MCCRACKEN & LIVINGSTON BRIDGE
US 60 OVER TENNESSEE RIVER

MCCRACKEN & LIVINGSTON COUNTIES, KY
ITEM NUMBER 01-1115.00

FINAL REPORT

STUDY DATE:

MAY 8 - 12, 2006

VALUE ENGINEERING STUDY

Prepared by URS Corporation

for Kentucky Transportation Cabinet

URS CORPORATION

MCCRACKEN & LIVINGSTON BRIDGE,
US 60 OVER TENNESSEE RIVER

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Final Report

June 16, 2006

URS Corporation

EXECUTIVE SUMMARY

General

URS conducted a Value Engineering Study on McMcracken-Livingston Bridge project, Highway US 60 over Tennessee River located in McMcracken and Livingston counties, Kentucky. The topic of the VE study was the proposed superstructure of the bridge, which consists of three spans of a truss, measuring 400 ft, 900 ft, and 500 ft for a total length for the entire bridge of 1800 ft. A construction contract for the four substructure piers, including one in the river has been awarded in the amount of approximately $28 million. Plans for the approach road and bridge are under development.

The VE team undertook the task using the value engineering work plan and approach. The work plan depends on what is commonly referred to as a "bottom up" approach. With this approach, the VE Team subdivided the project into its component parts, examined the functions, purpose, and requirements of each part, and then identified alternate approaches to accomplishing the identified functions. The ideas generated from this process and selected for full development as VE Team Recommendations are presented in Section 3 of this report. These recommendations are presented to all project stakeholders for judgment as to whether they should be implemented or not.

Estimate of Construction Costs and Budget

A construction cost estimate for the superstructure was not provided to the VE team. At the entrance briefing, it was stated by KYTC that the estimated cost of the superstructure including decking but excluding approaches was approximately $44 million. A future discussion of project cost is included in the project description section of this report. The total cost of the bridge as designed, including the substructure contract, is estimated at $72.2 million.

Discussion

The VE team was told at the entrance briefing that the KYTC was not satisfied with the current superstructure design. The design is similar to a bridge built several years ago by KYTC and neither KYTC nor the public using the bridge are happy with the structure. It is a massive truss bridge with large members use for cross bracing. The deck is 90 some feet wide with only an 18-foot vertical clearance for a structure that is over 60 feet high. This produces an affect of entering a tunnel when approaching the bridge. Usually a VE team is given a design and a cost estimate and tasked to come up with recommended changes to that design that will maintain all of the necessary functions at a reduced life cycle cost. The team did generate several ideas to improve upon the existing design. However, the majority of this report is recommendations to entirely change the design of the bridge. A significant restriction is the fact that a contract has been awarded for the substructure. Several of the suggested alternatives would include major changes to that contract. If any of those alternatives are preferred by KYTC, expeditious action will be needed to minimize cost impacts.

Recommendations & Design Alternatives

During the speculation phase of this VE study, 39 creative ideas were identified. Two of these ideas, which are changes to the existing truss bridge and procurement methods, were developed into VE recommendations. In addition, ten ideas were developed into design comments. Due to the timing of this study, the level of design, and other factors, these ideas did not fit into the same category as the recommendations, however, they remain viable considerations for the owner and design team as the design progresses.

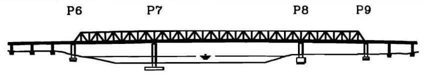
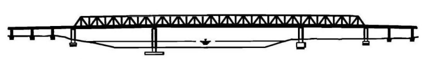
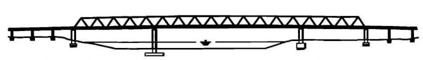
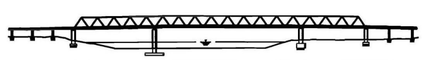
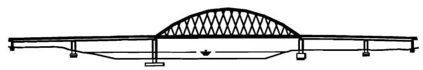
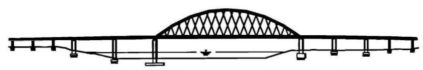
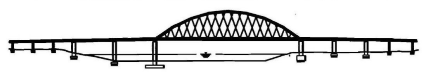
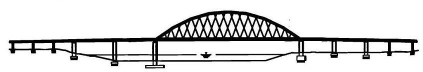
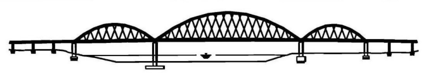
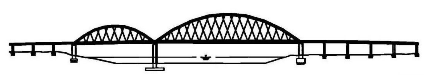
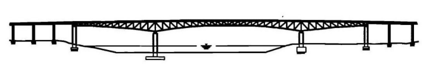
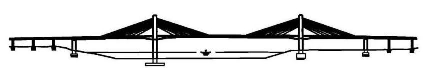
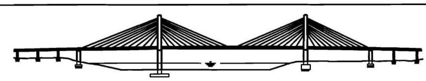
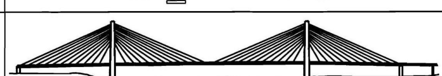
Neither of the recommendations to the exist bridge design will change the design to the extent that the "tunnel” effect upon approaching the bridge would be eliminated. At the entrance briefing, the structural engineer reasonable for the current design stated that the amount of cross bracing could be reduced by using moment connection thereby opening up the entrance appearance. The VE team, as presented in the alternatives, believes that to significantly improve the appearance of the bridge, an entire redesign is necessary. This could be expeditiously accomplished by design-build procurement. This design comment is included in the report.

Compared to other VE studies, there is a rather limited number of recommendations and design comments for this size of project. This is because the alternative superstructure designs are the real significant components of this study and report. The alternatives present entirely different superstructure designs compared to the truss design as originally proposed. These alternatives present numerous other bridge types with an array of costs. As the Alternatives are mutually exclusive of each other, only one of these Alternatives can be chosen. Given that the factors for the selecting a preferred alternative are out of the scope of this study, the VE team did not attempt to choose one of these alternatives over the other. However, if cost is the only consideration, the choices are limited. If the appearance of the bridge is paramount, several alternatives remain available.

The following tables present a summary of the ideas developed into recommendations, design comments, and superstructure design alternatives.

SUMMARY OF VE RECOMMENDATIONS and DESIGN COMMENTS		
Rec.#	Recommendation Title / Description	1st cost savings (or cost)
1	Paint only the steel above the deck on the original bridge or revised bridge in lieu of painting all of the steel	$863,000
2	Decrease the total amount of steel used in the truss by economizing the design and decreasing the member sizes	$5,700,000

DC#	Design Comment Title / Description
1	Use tube rail in lieu of jersey barriers for sides and center medians
2	Utilize an alternative barrier design with a rail on top of a concrete barrier to provide better aesthetics and a better scenic view
3	Increase the 5’ width bike lane to a more user-friendly width
4	Add aesthetic lighting on the bridge structure
5	Add a theme lighting plan on the approaches of the structure
6	Use colored concrete for the bridge deck construction
7	Have public involvement meetings to select paint color, an aesthetic lighting plan, and provide public with correct and updated information
8	Decorate and enhance the portal appearance to minimize the tunnel effect of the proposed design
9	Design at least one more superstructure and send multiple designs out for bidding
10	Make the superstructure a design/build project in lieu of a design/bid/build project

ALT. NO.	IDEA NO.	SUMMARY OF ALTERNATIVES		COST	MODIFICATION OF EXISTING CONSTRUCTION CONTRACT REQUIRED?				ADDITIONAL COAST GUARD PERMIT REQUIRED?
					PIER 6	PIER 7	PIER 8	PIER 9	
0	-		Existing Design : 3-Span Parallel Chord Through Truss	$72.4M	No	No	No	No	No
1	1		3-Span Parallel Chord Through Truss	$64.8M	No	No	No	No	No
2	32		Modified 3-Span Parallel Chord Through Truss	$66.1M	No	No	No	No	No
3	18		Modified 3-Span Parallel Chord Through Truss with Closed Sections	$72.7m	No	No	No	No	No
4	4		Tied Arch Mainspan with Steel Plate Girder Flanking Spans	$75.1M	Yes	No	No	Yes	Yes, for erection of arch superstructure.
5	9		Tied Arch Mainspan with Shorter Steel Plate Girder Flanking Spans	$69.3M	No	No	No	No	Yes, for erection of arch superstructure and additional pier in water.
6	15		Tied Arch Mainspan with Shorter Precast Concrete Girder Flanking Spans	$68.4M	No	No	No	No	Yes, for erection of arch superstructure and additional pier in water.
7	21		Tied Arch Mainspan with Support Elements Along Centerline of Bridge	$75.4M	No	No	No	No	Yes, for erection of arch superstructure and additional pier in water.
8	6		Three Tied Arch Spans	$76.6M	Yes	No	No	Yes	Yes, for erection of arch superstructure.
9	38		Two Tied Arches with Precast Concrete Girder Approach Spans	$68.3M	Yes	No	No	Yes	Yes, for erection of arch superstructure.
10	12		Deck Truss	$68.0M	Yes	No	No	Yes	No
11	11		Extradosed Steel Girder	$71.2M	Yes	Yes	Yes	Yes	No
12	7		Cable-Stayed Bridge with 900-ft Span	$78.2M	Yes	Yes	Yes	Yes	No
13	37		Cable-Stayed with 1200-ft Span	$105.3M	Yes	Yes	Yes	Yes	No

Acknowledgements
The team appreciates the input and able assistance of all of the staff members of the Kentucky Transportation Cabinet and the Federal Highway Administration who participated in the study. Without their participation, this successful value engineering study would not have been possible.

A very special thanks is extended to Tim Choate, and Dexter Newman of the KYTC and John Bargo of the FHWA for their dedication and technical input.

Value Engineering Study – Core Team

Name	Discipline/Role	Organization	Telephone
Ken True	Team Leader	URS	402-516-2635
Dave Jeakle	Bridge Design	URS	813-636-2467
John Bargo	Bridge Design	FHWA	502-223-6763
Dexter Newman	Team Member	KYTC	502-564-4555
Tim Choate	Team Member	KYTC	502-898-2431
Greg Sanders	Recorder	URS	913-344-1000

Certification
This is to verify that the Value Engineering Study was conducted in accordance with the standard Value Engineering principles and practices.

Kenneth True, PE, CVS, CCE
Value Engineering Team Leader

TABLE OF CONTENTS

SECTION 1 - INTRODUCTION

This report documents the results of a value engineering study on the proposed bridge design for Highway US 60 crossing over the Tennessee River in McMcracken and Livingston counties. The study workshop was held at the offices of the Kentucky Transportation Cabinet (KYTC) District 1 in Paducah, KY on May 8th and KYTC Headquarters in Frankfort, KY on May 9-12, 2006. The study team was from KYTC and URS and was facilitated by Ken True, a Professional Engineer and Certified Value Specialist (CVS) team leader from URS. The names and telephone numbers of all participants in the study are listed in Appendix A.

The Job Plan
The study followed the value engineering methodology as endorsed by SAVE International, the professional organization of value engineers. This report does not include an explanation of standard value engineering / value analysis processes used during the workshop in development of the results presented herein. This would greatly expand the size of the report. The purpose of the report is to document only the results of the study.

Ideas and Recommendations
Part of the value engineering methodology is to generate as many ideas as practical, evaluate each idea, and then select candidates for further development. If an idea thus selected, turns out to work in the manner expected, that idea is presented as a formal value engineering recommendation or alternative. Recommendations represent those ideas that are proven to the VE team's satisfaction.

Design Comments
Some ideas that did not make the selection for development as recommendations, were, nevertheless judged worthy of further consideration. These ideas have been written up as Design Comments and are included in Section 5.

Level of Development
Value Engineering studies are working sessions for the purpose of developing and recommending alternative approaches to a given project. As such, the results and recommendations presented are of a conceptual nature, and are not intended as a final design. Detailed feasibility assessment and final design development of any of the recommendations presented herein, should they be accepted, remain the responsibility of the designer.

Organization of the Report
The report is organized in the following outline.

1. Introductory information
    a. Section 1 - Introduction
    b. Section 2 - Project Description
2. Primary body of results
    a. Section 3 - Recommendations
    b. Section 4 - Alternatives
    c. Section 5 - Design Comments
3. Supporting documentation……Appendices

SECTION 2 – PROJECT DESCRIPTION

The project includes building a new roadway, the approaches and the bridge for Highway US 60 crossing over the Tennessee River. US 60 connects the two towns of Riedland and Ledbetter along the border of McMcracken and Livingston counties.

An existing bridge is located 2200 feet downstream from the proposed site. The existing bridge is two lanes wide (approximately 24 feet) with no walkway or shoulders. The current bridge design is 71 feet wide with 4, 11.5 foot driving lanes with a four foot shoulder and one five foot shoulder that is designated as a bike lane.

The total project includes relocating the existing road, construction of approaches, bridge substructure and a 3 span bridge with span lengths of 400, 900, and 500 feet for a total length of 1800 feet. The proposed superstructure is a Warren truss bridge with sway bracing producing a structure approximately 70 feet high. The clearance under the bridge must be maintained for barge traffic. The current design has one river pier. The environmental considerations involved with moving endangered mussels have already been satisfied for the pier locations on both river shores. A construction contract for the four bridge piers was awarded in the spring of 2006 for $28.4 million to CJ Mahan Construction. Site work has started and several construction site photos, taken during the VE team site visit, are included in Appendix F.

Due to the existing bridge, vehicle traffic should have no impact on bridge construction. However, the construction of piers in the channel and the superstructure construction could be impacted by river barge traffic.

Right of way has been obtained for the project.

This VE study is limited to analyzing the bridge superstructure. The constraints given at the entrance briefing are:

- Bridge width of 71 feet with 4 traffic lanes and 4 to 5 foot shoulders
- Construction contract awarded for 4 bridge piers. That contract includes language to vary pier caps

Project Cost

A total project cost was not available for the VE study team. A partial superstructure cost was furnished to the VE team (see Appendix C). This cost estimate dated 5/5/2006 is $27,736,970 for the truss structural steel. It is assumed this includes sway bracing. In the entrance brief Mr. Allen W Frank stated the total cost of the superstructure including deck steel, deck concrete, etc at approximately $44 million. The estimate of $27.7 million is based on 15,409,000 pounds of steel at $1.80 per pound erected. The Kentucky 90 bridge a truss superstructure, let on December 20,2002 had a steel cost of $1.48 per pound or $35.2 million. A construction contract for the four bridge piers has been awarded to CJ Mahan Construction Company in the amount of $28.4 million. Therefore the total estimated cost of the bridge, substructure and superstructure, is $72,200,000 excluding the cost for the approach bridges and roadway.

