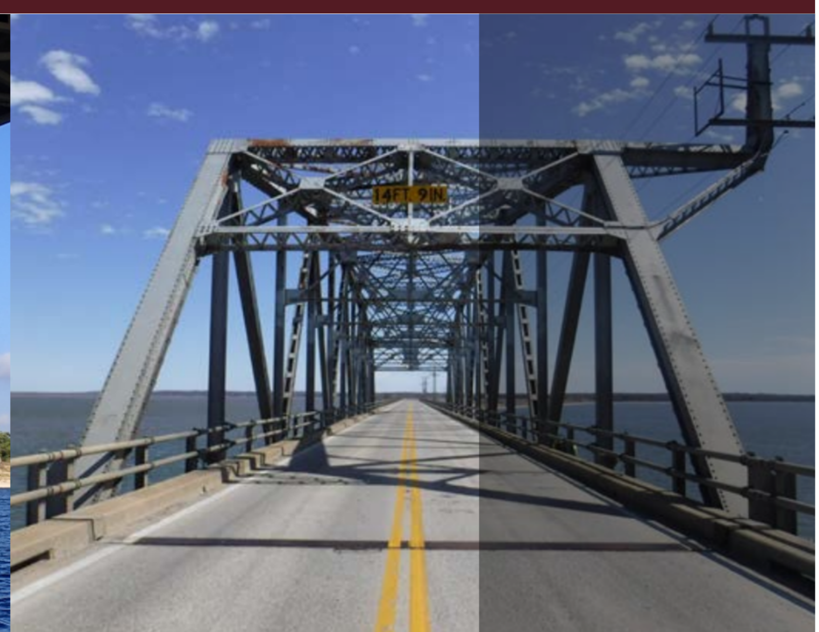
Preliminary Engineering Study

US-70 Over Lake Texoma
(Franklin D. Roosevelt Memorial Bridge)

JP 33873(07) Bryan & Marshall Counties

OKLAHOMA



Prepared For:

Oklahoma Department of Transportation

June 2022

GARVER
GarverUSA.com

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(Franklin D. Roosevelt Memorial Bridge)
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JP 33873(07)
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Prepared by:

GARVER

6100 S. Yale Avenue
Suite 1300
Tulsa, OK 74136

June 2022

Garver Project No.: 20T03060

Engineer's Certification

I hereby certify that this Preliminary Engineering Study for US-70 Over Lake Texoma (Franklin D. Roosevelt Bridge) was prepared by Garver under my direct supervision for the Oklahoma Department of Transportation.

Matthew J. Youngblood, PE, SE
State of OKlahoma PE License 25989

LICENSED PROFESSIONAL ENGINEER
Matthew J. Youngblood
25989
OKLAHOMA

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1.0 Executive Summary

The Oklahoma Department of Transportation (ODOT) contracted with Garver to perform a two-phase study of US-70 over Lake Texoma in Bryan and Marshall Counties. The purpose of the project is to provide a safe crossing along US-70 over Lake Texoma that accommodates current and future traffic demands. Phase I of the study generally includes Section 4(f) analysis, preliminary engineering, environmental studies, and public involvement services. To supplement the analysis, Phase I also included traffic data collection, traffic analysis, preliminary geotechnical exploration and analysis, hydrology and hydraulics analysis, and survey.

The Section 4(f) analysis noted above is a rehabilitation alternative analysis of the existing bridge that was performed to prior to this Preliminary Engineering Study, and can be found in **Appendix Q**. The Section 4(f) analysis is required due to the eligibility of the existing bridge to the National Register of Historic Places (NRHP) and was performed in accordance with ODOT Guidance in the “Design Support for Section 4(f) Analysis for Historic Bridges” document, which is incorporated into the Scope of Services. The rehabilitation alternative analysis evaluated Alternatives 1-5 that involved the re-use of the existing bridge in various facets.

The purpose of this preliminary engineering study is to investigate the replacement alternative (Alternative 6) of the existing Bridge. Alternative 6 does include several options as described in further detail below. The information presented in this report is intended to provide data and metrics for the use in selecting of a preferred alignment. A project summary matrix, specific for Alternative 6, was developed to present the developed data a more concise, tabular form and is presented as **Table 2** of this report.

The evaluation metrics presented in the Project Summary Matrix include:

- Construction Cost
- Right-of-Way Cost
- Utility Relocation Cost
- Total Retaining Wall Cost
- Compensatory Storage Impacts
- Wetland Impacts
- Stream Impacts
- Johnson Creek PUA Impacts
- Texoma State Park Impacts
- USACE Property Impacts
- Tribal Land Impacts
- Archeological Site Impacts

This report also includes the other supplemental studies/tasks listed below:

- Traffic Data Collection and Analysis (**Appendix N**)
- Preliminary Geotechnical Exploration and Analysis (**Appendix O**)
- Hydrology and Hydraulics Analysis (**Appendix P**)
- Survey (**Appendix Y**)
- Bridge Rehabilitation Alternative Analysis (**Appendix Q**)
- Historical Assessment of the Roosevelt Memorial Bridge over Lake Texoma (**Appendix T**)
- Stakeholder and Public Meetings (**Appendix X**)
- Preliminary Engineering Report

Phase II of the project includes preparation of functional plans for the selected alignment/alternative, and the final NEPA documentation.

1.1 Existing Conditions

The setting of the project area is primarily Lake Texoma which is owned and managed by the United States Army Corps of Engineers (USACE). The west portion of the project is more developed than the east portion of the project, with significant new developments anticipated along the west shore of Lake Texoma on the north and south sides of US-70.

The limits of the project study area are described as beginning at the intersection of US-70 and State Park Road and extending east approximately 4.03 miles, inclusive of the Lake Texoma crossing (Roosevelt Memorial Bridge). The study area is divided into five sections: the western extents of project, the Roosevelt Memorial Bridge, east of the existing bridge (lake causeway), eastern section of the project (land causeway), and the eastern extent of the project near the intersection of US-70 and Willow Springs Road/Johnson Creek Road. Refer to **Appendix E** for project photos.

The existing corridor is classified by five roadway segments with varying widths, lane configurations and vertical and horizontal geometry. The existing roadway geometry of the segments are as follows:

Segment	***Extents***	***Length***	***Existing Roadway Section***
Segment 1	*State Park Rd. to Roosevelt Br.*	*1,585 ft*	*Four 12' lanes; 8' Shoulders; 16' TWLT*
Segment 2	*Existing Roosevelt Bridge*	*5,000 ft*	*Two 12' Lanes; No Shoulders*
Segment 3	*Lake Causeway*	*5,220 ft*	*Two 12' Lanes; 8' Shoulders*
Segment 4	*Land Causeway*	*9,545 ft*	*Two 12' Lanes; 8' Shoulders*
Segment 5	*Segment 4 to Willow Springs Rd.*	*1,941 ft*	*Four 12' lanes; 8' Shoulders; 16' TWLT*

TWLT: Two-Way Left Turn Lane

The bridge structure is approximately 4,943 feet long with a 24-foot clear roadway and a 250’ steel Warren through-truss for a navigational span. The structure currently has an at-risk status due to a superstructure NBI condition rating of 5 and has recently received rehabilitation to increase the status from structurally deficient. See **Appendix L** for the latest Bridge Inspection Report describing the conditions of the bridge elements.

1.2 Traffic Safety and Analysis

1.2.1 Existing and Future Traffic Volumes

US-70 currently carries approximately 8,500 vehicles per day across the Roosevelt Memorial Bridge with 9% truck volume. State Park Road carries approximately 1,750 vehicles per day, and Willow Springs Road/Johnson Creek Road carries approximately 1,200 vehicles per day. The existing volumes on the corridor were analyzed to determine the current and ultimate functional conditions at the two intersections and along the Roosevelt Memorial Bridge segment.

Two sets of future traffic volume projections were developed for US-70 – “background growth only” and “with development”. For the “background growth only” scenario, traffic volumes were projected to the year 2050 and estimated to be 13,200 and 11,400 vehicles per day east and west of the study area, respectively. For the “with development” projection, 2050 traffic volumes estimated to be 28,200 and 26,700 vehicles per day east and west of the bridge, respectively. Refer to ***Section 2.4*** for additional details on the Pointe Vista development property. See **Appendix N** for Traffic Data Collection and Analysis Report.

1.2.2 Safety

To evaluate performance of US-70 in terms of safety, historical crash data was collected using ODOT’s Safe-T Database for a five-year period from 2015 to 2019. Over the five-year period, a total of 52 crashes occurred within the corridor limits, including 4 fatal collisions and 16 injury-related collisions. The most common crash types included 12 rear-ends, 11 angle-turning, nine fixed object, eight sideswipe-opposite direction, and six head-on collisions.

The data revealed that the corridor crash rate (78 crashes per 100 million vehicle miles traveled (MVMT)) was comparable to the statewide crash rate (76 crashes per 100 MVMT). However, the fatal crash rate for the corridor was almost 2.5 times larger at 6.0 per 100 MVMT than the statewide fatal crash rate at 2.6 per 100 MVMT.

Five crashes occurred at the truss span of the Roosevelt Memorial Bridge, with one of those crashes being fatal. The vertical clearance under the truss is deficient, and the existing bridge does not have shoulders, which may cause the traffic to move towards the centerline of the travel way. The Roosevelt Memorial Bridge also does not provide passing opportunities or shoulders for vehicular refuge, which are indicators of a less safe facility for vehicles.

1.2.3 Traffic Analysis

The Level of Service (LOS) along US-70 was evaluated for the existing two-lane conditions as well as a proposed four-lane section (Build Condition with two thru lanes per direction) for 2021, 2050 (background growth only), and 2050 (with Development) traffic volumes. This analysis showed that the drivers will experience increased delays on the bridge and at the two intersections by 2050 if the Pointe Vista property is built out and no improvements are made. With the potential widening of the bridge for the Build scenario, mainline LOS results for the bridge improve to LOS A and LOS B creating a free flow condition for drivers along US-70.

The widening of the bridge was also analyzed in terms of safety benefits, utilizing Highway Safety Software. The analysis indicated that a widened bridge with additional elements (such as providing a median, lighting, or wider shoulders) could result in a reduction of 57 to 64 fewer total bridge crashes over the 29-year period (using 2050 background growth only volumes) – which includes an anticipated reduction of 7 to 10 fatal or injury collisions.

The results of the traffic analysis demonstrate that the existing Roosevelt Memorial Bridge will not be able to adequately accommodate proposed 2050 (with development) volumes as a two-lane facility, as the segment LOS worsens on the bridge to LOS E conditions. Compiled LOS results for the US-70 Build and No-Build conditions are shown in **Table 1** below for each design year scenario.

Table 1: Level of Service Results

Scenario	*Level of Service (LOS) Results*	
	No-Build Condition	*Build Condition*
2021	*C*	*A*
2050 (background growth only)	*D*	*A*
2050 (with development)	*E*	*B*

1.3 Design Methodology/Analysis

To provide a systematic method for comparing multiple alternatives, both design criteria and evaluation factors were established. Preliminary design of all alternatives utilized the design criteria established, and then a Project Matrix was developed based on the traffic capacity recommendations and evaluation factors noted above. Preliminary roadway and bridge design criteria and other general information are summarized in **Section 4.0**.

1.4 Alignment Alternatives

For this study, nineteen general alignments were investigated to various degrees depending on the potential for selection at final design. The alignment alternatives were classified in this study as having low, medium, or high potential of selection. The classification was based on several factors, including alignment characteristics, constructability, feasibility, practicality, impacts to environmental features or facility users, and cost.

Seven of the nineteen alignments were considered to have a high potential of selection and were investigated more thoroughly for the report. Four of the seven high-potential alignments included sub-options that further investigated design alternatives such as including retaining walls and removal of existing causeway to minimize or eliminate impacts to flood storage.

The following table briefly summarizes all alignments based on the relative location of the proposed alignment to the existing US-70 alignment for each of the major corridor features (bridge, lake causeway and land causeway). All of the studied alternatives provide for the maintenance of existing traffic during construction of a new bridge.

Alignment Alternative	Offset to Existing				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-1	North	Full	Full	Full	Low
6-2A	North	Full	Partial	Partial	High
6-2B	North	Full	Partial	Partial	High
6-3	North	Full	Partial	Existing	High
6-4	North	Full	Existing	Existing	Medium
6-5	North	Partial	Full	Full	Low
6-6A	North	Partial	Partial	Partial	High
6-6B	North	Partial	Partial	Partial	High
6-7	North	Partial	Partial	Existing	Medium
6-8	North	Partial	Existing	Existing	Low
6-9	South	Partial	Full	Full	Low
6-10	South	Partial	Partial	Partial	Medium
6-11	South	Partial	Partial	Existing	Medium
6-12	South	Partial	Existing	Existing	Low
6-13	South	Full	Full	Full	Low
6-14	South	Full	Partial	Partial	High
6-15	South	Full	Partial	Existing	High
6-16	South	Full	Existing	Existing	Medium
6-17A	South	New	New	Existing	High
6-17B	South	New	New	Existing	High
6-18A	South	New	New	Partial	High
6-18B	South	New	New	Partial	High
6-19	South	New	New	Full	Low

High-Potential Alignment Alternative
Partial Offset = 27'-6"
Full Offset = 54'-0"
New = Realignment

1.5 Bridge Replacement Alternatives

Due to the length of the bridge and associated costs, several bridge replacement options were evaluated for each alignment alternative. All replacement options that were evaluated were for a four-lane bridge structure as recommended by the traffic study. Evaluation of the alternatives included considerations of detour and construction phasing requirements, causeway impacts, lake bathymetry, flood storage impacts, retaining structure needs, and accelerated construction methods.

