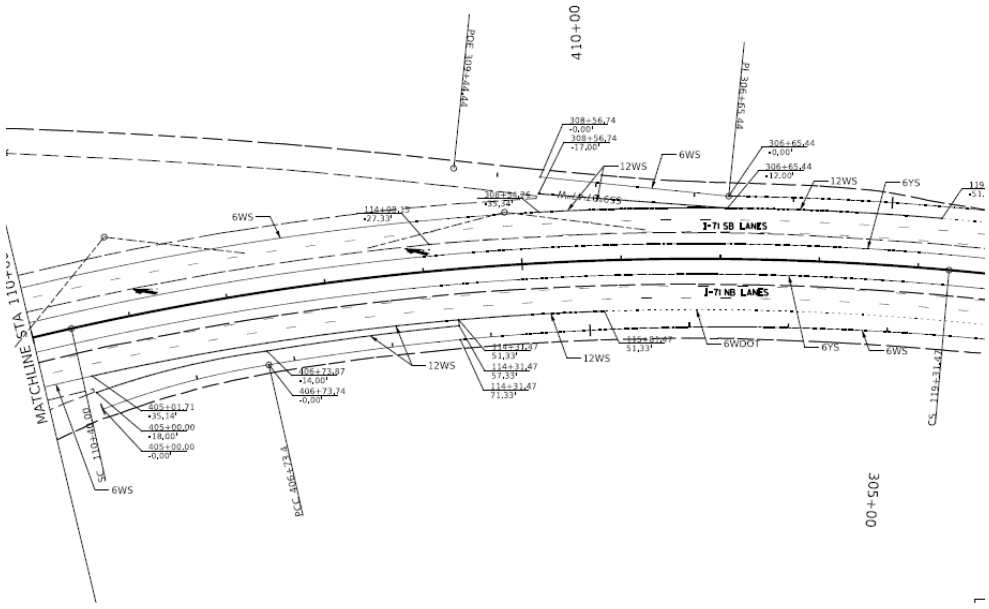
14

DROP/ADD THE 3RD LANE AT THE HIGHWAY 127 RAMPS



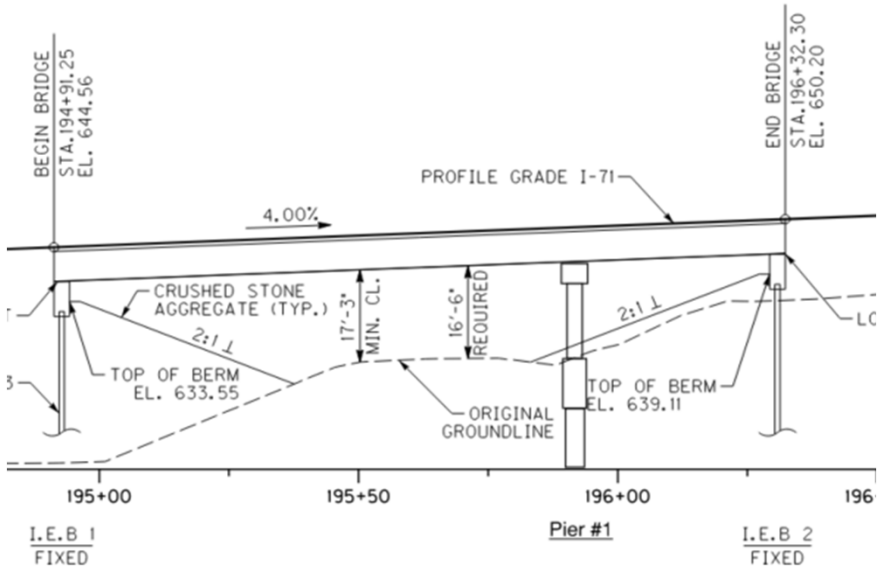
15

DROP/ADD THE 3RD LANE AT THE HIGHWAY 127 RAMPS



16

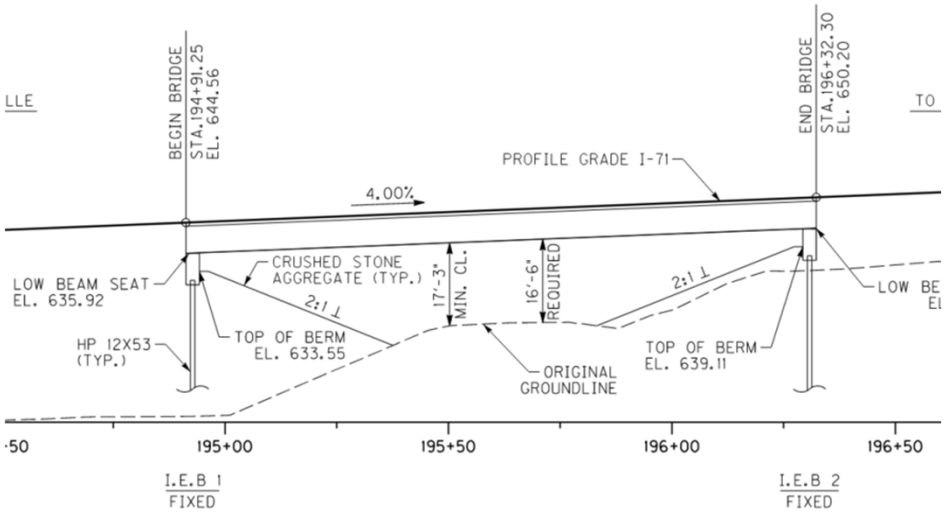