The bridge is 71 feet wide and 1,800 feet long (3 spans) or 127,800 sqft. This means the cost of the superstructure is $344.29 per SF. Steel usage is 121 pounds per SF.

Funding

The substructure construction contract for $28.2 is funded with FY 2006 money. In the entrance meeting additional funding was stated in the six-year highway plan as:

FY 2008	$15 million
FY 2009	$15 million
FY 2010	$10 million
Funding Total	**$40 million**

For comparing the current design to the purposed alternatives the following information is tabulated.

Substructure cost (under contract)	$28.2 million
Super structure steel cost	$27.7 million
Deck steel, deck, painting, misc.*	$16.3 million
* **Rough estimate verbally stated at entrance briefing**	
Total Estimated Project Cost	**$72.2 million**

SECTION 3 - VE RECOMMENDATIONS

This section contains the complete documentation of all of the recommendations that resulted from this study. The parent idea, or ideas, from which the recommendation began, can be determined from the Creative Idea List located in Appendix E of this report.

Each recommendation is documented by a separate write-up that includes a description of both the original design and recommended change, a list of advantages and disadvantages, and the economic impact of the recommendation on the project's cost where applicable.

VALUE ENGINEERING RECOMMENDATION # 1

PROJECT: MCCRACKEN & LIVINGSTON BRIDGE, US 60 OVER TENNESSEE RIVER
LOCATION: PADUCAH, KENTUCKY
STUDY DATE: MAY 8 - 12, 2006

DESCRIPTIVE TITLE OF RECOMMENDATION:
Paint only the steel above the deck on the original bridge or revised bridge in lieu of painting all of the steel.

ORIGINAL DESIGN:
Proposed painting all steel on the current bridge design.

RECOMMENDED CHANGE:
Paint only the steel above the deck on the original bridge or revised bridge. Delete painting on all the non-visible steel.
Note: The Recommended change cost savings is computed for only the present design. Savings for not painting under deck steel for other recommendations are included in those recommendations.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	\$863,000		\$863,000
RECOMMENDED DESIGN	\$0		\$0
ESTIMATED SAVINGS OR (COST)	\$863,000	\$0	\$863,000

VALUE ENGINEERING RECOMMENDATION # 1

ADVANTAGES:

- Save the painting cost associated with effected members ($0.15 per pound)
- Provide paint for visible members which improves the aesthetics of the current bridge design

DISADVANTAGES:

- Deicing agents could affect the life of the unpainted bridge

JUSTIFICATION:
At the value engineering entrance briefing it was stated that the proposed design is to use 50W (weathering) steel and painting all of the steel. The only reason to paint 50W is for aesthetics, with the exception of pockets in the steel between members. The cost difference between 50W and 50 steel is approximately 1.5% the cost of the steel. Deleting the painting on the non-visible steel does not impact the bridge aesthetics. This recommendation includes only the first cost savings.

VALUE ENGINEERING RECOMMENDATION # 1

COST ESTIMATE - FIRST COST

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Painting	Lbs	0.15	8	5,751,000	$862,650		
Subtotal					$862,650		$0
Mark-up (included)					$0		$0
Redesign Costs							
Total					$862,650		$0

SOURCE CODE:
1 Project Cost Estimate
2 CES Data Base
3 CACES Data Base
4 Means Estimating Manual
5 National Construction Estimator
6 Vendor Lit or Quote (list name / details)
7 Professional Experience (List job if applicable)
8 Other Sources (specify)

VALUE ENGINEERING RECOMMENDATION # 2

PROJECT: MCCRACKEN & LIVINGSTON BRIDGE, US 60 OVER TENNESSEE RIVER
LOCATION: PADUCAH, KENTUCKY
STUDY DATE: MAY 8 - 12, 2006

DESCRIPTIVE TITLE OF RECOMMENDATION:
Decrease the total amount of steel used in the truss by economizing the design and decreasing the member sizes.

ORIGINAL DESIGN:
The US 60 bridge design is a steel warren truss with deep lateral sway bracing at panel points. The truss as design and stated to the VE team has 27,736,920 pounds of structural steel NOT including the deck reinforcement.

RECOMMENDED CHANGE:
Decrease the total amount of steel used in the truss by economizing the design and decreasing the member sizes.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$5,750,000		$5,750,000
RECOMMENDED DESIGN	$0		$0
ESTIMATED SAVINGS OR (COST)	$5,750,000	$0	$5,750,000

VALUE ENGINEERING RECOMMENDATION # 2

ADVANTAGES:

- Decreases the total amount of steel needed
- Decreases dead load
- Improves the bridge appearance by decrease the total mass of the bridge
- Decreases painting necessary
- Decreases the total cost of the bridge

DISADVANTAGES:

- May slightly increase the bridge deflections, however, values will still be within code limits

JUSTIFICATION:
The current design has a 71-foot wide deck 1800 feet long, or 127,800 square feet. This equates to 125 lbs/ft^2 of steel for the truss steel (not the deck rebar).

I-526 over the Cooper River, North Charleston, SC
Parallel Chord 3-Span Modified Warren Truss
400' – 800' – 400' Span Lengths
93'-7" Wide
83 lbs/ft^2 of structural steel for superstructure truss

US-27 over the Ohio River, Cincinnati OH – Newport, KY
Parallel Chord 3-Span Warren Truss
574' – 850' – 425' Span Lengths
67'-0" Wide
93 lbs/ft^2 of structural steel for superstructure truss

Assume design can be refined and optimized to achieve 100 lbs/ft^2 of structural steel for the truss superstructure.

Assume reduction: 25 lbs/ft^2 * 127,800 ft^2 * $1.80/lbs = $5,750,000

VALUE ENGINEERING RECOMMENDATION # 2

COST ESTIMATE - FIRST COST

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Reduction in amount of structural steel for superstructure	LS		7		$5,750,000		$0
Subtotal					$5,750,000		$0
Mark-up (included)					$0		$0
Redesign Costs							
Total					$5,750,000		$0

SOURCE CODE:
1 Project Cost Estimate
2 CES Data Base
3 CACES Data Base
4 Means Estimating Manual
5 National Construction Estimator
6 Vendor Lit or Quote (list name / details)
7 Professional Experience (List job if applicable)
8 Other Sources (specify)

SECTION 4 – ALTERNATIVES

This section presents the alternative superstructure designs that resulted from the workshop. The alternatives are the real significant components of this study and report. The alternatives present entirely different superstructure designs compared to the Warren truss design as originally proposed. These alternatives present numerous other bridge types with an array of costs.

As the Alternatives are mutually exclusive of each other, only one of these Alternatives can be chosen. Given that the factors for the selecting a preferred alternative are out of the scope of this study, the VE team did not attempt to choose one of these alternatives over the other. However, if cost is the only consideration, the choices are limited. If piers are preferred, the choices are also limited. If the appearance of the bridge is paramount, several alternatives remain available.

VALUE ENGINEERING ALTERNATIVE # 0

DESCRIPTIVE TITLE OF ALTERNATIVE:
Use existing steel truss superstructure design

DESCRIPTION OF ALTERNATE:
The current design of the river crossing consists of a three-span parallel chord through truss with spans of 500' - 900' - 400'. The superstructure consists of a traditional Warren Truss, including vertical members on the side truss and a transverse lateral sway bracing system at all panel points consisting of K-frames. The substructure and foundation designs are complete and a contract for construction of these elements (Piers 6, 7, 8, and 9) has been awarded to C.J. Mahan in early 2006. The superstructure design and plans have been estimated to be approximately 60% complete with little drafting being complete.

ADVANTAGES:
- Design is already being completed in house
- Existing substructure contract will be unaffected

DISADVANTAGES:
- Entrance of bridge has a tunneling affect
- Superstructure design is relatively heavy (approx. 121 psf) for a parallel chord truss bridge

COST ESTIMATE:

- $28.4 million Existing contract for Piers 6 to 9
- $44.0 million Engineer of Record's preliminary cost estimate for superstructure of truss
- $72.4 million Total estimated for full cost of 1800' of parallel chord truss bridge

VALUE ENGINEERING ALTERNATIVE # 1

DESCRIPTIVE TITLE OF ALTERNATIVE:
Traditional 3-Span Parallel Chord Through Truss

DESCRIPTION OF ALTERNATE:
This 3-span traditional parallel chord through truss is based upon the existing US-60 over Tennessee River design with the following modifications:

- Remove the lateral sway bracing and replace with a moment resisting frame to improve the appearance
- Redesign the truss to reduce quantity of steel. Current design has approximately 125 psf of structural steel, other parallel chord truss bridges with similar span lengths and widths (Taylor-Southgate, Cincinnati, OH and I-526 Bridge over the Cooper River, Charleston, SC) have about 83 and 95 psf of structural steel, respectively (approximately $5,750,000 savings with steel reduction).

Precast/Prestressed Concrete Beam Approach structures leading up to the 3-span continuous unit will not require modification. The existing pier and foundation contract with C.J. Mahan to construct Piers 6 to 9 can be completed as-is without modification.

ADVANTAGES:

- Changes to existing plans can be performed in-house and meet letting schedules.
- Minor improvement in aesthetics relative to current design in progress.
- Does not require modification or termination of existing contract to construct Piers 6 to 9.
- Removal of lateral sway bracing will clean up and simplify the appearance and create additional clearance to the top lateral bracing, thus reducing the tunnel effect.
- Redesigning for efficiency will reduce material consumption and cost.
- The three span continuous system allows for simpler construction over the navigation channel compared to simple span alternatives. Simple span alternatives will require either temporary works within the navigation channel or to float in the completed structural system, which has risks associated with it. The three span continuous system can be built over the navigation channel without the need for large temporary works within the navigation channel.

DISADVANTAGES:

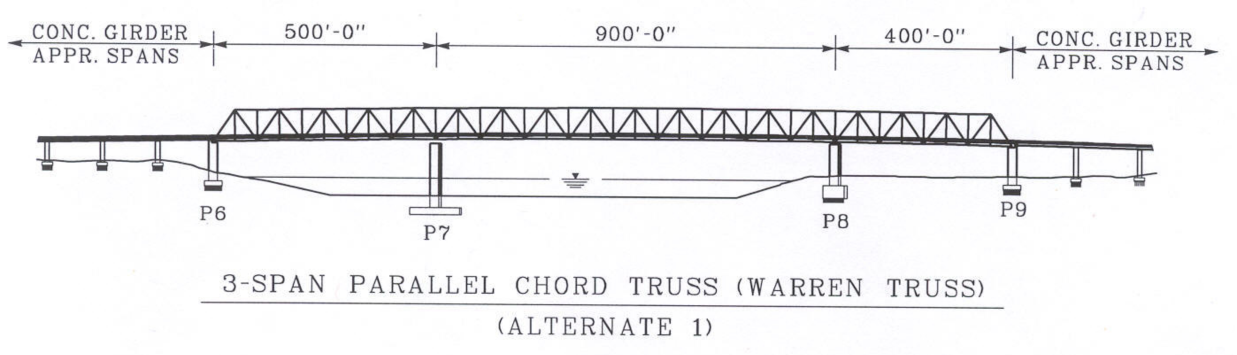
- Even though this modified truss will have improved aesthetics, it is the team's opinion that this design will not be as aesthetically appealing as the truss in Alternate 32 or other bridge types discussed in this report.
- Requires additional time and effort to redesign the truss; however, the cost of redesigning will be more than offset by the savings from reducing quantity of steel required.
- Removal of lateral sway bracing will require larger top lateral bracing members with more complicated connections.
- The steel will need to be painted and on-going maintenance on the painting for the life of the structure.

COST ESTIMATE:

- $275/sf *1800'* 73.5' = $36.4M (1800' Truss Superstructure)
- = $28.4M (Existing Construction Contract for Piers 6 to 9)
- TOTAL = $64.8M

VALUE ENGINEERING ALTERNATIVE # 1

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING ALTERNATIVE # 1

ARTISTIC RENDERING OF RECOMMENDED DESIGN

VALUE ENGINEERING ALTERNATIVE # 2

DESCRIPTIVE TITLE OF ALTERNATIVE:
Modified 3-Span Parallel Chord Through Truss

DESCRIPTION OF ALTERNATE:
This alternate is the same as Alternate 1 with the exception that the detailing of the truss will be enhanced to provide higher aesthetic appeal. First, the vertical elements of the truss will be eliminated and the diagonals will carry the entire load. Second, the number of members for the top chord lateral bracing will be reduced in an effort to improve the appearance. Both of these revisions are meant to create a clean and distinctive truss system with improved aesthetics; however, these revisions also have the affect of complicating the connections and decreasing the efficiency of some of the members, both of which will increase the cost slightly.

ADVANTAGES:

- Does not require modification or termination of existing contract to construct Piers 6 to 9.
- Improved aesthetics relative to Alternate 1 and the current truss design. The elimination of the verticals and reconfiguration of the top lateral bracing creates a more open and transparent design, which leads to enhanced visual appeal.
- Still a cost effective solution.
- Does not require major temporary works within the river for constructing the superstructure over the navigation channel.

DISADVANTAGES:

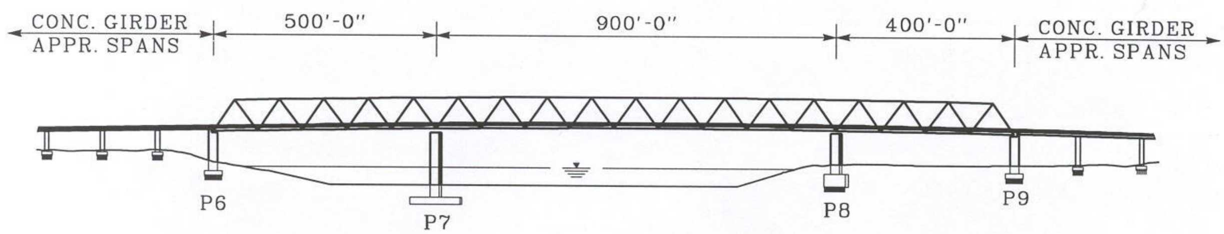
- Requires painting of the structural steel.
- The removal of the verticals and the reconfiguration of the top lateral bracing is not as structurally efficient as Alternate 1.