The *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report* was developed to function as a companion to this report to cover bridge specific replacement options in detail and describe the method for determining the most cost-efficient bridge replacement option for each proposed alignment. Refer to **Appendix K** for the Bridge Specific Replacement Report.

The report investigated the following bridge types and options:

- Traditional Prestressed Beams
    - AASHTO Type IV and J
    - Tx70 Girders
    - Nebraska (NU) Girders
- Structural Steel
    - Continuous Plate Girders
    - Rolled Shapes
    - Haunching and Stiffening
    - Hybrid Girders
- Spliced Prestressed Concrete Girders
- Accelerated Bridge Construction (ABC) Techniques

1.6 Impacts and Mitigation

1.6.1 General

As shown in **Table 2: Project Summary Matrix**, impacts to right-of-way, utilities, flood storage, streams, public use areas, parks, public property, tribal lands, and potential archeological sites is summarized. See **Section 5.0** of the report for a detailed discussion of impacts to each individual alternative.

1.6.2 Right-of-Way and Utilities

As expected, the alternatives have varying impacts to the right-of-way and utilities, depending on the horizontal offset distance, profile, and utilities. For some alternatives, retaining walls were used to minimize impacts. Utility relocation costs were not provided at the time of this report and will be provided at a later date. **Appendix G** has been created as a placeholder for utility relocation costs that have yet been provided. Refer to **Appendix F** for Right-of-Way Impact Tabulations.

1.6.3 Compensatory Storage

Since Lake Texoma is owned and operated by the USACE, flood storage impacts are an important issue to evaluate. The impact to flood storage varies depending on the alignment alternative and is measured based on additional volume of fill material that would be added between the elevations of normal pool elevation and the base flood elevation (617 to 640 feet) inside of the Lake Texoma flood plain. Typically, alignments with full offsets of the lake and land causeways caused the greatest impacts to flood storage.

Refer to **Table 2: Project Summary Matrix** which provides tabulated results correlating to the discussion below. Alternative 6-2B shows a net zero impact to flood storage, although any of the alternatives could be modified to avoid impacts. See **Section 6.0** of the report for a more detailed discussion of impacts and potential costs for mitigation.

Alternative 6-2B was developed to understand methods to mitigate compensatory storage. The methods developed were extrapolated to the remaining alignment alternatives as possibilities for compensatory storage mitigation. Methods of flood storage impact mitigation included lengthening the proposed bridge, removal of existing lake causeway, and constructing retaining walls with the proposed causeway widening to provide retention of the embankment. Generally, the construction of retaining walls is less expensive than the lengthening of the bridge and mitigates the cost of widening a large embankment. However, retaining walls are not preferred due to risk of failure and maintenance costs.

Construction of or widening of large embankments on a lake is very costly, therefore Alternatives 17 and 18 were developed to evaluate the differences on a new offset southern alignment. Alternatives 17A and 18A include the construction of a combination of a new bridge and causeway, which does avoid impacts to the existing facility, but has a large impact to flood storage. Alternatives 17B and 18B include a much longer bridge to minimize the cost and impacts of a new causeway and could require the removal of portions of the existing causeway to arrive at a net zero impact to flood storage. The drawback of the removal of existing causeway is the impacts to the future use of the existing bridge, although this method prevents the potential need for offsite or other mitigation.

1.7 Summary/Conclusion

1.7.1 General

The potential replacement of the existing US-70 Roosevelt Memorial Bridge is a massive undertaking, even in the preliminary stages due to the location, size, complexity, and the presence of the existing NRHP eligible bridge. As previously noted, this Preliminary Engineering Report included several sub-tasks, such as traffic data collection, traffic analysis, preliminary geotechnical exploration and analysis, hydrology and hydraulics analysis, and survey. These sub-tasks allowed for a more detailed and defined study of the bridge replacement alternative (Alternative 6)

1.7.2 Construction Costing

Construction cost estimation for such a large and complex project is challenging. Furthermore, our current economic climate of high inflation and increasing labor costs adds to the difficulty. The estimated costs presented in this report are made based on experience and qualifications and represent our reasonable judgment and familiarity with the construction industry. These costs are for the current time and do not account for any future inflation or marked fluctuations.

1.7.3 Closing

To present the results of the analysis in a clear format, a Project Evaluation Matrix was created. The Project Evaluation Matrix is present below in **Table 2: Project Summary Matrix**.

(See Fold Out Next Page)

JP No. 33873(04), US-70 over Lake Texoma (Roosevelt Bridge), Project Summary Matrix																
Alternative Name and Description		Sub-Option	Construction Cost (1)	Right-of-Way Cost (2)	Utility Relocation Cost (3)	Total Bridge Length (ft)	Total Retaining Wall Cost	Flood Storage Impacts (cy)	Wetlands (ac)	Streams (ac)	Johnson Creek PUA (ac)	Texoma State Park (ac)	USACE Property (ac)	Tribal Land (ac)	Hazardous Materials Site	Archeological Site 34BR11
6-2	North Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - 27.5'	A	$144.55 M	$1.73 M	$ -	4,942	-	590,165	0.77	0.11	3.8	2.83	62.96	0	N	Y
		B	$189.56 M	$.7 M		6,146	$58.81 M	-811	0.67	0.06	2.2	2.83	20.65	0	N	Y
6-3	North Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - On Existing Alignment	-	$144.37 M	$1.67 M	$ -	4,942	-	595,520	0.81	0.09	3.74	2.65	64.3	0	N	Y
6-6	North Offset with Phased Bridge Construction Bridge - 27.5' Lake Causeway - 27.5' Land Causeway - 27.5'	A	$149.84 M	$1.69 M	$ -	4,942	-	595,169	0.49	0.07	3.18	3.39	51.8	0	Y	Y
		B	$156.35 M	$1.08 M		4,942	$35.31 M	279,876	0.49	0.07	3.18	3.39	32.61	0	Y	Y
6-14	South Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - 27.5'	-	$150.2 M	$2.7 M	$ -	4,942	-	590,165	1.32	0.09	3.74	6.19	64.76	1.16	Y	Y
6-15	South Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - On Existing Alignment	-	$149.9 M	$2.68 M	$ -	4,942	-	595,520	0.89	0.08	3.73	6.19	64.79	1.16	Y	Y
6-17	New Southern Alignment Land Causeway - On Existing Alignment	A	$423.45 M	$3.45 M	$ -	5,422	-	1,101,425	1.09	0.09	3.73	6.56	105.16	1.43	Y	N
		B	$148.89 M	$1.99 M		10,625		226,348	1.09	0.09	3.73	6.56	58.97	1.43	Y	N
6-18	New Southern Alignment Land Causeway - 27.5' Offset	A	$422.5 M	$3.46 M	$ -	5,422	-	1,120,416	1.49	0.08	3.74	6.34	106.15	1.43	Y	N
		B	$147.02 M	$2.01 M		10,625		226,348	1.49	0.08	3.74	6.34	60.06	1.43	Y	N

(1) 20% Contingency. Mitigation costs not included.
(2) 5% Contingency. ODOT provided values.
(3) Utility relocation costing information not provided at the time of the report submittal. Information is to be provided at a later date.

Table 2: Project Summary Matrix

2.0 Project Overview

2.1 Scope

The Oklahoma Department of Transportation (ODOT) contracted with Garver to perform a Section 4(f) analysis, complete bridge replacement preliminary engineering studies, environmental studies, NEPA documentation, provide public involvement services, and prepare functional construction plans for the historic Franklin D. Roosevelt Memorial Bridge (Roosevelt Bridge) carrying US-70 over Lake Texoma in Bryan and Marshall Counties. The purpose of this preliminary engineering study is to investigate replacement alternatives of the existing bridge that will improve the geometrics of the US-70 corridor, provide a safe-crossing of Lake Texoma, and assess the costs and impacts for each of the proposed alternatives.

The project is separated into two phases. Phase I includes:

- Traffic Data Collection and Analysis (**Appendix N**)
- Preliminary Geotechnical Exploration and Analysis (**Appendix O**)
- Hydrology and Hydraulics Analysis (**Appendix P**)
- Survey (**Appendix Y**)
- Bridge Rehabilitation Alternative Analysis (**Appendix Q**)
- Historical Assessment of the Roosevelt Memorial Bridge over Lake Texoma (**Appendix T**)
- Stakeholder and Public Meetings (**Appendix X**)
- Preliminary Engineering Report

Phase I will culminate with the selection of a preferred alignment and bridge span configuration prior to proceeding to Phase II of the project. Phase II includes preparation of functional plans for the selected alignment, and the final NEPA documentation.

As a part of Phase I of this contract, an alternative analysis report was created for documentation of the Section 4(f) Evaluation for the Use of Historic Bridge that investigated five main avoidance alternatives with two alternatives that included subparts.

<u>Avoidance Alternative Summary</u>

- Alternative 1 – Do Nothing
- Alternative 2A – Rehabilitate Existing Bridge without Widening
- Alternative 2B – Rehabilitate Existing Bridge with Widening
- Alternative 3A – One-Way Pair and Rehabilitate Existing Bridge without Widening
- Alternative 3B – One-Way Pair and Rehabilitate Existing Bridge with Widening
- Alternative 4 – Convert Existing Bridge to Pedestrian and Bicycle Use Only
- Alternative 5 – Convert Existing Bridge to Monument Only

For additional information on the alternatives analysis see the *US-70 over Lake Texoma (Franklin D. Roosevelt Memorial Bridge) Section 4(f) Alternatives Analysis & Report* **(Appendix Q)**. Alternative 6, the bridge replacement alternative, is described in further detail in this report.

The limits of the project study area are described as beginning at the intersection of US-70 and State Park Road and extending east approximately 4.03 miles, inclusive of the Roosevelt Memorial Bridge. The study area is divided into five segments: the western extents of the project, at the existing bridge, east of the existing bridge (lake causeway), eastern section of the project (land causeway), and the eastern extent of the project.

2.2 Project Study Area

The project study area includes the US-70 corridor from the State Park Road intersection on the western extends of the project to the Willow Springs/Johnson Creek Road intersection on the eastern extents of the project and is inclusive of the existing Roosevelt Memorial Bridge over Lake Texoma. Approximately halfway across Lake Texoma is the county line between Bryan and Marshall Counties. The confluence of Lake Texoma and the Red River is approximately seven miles to the south of the project and acts as the state line between Oklahoma and Texas.

An existing causeway extends from the east end of the Roosevelt Memorial Bridge back to the east bank of Lake Texoma. The majority of the land surrounding the project is owned by the US Army Corps of Engineers (USACE). Natural recreation areas in the vicinity of the bridge include, but are not limited to, Lake Texoma State Park, Johnson Creek Campgrounds, and Willow Springs Public Use Area. The Chickasaw Nation also owns land on the south of US-70 on the west side of the lake. There is a USACE-owned air strip approximately 2,000 feet to the west of the bridge. See **Figure 1** and **Figure 2** for the county maps and general location of the project area.