USE SINGLE SPAN BRIDGE AT TAPERING POINT ROAD



Baseline Concept (2 span)

17

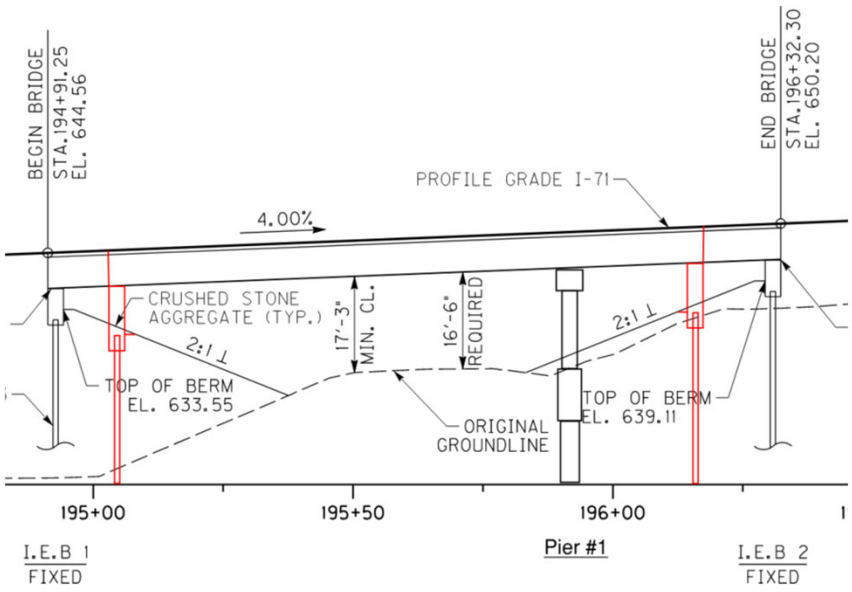
USE SINGLE SPAN BRIDGE AT TAPERING POINT ROAD



Alternative Concept (1 span)