COST ESTIMATE:

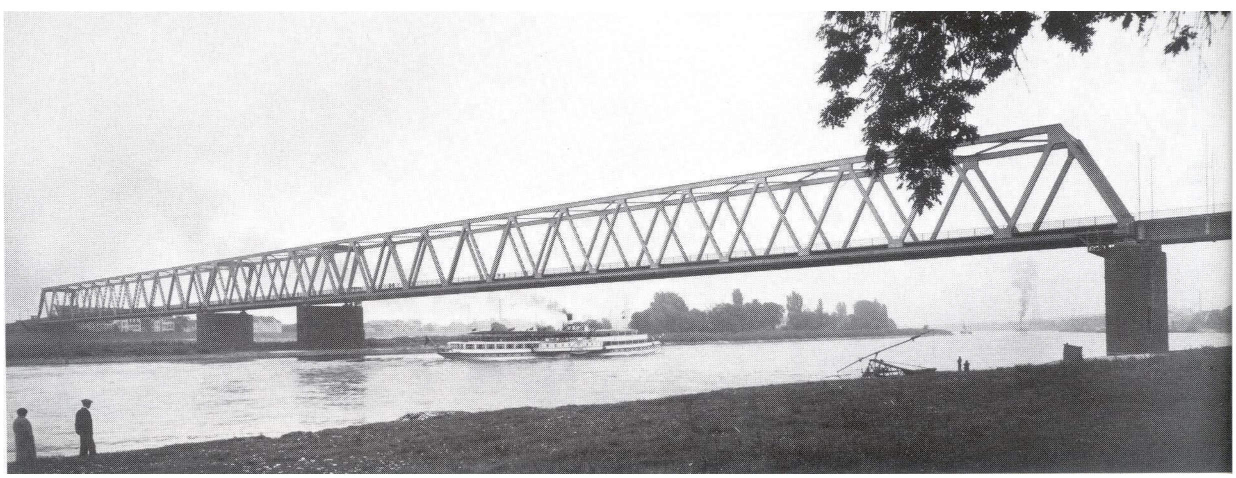
$285/sf *1800'* 73.5' = $37.7M (1800' Truss Superstructure)
= $28.4M (Existing Construction Contract for Piers 6 to 9)
TOTAL = $66.1M

VALUE ENGINEERING ALTERNATIVE # 2

SKETCH OF RECOMMENDED DESIGN



3-SPAN MODIFIED PARALLEL CHORD TRUSS (WARREN TRUSS)
(ALTERNATE 32)



VALUE ENGINEERING ALTERNATIVE # 2

ARTISTIC RENDERING OF RECOMMENDED DESIGN

VALUE ENGINEERING ALTERNATIVE # 3

DESCRIPTIVE TITLE OF ALTERNATIVE:
Use Closed Sections for Mainspan Bridge

DESCRIPTION OF ALTERNATE:
This alternate applies to the two alternates that have truss elements above deck (Alt. 1 and 32). In general, instead of using wide flange steel sections for the truss members, we would use closed sections like welded or bolted steel box shapes to improve the aesthetics of the structure. The custom fabrication of the steel boxes compared to using rolled sections will drive up the fabrication cost of the steel without increasing the quantity of steel.

ADVANTAGES:

- Use of closed sections has a marginal increase in the aesthetic appearance of the above deck structure.

DISADVANTAGES:

- Drives up the price of the steel because many of the members will need to be custom fabricated instead of using rolled sections.

COST ESTIMATE:

$64.8M * 1.10 = $71.3M (Alternate 1 modified to include closed sections for all members)

$66.1M * 1.10 = $72.7M (Alternate 32 modified to include closed sections for all members)

VALUE ENGINEERING ALTERNATIVE # 4

DESCRIPTIVE TITLE OF ALTERNATIVE:
Tied Arch Mainspan with Steel Plate Girder Flanking Spans

DESCRIPTION OF ALTERNATE:
Span the navigation channel with a steel tied arch structure with one arch rib on each side of the roadway. Consideration should be given to using a diagonal hanger system to reduce flexural demands on the arch rib and increase the stiffness of the system. On each side of the mainspan will be a two-span continuous steel plate girder structure, beyond the steel plate girder structure will be the currently planned precast/prestressed concrete beams spans. The flanking spans with steel plate girders are recommended as two-span structures since single spans at 500' and 400' will be very expensive and difficult to erect.

The existing design for Piers 7 and 8 under contract with C.J. Mahan should be acceptable and can continue construction. However, Piers 6 and 9 will need to be evaluated for adequacy considering the new structure type being supported and may require a new design and modification to the existing construction contract.

With the two-span flanking spans a single substructure unit on each side (Piers 5 and 10) can be eliminated. Eliminated two precast/prestressed concrete beam approach spans on each side of the river to accommodate the second steel plate girder span.

ADVANTAGES:
- The arch structure is an aesthetically pleasing bridge.
- Existing contract to construct Piers 7 and 8 should be able to proceed as-is.
- Steel plate girders on flanking spans can utilize weathering steel if desired.
- Current technology for tied arch bridge design includes special detailing of the lower tension tie so it will not be classified as a fracture critical element.
- Matches other newer long span bridges in the area (i.e. I-24 over Ohio and Tennessee River).
- No painting of steel plate girders.

DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 2462' of bridge.
- There is a significant cost premium associated with this alternate.
- Long span steel plate girders will be about 16' deep which is substantially deeper than the tied arch and prestressed concrete beams on both sides of the steel spans, thus creating a visual discontinuity when viewed from the side.
- Existing contract to construct Piers 6 and 9 may need to be modified in order to build more substantial piers and foundations.
- Steel for tied arch would be recommended as painted steel.

DISADVANTAGES (continued):

- Construction of a simple span tied arch bridge over the navigation channel will require either temporary bents located within the navigation channel to erect the superstructure from or the partially completed superstructure will be floated in on barges and lowered onto Pier 7 and Pier 8. Both of these options carry inherent risks to contractor and the river traffic. Using temporary bents within the navigation channel is the more common approach and is being used on the Blennerhasset Island (WV) tied arch bridge over the Ohio River that is currently under construction. This bridge requires temporary bents in the navigation channel that temporarily reduces the channel opening to 600' and required that the contractor obtain a permit from the Coast Guard for this provision. The significant difference between Blennerhasset Island and the US-60 bridge is that the Blennerhasset bridge is on a tangent section of river, whereas the US-60 bridge crosses the Tennessee River on a bend. Due to the bend in the river the Coast Guard may not allow a temporary narrowing of the navigation channel in which case the tied arch superstructure must then be partially assembled on barges and floated into position. Floating in the partial superstructure may require a substantial dredging of the river in the vicinity of Pier 8 along with the relocation of mussels. Obtaining the Coast Guard permit for temporary works is typically performed by the contractor as part of their means and methods of erection; however, if this option is pursued then it is recommended to work with the Coast Guard during the early stages of design development to create a permitable project from the standpoint of temporary works. This process could take from three to six months to develop a workable solution assuming there is a workable solution from the Coast Guard's perspective.

COST ESTIMATE:

$425/sf * 900’ * 73.5’ = $28.1M (900’ Arch Superstructure)

$200/sf * 875’ * 69.7’ = $12.2M (375’-500’ Steel Plate Girder Flanking Span Sub and Superstr)

$200/sf * 687’ * 69.7’ = $9.6M (400’-287’ Steel Plate Girder Flanking Span Sub and Superstr)

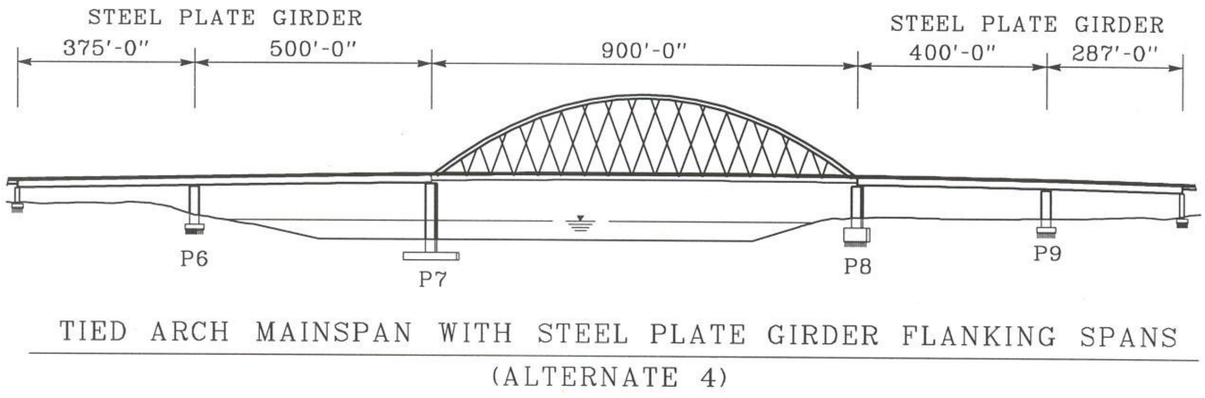
$-70/sf * 662’ * 69.7’ = $-3.2M (Deduct 375’+287’ of Precast Concrete Beam Superstructure)

= $28.4M (Existing Construction Contract for Piers 6 to 9)

TOTAL = $75.1M

VALUE ENGINEERING ALTERNATIVE # 4

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING ALTERNATIVE # 5

DESCRIPTIVE TITLE OF ALTERNATIVE:
Tied Arch Mainspan with Shorter Steel Plate Girder Flanking Spans

DESCRIPTION OF ALTERNATE:
Span the navigation channel with a steel tied arch structure with one arch rib on each side of the roadway. The sidespans of the existing truss design will be replaced with two-span continuous steel plate girder structures with span lengths of 250' on the west and 200' on the east. Providing a two-span structure for the flanking spans requires the addition of one land based pier between Piers 8 and 9, and one water based pier between Piers 6 and 7.

The existing design for Piers 6 to 9 under contract with C.J. Mahan should be acceptable and can continue construction without major modification.

ADVANTAGES:
- The tied arch structure is an aesthetically pleasing bridge.
- The shorter span lengths for the flanking spans allows for a shallower structural depth, which will match those of the tied arch span and the precast/prestressed concrete beam spans.
- Do not have to modify the existing contract for Piers 6 to 9.
- This is a very cost effective solution.

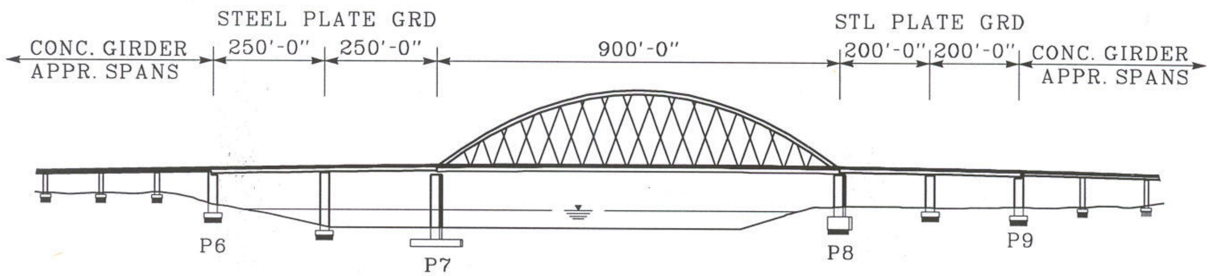
DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 1800' of bridge.
- Construction of the central tied arch span will require either temporary works within the navigation channel or to float in the completed structural system, both of which carry significant risks.
- Requires an additional pier in the water that will be both expensive and subject to impact from barges. The cost of this pier is also difficult to estimate without performing the analysis.
- Steel for tied arch span would need to be painted.

COST ESTIMATE:

$425/sf * 900' * 73.5'	= $28.1M (900' Tied Arch Superstructure)
$70/sf * 500' * 69.7'	= $2.4M (250'-250' Steel Plate Girder Superstructure)
$70/sf * 400' * 69.7'	= $2.0M (200'-200' Steel Plate Girder Superstructure)
$30/sf * 200' * 69.7'	= $0.4M (Added substructure unit on land)
	= $8.0M (Added substructure unit in river)
	= $28.4M (Existing Construction Contract for Piers 6 to 9)
TOTAL	= $69.3M

VALUE ENGINEERING ALTERNATIVE # 5

SKETCH OF RECOMMENDED DESIGN



TIED ARCH MAINSPAN WITH SHORTER STEEL PLATE GIRDER FLANKING SPANS
(ALTERNATE 9)

VALUE ENGINEERING ALTERNATIVE # 6

DESCRIPTIVE TITLE OF ALTERNATIVE:
Tied Arch Mainspan with Shorter Precast Concrete Girder Flanking Spans

DESCRIPTION OF ALTERNATE:
This alternative is the same as Alternate 9 with the exception that the steel plate girder flanking spans are replaced with post-tensioned segmented concrete I-girders and represents only a minor adjustment to Alternate 9.

ADVANTAGES:

- The tied arch structure is an aesthetically pleasing bridge.
- The shorter span lengths for the flanking spans allows for a shallower structural depth, which will match those of the tied arch span and the precast/prestressed concrete beam approach spans.
- Do not have to modify the existing contract for Piers 6 to 9.
- This is a very cost effective solution.

DISADVANTAGES:

- Requires significant time and effort for a complete redesign of 1800’ of bridge.
- Construction of the central tied arch span will require either temporary works within the navigation channel or to float in the completed structural system, both of which carry risks.
- Requires an additional pier in the water that will be both expensive and subject to impact from barges. The cost of this pier is also difficult to estimate without performing the analysis.

COST ESTIMATE:

$425/sf * 900’ * 73.5’ = $28.1M (900’ Tied Arch Superstructure)

$55/sf * 500’ * 69.7’ = $2.0M (250’-250’ Precast Segmented Concrete Girder Superstructure)

$55/sf * 400’ * 69.7’ = $1.5M (200’-200’ Precast Segmented Concrete Girder Superstructure)

$30/sf * 200’ * 69.7’ = $0.4M (Added substructure unit on land)
= $8.0M (Added substructure unit in river)
= $28.4M (Existing Construction Contract for Piers 6 to 9)

TOTAL = $68.4M

VALUE ENGINEERING ALTERNATIVE # 6

ARTISTIC RENDERING OF RECOMMENDED DESIGN

VALUE ENGINEERING ALTERNATIVE # 7

DESCRIPTIVE TITLE OF ALTERNATIVE:
Support Elements Along Centerline of Bridge

DESCRIPTION OF ALTERNATE:
This alternate is the same as Alternate 9 with the exception that three planes of arch ribs would be provided, one along each outside edge of the roadway plus one additional rib down the centerline of the bridge. To accommodate this median arch rib the roadways would need to be separated by about 5' and an additional concrete barrier would be added.