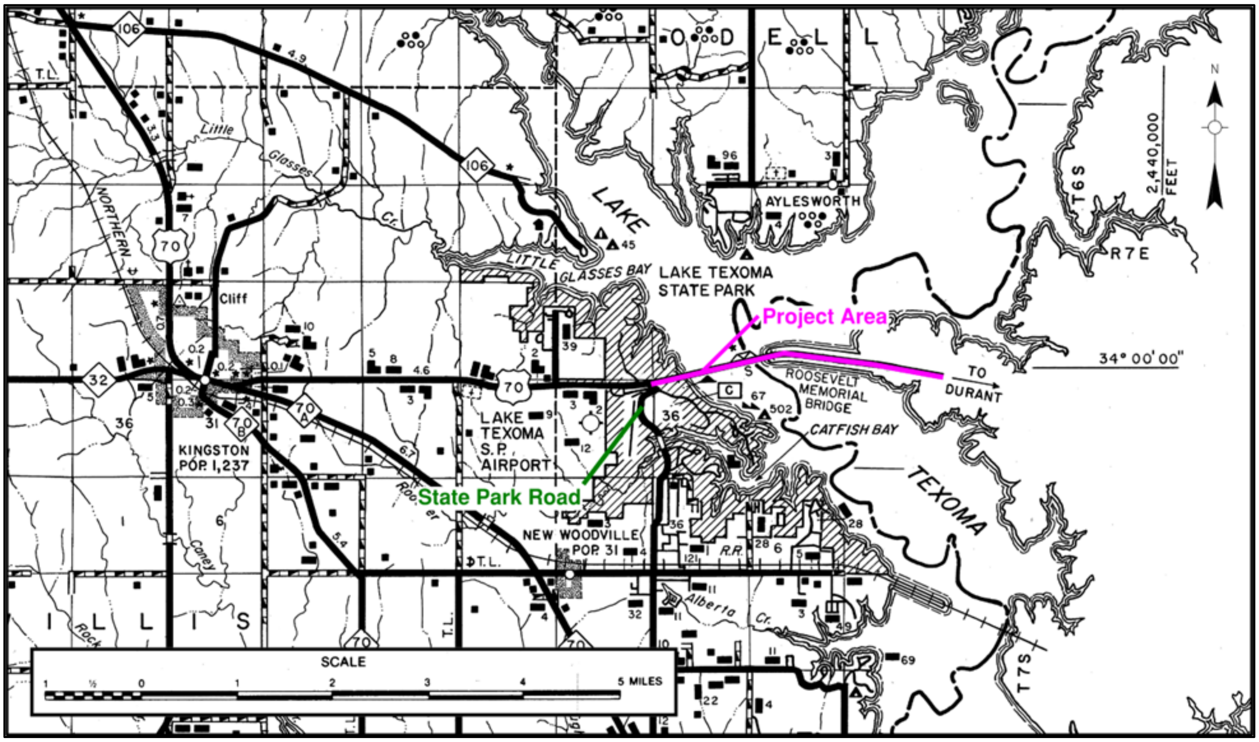


Figure 1: Project Location Map - Marshall County

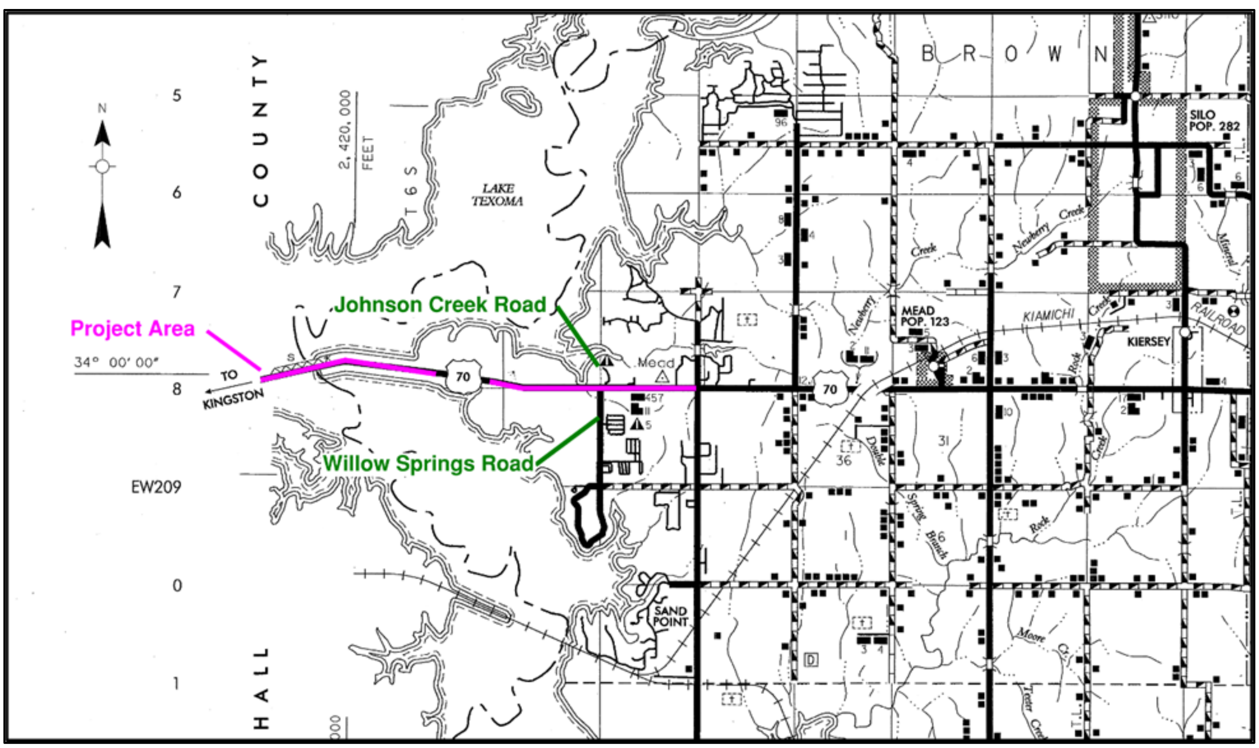


Figure 2: Project Location Map - Bryan County

2.3 Project History

The following tasks have been completed thus far for the Phase I of the ODOT contract ID CI-2262.

Date	Description	Type	Appendix
1/15/21	Notice to Proceed Date & Scope Meeting	Meeting	
1/29/21	STATE Project Specific Design/NEPA Kick-Off Meeting	Meeting	
2/5/21	Initial Tribal Consultation	Meeting	
3/5/21	Analysis of Existing Bridge - Report Submittal	Deliverable	**Appendix R**
3/11/21	Tribal Consultation Waiting Period	Task	
3/26/21	Preliminary Embankment (Causeway Survey) Report	Deliverable	**Appendix O**
3/29/21	Section 4(f) Alternative Discussion – ODOT	Meeting	**Appendix V**
3/29/21	Analysis of Existing Bridge – ODOT	Presentation	
4/15/21	Initial Section 106 Consulting Parties Letter	Task	
4/30/21	Initial Section 4(f) Meeting with FHWA	Meeting	**Appendix W**
4/30/21	Approval of Section 4(f) Scope by FHWA	Task	
5/27/21	Signature Bridge Report	Deliverable	**Appendix S**
7/6/21	Comment Period for Section 106 Consulting Parties	Task	
7/12/21	US-70 over Lake Texoma Pre-USACE Meeting	Meeting	
7/29/21	Initial Section 4(f) & 6(f) letter for Recreational Use	Submittal	
8/9/21	Stakeholder Meeting	Meeting	
9/3/21	Survey Work Order 5477(1) Completion	Task	
9/9/21	Traffic Data Collection	Task	
9/13/21	Initial Alternative Meeting with USACE, Chickasaw and State Park	Meeting	
10/12/21	Preparation of Footprint	Task	
10/13/21	Approval of Footprint	Task	
10/14/21	Property Owner Notifications	Task	
11/5/21	Traffic Analysis Memo Submittal	Deliverable	**Appendix N**
12/13/21	Section 4(f) Alternative Analysis – Report Submittal	Deliverable	**Appendix Q**
12/20/21	ARPA Permit for Cultural Resources Studies	Task	
12/28/21	Hazardous Waste Studies	Task	
1/10/22	Section 4(f) Report Review – ODOT	Meeting	
2/4/22	T&E & Wetland Studies	Task	
2/22/22	USFWS Consultation	Task	
2/23/22	ODOT Review of Haz Waste Studies	Task	
2/24/22	PointeVista Private Developer Meeting	Meeting	
3/8/22	Contractor Consultation – Bexar Concrete Works	Meeting	
3/10/22	Cultural Resources Survey Report	Task	
3/28/22	Pavement Design Report	Deliverable	**Appendix O**
6/17/22	Preliminary Subsurface Exploration for Bridges Report	Deliverable	**Appendix O**
6/17/22	Preliminary Embankment Subsurface Investigation Report	Deliverable	**Appendix O**

2.4 Development

Pointe Vista at Lake Texoma is an ongoing development on the west side of Lake Texoma, north and south of US-70 (**Figure 3**). Pointe Vista at Lake Texoma is described as a 2,700-acre mixed use development, and the home to the Chickasaw Pointe Golf Course and Catfish Bay Marina and will include over 2,100 residences. It is expected to be developed in eleven phases (Pointe Vista Development, LLC, 2022).

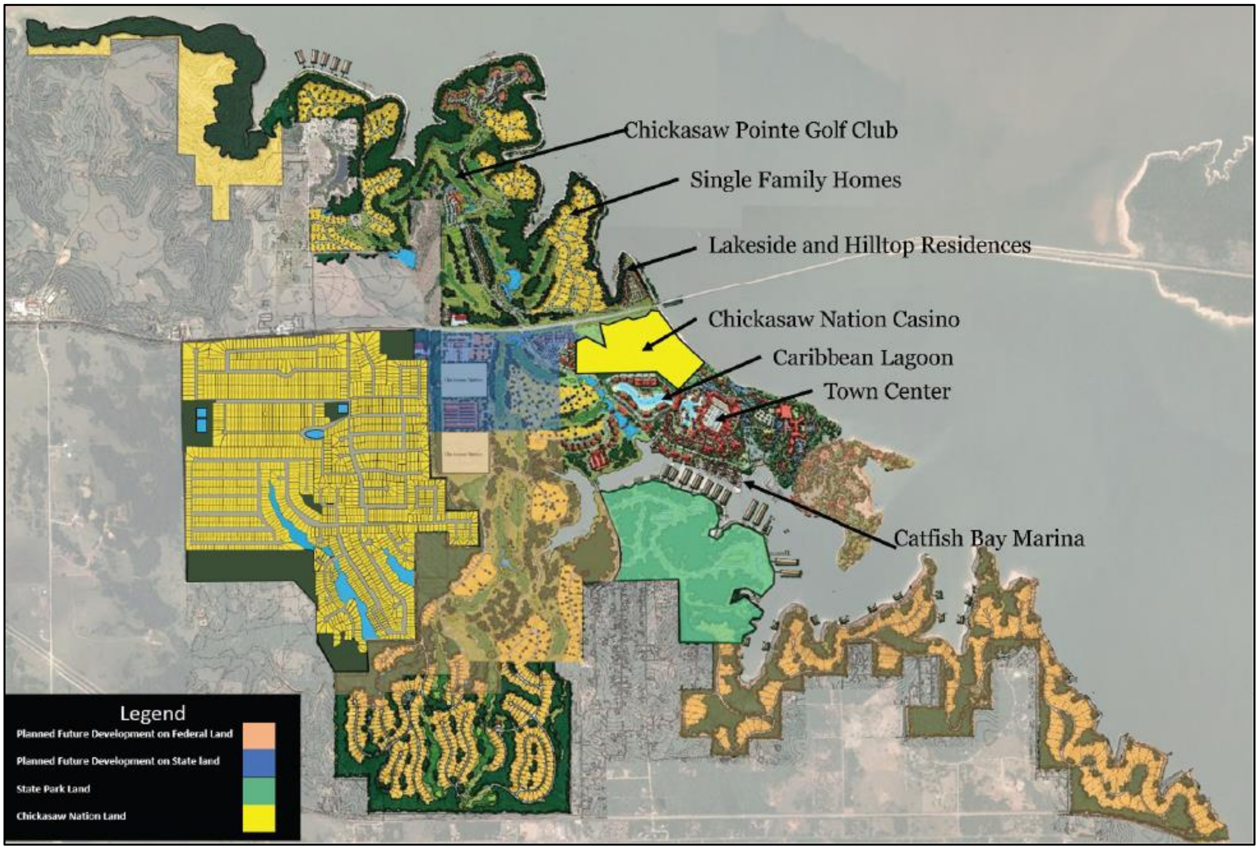


Figure 3: Pointe Vista at Lake Texoma Development – Proposed Final Layout

Pointe Vista was formed in 2008 with the intent to create a master planned destination resort community at Lake Texoma, including a shoreline residential lake community, hotel, convention center, a luxury resort, small to large high-end lakefront properties, 18-hole golf course as well as enhancing the existing marina facility at Catfish Bay.

Pointe Vista originally acquired 800 acres from the state of Oklahoma, which was originally Lake Texoma State Park, and has continued to acquire additional land along Lake Texoma for an approximate total acquired land of 2,700 acres. The current acquired acreage is expected to encompass the entire development.

At the time of this report submittal, construction is thought to be in Phase I with 84 single family lots and 57 lakeside and hilltop residences in the areas of the Lakeside and Hilltop Residences and Chickasaw Nation Casino, as show in **Figure 3**.

Figure 4 reflects the current development of Pointe Vista as of January 2022, and construction of all eleven phased is anticipated to continue through the year 2035.

Figure 4: Pointe Vista - Phase I Development

Photo 1: Pointe Vista - Bridge Pointe

Photo 2: Pointe Vista - Reflection Pointe

3.0 Existing Conditions

3.1 Environmental Setting

The project area is in the Eastern Cross Timbers region of Oklahoma. This ecoregion is characterized as having rolling hills, cuestas, long narrow ridges, and a few strongly dissected areas, and stream substrates are mostly comprised of quartz sand. The vegetation in this ecoregion is mostly cross-timbers (post oak, blackjack oak, little bluestem), and tall grass prairie (big bluestem, little bluestem, switchgrass, Indiangrass). The land cover is mostly grassland, pastureland, and woodland, with some cropland mixed in. The main crops are small grains, grain sorghum, forage sorghum, and peanuts.

Geologically, the uplands in the Eastern Cross Timbers ecoregion are mantled by Quaternary sand, gravel, silt, and clay decomposition residuum. Valleys are veneered with Quaternary alluvium, and the entire region is underlain by Cretaceous-age sand, shale, clay, sandstone, calcareous shale, and limestone.