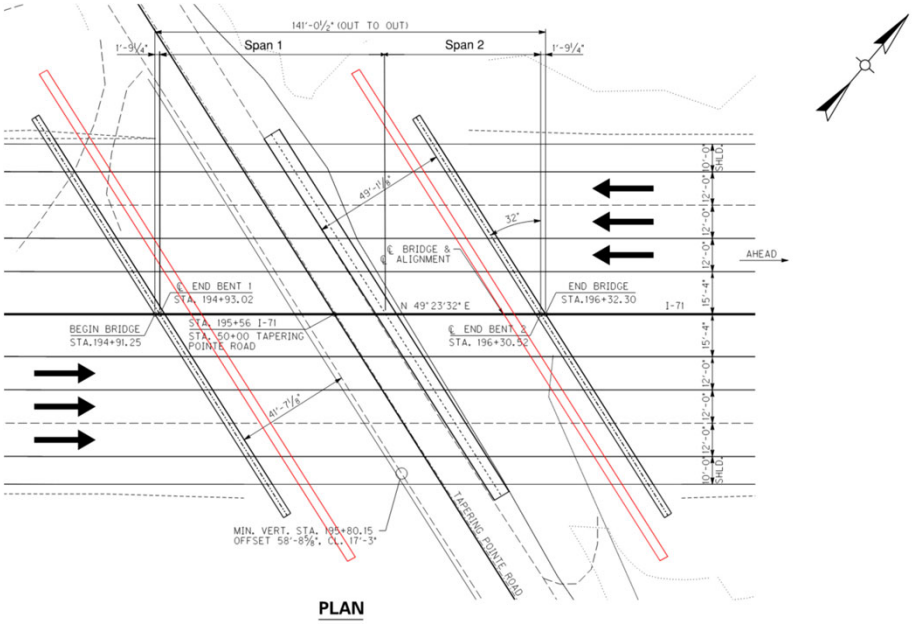
18

INCREASE HEIGHT OF PILE CAPS AND REDUCE BRIDGE LENGTH



19

INCREASE HEIGHT OF PILE CAPS AND REDUCE BRIDGE LENGTH

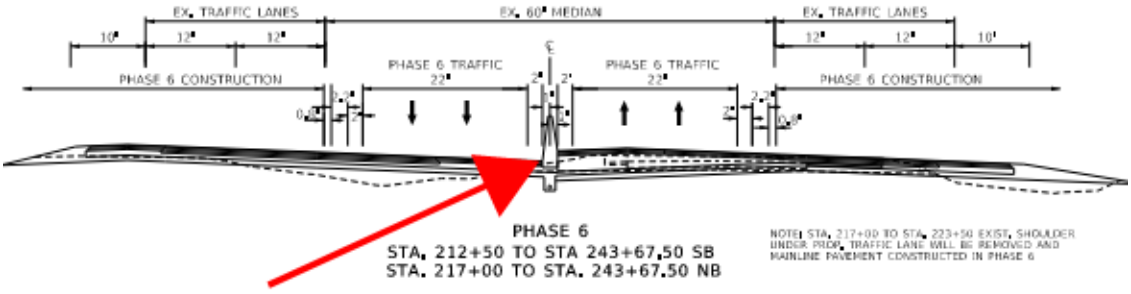


20

PAVE THE SURFACE COURSE IN ECHELON