By increasing the width of the superstructure by about 6', this would require substantial modifications to the existing pier designs, which would modify C.J. Mahan's existing construction contract.

ADVANTAGES:

- By adding a third structural arch rib down the middle the transverse floorbeams supporting the roadway will be substantially decreased in size since they are only spanning half the distance.

DISADVANTAGES:

- The addition of the third rib adds substantial complication to the structural system by creating a statically indeterminate system in the transverse direction.
- Adds cost to the overall system.
- Requires modification to the existing construction contract.

COST ESTIMATE:

$425/sf * 900' * 79.5'	=	$32.2M	(900' Tied Arch Superstructure)
	=	$4.4M	(Steel Plate Girder Span Superstructure)
	=	$0.4M	(Added substructure unit on land)
	=	$8.0M	(Added substructure unit in river)
	=	$2.0M	(Funds to modify C.J. Mahan construction contract)
	=	$28.4M	(Existing Construction Contract for Piers 6 to 9)
TOTAL	=	$75.4M	

VALUE ENGINEERING ALTERNATIVE # 7

SKETCH OF RECOMMENDED DESIGN

VALUE ENGINEERING ALTERNATIVE # 8

DESCRIPTIVE TITLE OF ALTERNATIVE:
Three Tied Arch Spans

DESCRIPTION OF ALTERNATE:
Three independent simple span tied arch structures are used to span the navigation channel plus the flanking span on each side of the channel. Each arch span will have one arch rib on each side of the roadway. Consideration should be given to using a diagonal hanger system to reduce flexural demands on the arch rib and increase the stiffness of the system.

The existing design for Piers 7 and 8 under contract with C.J. Mahan should be acceptable and can continue construction. However, Piers 6 and 9 will need to be evaluated for adequacies considering the new structure type being supported and will probably require a re-design and modification to the existing construction contract. The estimated cost for this alternate includes money for increasing the size of the foundations; however, the potential dollar value that may be incurred due to modifying the C.J. Mahan contract (time delays, in-house engineering, re-mobilization, etc.) has not been included.

ADVANTAGES:
- The arches create a very aesthetically pleasing site.
- Existing contract to construct Piers 7 and 8 should be able to proceed as-is.
- Current technology for tied arch bridge design includes special detailing of the lower tension tie so it will not be classified as a fracture critical element.

DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 1800' of bridge.
- There is a significant cost premium associated with this alternate.
- Existing contract to construct Piers 6 and 9 will probably need to be modified in order to build more substantial piers and foundations.
- Steel for tied arch would be recommended as painted steel.
- Construction of the central tied arch span will require either temporary works within the navigation channel or to float in the completed structural system, both of which carry risks.

COST ESTIMATE:

$425/sf * 900' * 73.5' = $28.1M (900' Arch Superstructure)

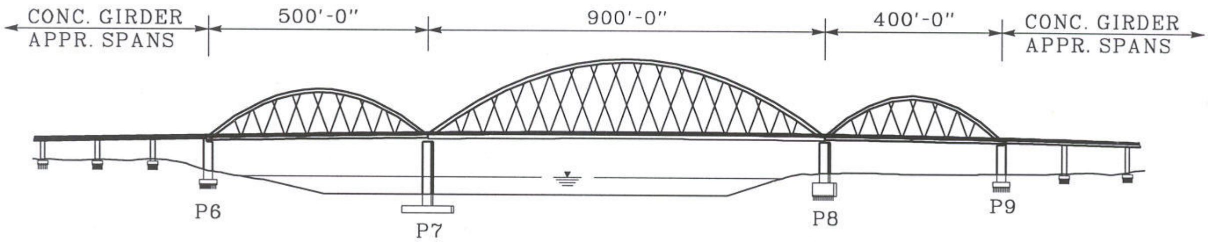
$300/sf * 500' * 73.5' = $11.0M (500' Arch Superstructure)

$300/sf * 400' * 73.5' = $8.8M (400' Arch Superstructure)
= $0.3M (Increase capacity of Pier 6 and 9)
= $28.4M (Existing Construction Contract for Piers 6 to 9)

TOTAL = $76.6M

VALUE ENGINEERING ALTERNATIVE # 8

SKETCH OF RECOMMENDED DESIGN



THREE TIED ARCH SPANS

(ALTERNATE 6)

VALUE ENGINEERING ALTERNATIVE # 9

DESCRIPTIVE TITLE OF ALTERNATIVE:
Two Tied Arches with Precast Concrete Girder Approach Spans

DESCRIPTION OF ALTERNATE:
This alternate consists of two independent tied arch spans with lengths of 500' and 900'. The 500' tied arch span allows for the use of the piers associated with the existing construction contract while keeping additional piers out of the river. Precast/Prestressed concrete girder spans will be used as approaches on both sides of the tied arch spans. In the cost estimate, 400' of concrete girder spans was included so a direct comparison can be made between the various alternates.

The existing design for Piers 7 and 8 should be adequate to support the revised structural system; however, Pier 6 will more than likely require additional strengthening. Pier 9 will no longer be necessary and would be removed from the existing construction contract.

Leading up to Pier 6 will utilize 6 spans of concrete beams at 125'-0", while the after Pier 8 there will be 11 spans of concrete beams at 140'-9".

ADVANTAGES:
- Existing contract to construct Piers 7 and 8 should be able to proceed as-is.
- Current technology for tied arch bridge design includes special detailing of the lower tension tie so it will not be classified as a fracture critical element.
- Relatively cost effective alternative.
- Does not place any additional piers in the river.

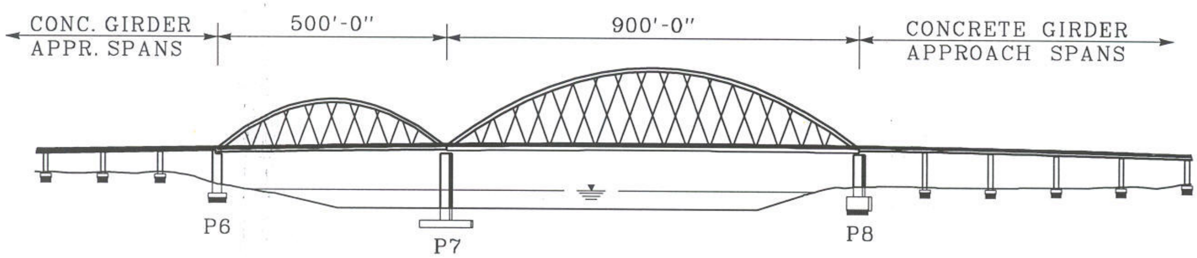
DISADVANTAGES:
- Requires significant time and effort for a complete redesign of twin arches.
- Existing contract to construct Piers 6 will need minor modification and Pier 9 will need to be removed from the contract.
- Steel for tied arch would be recommended as painted steel.
- Construction of the central tied arch span will require either temporary works within the navigation channel or to float in the completed structural system, both of which carry risks.

COST ESTIMATE:

$425/sf * 900' * 73.5' = $28.1M (900' Arch Superstructure)
$300/sf * 500' * 73.5' = $11.0M (500' Arch Superstructure)
$100/sf * 400' * 69.7' = $2.8M (400' of precast concrete beam sub and superstructure)
= -$2.0M (Remove Pier 9, Modify Pier 6, Buyout partial Mahan contract)
= $28.4M (Existing Construction Contract for Piers 6 to 9)
TOTAL = $68.3M

VALUE ENGINEERING ALTERNATIVE # 9

SKETCH OF RECOMMENDED DESIGN



TWO TIED ARCHES WITH PRECAST CONCRETE GIRDER APPROACH SPANS
(ALTERNATE 38)

VALUE ENGINEERING ALTERNATIVE # 9

ARTISTIC RENDERING OF RECOMMENDED DESIGN

VALUE ENGINEERING ALTERNATIVE # 10

DESCRIPTIVE TITLE OF ALTERNATIVE:
Deck Truss

DESCRIPTION OF ALTERNATE:
This alternate would consist of a traditional variable depth below deck truss with a 900' mainspan length. Since the supporting structural system is placed completely below deck the profile will need to be raised by approximately 43' to maintain required clearances within the navigation channel. Raising the profile impacts the substructures for all the approach spans plus the quantity of fill beyond the limits of the bridge. The additional fill required beyond the bridge limits also will require a power line to be raised, ROW to be purchased and additional wetland mitigations. Costs associated with these impacts have been included in cost estimate. With the raising of the profile over the mainspan unit the capacity of the foundations for Piers 6 to 9 will probably be deemed inadequate and will need to be modified to account for the additional design loads. Modifying the foundations will necessitate the modification of the C.J. Mahan contract to construct these piers, the cost of which has been incorporated into the estimate.

ADVANTAGES:
- Deck truss structures can make for relatively pleasing bridges.
- Construction of the mainspan can be performed without the need for temporary works within the navigation channel.
- Structural steel can be unpainted weathering steel since all steel is below deck.
- Relatively cost–effective system.
- Existing construction contract for Piers 7 and 8 will probably not need to be modified. For this alternate the concrete deck is place higher above the water and therefore, the impact to the seismic evaluation to the Pier 7 and 8 foundation needs to be confirmed.

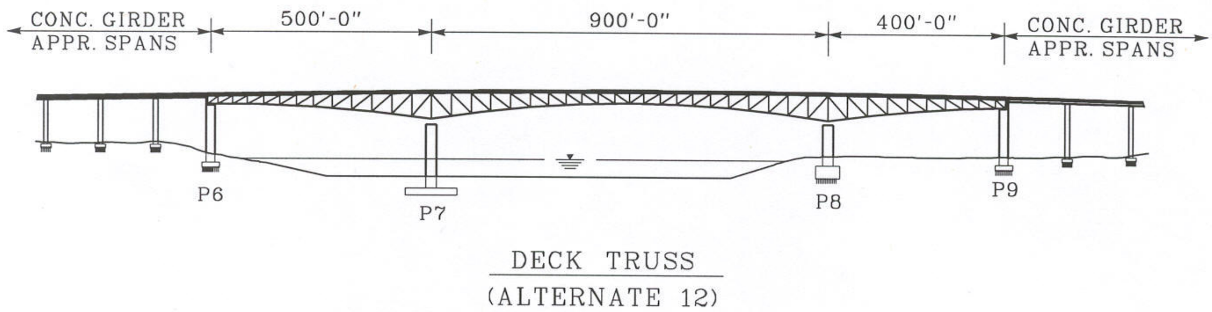
DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 1800' of bridge.
- Existing construction contract for Piers 6 and 9 need to be terminated.
- Raising the profile makes significant impacts to a substantial length of the project.
- Roadway grades on the approach to the river, although within code limits, are increased to 4%, which creates concerns with snow and ice.
- Requires additional right-of-way and utility relocation.
- Borrow material for fills must be identified.

COST ESTIMATE:

$275/sf *1800'* 69.7'	=	$34.5M	(1800' Deck Truss Superstructure)
$15/sf *1898'* 69.7'	=	$2.0M	(Increase substructure cost for concrete beam pp spans)
	=	$0.5M	(Raise power line)
	=	$1.0M	(Increased fill for raising profile)
	=	$0.5M	(Additional ROW and wetland mitigation)
100psf *1800*69.7*$0.15/lbs	=	$-1.9M	(Deduct for not painting the steel)
	=	$3.0M	(Modify/Strengthen Piers 6 to 9)
	=	$28.4M	(Existing Construction Contract for Piers 6 to 9)
TOTAL	=	$68.0M	

VALUE ENGINEERING ALTERNATIVE # 10

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING ALTERNATIVE # 10

ARTISTIC RENDERING OF RECOMMENDED DESIGN

VALUE ENGINEERING ALTERNATIVE # 11

DESCRIPTIVE TITLE OF ALTERNATIVE:
Extradosed Steel Girder Bridge

DESCRIPTION OF ALTERNATE:
An extradosed bridge is a hybrid between a cable-stayed bridge and a true girder bridge. For a true cable-stayed bridge the superstructure is extremely thin and flexible and requires the stay-cables to provide nearly 100% of the support. On the other hand, a girder bridge has a deep and stiff superstructure that can span between piers without the aid of stay-cables. An extradosed bridge is somewhere in between the cable-stayed and girder bridge, using a girder that is shallower than a girder bridge but deeper than a cable-stayed bridge, therefore small cables are needed to assist in the superstructure support. Typically, the towers are relatively short compared to a cable-stayed structure and the cables are only provided along a portion of the span.

This alternate calls for a three span extradosed steel girder bridge with a plane of cables along each edge of the roadway. The foundations and piers associated with this alternate are not consistent with the piers under the existing construction contract; therefore the contract with C.J. Mahan would need to be terminated.

ADVANTAGES:
- The extradosed structure will create an aesthetically pleasing signature bridge.
- Construction of the mainspan can be performed without the need for temporary works within the navigation channel.
- The 900’ span length is within the practical span lengths for an extradosed bridge. The superstructure can be either concrete or steel.
- Bridge can be designed so deck is replaceable.

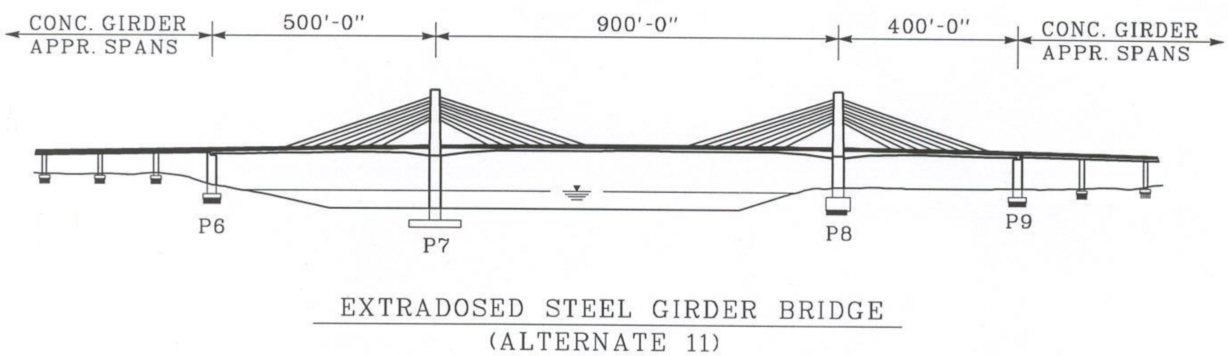
DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 1800’ of bridge.
- Existing construction contract for Piers 6 to 9 needs to be terminated.
- Extremely limited experience with this bridge type in United States for both design and construction.
- Cost estimating with minimal historical data points is of limited accuracy.
- Not a cost effective solution.