The setting of the project area is primarily Lake Texoma which is owned and managed by the United States Army Corps of Engineers (USACE). The west end of the project is more developed and includes the Lake Texoma State Park and Catfish Bay Marina located adjacent to the lake on the south side of US-70. Closer to the existing highway, a gas station is on the south side with direct access to US-70. An existing golf course and the new Pointe Vista development currently under construction are on the north side of US-70. The east side of the project is more natural with wooded areas on both sides of the highway, and also includes the Johnson Creek Campgrounds on the north side of the US-70. On the east side of the bridge, most of US-70 is on a peninsula with the lake encroaching on the low-lying areas located on the north and south sides of the highway.

3.2 Roadway

Figure 5: Project Segments

The existing roadway varies in width across the project corridor with most of the corridor having two 12-foot lanes with 8-foot shoulder and guardrail. The corridor consists of six horizontal curves that range from 1 to 2 degrees and 400 to 1000 feet. See **Table 3** for existing horizontal curve information. The corridor has multiple vertical curves through the corridor with the largest curves at the east and west ends of the corridor. Refer to **Table 4** for existing vertical curve information. The following section breaks the corridor into 5 segments and describes the existing condition of each segment.

Table 3: Existing Horizontal Curve Evaluation

US-70 EXISTING HORIZONTAL CURVE EVALUATION								
Existing Curve Information							Required Design Criteria	
Curve	Survey Centerline P.I. Station	Radius	Degree	Degrees Minutes Seconds	Existing Length	Super Elevation %	Required Super (V=65MPH) *	Curve Length Required (975 FT)
1	170+26.23	5,729.58	1.00	01 00 00	479.06	3.2%	3.2%	975
2	139+59.09	5,729.58	1.00	01 00 00	905.69	3.2%	3.2%	975
3	159+11.45	5,729.58	1.00	01 00 00	527.31	3.2%	3.2%	975
4	225+63.57	2,864.84	2.00	02 00 00	1002.64	6.3%	5.5%	975
5	297+73.48	5,729.58	1.00	01 00 00	400.00	3.7%	3.2%	975
6	322+66.54	2,864.90	2.00	02 00 00	555.80	6.3%	5.5%	975

* Per AASHTO Criteria: Max Superelevation, Emax = 8%

Table 4: Existing Vertical Curve Evaluation

APPROXIMATE VERTICAL CURVE EVALUATION										
Design Speed: 65 mph										
Survey Centerline P.V.I. Station	G1	G2	Length (ft)	Classification	Computed K	Desired K	Required Length (ft)	Design Speed per K Value (mph)	4R	3R
West Approach										
110+46.67	-1.38	-0.55	200	Sag	240.96	157.00	130.31	80	Yes	Yes
125+27.17	-0.55	1.16	800	Sag	467.84	157.00	268.47	80	Yes	Yes
136+00.00	1.16	0.30	400	Crest	465.12	193.00	165.98	80	Yes	Yes
152+98.44	0.30	-4.90	1200	Crest	230.77	193.00	1003.60	65	Yes	Yes
164+29.68	-4.90	0.00	700	Sag	142.86	157.00	769.30	60	No	Yes
East Approach										
221+12.87	0.00	-0.30	200	Crest	666.67	193.00	57.90	80	Yes	Yes
224+70.30	-0.30	-0.26	200	Sag	5000.00	157.00	6.28	80	Yes	Yes
229+10.06	-0.26	0.12	200	Sag	526.32	157.00	59.66	80	Yes	Yes
234+59.11	0.12	-0.02	200	Crest	1428.57	193.00	27.02	80	Yes	Yes
250+68.97	-0.02	0.15	200	Sag	1176.47	157.00	26.69	80	Yes	Yes
255+50.00	0.15	-0.11	200	Crest	769.23	193.00	50.18	80	Yes	Yes
290+81.90	-0.11	0.20	200	Sag	645.16	157.00	48.67	80	Yes	Yes
299+07.72	0.20	-0.11	200	Crest	645.16	193.00	59.83	80	Yes	Yes
312+99.93	-0.11	0.08	200	Sag	1052.63	157.00	29.83	80	Yes	Yes
324+87.44	0.08	-0.10	200	Crest	1111.11	193.00	34.74	80	Yes	Yes
336+17.19	-0.10	0.12	200	Sag	909.09	157.00	34.54	80	Yes	Yes
349+90.99	0.12	-0.14	200	Crest	769.23	193.00	50.18	80	Yes	Yes
359+19.59	-0.14	0.12	200	Sag	769.23	157.00	40.82	80	Yes	Yes
362+17.57	0.12	-0.04	200	Crest	1250.00	193.00	30.88	80	Yes	Yes
366+77.77	-0.04	2.93	300	Sag	101.01	157.00	466.29	50	No	Yes
377+77.77	2.93	0.00	400	Crest	136.52	193.00	565.49	55	No	Yes
385+77.77	0.00	6.00	600	Sag	100.00	157.00	942.00	50	No	Yes

3.2.1 Segment Overview

3.2.1.1 Segment 1: West End

Segment 1 of the corridor extends from the intersection of US-70 and State Park Road to the western abutment of the Roosevelt Memorial Bridge. The three-legged State Park Road intersection lane configuration includes a right turn only lane drop for eastbound traffic, a second westbound through lane added just east of the intersection, and a flared northbound approach that can accommodate right turning traffic. US-70 transitions from a five-lane cross-section (four 12-foot lanes and one 16-foot two way left turn lane (TWLTL) with 10-foot shoulders) at the intersection of State Park Road to two 12-foot lanes with 10-foot shoulders at the approach of the bridge. This segment contains a 1-degree horizontal curve that is superelevated to 3.2% at 65 mph as well as a 1200' crest vertical curve and a 700' sag vertical curve just west of the bridge approach.

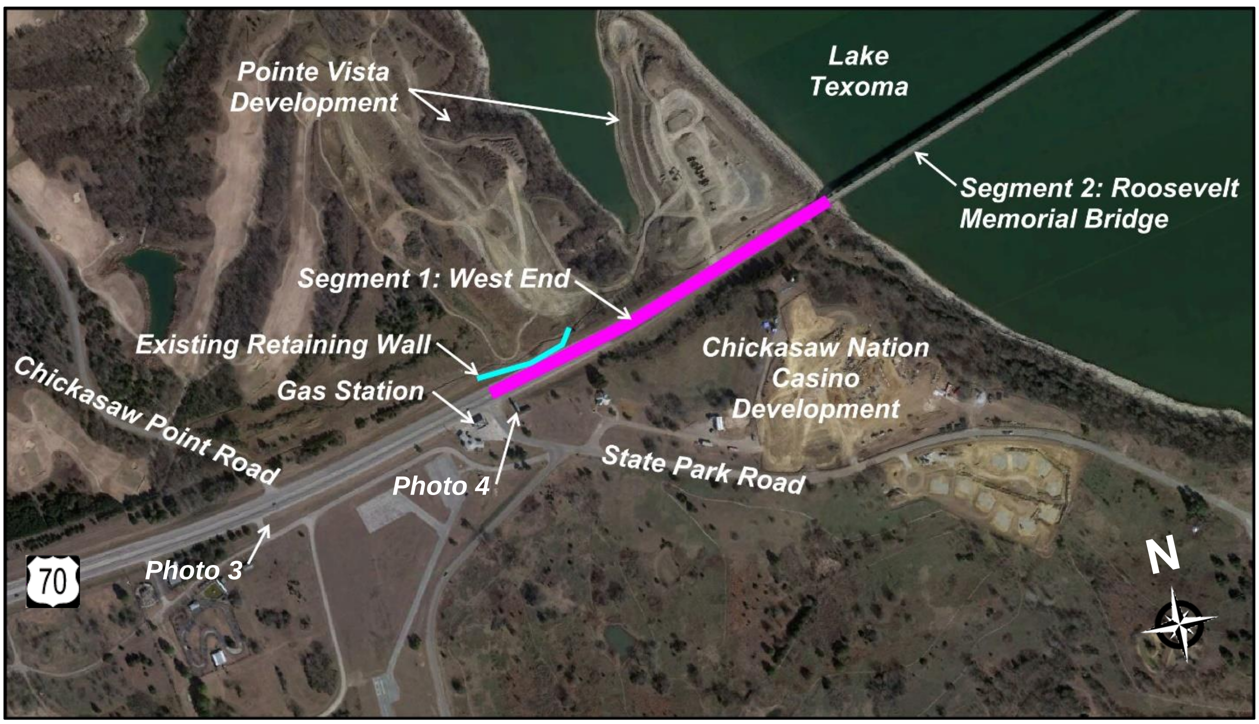


Figure 6: Segment 1 – West End

Photo 3: State Park Road Looking East

Photo 4: Looking East near Chickasaw Pointe

Intersection sight distance at State Park Road was observed in the field and the presence of signage and vertical elevation changes contribute to less visibility at this stop-controlled intersection. The available sight distance at State Park Road is approximately 700 feet for vehicles traveling eastbound on US-70, which is considered substandard based on the intersection sight distance requirements for single-unit and combination trucks to conduct a maneuver from a stop condition on a minor street to a major street in either direction. Required sight distance was calculated in accordance with the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets*.

Segment 1 also features a retaining wall on the north side of US-70 near the Chickasaw Pointe Golf course (**Photo 3**). Refer to *Section 3.4.2* for additional information of the existing retaining wall.

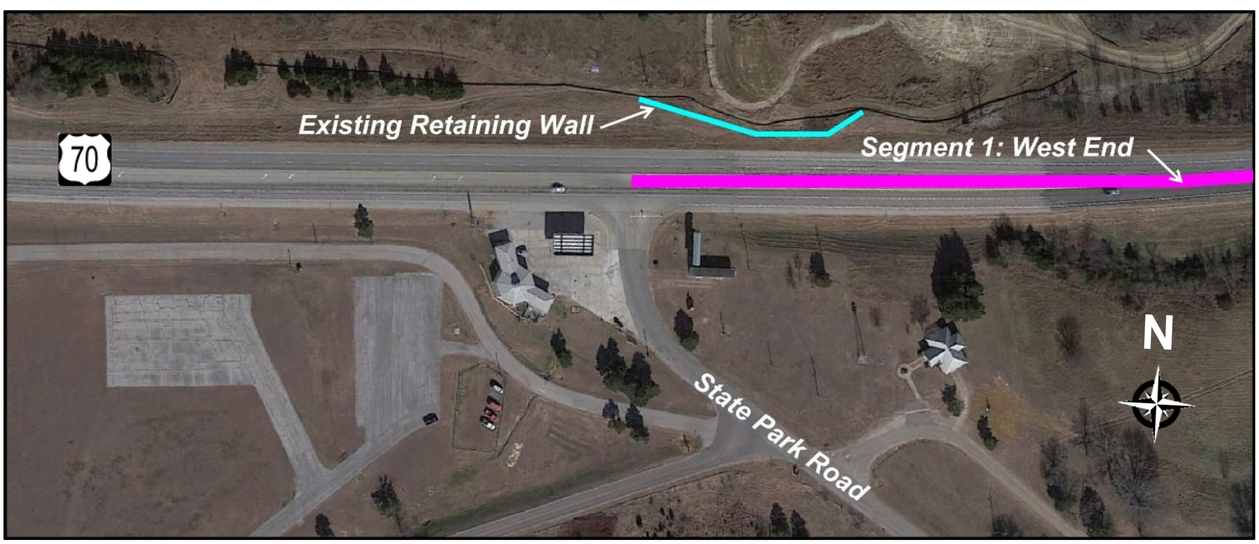


Figure 7: Segment 1 - State Park Road Intersection

3.2.1.2 Segment 2: Roosevelt Memorial Bridge

Segment 2 of the corridor includes the full length of the existing Roosevelt Memorial Bridge (approximately 4,943 feet) that carries US-70 eastbound and westbound traffic across Lake Texoma. The existing section on the bridge features two 12-foot lanes without shoulders, metal traffic rail, and a speed limit of 55 miles per hour. There is one navigational span that consists of a 250-foot Warren through-truss. See *Section 3.4* for additional details regarding the existing bridge section.

This segment has a crowned cross-section with approximately 2% cross slope, does not have horizontal curve, and has a zero-percent vertical grade. The vertical clearance at the Warren through-truss is posted for 14'-9" and is considered a substandard functional feature for current roadway criteria. Overhead power lines run along the south side of the roadway, supported by utility towers that are connected to the Roosevelt Memorial Bridge.

Figure 8: Segment 2 - Roosevelt Memorial Bridge

Photo 5: Roosevelt Memorial Bridge – Looking Northeast

Photo 6: West Approach Looking East

3.2.1.3 Segment 3: Lake Causeway

Segment 3 of the corridor consists of the lake causeway that extends from the eastern abutment of the Roosevelt Memorial Bridge to the west shoreline of Lake Texoma. The existing section for this segment is two 12-foot lanes with 8-foot shoulders and guardrail on both sides, with a 65 mile per hour speed limit. Aluminum guardrail parallels the existing roadway on both sides through the entire segment.