21

INSTALL MEASURES TO REDUCE SURFACE WATER RUNOFF AT BARRIER DURING SELECT PHASES



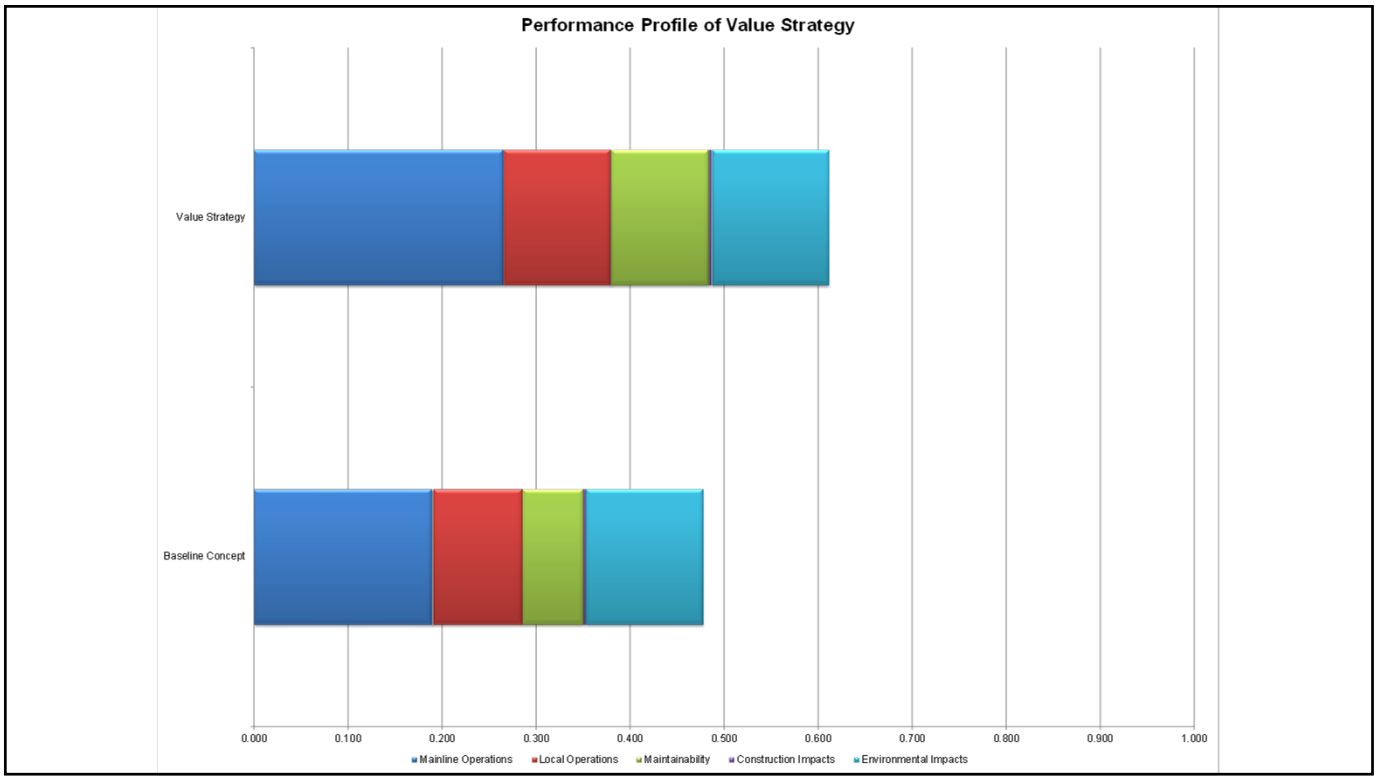
Add additional drainage structures (CMBBI) to drain gutter line during MOT phase