COST ESTIMATE:

$450/sf *1800’* 78.0’	= $63.2M	(900’ Mainspan Extradosed Sub and Superstructure)
	= $-20.4M	(Remaining Funds after buyout of Mahan Contract)
	= $28.4M	(Existing Construction Contract for Piers 6 to 9)
TOTAL	= $71.2M	

VALUE ENGINEERING ALTERNATIVE # 11

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING ALTERNATIVE # 12

DESCRIPTIVE TITLE OF ALTERNATIVE:
Cable-Stayed Bridge with 900-ft Span

DESCRIPTION OF ALTERNATE:
This alternate consists of a traditional 3-span symmetrical cable-stayed bridge with two planes of cables, one along each roadway edge. This alternate would require that the existing construction contract for Piers 6 to 9 be terminated and the piers/foundations be redesigned to accommodate a cable-stayed bridge.

The estimated cost for this alternate includes the price for building the entire substructure and superstructure for the three span cable-stayed bridge plus a substantial dollar cost for canceling the C.J. Mahan contract.

ADVANTAGES:
- The cable-stay structure is an aesthetically pleasing and signature bridge.
- The mainspan structure can be built without temporary works interfering with the navigation channel.

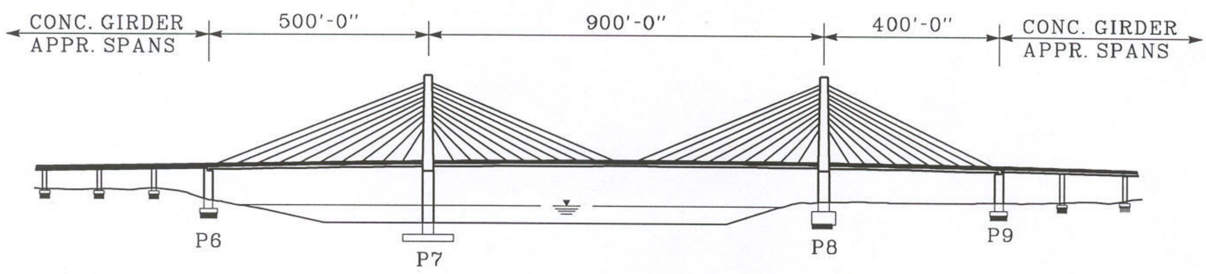
DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 1800' of bridge. Slows progress of project by 18 months.
- There is a significant cost premium associated with this alternate.
- Existing contract to build Piers 6 to 9 would need to be terminated and significant expenses incurred due to this termination.
- Foundations for the cable-stayed towers will be larger than the currently proposed foundations for Piers 7 and 8.
- Deck is not replaceable.
- Political implications.

COST ESTIMATE:

$500/sf *1800'* 78.0'	= $70.2M (900' Mainspan Cable Stayed Sub and Superstructure)
	= $-20.4M (Remaining Funds after buyout of C.J. Mahan Contract)
	= $28.4M (Existing Construction Contract for Piers 6 to 9)
TOTAL	= $78.2M

VALUE ENGINEERING ALTERNATIVE # 12

SKETCH OF RECOMMENDED DESIGN



CABLE-STAYED BRIDGE WITH 900-FT SPAN
(ALTERNATE 7)

VALUE ENGINEERING ALTERNATIVE # 13

DESCRIPTIVE TITLE OF ALTERNATIVE:
Cable-Stayed Bridge with 1,200-ft Span

DESCRIPTION OF ALTERNATE:
This alternate consists of a traditional 3-span symmetrical cable-stayed bridge that spans the entire river with two planes of cables, one along each roadway edge. The main towers would be placed near each bank at normal pool, eliminating all piers from the river. This alternate would require that the existing construction contract for Piers 6 to 9 be terminated.

The estimated cost for this alternate includes the price for building the entire substructure and superstructure for the three span cable-stayed bridge plus a substantial dollar cost for canceling the C.J. Mahan contract.

ADVANTAGES:

- The cable-stay structure is an aesthetically pleasing signature bridge.
- The mainspan structure can be built without temporary works interfering with the navigation channel.
- All piers are out of the river at normal pool, therefore the risk of barge impact is greatly reduced.
- Steel does not require paint and can be left as weathering steel.

DISADVANTAGES:

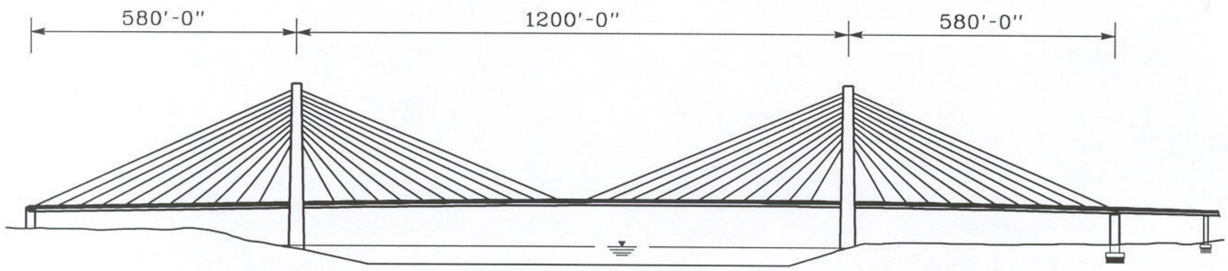
- Requires significant time and effort for a complete redesign of major cable-stayed bridge.
- There is a significant cost premium associated with this alternate.
- Existing contract to build Piers 6 to 9 would need to be terminated and significant expenses incurred due to this termination.
- Deck is not replaceable.
- Political implications.

COST ESTIMATE:

$550/sf *2360'* 78.0' =$101.2M (1200' Cable-Stayed Substructure and Superstructure)
$100/sf * 560' * 69.7' = $-3.9M (Deduct 500' of concrete beam approach sub and superstr)
= $-20.4M (Remaining Funds after buyout of C.J. Mahan Contract)
= $28.4M (Existing Construction Contract for Piers 6 to 9)
TOTAL = $105.3M

VALUE ENGINEERING ALTERNATIVE # 13

SKETCH OF RECOMMENDED DESIGN



CABLE-STAYED BRIDGE WITH 1200-FT SPAN
(ALTERNATE 37)

VALUE ENGINEERING ALTERNATIVE # 14

DESCRIPTIVE TITLE OF ALTERNATIVE:
Tied Arch Mainspan with Steel Box Girder Flanking Spans

DESCRIPTION OF ALTERNATE:
This alternate is the same as Alternate 4 with the exception that the steel plate girders will be replaced with steel box girders in an effort to improve the aesthetics. This is probably not a reasonable alternative because the size and weight of the steel box beam field sections will make delivery and installation very challenging. In general, steel box girder bridges are more expensive than an equivalent steel plate girder bridge for straight alignments.

Conclusion is that the additional aesthetic value offered by the closed steel box girder relative to the plate girder alternative is not worth the cost increase and construction complexity. Cost estimating was not performed on this alternate.

ADVANTAGES:
- The arch structure is an aesthetically pleasing bridge.
- Existing contract to construct Piers 7 and 8 should be able to proceed as-is.
- Steel box girders on flanking spans can utilize weathering steel if desired.
- Current technology for tied arch bridge design includes special detailing of the lower tension tie so it will not be classified as a fracture critical element.

DISADVANTAGES:
- Requires significant time and effort for a complete redesign of 2462' of bridge.
- There is a significant cost premium associated with this alternate.
- Long span steel box girders will be about 16' deep which is substantially deeper than the tied arch and prestressed concrete beams on both sides of the steel spans, thus creating a visual discontinuity when viewed from the side.
- Existing contract to construct Piers 6 and 9 may need to be modified in order to build more substantial piers and foundations.
- Steel for tied arch would be recommended as painted steel.
- Construction of tied arch span will require either temporary works within the navigation channel or to float in the completed structural system, both of which carry risks.
- Delivery and installation of the large box girder field sections will add complication.

COST ESTIMATE:

Not calculated due to significant disadvantages.

SECTION 5 - VE DESIGN COMMENTS

Design Comments are ideas that in the opinion of the team were good ideas, but for any number of reasons were not selected for development as VE recommendations. Design Comments can be notes to the owner or designer, a documentation of various thoughts that come up during the course of the study, a reference to possible problems, suggested items that might need further study, or questions that the owner and designer might want to explore. Some comments might relate to things of which the owner or designer is already aware. Because the study is done on a design in progress and as an independent team, the VE team may not be aware of everything intended by the owner and designer. The following comments are presented with the intent that there might be a few comments that aid the design team in some way.

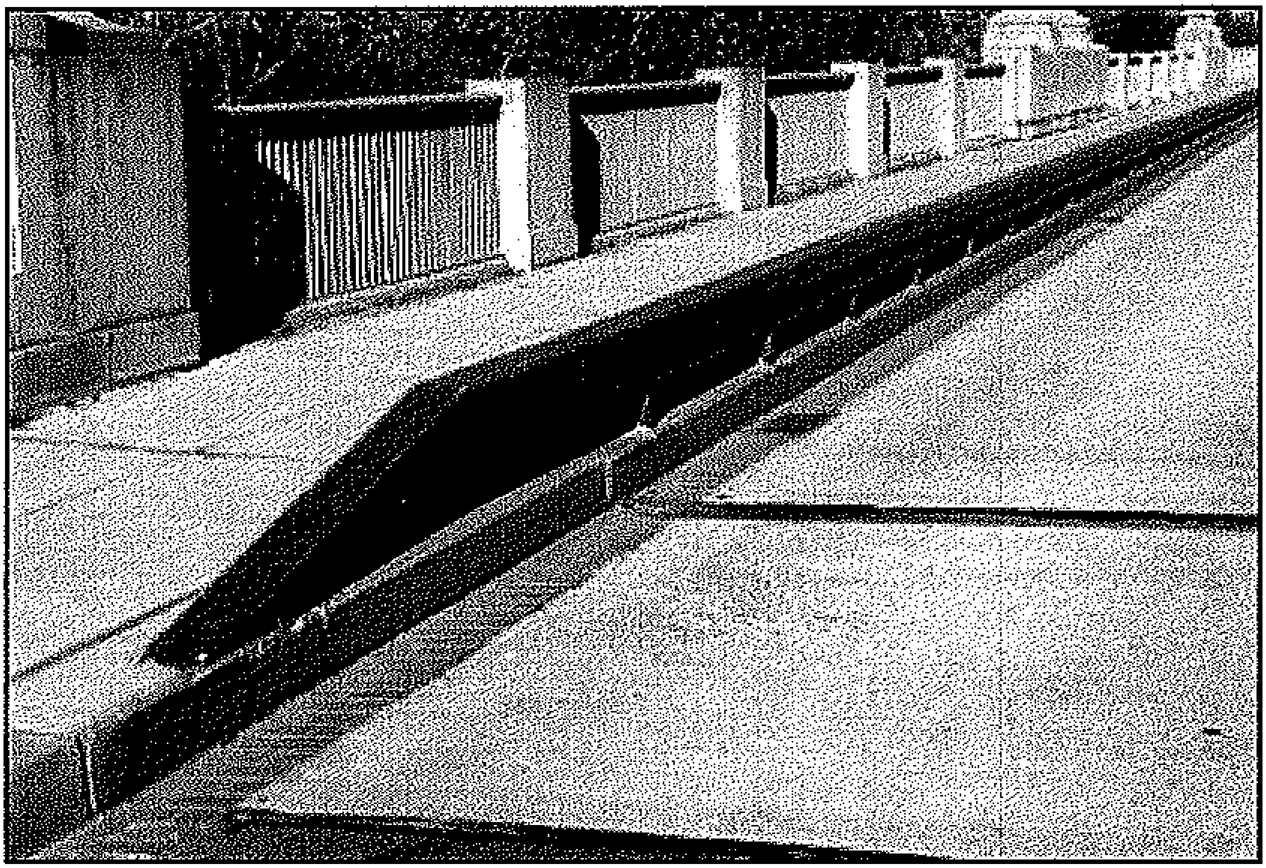
VALUE ENGINEERING DESIGN COMMENT # 1

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Use tube rail in lieu of jersey barriers for sides and center medians.

COMMENTARY:
The present design proposes using Jersey barriers for sides and center medians. Utilizing tube rail would provide more daylight and counter the box effect of the current truss design. A rail would also provide a better scenic view of the river and its surroundings. Given the reduced shoulder width of 4 feet as designed; this would give the appearance of a wider bridge. Sketches of several railing types are attached.