The segment has a 2-degree horizontal curve with 5.8% superelevation near the east end of the bridge. The profile through this section is flat with grades between -0.2% and 0.2%. This segment of the corridor has overhead power lines running along the south side of the road with crossings throughout.

Figure 9: Segment 3 - Lake Causeway

Photo 7: Lake Causeway - Looking East

Photo 8: Lake Causeway - Looking West

The roadway section also includes fore slopes at approximately 1:2 to an elevation of 620' then approximately 1:3 to the bottom of the lake. The fore slopes are armored with rip rap from the elevation of 620' to the bottom of the lake. The below **Figure 10** is taken from the Record (As-Built) Drawings found in **Appendix T**.

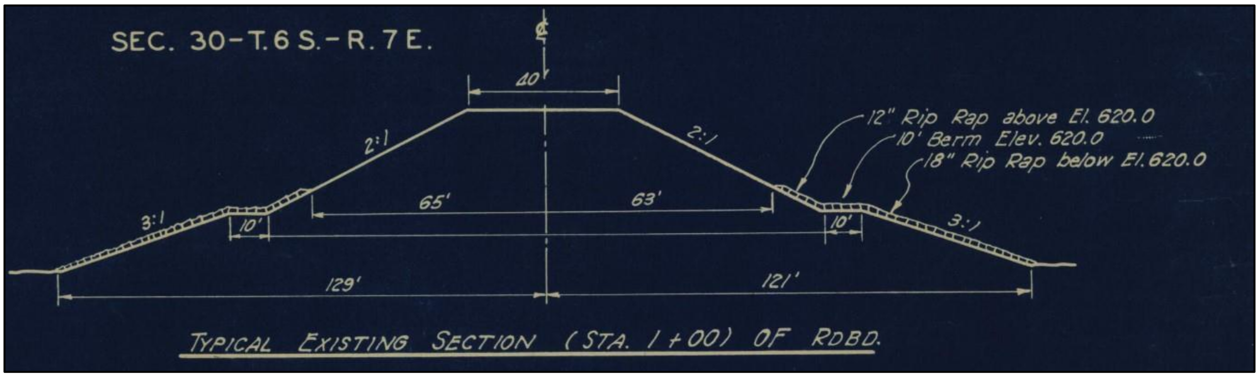


Figure 10: Existing Causeway Typical

The existing causeway consists of clayey sand from the top of the causeway to 45 feet deep then changes to poorly graded sand before terminating in weathered shale 70 feet deep (See **Appendix O** for additional Geotechnical Data)

3.2.1.4 Segment 4: Land Causeway

Segment 4 of the corridor consists of the land causeway that extends 9,000 feet from the west shoreline of Lake Texoma east to the Willow Springs Road/Johnson Creek Road intersection. The existing section for this segment is two 12-foot lanes with 8-foot shoulders and guardrail paralleling the roadway on both sides.

The existing causeway is made of the same material as Segment 3 – a clayey fill material with poorly graded sand underneath. The surrounding area of the land causeway is low lying marsh area. The segment contains 2 driveways, one on the north side of US-70 and one on the south side of US-70 that lead out into the low-lying marsh area and eventually to the Lake Texoma shoreline.

The segment has a 1-degree horizontal curve with 3.2% superelevation and a 2-degree horizontal curve with 5.8% superelevation. The profile through this section is the same as the lake causeway section with small flat grades. Overhead powerlines continue through this segment along the south side of US-70.

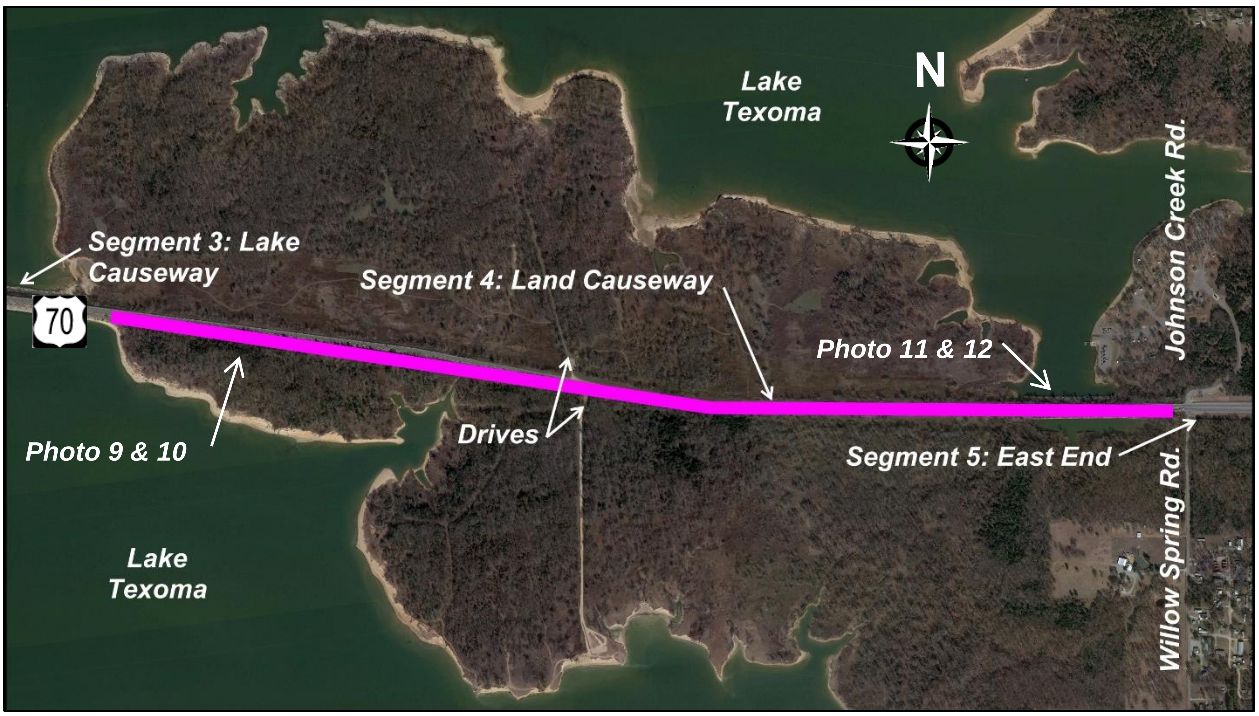


Figure 11: Segment 4 – Land Causeway

See the following page for Segment 4 overview photos of the existing land causeway features.

Segment 4 Overview Photos

Photo 9: Segment 4 - Memorial Highway Sign

Photo 10: Segment 4 Begin - Looking East

Photo 11: Segment 4 (End) - Looking East

Photo 12: Segment 4 (End) - Looking West

3.2.1.5 Segment 5: East End

Segment 5 of the corridor is the east end of the alignment approaching the Willow Springs Road/Johnson Creek Road stop-controlled intersection. Approaching the intersection from the west, the cross-section features two 12-foot lanes with a middle lane transition taper. Each side of the roadway include 8-foot wide shoulders with guardrails and terminate at the intersection (**Photo 13**).

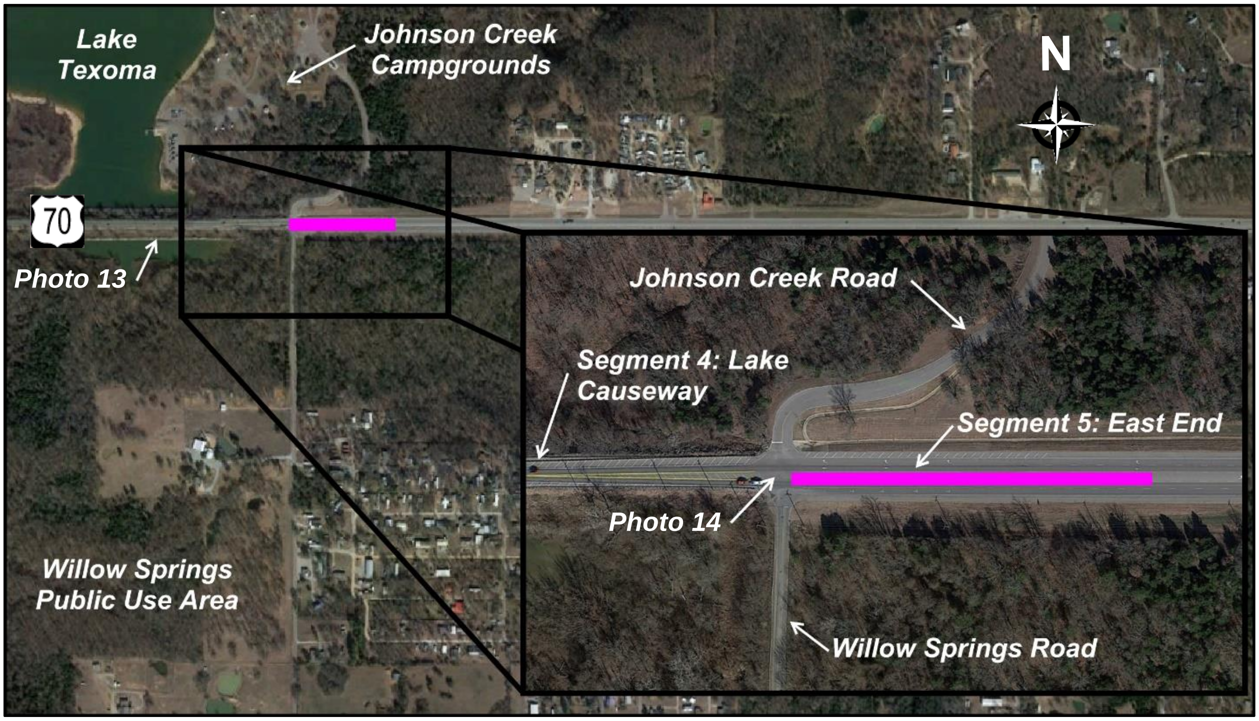


Figure 12: Segment 5 – East End

The east side of the intersection features five 12-foot lanes, including a westbound right and left turn lane, along with 10-foot shoulders and a 1:6 fore slope to the clear zone (**Photo 14**). The north side of US-70 has a standard 8-foot ditch that parallels the roadway to a side drain under Johnson Creek Road. The south side of US-70 has a fill slope out to the right-of-way.

The horizontal alignment through this section is straight tangent with a 300’ sag vertical curve near the intersection of Willow Springs Road/Johnson Creek Road and US-70. With a 65 mile per hour speed limit, inadequate intersection sight distance at Willow Springs Road/Johnson Creek Road was observed in the field. Visibility is obstructed for vehicles attempting to make a left turn from the minor side street of Willow Springs Road onto US-70 due to the presence of trees, power poles, signage, and guardrails located adjacent to the corridor. Approximately 650 feet of distance is offered from Willow Springs Road and Johnson Creek Road with vehicles traveling eastbound on US-70, a substandard distance according to AASHTO for intersection sight distance requirements regarding a left-turn maneuver from a minor street to a major street.

Photo 13: Lake Causeway - Looking East

Photo 14: US-70 and Willows Spring Rd./Johnson Creek Road Intersection - Looking East

3.2.2 Existing Traffic Volumes and Capacity

Traffic volumes were collected in May 2021 (to reflect warm-weather conditions and capture school traffic) and summarized into design traffic volumes. **Figure 13** reflects the traffic volumes observed at US-70 and State Park Road and US-70 at Willow Springs Road/Johnson Creek Road. An analysis of the 7-day volumes on US-70 were taken into account to determine any variations of daily traffic – reflecting a slight increase on Thursday volumes compared to the 24-hour data collected on a Tuesday. To account for the variability of traffic volumes during a typical week, the 24-hour turning movements were adjusted accordingly.

US-70 currently carries approximately 8,500 vehicles per day across the Roosevelt Memorial Bridge with 9% truck volume. State Park Road carries approximately 1,750 vehicles per day, and Willow Springs Road/Johnson Creek Road carries approximately 1,200 vehicles per day.

Level of Service (LOS) analysis was conducted for the intersections at US-70 and State Park Road and US-70 and Willow Springs Road/Johnson Creek Road. LOS is a concept defined by the Highway Capacity Manual, 6th Edition (HCM) (Transportation Research Board, 2016) to define the quality of operations through six categories: LOS A through LOS F, with LOS A indicating low delay, free flow conditions while LOS F indicates that demand exceeds capacity. All movements, at both study intersections, resulted in a LOS B or better for the existing 2021 design volumes (**Table 5**).