22

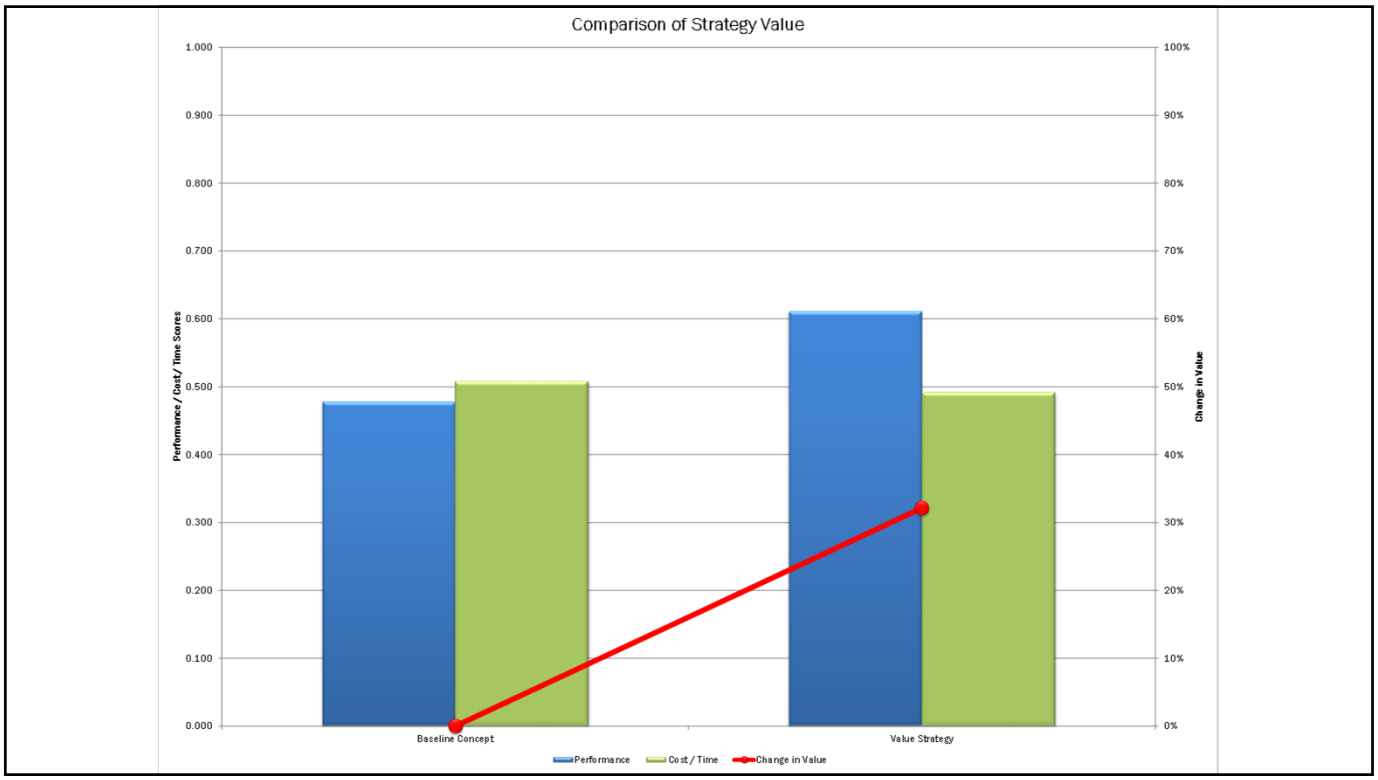
TAKE AWAYS / VE STRATEGY

- VE Strategy = Combination of VE Alternatives into one cumulative set for evaluation
  - Does not preclude consideration of individual alternatives or alternatives not initially selected
- Includes VE Alts E-1, E-2, E-3, XP-2, S-1, S-2, C-1
- Total Cumulative Cost Savings Potential: ~$1.5M

23



24



25

Next Steps

- Draft VE Report Submitted (May 22)
- Draft Report Review
  - Includes Implementation Action & Decisions
- Final VE Study Report

26

27

Appendix E. VE Implementation Approval Form

Summary of VE Alternative Implementation

Alt No.	Alternative Title	Cost Savings or (Cost Added)	Performance/Risk	Preliminary Decision	Implementation Decision Rationale
E-1	Flatten side slopes with excess roadway excavation material	$456,000	Improved (MO, M) Reduced (ROW/EI)	Accept	The Project Design Team would like to accept this recommendation. Since this area is prone to slides, flattening the side slopes will be very beneficial to the project and ensure that the excess roadway material can be utilized and reduce the amount of guardrail installed.
E-2	Construct grading for temporary diversions as permanent in lieu of removing	$330,000	Reduced (M)	Accept	The Project Design would like to accept this recommendation. This recommendation will require additional work by the Consultant to incorporate into the plan set.
E-3	Eliminate interceptor ditch	$180,000	Improved (M)	Accept	Ther Project Design Team would like to accept this recommendation due to simplified construction, reduction in construction limits and reduction in quantity of channel lining. May require a special note to use straw/mesh to ensure vegetation establishment.
XP-1	Reduce inside shoulders from 14.3' to 12.0'	$520,000	Improved (M) Reduced (MO)	Reject	The Project Design Team would like to reject this recommendation after taking an additional look. Because this recommendation will require a large re-design of this project, the team decided that they would not move forward with this recommendation. Although it is suggested to reduce the inside shoulders by almost 2 ft, additional pavement would be needed regardless due to the maintenance of traffic.

Summary of VE Alternative Implementation

Alt No.	Alternative Title	Cost Savings or (Cost Added)	Performance/Risk	Preliminary Decision	Implementation Decision Rationale
XP-2	Drop/Add the 3rd lane at the Highway 127 ramps	$173,000	Improved (M, CI)	Reject	The Project Design Team would like to reject this recommendation. After much discussion they determined that this recommendation does not take into account the adjoining section of I-71 and when looking at both projects, it was determined that dropping/adding the 3rd lane would not provide an overall benefit for this project.
S-1	Use single span structure at Tapering Point Road	$0	Improved (LO, M)	Accept	The Project Design Team would like to accept this recommendation.
S-2	Increase height of pile caps and reduce bridge length	$460,000	No change	Accept	The Project Design Team would like to accept this recommendation.
C-1	Pave the surface course in echelon	($86,000)	Improved (M) Reduced (CI)	Accept	The Project Design Team would like to accept this recommendation and a special note will need to be included in the plan set.
C-2	Install measures to reduce surface water runoff at barrier during select phases	($306,000)	Improved (CI, Risk) Reduced (M)	Accept	The Project Design Team would like to accept this recommendation. Additional work will be required. They will look into reducing surface water runoff by adding median barrier and box inlets.