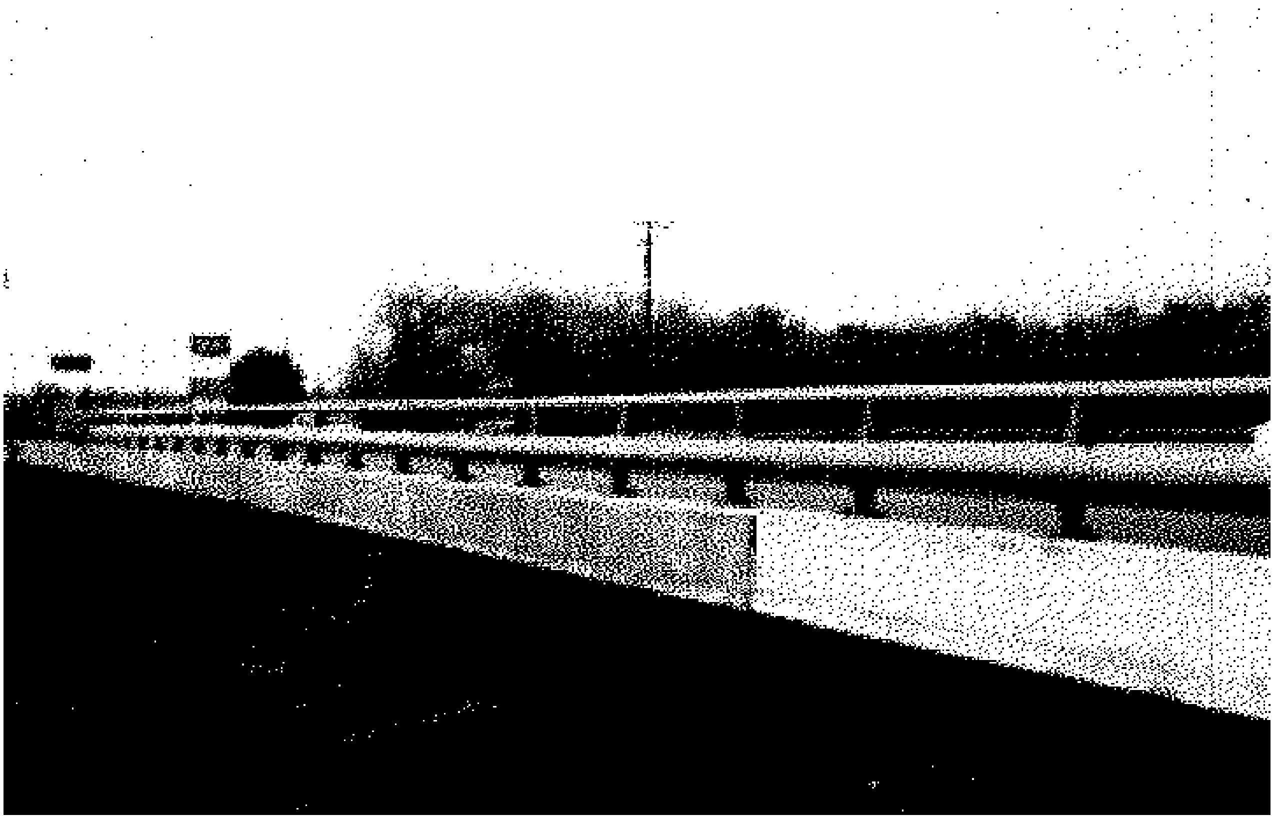
VALUE ENGINEERING DESIGN COMMENT # 1

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING DESIGN COMMENT # 1

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING DESIGN COMMENT # 2

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Utilize an alternative barrier design with a rail on top of a concrete barrier to provide better aesthetics and a better scenic view.

COMMENTARY:
Utilize an alternative barrier design with a rail on top of a concrete barrier to provide better aesthetics and a better scenic view.

VALUE ENGINEERING DESIGN COMMENT # 2

SKETCH OF RECOMMENDED DESIGN

VALUE ENGINEERING DESIGN COMMENT # 3

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Increase the 5' width bike lane to a more user-friendly width.

COMMENTARY:
The current bridge design includes a 5-foot bikeway. The proposed 5-foot painted non-vehicular non-separated lane is perceived as a minimal width for the anticipated pedestrian bike use on the bridge. This bridge connects two populations. A 5-foot wide painted bike lane for an 1800-foot bridge is very narrow. Considerations could be given to widening the bike lane.

VALUE ENGINEERING DESIGN COMMENT # 4

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Add aesthetic lighting on the bridge structure.

COMMENTARY:
Kentucky Transportation Cabinet has previously committed to lighting the proposed structure. An appropriate lighting plan could enhance nighttime aesthetics of the bridge.

VALUE ENGINEERING DESIGN COMMENT # 5

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Add a theme lighting plan on the approaches of the structure.

COMMENTARY:
The approach span lighting theme should be coordinated with the main span lighting to achieve an overall aesthetic appearance. A gradual illumination transition would be desirable as the driver enters and exits the structure.

VALUE ENGINEERING DESIGN COMMENT # 6

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Use colored concrete for the bridge deck construction.

COMMENTARY:
Colored concrete could be used to help mitigate the stains that are a result of the use of weathering steel.

VALUE ENGINEERING DESIGN COMMENT # 7

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Have public involvement meetings to select paint color, an aesthetic lighting plan, and provide public with correct and updated information.

COMMENTARY:
A public involvement process could facilitate positive public perception of the project as a whole. Public participation in paint color selection and comments on the proposed aesthetic lighting plan could help promote community ownership of the final bridge design.

VALUE ENGINEERING DESIGN COMMENT # 8

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Decorate and enhance the portal appearance to minimize the tunnel effect of the proposed design.

COMMENTARY:
A portal façade could be utilized to minimize the tunnel effect of the proposed design. It could also be used to provide a gateway theme to the communities on each end of the structure.

VALUE ENGINEERING DESIGN COMMENT # 9

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Design at least one more superstructure and send multiple designs out for bidding.

COMMENTARY:
The original design calls for only one design to be bid and awarded for construction. The VE Team recommends designing at least one more superstructure and sending multiple designs out for bidding. This allows the owner, KYTC, options on weighing cost and alternate bridge types. This could somewhat limit some options throughout the design/build process, and it will require another complete bridge design. The owner can gather more information about the cost of different bridge types instead of using standard hard bidding. This will require more design work up front, but the end result will likely be a better bridge for a reduced cost.

VALUE ENGINEERING DESIGN COMMENT # 10

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Make the superstructure a design/build project in lieu of a design/bid/build project.

COMMENTARY:
The original plan for awarding of the superstructure contract was to use a conventional design/competitive bid procurement process. The VE Team proposes that a design/build contract be utilized for the superstructure. This will allow more options to be considered for the superstructure, which can improve the value of the project from a cost and aesthetic approach. A design/build contract could save considerable time over a conventional design/bid/build contract. Depending on the alternative selected, the existing construction contract could be negatively impacted (i.e. partial buyout or modification to substructure design). Design/Build procurement creates a favorable consideration for the superstructure to optimize cost while not sacrificing aesthetics for several different bridge types. If one or several of the alternatives were desired, a design/build contract would definitely be a recommended procurement method.

APPENDICES

The appendices in this report contain backup information supporting the body of the report, and the mechanics of the workshop. The following appendices are included.

CONTENTS

APPENDIX A
Participants

APPENDIX A - Participants

Workshop Attendance										
Attendees				**Participation**						
				Meetings		**Study Sessions**				
Name	Organization and Address (Organization first, with complete address underneath)	Tel # and FAX. (Tel first with FAX underneath)	Role in wk shop	In Brief 5/08	Out Brief 5/23	Day 1 5/08	Day 2 5/09	Day 3 5/10	Day 4 5/11	Day 5 5/12
Ken True	URS	(402) 516 2635	VE Team Leader	X		X	X	X	X	X
Dave Jeakle	URS	(813) 636-2467	VE Team Bridge Engineer	X	X	X	X	X	X	X
Greg Sanders	URS	(913) 344-1105	VE Technical Recorder	X		X	X	X	X	X
Danny Jasper	KYTC	(502) 564-3280	VE Team Member	X	X	X	X			
Allan Frank	KYTC	(502) 564-4560	Bridge Engineer	X		X				
John Bargo	FHWA	(502) 223-6763	Bridge Engineer	X	X	X	X	X		
Robert Semones	KYTC	(502) 564-3280	VE Coordinator	X	X	X				
Dexter Newman	KYTC	(502) 564-4555	VE Coordinator	X	X	X	X	X	X	X
David Davis	KYTC D-1	(270) 898-2431		X		X				
Allen W. Thomas	KYTC D-1	(270) 898-2431		X		X	X			
Chris Kuntz	KYTC D-1	(270) 898-2431		X	X	X				
Mike McGregor	KYTC D-1	(270) 898-2431		X		X				
Tim Choate	KYTC D-1	(270) 898-2431	Pre-Construction Project Manager	X	X	X	X	X	X	X
Siamak Shafaghi	KYTC-Program Perf.	(502) 564-4555			X					
Frank Bush, Jr.	KYTC-Design				X					
Kyle Poat	KYTC-D1	(270) 444-0087	Resident Engineer		X					
Steve Criswell	KYTC-Construction	(502) 564-4780			X					
Darrin Beckett	KYTC-Geotech	(502) 564-2374			X					
Marcie Mathews	KYTC 0 SHE Office	(502) 564-3730	SHE		X					

Workshop Attendance										
Attendees				Participation						
				Meetings		Study Sessions				
Name	Organization and Address (Organization first, with complete address underneath)	Tel # and FAX. (Tel first with FAX underneath)	Role in wk shop	In Brief 5/08	Out Brief 5/23	Day 1 5/08	Day 2 5/09	Day 3 5/10	Day 4 5/11	Day 5 5/12
Kyle Schafersman	URS	(913) 344-1019	VE Technical Recorder							
David Kratt	KYTC-Highway Design	(502) 564-3280			X					
Ray Polly	DSHE	(202) 564-3730	Project Development		X					
Jim Rummage	DSHE	(202) 564-3730	Project Delivery		X					
Jim Wathen	KYTC-Director	(502) 564-4555			X					

APPENDIX B
KYTC Cost Estimate

APPENDIX B – KYTC Cost Estimate

Assume truss steel at 1.80 (KY-90 went for 1.50)

$$\text{TrussSS} := \underbrace{(\overset{\text{Truss}}{13614.0\text{kips}} + \overset{\text{Stringer}}{1795.4\text{kips}})}_{15{,}409{,}000\ \text{lbs}} \cdot \frac{\$1800}{\text{kips}} \qquad \text{TrussSS} = \$27{,}736{,}920$$

From KY-90 Deck

$$\text{rebar\_ratio2} := \frac{572105\text{kg}}{3407.2\text{m}^3} \qquad \text{rebar\_ratio2} = 283.0225\,\frac{\text{lb}}{\text{yd}^3}$$

$$\text{TrussAA} := (13148.6\cdot\text{kips} + 2750.6\cdot\text{kips} + 1800.4\cdot\text{kips})\cdot\frac{\text{yd}^3}{4.05\cdot\text{kips}}\cdot\left(\frac{450}{\text{yd}^3} + \text{rebar\_ratio}\cdot\frac{1.00}{\text{lb}}\right)$$

$$\text{TrussAA} = 2333956.0834$$

$$\text{MainSpans} := \text{PierAcost} + \text{PierBcost} + \text{PierCcost} + \text{PierDcost} + \text{TrussSS} + \text{TrussAA}$$

$$\text{TrussSS} + \text{TrussAA} = 30070876.0834$$

$$\text{MainSpans} = 49516568.1039$$

Estimate for main spans

$$\frac{\text{MainSpans}}{(\text{rwidth} + 2\cdot\text{BW})\cdot 1600\text{ft}} = 444.2276\,\frac{1}{\text{ft}^2}$$

$$\text{EstimatedCost} := (\text{WA} + \text{MainSpans} + \text{EA})\cdot 1.065 \qquad \text{EstimatedCost} = 65355714.5307$$

$$(\text{PierBcost} + \text{PierCcost})\cdot 1.065 = 15329283.9522$$

$$(\text{PierAcost} + \text{PierBcost} + \text{PierCcost} + \text{PierDcost})\cdot 1.065 = 20{,}709{,}662.0018$$

APPENDIX C
Steel Weight Summary

APPENDIX C – Steel Weight Summary

STEEL WEIGHT FOR 1 TRUSS LINE

Grade 36 Steel	487867.2030 Lb
Grade 50 Steel	3260395.0795 Lb
Grade 70W Steel	393815.9248 Lb
Total for 1 Truss Line	4142078.2073 Lb

STEEL WEIGHT FOR 2 TRUSS LINES

Grade 36 Steel	975734.4061 Lb
Grade 50 Steel	6520790.1590 Lb
Grade 70W Steel	787631.8496 Lb
Total for 2 Truss Lines	8284156.4147 Lb

APPENDIX D
VE Study Cost Estimating Background and Development

APPENDIX D – VE Study Cost Estimating Background and Development

1. OVERVIEW

The objective of this Value Engineering study is to evaluate numerous bridge options for crossing the Tennessee River as alternatives to the currently proposed design. In order to draw meaningful conclusions from the cost estimates of the various alternate it is of utmost importance to make all comparisons on an equal basis.

For this study it was decided to use historical unit prices for various bridge types and span lengths from around the country as a basis for evaluating the relative probable cost for each alternative, as opposed to estimating quantities of steel and concrete and applying material prices to estimate cost. The first task was to compile a database of historical costs for relevant bridge types and span lengths from around the country. Since the costs from these projects are potentially from different geographical locations and of different ages, the data must be manipulated to so it is relevant to the current day (2006) and western Kentucky region. Table 1 contains cost data for numerous long span bridge projects from around the country, with a majority of the data being cable-stayed bridges. The resulting unit prices for each bridge project are then brought forward to the year 2006 using ENR Construction Cost Indexes and also transferred to the western Kentucky region using RS Means Geographic Indexes. As everyone is aware, using historical unit price data requires good engineering judgment realizing that extracting costs out of bid tabs can be misleading and also realizing that each and every project represents a unique situation when it comes to long span bridges and these special situations can have potentially large impacts on the resulting cost. The data presented in Table 1 is also graphed in Figure 1 which depicts the general trend of increasing unit cost as the span length increases. What is not explicitly evident in this figure is the story behind or unique situation associated with each of these data points that may have substantially affected the project's final cost.

With that being said the use of the manipulated historical data presented in Figure 1 represents the most appropriate information available for making relative cost comparisons between numerous long-span bridge concepts within a reasonable time frame. The important aspect of this exercise is that all concepts are evaluated on a consistent basis. This means that the relative cost comparison between various alternates should be sufficiently accurate; however, this method may not be as accurate in determining the absolute cost for any given concept.

In the Cost Estimate section for each bridge alternative the total cost indicated is an estimate for constructing the foundations, columns and superstructure for an 1,800-foot long section of bridge. This cost also includes the $28.4 million contract that has already been awarded to C.J. Mahan to construct the foundations and columns for Piers 6, 7, 8 and 9. Additionally, if a particular bridge alternate cannot utilize the foundations and columns for Piers 6 to 9, then this construction contract will need to be bought out and the cost associated with this buyout has been estimated and included with the cost estimate.

The following sections detail the development of estimated unit prices for each structure type and span lengths.