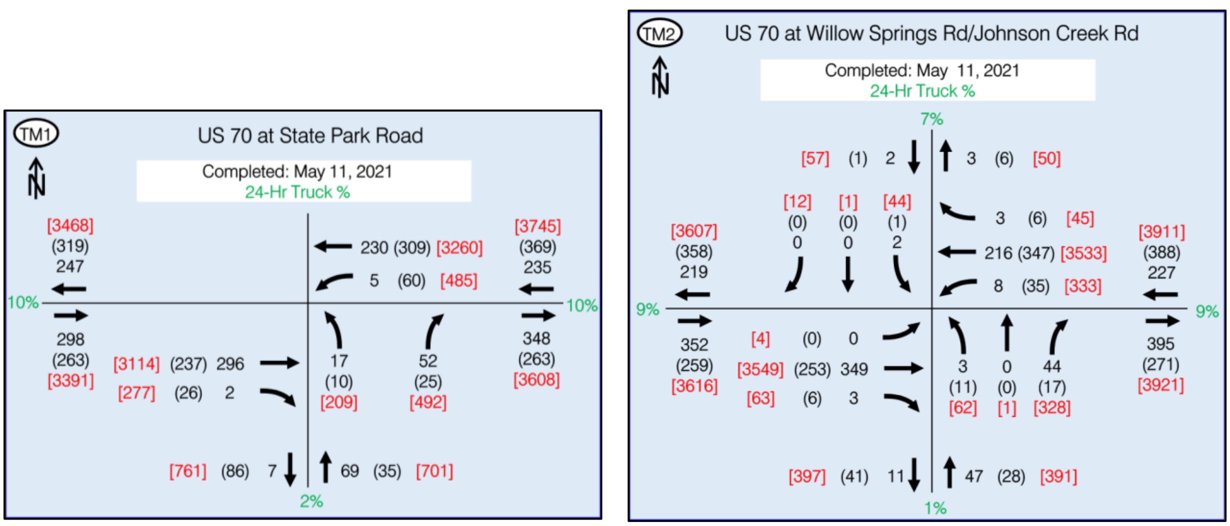


Figure 13: Traffic Volumes

Table 5: 2021 Existing Analysis Results

Time Period	Analysis Means	MOE	EB Movement			WB Movement			NB Movement			SB Movement			Overall
			Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
US-70 at State Park Road															
AM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]		A						A
AM	HCM	Delay		n/a[1]	n/a[1]	8.2	n/a[1]		9.5						1.3
AM	SimTraffic	LOS		A	A	A	A		A		A				A
AM	SimTraffic	Delay		2.1	1.0	1.6	0.5		8.0		2.1				1.7
PM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]		A						A
PM	HCM	Delay		n/a[1]	n/a[1]	8.2	n/a[1]		8.4						1.2
PM	SimTraffic	LOS		A	A	A	A		A		A				A
PM	SimTraffic	Delay		1.7	1.1	2.1	0.5		8.8		1.9				1.3
US-70 at Willow Springs Road/Johnson Creek Road															
AM	HCM	LOS	A	n/a[1]		A	n/a[1]		B			B			A
AM	HCM	Delay	8.0	n/a[1]		8.5	n/a[1]		12.7			13.2			1.2
AM	SimTraffic	LOS	n/a[1]	A	A	A	A	A	A	A	A	n/a[1]	A	A	A
AM	SimTraffic	Delay	n/a[1]	1.2	0.0	2.4	1.6	0.5	8.0	6.2	3.2	n/a[1]	7.3	2.7	1.5
PM	HCM	LOS	A	n/a[1]		A	n/a[1]		B			B			A
PM	HCM	Delay	8.4	n/a[1]		8.1	n/a[1]		14.1			13.4			1.1
PM	SimTraffic	LOS	n/a[1]	A	A	A	A	A	A	A	A	A	A	A	A
PM	SimTraffic	Delay	n/a[1]	1.4	0.2	3.1	2.5	1.2	7.5	8.0	3.1	3.4	9.1	5.9	2.2

[1] free movement

Additional analysis was completed utilizing the Highway Capacity Software 7 (HCS7) for the existing two-lane bridge facility to determine the segment LOS, which is a level of service parameter quantifying the proximity of other vehicles and is directly related to the freedom to maneuver within the traffic stream. The existing Roosevelt Memorial Bridge segment operates at LOS C for both the AM and PM peak periods.

The intersection sight distance at both intersections of US-70 and State Park Road, and US-70 and Willow Springs Road/Johnson Creek Road is considered substandard for safe vehicular movements from a minor street to a major street. The sight distance is typically reduced by the presence of trees, power poles, signage, and guardrails.

Refer to *Section 4.1.2* for information on future traffic volumes and analysis conducted for No-Build and Build scenarios. Refer to **Appendix N** for additional information of the traffic analysis.

3.2.3 Safety

3.2.3.1 Crash History

Crash data was collected using ODOT's Safe-T Database over a five-year period from 2015 to 2019. The historical crash data was used to determine crash statistics based on occurrence, severity, and road conditions, along with crash frequency and hot spot locations of the crashes. A total of 52 crashes occurred within the corridor limits over the five-year period, with 18 crashes classified as intersection related at the two adjacent intersections of State Park Road and Willow Springs Road/Johnson Creek Road.

Approximately one-third of the total collisions were classified as intersection-related with the two adjacent intersections which can be attributed to the limited sight distances and high travel speeds along US-70. Nine fixed-object collisions also occurred alongside the roadway of the study area, including stationary items such as guardrails, a tree, traffic signage, and a curb.

3.2.3.2 Left of Center Protection

The truss span of the Roosevelt Memorial Bridge experienced five crashes over the five-year period which crash data was collected. These crashes resulted in one fatal collision, two non-incapacitating injury collisions, and two property damage only collisions. The roadway at the truss span has a vertical confinement and no shoulders which could cause drivers to move towards the centerline and potentially cross over into opposing traffic and cause a collision. Possible solutions for this issue at the truss span include provision of a median, widen to two-lanes in each direction, rumble strips on the centerline and outside shoulder, and a shoulder provision.

Segments 3 and 4 consisting of the Lake and Land Causeways do not have a median to protect drivers from crossing into the opposite lane, and the most common crash type occurred left of center (19% of the 52 total crashes in this area). Installation of any type of median barrier would result in a 43% reduction of fatal crashes (CMF ID: 42).

3.2.3.3 Passing Opportunities

Segment 2 (Roosevelt Memorial Bridge) does not provide opportunities for vehicles to pass for the entire 4,493 feet length of bridge. Segment 3 and 4 (Lake and Land Causeway) does include a passing zone for vehicles to use the opposing lane along an unlit portion of the corridor. Adding additional lanes in each direction would allow for safer methods for vehicles to pass one another.

3.2.3.4 Shoulders and Vehicular Refuge

The Roosevelt Memorial Bridge lacks shoulders for the entire bridge length, which does not provide safe refuge for disabled vehicles traveling across Lake Texoma. Adding shoulders would increase safety by providing a recovery area for drivers who leave the travel lane, provide an area for drivers to maneuver to avoid crashes, and offer space for maintenance activities.

3.2.3.5 Roadway Illumination

The only portion of the corridor that is illuminated is the Roosevelt Memorial Bridge. Crashes occurring in darkness or twilight hours accounted for 17% of the total crashes. Providing street lighting throughout the entire route could result in a 37% reduction for night-time, injury related collisions according to CMF Clearinghouse (CMF ID: 7774).

3.2.3.6 Fixed-Object Related Collisions

Nine fixed object collisions occurred throughout the study corridor, which attributed to 17% of the total crashes. A summary of the number of collisions and type of fixed-object are as follows:

1 - Traffic Sign	6 - Guardrail or Barrier
1 - Tree	1 - Curb

Removing or relocating fixed objects outside of a clear zone could result in a 38% reduction of crashes. An increase in the outside shoulder width would allow additional clearance from objects located on the route, such as guardrails, signs, and curbs. It is anticipated that a reduction in fixed-object related collisions would occur with this additional width added to the shoulders.

3.3 Hydrology and Hydraulics

A hydraulics study was performed for the existing bridge along US-70 over Lake Texoma. The bridge is located on the Washita River arm of Lake Texoma and is mapped by FEMA as an AE Zone (the Bryan County portion). Data collected from resources including the USACE and recent flood events were used to determine the hydraulic impact of flows at the bridge under natural and existing condition. Additional analysis modeling techniques are further defined in Section 4.5 of this report.

3.3.1 Denison Dam Elevation and Probability Curves

The Denison Dam is located approximately 15.0 miles downstream of the Roosevelt Bridge and serves as flood control for Lake Texoma. Flood control elevations at the Dam were extrapolated to analyze the hydraulic conditions at the bridge.

The Lake Texoma water elevations reported in this section utilized different vertical datum references based on the agency or time of measurement. The vertical datums used are as follows:

- Denison Dam Control Elevations – NGVD29
- Hydraulic modeling and results – NAVD88
- Existing Conditions based on as-builts plans – NGVD29

The conversion from NGVD29 to NAVD8 in Bryan County, Oklahoma is +0.15 feet, according to the Flood Insurance Study (FIS), created by the Federal Emergency Management Agency (FEMA) (FEMA, 2011).

A summary of elevations are as follows:

- Gauged - USGS:07331500
- Vertical Datum – NGVD29

- Denison Dam Control Elevations (Water Data For Texas)
  - Normal Pool 617.00’
  - Flood Control Pool 640.00’
  - Maximum Design Elevation 666.40’
  - Top of Dam Elevation 670.00’
  - Conservation Pool 616.50’
  - Low Water Elevation 590.00’
  - Design Water Elevation 585.00’
  - Dead Pool elevation 523.00’

Pool elevation probability curves are used to determine the probability of water surface elevations given a period of time. The following table was developed by the USACE for Lake Texoma.

Table 6: Lake Texoma Storm Event Summary

Frequency	Annual Frequency	Pool Elevation
0.99	1-Yr	611.0
0.5	2-Yr	621.0
0.2	5-yr	628.8
0.1	10-Yr	636.0
0.05	20-Yr	641.0
0.04	25-yr	642.0
0.02	50-Yr	646.0
0.01	100-Yr	646.5
0.005	200-Yr	647.0
0.004	250-Yr	647.1
0.002	500-Yr	647.3

3.3.2 Geometric Data Specific to Hydraulics

Summary of data (as can be found in **Appendix U** – Existing Plan sets))

- High Elevation of causeway = 649.0’ (Plan Set FAP F-59(4) – Sheet 8)
- Low Elevation of causeway = 643.4’ (Plan Set FAP F-59(4) – Sheet 11)
- Top of bridge deck = 649.0’ (USACE – February 1942, As-built)
- Low beam (approach span) = 642.2’ (USACE – February 1942, As-built)
- Low beam (truss span) = 645.29’ (USACE – February 1942, As-built)

3.3.3 Existing Bridge and Approach Roadway Hydraulics

The existing Roosevelt bridge was analyzed as a 4,943.1-foot-long bridge with 88 piers of varying span lengths. Based on the design methodologies in *Section 4.5* and the definitions presented in the previous sections of the report, the existing Roosevelt Bridge hydraulic conditions were analyzed. The bridge itself has an over-topping frequency greater than the 500-yr. However, the causeway overtops between the 25-yr and the 50-yr, in the Segment 4 (Land Causeway) at an elevation of 645.6.

3.4 Structures

3.4.1 Franklin D. Roosevelt Memorial Bridge

Within the project limits there is one bridge structure, US-70 over Lake Texoma, Franklin D. Roosevelt Memorial Bridge (Roosevelt Memorial Bridge) and was determined eligible for inclusion in the National Register of Historic Places (NRHP). The Roosevelt Bridge has a structure length of 4,943 feet and was constructed in 1942 by the U.S. War Department prior to the construction of the Denison Dam on the Red River, which led to the formation of Lake Texoma (**Photo 15**).

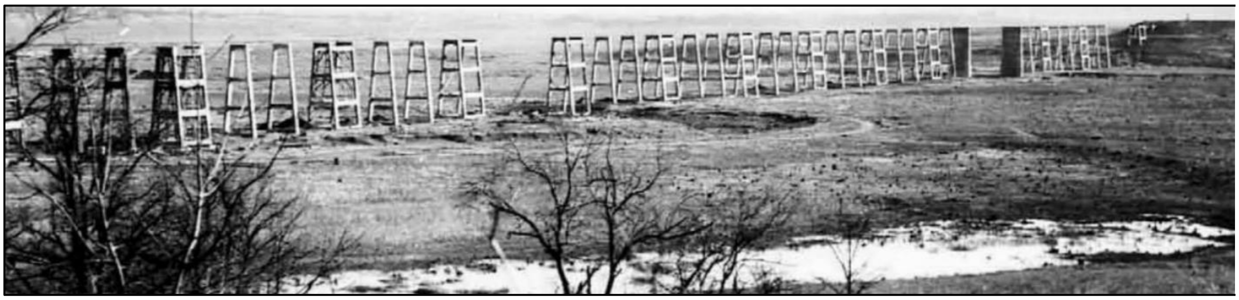


Photo 15: Roosevelt Memorial Bridge - Construction

Photo 16: Bridge Overview

Photo 17: Bridge Section

Photo 18: Bridge Warren Through-Truss

The structure typically has span lengths varying from 36’ to 62’, with one 250’ steel Warren through-truss navigational span (**Photo 18**) with a posted vertical clearance of 14’-9”.

The typical superstructures consists of floor beams that transfer loadings from the deck to the steel stringers that transfer loadings longitudinally to the substructure supports. The Roosevelt Bridge is currently considered “at-risk” due to deterioration of the ends of the floor beams. Additionally, the traffic rail attached to the bridge is composed of W-shape posts anchored to the concrete curb and each floor beam. The current condition of the rail is heavily deteriorated and has effectively no structural capacity in various locations throughout the bridge due to broken connections. Active overhead power utilities are carried by utility towers, which are connected to the floor beams and southern girder. These utility towers overhang the south edge of the structure by approximately 9’ and stand 26’ above the top of roadway.

3.4.2 Retaining Wall

Along the north of US-70, near the State Park Road intersection, there is an existing geosynthetic reinforced segmental retaining wall with a Chickasaw Pointe Golf Resort placard attached to the southern face, and a steel rail post fencing running along the top of the wall for pedestrian protection (**Photo 19**). The wall is approximately 80’ from the centerline of US-70, and varies in height from 2.5-to-20-feet high, and is 315’ long with the western 150’ and eastern 55’ ends of the wall flared away from the roadway and the remaining length running parallel to US-70. The retained soil does not support any permanent structures but has a paved path within 30’ of the face of the wall.

Photo 19: Existing Retaining Wall

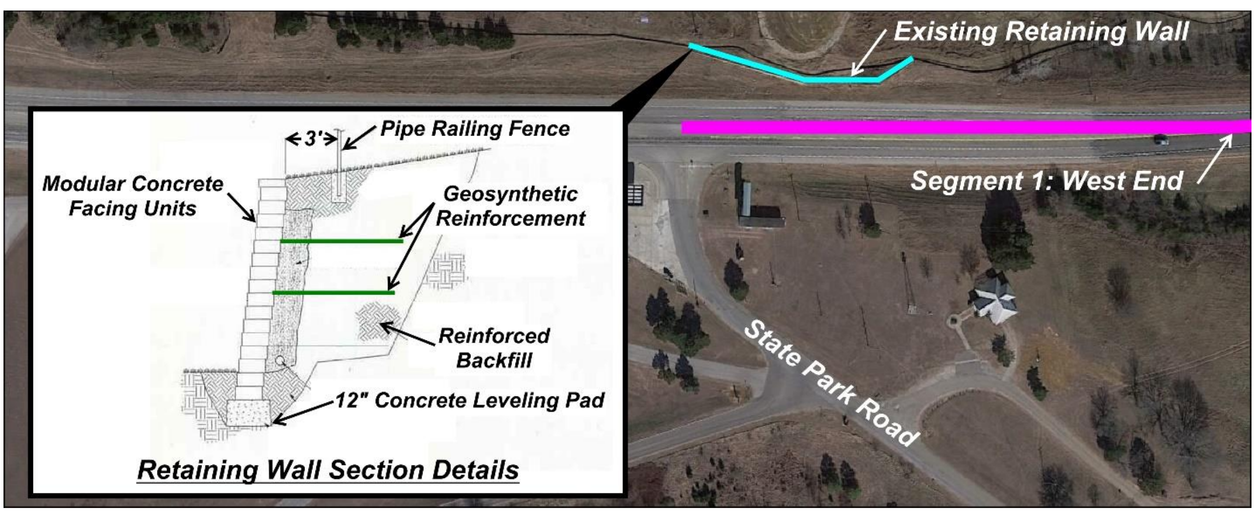


Figure 14: Existing Retaining Wall Overview

3.5 Lighting

Throughout the entire study corridor there is only lighting provided for US-70 throughout the bridge section, with the exception of one light at the intersection of US-70 and Willow Springs Road/Johnson Road. Lighting at all locations appear to be functional.

Photo 20: Typical Bridge Lighting

The bridge lighting is attached to the utility towers on the south side of the bridge and are typically spaced at 440', with the last light located approximately 100' from the east end of the bridge supported on a light pole foundation.

The light pole at the US-70 and Willow Springs Road/Johnson Creek Road intersection is located on the south side of the road and offset 25' from the edge of east bound lane.

3.6 Utilities

Existing utilities within the project study area include waterlines, overhead power lines, gas lines, sanitary sewer lines, fiber optic lines and underground telephone lines. The majority of the utilities in the project area run parallel along the southside of the existing roadway with a few crossings near the state park facility on the west and Willow Springs Road/Johnson Creek Road intersection on the east end of the project area. See **Table 7** for utility owners within project study area.

Table 7: Public and Privately Owned Utilities List

Electric Transmission Lines	
Red River Valley	Wire Power Overhead
OGE	Wire Power Overhead
Southeastern ElectricCoop	Wire Power Overhead
Pipe Lines	
Lake Texoma CNP	Gas Main Size & Type Unknown
	Gas Service Size & Type Unknown
	Gas Main Size & Type Unknown
Bryan County Water RWD2	Water Main
Telephone Lines	
OCAN-OneNet	Fiber Optic - Underground
	Fiber Optic - Overhead

3.7 Right-of-Way

Starting on the west end of the study corridor the existing right-of-way ranges from 65 feet to 180 feet on the south side and 75 feet to 185 feet on the north side of the existing US-70 survey centerline.

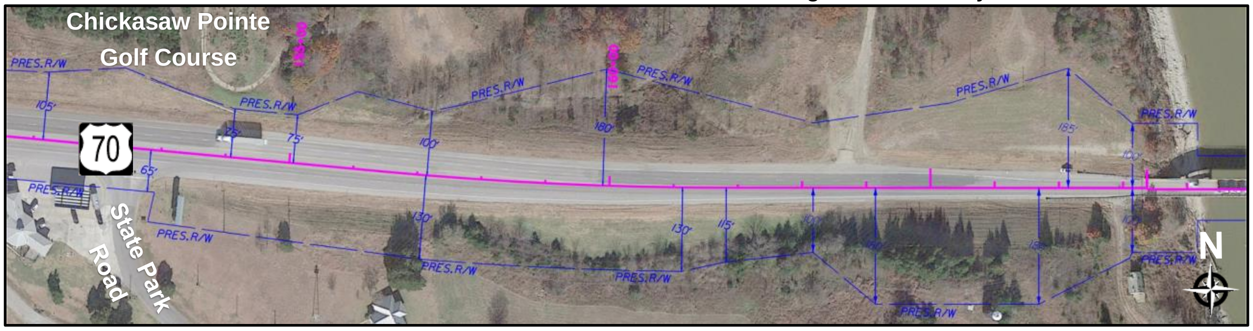


Figure 15: Present Right-of-Way West End

The present right-of-way starting on the west end of the existing bridge stretches 100' across the bridge approximately 50 feet to the south and 50 feet to the north for the entire length of the bridge.

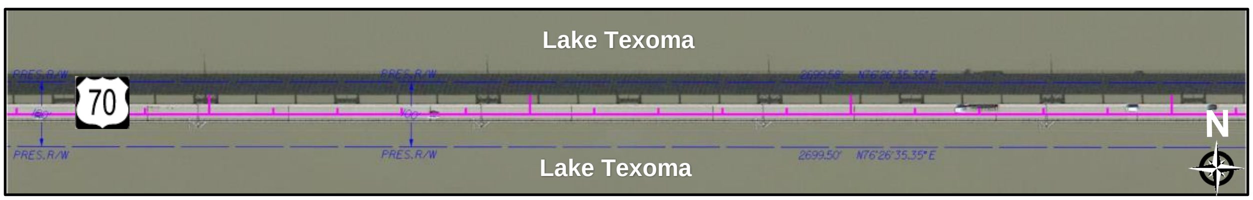


Figure 16: Present Right-of-Way

The east end of the bridge the right-of-way increases to 170 feet to the north and south for about 163 feet along the alignment. The lake causeway has an existing right-of-way dimension of 80 feet to the north and 80 feet to the south of the survey centerline.

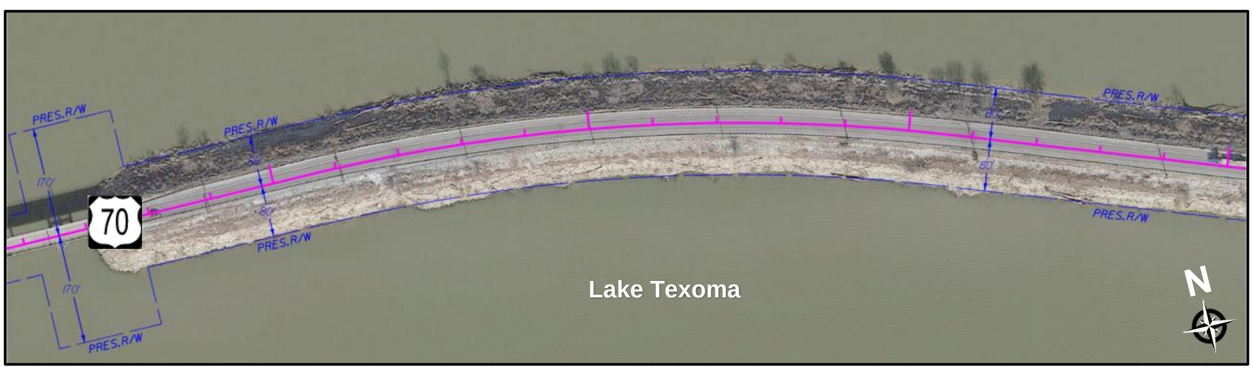


Figure 17: Present Right-of-Way Lake Causeway

The land causeway has a present right-of-way offset of 60 feet to the north and the south for a majority of the causeway with a few areas that extend out to 100 feet and 75 feet.

Figure 18: Present Right-of-Way Land Causeway

At the willow springs intersection, the present right-of-way is 75' to the north and south of the existing alignment on the west side of the intersection and 60' north and south on the east side of the intersection.

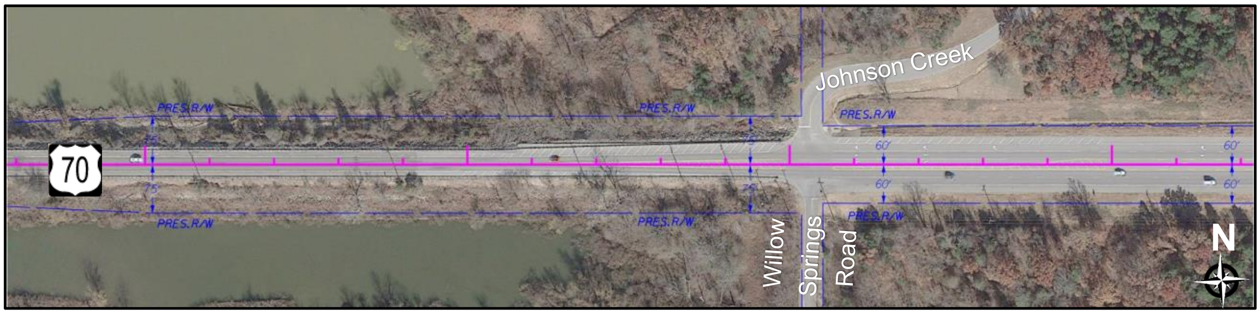


Figure 19: Present Right-of-Way East End

Properties located within the study corridor area are mainly Lake Texoma with a state park, a golf course, tribal land, and other future development on the west side of the alignment and a state park on the northeast side of the alignment.

4.0 Design Methodology, Analysis and General Information

4.1 Traffic

4.1.1 Traffic Evaluation Methodology

The following manuals, software, and resources were used for computing level of service, required sight distances, and obtaining data for the US-70 study corridor.

- The Highway Capacity Manual (HCM), 6th Edition (Transportation Research Board, 2016)
- AASHTO A Policy on Geometric Design of Highways and Streets (AASHTO, 2018)
- ODOT Safe-T Database
- Synchro 11 Analysis software
- Highway Capacity Software 7 (HCS7)
- Manual on Uniform Traffic Control Devices (MUTCD)
- Highway Safety Software (HSS)
- Field Observations for sight distance and existing conditions.

4.1.2 Future Traffic Conditions

Analysis was completed for the No-Build and Build scenarios for the future 2050 year at the study intersections using Synchro 11 software, and along US-70 mainline utilizing HCS7 software.

4.1.2.1 Traffic Analysis – No-Build Capacity Analysis

The existing traffic volumes were grown and analyzed to predict operational conditions in the proposed design year of 2050 if no changes were made to the existing configuration of the roadway, referred to as the No-Build condition. Utilizing current 2021 volumes, analysis was completed and is described in *Section 3.2.2* as a baseline for the current conditions operating at the adjacent intersections and along US-70 mainline.

For the 2050 No-Build (background growth only) analysis, intersection conditions worsen by 2050, but all movements will operate at LOS C conditions or better (**Table 8**). Results for the No-Build bridge facility indicated LOS D results for both the AM and PM peak periods for the 2050 (background growth only) design volumes.

For the 2050 No-Build (with development) analysis, intersection conditions show significant delay with LOS E and LOS F results on the side street movements (**Table 9**). With the Pointe Vista proposed development added, the segment LOS worsens on the Roosevelt Memorial Bridge with LOS E conditions on US-70 during both peak periods. The two-lane bridge would be a bottleneck under this scenario.