TABLE 1

Structure[1]	Location	Date Bid	Bid Price (million)	Main Span Length (ft)	Total Length (ft)	Deck Width (ft)	Deck Area (ft^2)	ENR Index	RS Means Geographic Index	Raw Unit Cost (ft^2)	Time Adjusted Cost (ft^2)	Time + Loc. Adjusted Cost (ft^2)
17th Street[4]	Atlanta, Ga.	2001	$ 18.0	336	830	137.0	113,710	6390	88.4	$158	$191	$195
Lake Cumberland[8]	Pulaski Co, Ky	2002	$ 49.2	786	1572	85.7	134,668	6538	95.5	$365	$430	$408
Blennerhassett Is[7]	Parkersburg, WV	2005	$ 50.0	878	878	107.0	93,946	7500	93.6	$532	$546	$529
Foss Waterway	Tacoma, Wa.	1994	$ 17.0	350	-	-	102,531	5408	103.4	$166	$236	$207
Lower Buffalo[5]	West Virginia	1997	$ 18.0	525	1850	38.7	71,595	5765	94.0	$251	$335	$324
James River	Richmond, Va.	1988	$ 11.8	630	1230	128.0	157,440	4519	85.1	$75	$128	$136
Acosta[2]	Jacksonville, Fl.	1989	-	630	-	-	-	4615	84.1	$183	$305	$329
Burlington	Burlington, Iowa	1990	$ 28.8	660	1245	84.3	104,991	4732	79.0	$274	$446	$512
Charles River	Boston, MA	1997	$ 87.0	745	1407	185.0	260,162	5826	116.7	$334	$441	$343
C&D Canal	Delaware	1991	$ 24.6	750	1650	127.3	209,963	4835	98.4	$117	$186	$172
Clark Bridge	Alton, Ill.	1991	$ 34.9	756	1360	108.0	146,880	4835	100.1	$238	$378	$342
Cochrane	Mobile, Al.	1985	$ 32.0	800	1600	82.0	131,200	4228	83.4	$244	$444	$482
Weirton-Steubenville	Steubenville, Oh.	1988	$ 30.0	820	1965	92.0	180,780	4732	94.4	$166	$270	$259
Taylor Southgate[3]	Cincinnati, Oh.	1991	$ 25.9	850	1849	67.0	123,883	4896	92.5	$209	$328	$322
U.S. Grant	Portsmouth, Oh.	2001	$ 25.9	875	1685	70.0	117,950	6286	95.5	$220	$269	$255
East Huntington	Huntington, WV.	1981	$ 19.3	900	1808	46.5	84,072	3471	95.5	$230	$509	$483
Maysville	Maysville, Ky.	1997	$ 37.0	1050	2100	58.5	122,850	5825	95.5	$301	$398	$378
Talmadge	Savannah, Ga.	1987	$ 25.7	1100	2040	75.0	153,000	4406	82.3	$168	$293	$323
Cape Girardeau	Cape Girardeau,Mo.	1997	$ 50.8	1150	2086	93.8	195,729	5826	96.8	$260	$343	$321
Sunshine Skyway	Tampa, Fl.	1982	$ 71.1	1200	4000	95.0	380,000	3825	84.2	$187	$376	$405
Owensboro	Owensboro, Ky.	1997	$ 27.1	1200	2197	75.2	165,127	5826	89.8	$164	$217	$219
Maumee River	Toledo, Oh.	2002	$ 63.2	1225	1825	114.0	207,943	6538	98.0	$304	$357	$331
Fred Hartman	Baytown, Tx.	1987	$ 50.0	1250	2214	156.0	345,384	4406	89.3	$145	$253	$257
Sydney Lanier	Brunswick, Ga.	1996	$ 54.3	1250	2496	79.5	198,432	5719	82.3	$274	$368	$406
Dame Point	Jacksonville, Fl.	1984	$ 47.0	1300	2600	105.0	273,000	4146	84.1	$172	$319	$344
Greenville	Greenville, Miss.	2001	$ 55.4	1378	2560	95.0	243,170	6334	78.9	$228	$277	$318
Annacis	Vancouver, BC	1984	$ 45.7	1525	2724	105.0	286,020	4146	108.2	$160	$296	$248
Carquinez[6]	San Francisco, CA	1999	$ 190.0	2388	3474	84.0	291,705	6059	124.2	$651	$827	$604
Tacoma Narrows[6]	Tacoma, Wa.	2002	$ 340.0	2800	5400	78.0	421,092	6538	103.4	$807	$950	$833

Current ENR Construction Cost Index (May 2006) = 7690

Base Geographic Index (Paducah, KY) = 90.7

Notes:

1. All bridges are cable-stayed unless noted otherwise.
2. Segmental concrete CIP
3. Parallel chord truss
4. Steel box girder
5. Steel plate girder
6. Suspension
7. Tied Arch
8. 2-Span Through Truss

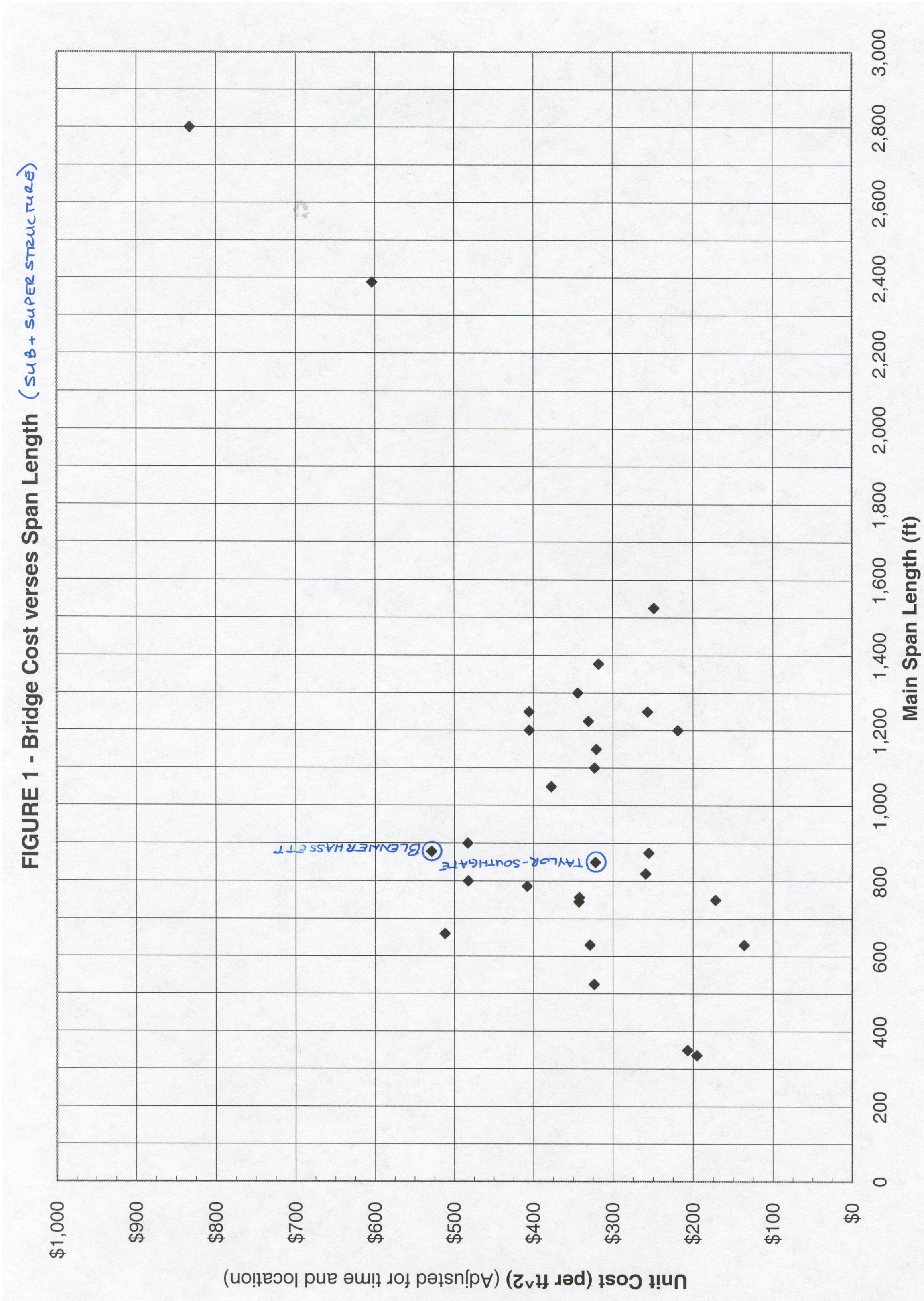


FIGURE 1 - Bridge Cost verses Span Length

2. TIED ARCH WITH 900' SPAN

Use the Blennerhassett Island, WV tied arch bridge that is currently under construction as the basis of unit price for the Tied Arch alternates.

Blennerhassett is an excellent data point due to the similarity in span length, bridge width and geographical location.
Span Length = 878'
Bridge Width = 107'
Bid in 2005, currently under construction
Bid price for mainspan structure was approximately $45.0 million; however, use $50.0 million as basis to account for construction issues and cost overruns that will occur during construction.
Assume that of the $50.0 million, $40.0 million of this represents the superstructure value:

$40,000,000/(878' * 107') = $425/sf for the superstructure alone

Use $425/sf for the superstructure.

3. 3-SPAN PARALLEL CHORD THROUGH TRUSS WITH MAINSPAN LENGTH OF 900’

This bridge type represents the unit price development for an efficiently designed traditional through truss using a moment resisting frame in the transverse direction as opposed to lateral sway bracing portals at all verticals.

The Talyor-Southgate bridge in Cincinnati, Ohio is an excellent example of an efficiently designed parallel chord truss; however, it was built in 1991 which means it must be extrapolated forward 15 years reducing the reliability of the results.

Span lengths: 574’ – 850’ – 425’; Width = 67’
Characteristics are very similar to US-60 over Tennessee River.

$209/sf in 1991, extrapolate forward using ENR Indexes to
$322/sf in 2006 (based upon Figure 1 this value is in the middle of the available data)

Engineering Judgment – Use $400/sf for substructure plus superstructure as a more conservative estimate.

Assume superstructure represents 65% of total bridge costs, therefore:
Superstructure cost = $400/sf * 0.65 = $260/sf

Use $275/sf for the superstructure

3.1 MODIFIED 3-SPAN PARALLEL CHORD TRHOUGH TRUSS WITH MAINSPAN LENGTH OF 900’

This concept is essentially the same as above; however, minor modifications are made to improve the aesthetics of the truss. The modifications include eliminating the verticals from the truss and providing fewer top chord lateral bracing members. An excellent example of this concept is the I-526 Bridge over Cooper River, Charleston, South Carolina. This bridge was constructed in 1992 and cost data was not available.

The modifications to the traditional parallel chord truss are relatively minor and should have a result of increasing the unit cost of the bridge. By eliminating the verticals the structural efficiency of the diagonals will be slightly reduce, and the connections between the transverse floor beams, lower lateral bracing and top lateral bracing to the chord members will be more complicated.

Use $285/sf for the superstructure

4. CABLE-STAYED BRIDGE WITH 900' MAINSPAN LENGTH

There are several relevant data points for estimating the unit cost for a cable-stayed bridge with short to medium span lengths. From Figure 2 the following projects are considered relevant in determining a unit cost:

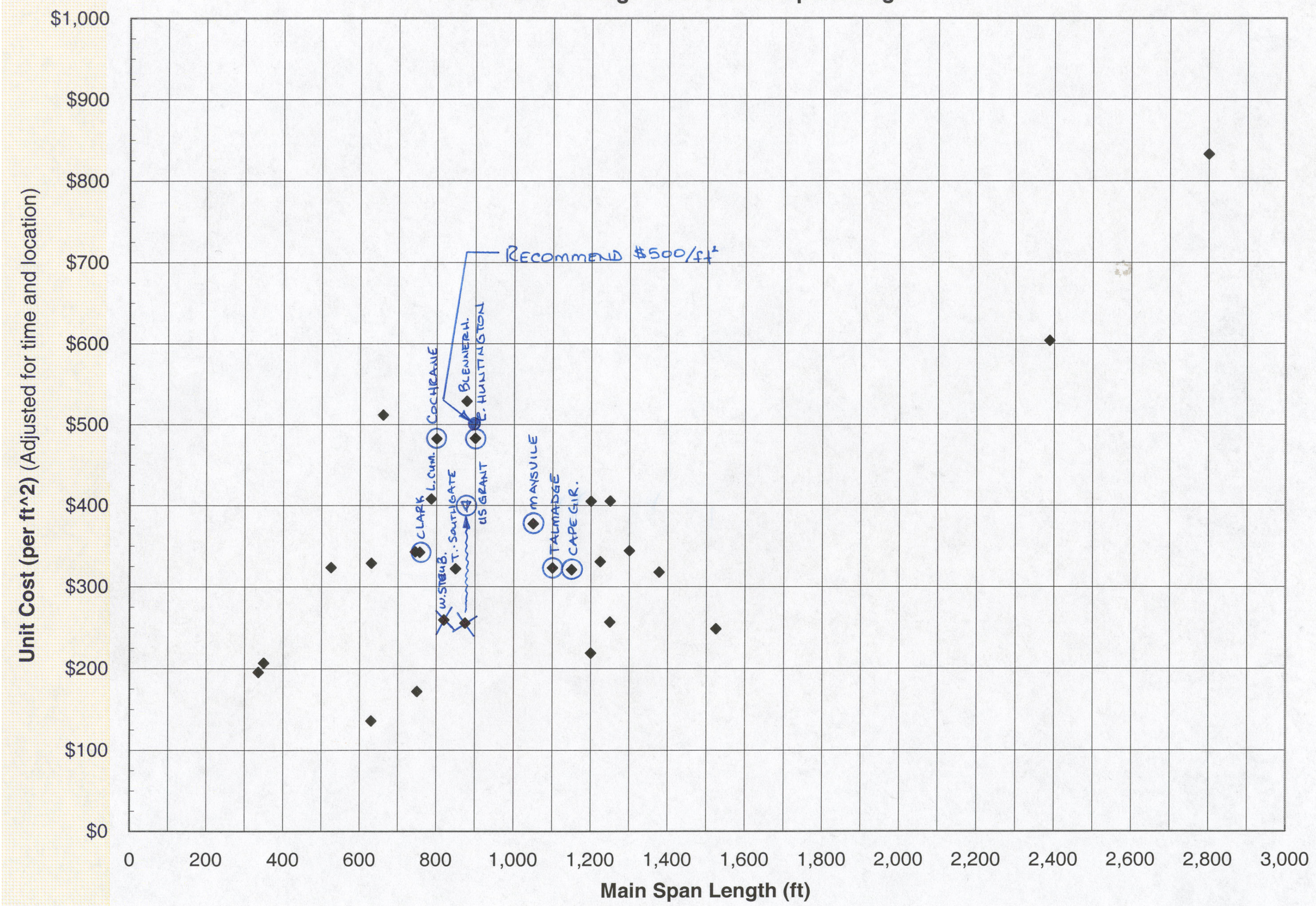
Cochrane Bridge; Mobile, AL (800' Span, 1985)
East Huntington Bridge; Huntington, WW (900' Span, 1981)
U.S. Grant Bridge; Portsmouth, OH (875' Span, 2001)
Maysville Bridge; Maysville, KY (1050' Span, 1997)
Clark Bridge, Alton, IL (756' Span, 1991)
Weirton-Steubenville Bridge, Steubenville, OH (820' Span, 1988)
Talmadge Bridge, Savannah, GA (1100' Span, 1987)
Cape Girardeau Bridge, MO (1150' Span, 1997)

The data point associated with the U.S. Grant bridge, which is currently under construction by C.J. Mahan, has been adjust upward to approximately $400/sf to account for construction issues and claims that have occurred over the past several years that is running the effective price for the bridge up substantially. The Weirton-Steubenville Bridge data point is being ignored as it is an outlying point and appears to be inconsistent with the remainder of the cable-stayed bridge points.

Based upon the data points indicated above and in Figure 2, engineering judgment is utilized to recommend a unit price of $500/sf taking into consideration the poor foundation conditions that exist at this Tennessee River site.

Use $500/sf for the substructure plus superstructure

FIGURE 2 - Bridge Cost verses Span Length



5. CABLE-STAYED BRIDGE WITH 1,200' MAINSPAN LENGTH

There are several relevant data points for estimating the unit cost for a cable-stayed bridge with medium to long span lengths. From Figure 3 the following projects are considered relevant in determining a unit cost:

Fred Hartman Bridge, Baytown, TX (1250' Span, 1987)
Owensboro Bridge, Owensboro, KY (1200' Span, 1997)
Annacis Bridge, Vancouver, BC (1524' Span, 1984)
Dame Point Bridge, Jacksonville, FL (1300' Span, 1984)
Cape Girardeau Bridge, MO (1150' Span, 1997)
Sunshine Skyway Bridge, Tampa, FL (1200' Span 1982)
Sydney Lanier Bridge, Brunswick, GA (1250' Span, 1996)
Greenville Bridge, Greenville, MS (1378' Span, 2001)
Maumee River Bridge, Toledo, OH (1225' Span, 2002)

The data points associated with Fred Hartman (foreign steel), Owensboro and Annacis Island Bridge all appear to be of questionable accuracy and have not been used to pick an appropriate unit cost for a cable-stayed bridge.

Based upon the data points indicated above and Figure 3, engineering judgment is utilized to recommend a unit price of $550/sf taking into account the poor foundation conditions that exist at this Tennessee River site.

Use $550/sf for the substructure plus superstructure

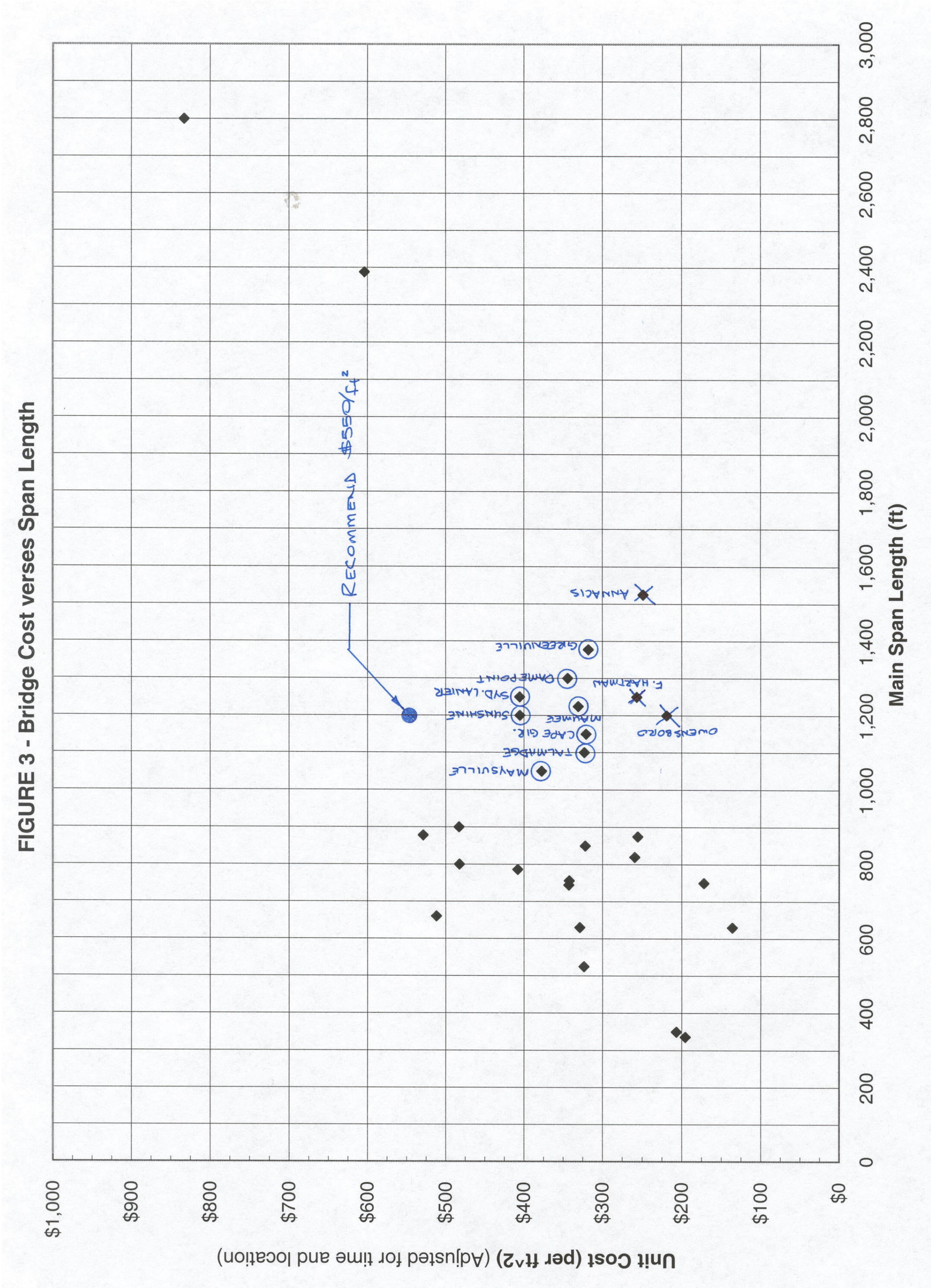


FIGURE 3 - Bridge Cost verses Span Length
Unit Cost (per ft^2) (Adjusted for time and location)
Main Span Length (ft)
$0
$100
$200
$300
$400
$500
$600
$700
$800
$900
$1,000
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
2,800
3,000
MAYSVILLE
TALMADGE
CAPE GIR.
SUNSHINE
SYD. LANIER
MAUMEE
DAME POINT
F. HARTMAN
GREENVILLE
ANNACIS
OWENSBORO
RECOMMEND $550/ft²

6. STEEL PLATE GIRDER AND BOX GIRDERS WITH 400’ TO 500’ SPAN LENGTHS

Use the Lower Buffalo Bridge in West Virginia as a data point for continuous steel girder structures in the 400’ to 500’ span lengths.

5-Span continuous steel plate girder over the Kanawha River.
Total bridge length is 1850’ with a mainspan of 525’.
Bridge width = 38.7’
Bid in 1997

For Tennessee River use $300/sf (substructure and superstructure)
For superstructure only = 0.65 * $300/sf = $195/sf

Use $200/sf for the superstructure

7. STEEL PLATE GIRDERS WITH 200’ TO 250’ SPAN LENGTHS

Assume that the steel plate girders are at a minimum 2-span continuous units for efficiency.

Use $125/sf for the superstructure

8. DECK TRUSS

Make the assumption that a below deck truss is nearly equivalent in unit cost to an above deck through truss. However, the cost implications of raising the profile to accommodate a below deck structural system will need to be addressed.

9. EXTRADOSED BRIDGE

There are essentially no data points for Extradosed bridges in the United States that have gone through the bidding process; therefore, assumptions must be made in order to estimate a reasonable unit price.

In general, at 900’ span length the Extradosed structural system should be slightly more efficient than a cable-stayed bridge. For a cable-stayed bridge, the 900’ span length is on the shorter end of the spectrum. For this reason assume that the Extradosed is slightly less expensive than a cable-stayed bridge.

Use $450/sf for the substructure plus superstructure

APPENDIX E
Creative Idea List and Evaluation

APPENDIX E - Creative Idea List and Evaluation

List of CREATIVE IDEAS			
ID #	**Name of Idea / description**	**Develop Status**	**TM Resp.**
1	New superstructure design removing the sway bracing, lowering the deck and using moment connections	Develop	A Thomas T Choate D Jasper
2	Paint all steel on the original bridge design	Eliminated	
3	Paint only the steel above the deck on the original bridge or the revised bridge	Develop	A Thomas T Choate D Jasper
4	New superstructure design with a 900 ft tied arch and plate girder tail spans	Develop	J Bargo D Jeakle
5	New superstructure design 900 ft truss and box girder tail spans	Eliminated	
6	New superstructure design with three tied arches	Develop	J Bargo D Jeakle
7	Cancel current contract and replace it with a new design using a 900 ft center span cable stay bridge	Develop	J Bargo D Jeakle
8	New superstructure design 900 ft trussed arch and plate girder tail spans	Eliminated	
9	Replace the current design with 900 ft tied arch and shortened plate girder tail spans (250/250,200/200)	Develop	J Bargo D Jeakle
10	New superstructure design using concrete segmental	Eliminated	
11	Replace the current design with extradosed design (hybrid cable girder)	Develop	J Bargo D Jeakle
12	Replace the current design with a below deck truss design	Develop	J Bargo D Jeakle
13	Replace the current design with a below deck arched truss design	Eliminated	
14	Replace the current design with a K-frame design	Eliminated	
15	Replace the current design with concrete segmented post tension tail spans	Develop	J Bargo D Jeakle
16	Replace the current design with 900 ft suspension bridge	Eliminated	
17	New 900 ft tied arch design using steel box sections in the construction of the 400 ft and 500 ft tail spans	Develop	J Bargo D Jeakle
18	Use closed sections for the main span	Develop	J Bargo D Jeakle
19	New superstructure design using Vierndeel Truss	Eliminated	
20	Cancel current contract and change spans to 500 ft 800 ft 500 ft	Eliminated	
21	Add vertical supports in the center lane	Develop	D Jeakle

List of CREATIVE IDEAS			
ID #	**Name of Idea / description**	**Develop Status**	**TM Resp.**
22	Use tube rail instead of jersey barriers	Design comment +cost	A Thomas T Choate D Jasper
23	Add more aesthetic barriers	Design comment +cost	A Thomas T Choate D Jasper
24	Increase the width for more user friendly bike lane	Design comment +cost	A Thomas T Choate D Jasper
25	Replace the jersey barriers with see through steel barriers	Eliminated	
26	Add aesthetic lighting on the structure	Design comment +cost	A Thomas T Choate D Jasper
27	Add a theme lighting plan on the approach structure	Design comment +cost	A Thomas T Choate D Jasper
28	Use colored concrete for the bridge deck construction	Design comment +cost	A Thomas T Choate D Jasper
29	Replace the current design with design similar to cooper bridge design	Eliminated	
30	Have public involvement meeting to discuss the color light and provide information	Design comment	A Thomas T Choate D Jasper
31	Enclose the current structure and add lighting	Eliminated	
32	Replace the current design with new truss bridge design using moment connections, a lower bridge deck, and lighter members (similar to cooper river)	Develop	J Bargo D Jeakle
33	Use alternative bidding method (summit multiple designs).	Develop	J Bargo
34	Make the superstructure a design/build project	Develop	J Bargo
35	Contract out bridge design	Eliminated	
36	Decorate and enhance the portal appearance	Design comment +cost	A Thomas T Choate D Jasper
37	Delete the center pier and build a cable stay or suspension bridge	Develop	J Bargo D Jeakle
39	Decrease total steel weight in proposed truss design	Develop	D Jeakle

List of Eliminated CREATIVE IDEAS		
ID #	**Name of Idea / Description**	**Reason for Elimination**
2	Paint all steel on the original bridge design	Painting is already included in the current design
5	New superstructure design 900 ft truss and plate girder tail spans	Will add less aesthetic value than idea number 4 and will have a higher cost
8	New superstructure design 900 ft trussed arch and plate girder tail spans	It complicates a tied arch design ,adds little aesthetic value and adds cost
10	New superstructure design using concrete segments	Weight of new structure would be too great
13	Replace current design with a below deck arched truss design	Depth of structure is too great for approaches and does not provide enough clearance for barge traffic.
14	Replace current design with a K-frame design	Depth of structure is too great for approaches and does not provide enough clearance for barge traffic.
16	Replace current design with 900ft suspension bridge	Not economical
19	New superstructure design using Vierndeel Truss	Not efficient
20	Cancel current contract and change spans to 500ft 800ft 500ft	Design causes conflicts with easement, environmental concerns, constructability, and river migration
25	Replace jersey barriers with see through steel barriers	No real benefit
29	Replace current design with cooper bridge design	Same as idea number 32
31	Enclose the current structure and add lighting	Does not add significant aesthetic value without added significant cost
35	Contract out bridge design	Decision will be made by KTC if necessary

APPENDIX F
Site Pictures

APPENDIX F – Site Pictures

Site Picture 1: Existing US 60 Bridge over the Tennessee River

Site Picture 2: Ground breaking/clearing on riverbank in preparation for pier construction

Site Picture 3: Driven piling for pier construction

Site Picture 4: Cleared site ready for pier construction

END OF REPORT

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