Table 8: 2050 (background growth only) No-Build Analysis Results

Time Period	Analysis Means	MOE	EB Movement Left	EB Movement Thru	EB Movement Right	WB Movement Left	WB Movement Thru	WB Movement Right	NB Movement Left	NB Movement Thru	NB Movement Right	SB Movement Left	SB Movement Thru	SB Movement Right	Overall
US-70 at State Park Road															
AM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]			B					A
		Delay		n/a[1]	n/a[1]	8.8	n/a[1]			11.0					1.5
	SimTraffic	LOS		A	A	A	A		B		A				A
		Delay		3.0	1.2	2.9	0.5		12.5		2.3				2.3
PM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]			A					A
		Delay		n/a[1]	n/a[1]	8.8	n/a[1]			9.3					1.3
	SimTraffic	LOS		A	A	A	A		B		A				A
		Delay		2.7	1.2	3.2	0.5		14.2		2.0				1.8
US-70 at Willow Springs Road/Johnson Creek Road															
AM	HCM	LOS	A	n/a[1]		A	n/a[1]			C			C		A
		Delay	8.4	n/a[1]		9.2	n/a[1]			18.6			16.8		1.8
	SimTraffic	LOS	A	A	A	A	A	A	B	C	A	A	A	A	A
		Delay	1.8	1.5	0.1	4.8	2.0	0.9	13.0	18.0	3.4	5.7	8.0	3.2	2.0
PM	HCM	LOS	A	n/a[1]		A	n/a[1]			C			C		A
		Delay	9.0	n/a[1]		8.6	n/a[1]			21.3			17.0		1.5
	SimTraffic	LOS	A	A	A	A	A	A	B	B	A	C	C	A	A
		Delay	1.9	2.1	0.2	5.2	3.8	1.3	11.3	14.8	4.1	24.6	16.8	6.2	3.4

[1] free movement

Table 9: 2050 (with development) No-Build Analysis Results

Time Period	Analysis Means	MOE	EB Movement Left	EB Movement Thru	EB Movement Right	WB Movement Left	WB Movement Thru	WB Movement Right	NB Movement Left	NB Movement Thru	NB Movement Right	SB Movement Left	SB Movement Thru	SB Movement Right	Overall
US-70 at State Park Road															
AM	HCM	LOS		n/a[1]	n/a[1]	B	n/a[1]			C					A
		Delay		n/a[1]	n/a[1]	12.8	n/a[1]			16.9					0.7
	SimTraffic	LOS		A	A	C	A		F		A				A
		Delay		8.3	2.6	18.7	0.6		114.3		2.6				6.2
PM	HCM	LOS		n/a[1]	n/a[1]	B	n/a[1]			F					B
		Delay		n/a[1]	n/a[1]	14.6	n/a[1]			145.4					14.4
	SimTraffic	LOS		A	A	C	A		F		F				F
		Delay		7.1	3.0	21.8	0.7		1191.2		1051.8				70.9
US-70 at Willow Springs Road/Johnson Creek Road															
AM	HCM	LOS	B	n/a[1]		B	n/a[1]			F			E		A
		Delay	10.8	n/a[1]		12.5	n/a[1]			181.3			46.9		7.9
	SimTraffic	LOS	A	A	A	C	A	A	E	n/a[1]	A	E	C	B	A
		Delay	2.4	2.2	0.1	16.0	5.1	1.2	36.2	n/a[1]	4.4	43.6	15.8	14.0	3.7
PM	HCM	LOS	B	n/a[1]		B	n/a[1]			F			F		E
		Delay	14.7	n/a[1]		13.0	n/a[1]			1833.8			66.1		41.1
	SimTraffic	LOS	A	A	A	C	C	A	F	F	F	F	F	F	C
		Delay	7.9	2.7	0.3	23.9	17.8	5.9	529.0	361.9	384.2	311.5	172.5	97.1	22.7

[1] free movement

4.1.2.2 Traffic Analysis – Build Capacity Analysis

A potential Build scenario assumed an increased capacity from the existing two-lane configuration bridge/causeway to a four-lane configuration with the addition of 10' wide shoulders on either side.

Analysis of the Build scenario at the two adjacent intersections with 2021 design volumes resulted in LOS A and LOS B conditions for all movements. 2021 design volumes resulted in LOS A conditions for each direction of travel along the US-70 bridge segment for the Build scenario in both the AM and PM peak period conditions (**Table 10**).

Table 10: 2021 Build Analysis Results

Time Period	Analysis Means	MOE	EB Movement			WB Movement			NB Movement			SB Movement			Overall
			Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
US-70 at State Park Road															
AM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]			A					A
		Delay		n/a[1]	n/a[1]	8.2	n/a[1]			8.5					1.2
	SimTraffic	LOS		A	A	A	A		A		A				A
		Delay		1.5	1.0	2.0	0.6		8.0		2.2				1.4
PM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]			A					A
		Delay		n/a[1]	n/a[1]	8.3	n/a[1]			8.0					1.2
	SimTraffic	LOS		A	A	A	A		A		A				A
		Delay		1.5	1.2	1.9	0.6		7.6		1.9				1.2
US-70 at Willow Springs Road/Johnson Creek Road															
AM	HCM	LOS	A	n/a[1]		A	n/a[1]			B			B		A
		Delay	8.0	n/a[1]		8.5	n/a[1]			10.9			12.2		1.0
	SimTraffic	LOS	n/a[1]	A	A	A	A	A	A	A	A	n/a[1]	A	A	A
		Delay	n/a[1]	0.7	0.0	3.0	1.2	0.9	6.6	5.4	3.9	n/a[1]	6.6	2.3	1.2
PM	HCM	LOS	A	n/a[1]		A	n/a[1]			B			B		A
		Delay	8.4	n/a[1]		8.2	n/a[1]			12.1			12.8		1.0
	SimTraffic	LOS	A	A	A	A	A	A	A	C	A	A	B	A	A
		Delay	0.0	0.8	0.1	2.5	1.7	1.5	8.0	20.5	3.7	4.4	11.8	3.1	1.6

[1] free movement

For the 2050 (background growth only) design volumes, the State Park Road northbound movement improves to LOS A in the AM period and delay is also reduced in the PM peak period. The northbound and southbound movements at the Willow Springs Road/Johnson Creek Road intersection both improve delay from the No-Build scenario, with the PM peak period improving to LOS B results (**Table 11**). Results for the Build bridge segment indicate LOS A conditions for each direction of travel in the AM and PM peak period conditions when analyzing the bridge using multi-lane criteria.

Table 11: 2050 (Background Growth Only) Build Analysis Results

Time Period	Analysis Means	MOE	EB Movement			WB Movement			NB Movement			SB Movement			Overall
			Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
US-70 at State Park Road															
AM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]		A						A
		Delay		n/a[1]	n/a[1]	8.8	n/a[1]		9.2						1.3
	SimTraffic	LOS		A	A	A	A		B		A				A
		Delay		2.0	1.3	2.0	0.7		11.5		2.4				1.9
PM	HCM	LOS		n/a[1]	n/a[1]	A	n/a[1]		A						A
		Delay		n/a[1]	n/a[1]	8.9	n/a[1]		8.5						1.3
	SimTraffic	LOS		A	A	A	A		B		A				A
		Delay		1.4	1.2	2.9	0.7		12.7		2.0				1.6
US-70 at Willow Springs Road/Johnson Creek Road															
AM	HCM	LOS	A	n/a[1]		A	n/a[1]		B			B			A
		Delay	8.4	n/a[1]		9.3	n/a[1]		13.8			14.5			1.4
	SimTraffic	LOS	A	A	A	A	A	A	B	B	A	B	B	A	A
		Delay	0.5	1.1	0.1	3.0	1.5	1.2	10.8	10.5	5.3	11.9	11.6	2.7	1.7
PM	HCM	LOS	A	n/a[1]		A	n/a[1]		C			C			A
		Delay	9.1	n/a[1]		8.7	n/a[1]		15.8			15.8			1.3
	SimTraffic	LOS	A	A	A	A	A	A	A	B	A	B	B	A	A
		Delay	0.8	1.0	0.0	3.1	2.3	1.6	9.7	13.3	4.0	10.3	10.3	3.9	2.0

[1] free movement

Preliminary analysis was completed for the Build scenario including the Pointe Vista development property, which is projected to drastically boost 2050 traffic volumes. **Figure 20** depicts the assumed configuration at the main entrance (turn lanes on all approaches), with State Park Road still providing access to the Chickasaw Nation Casino. State Park Road would warrant a signal with these projected volumes but was assumed to remain unsignalized due to spacing and to gauge LOS.

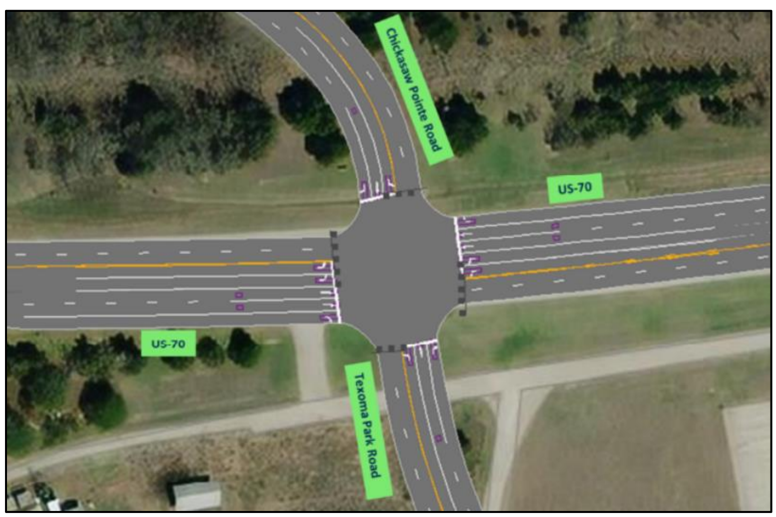


Figure 20: Build Conditions - US-70 at New Signalized Intersection

LOS results for the 2050 (with development) design volumes indicate LOS E and LOS F movements at both intersections during the AM and PM peak periods (**Table 12**). For multi-lane analysis using 2050 (with Development) design volumes, LOS B results are expected for the eastbound direction of travel and LOS A conditions for the westbound direction of travel during the AM peak period. The PM peak period indicated LOS B results for each direction of travel.

Table 12: 2050 (with Development) Build Analysis Results

Time Period	Analysis Means	MOE	EB Movement			WB Movement			NB Movement			SB Movement			Overall
			Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
US-70 at Chickasaw Pointe Road (New Intersection)															
AM	HCM	LOS	C			C			C			C			C
		Delay	26.2			24.5			29.1			24.1			26.2
	SimTraffic	LOS				A	A	A		A	A	A	A		A
		Delay				4.6	0.2	2.1		0.2	0.3	1.7	0.1		1.3
PM	HCM	LOS	C			C			C			C			C
		Delay	28.9			25.9			28.0			25.9			27.1
	SimTraffic	LOS				A	A	A		A	A	A	A		A
		Delay				4.3	0.0	2.6		0.4	0.2	1.7	0.3		1.4
US-70 at State Park Road															
AM	HCM	LOS		n/a[1]	n/a[1]	B	n/a[1]		C						A
		Delay		n/a[1]	n/a[1]	12.9	n/a[1]		15.2						0.7
	SimTraffic	LOS		A	A	A	A		A		A				A
		Delay		1.5	1.4	1.5	0.2		7.3		2.2				1.4
PM	HCM	LOS		n/a[1]	n/a[1]	B	n/a[1]		F						B
		Delay		n/a[1]	n/a[1]	14.0	n/a[1]		113.7						11.4
	SimTraffic	LOS		A	A	A	A		A		A				A
		Delay		0.0	2.6	4.3	0.0		0.4		0.2				1.4
US-70 at Willow Springs Road/Johnson Creek Road															
AM	HCM	LOS	B	n/a[1]		B	n/a[1]		E			D			A
		Delay	10.9	n/a[1]		12.7	n/a[1]		44.7			27.8			2.1
	SimTraffic	LOS	n/a[1]	A	A	A	A	A	A	A	A	n/a[1]	A	A	A
		Delay	n/a[1]	0.8	0.1	2.4	1.2	0.5	6.5	9.5	3.7	n/a[1]	5.4	3.2	1.2
PM	HCM	LOS	B	n/a[1]		B	n/a[1]		F			E			A
		Delay	13.8	n/a[1]		12.3	n/a[1]		180.2			39.8			4.4
	SimTraffic	LOS	n/a[1]	A	A	A	A	A	A	A	A	n/a[1]	A	A	A
		Delay	n/a[1]	0.4	2.6	4.3	0.4	0.4	4.8	0.0	2.9	n/a[1]	0.0	2.9	2.9

[1] free movement

4.1.3 Bridge Cross-Section Safety Analysis

The potential safety benefits of additional cross-section elements were considered along the one-mile bridge segment, such as providing a median, lighting, or wider shoulders. Highway Safety Software (HSS) was utilized to deploy the Highway Safety Manual (HSM) methodology to estimate the predicted crashes between potential cross-section configurations. HSS considers Safety Performance Functions (SPFs) for rural two-lane and multi-lane highways to predict the number of expected crashes, then adjusts this total based on Crash Modification Factors (CMFs) from the presence of a limited number of cross-sectional elements (lane width, shoulder type and width, presence of horizontal curve and superelevation, number of driveways, rumble strips, grade and lighting presence) using data published in the original HSM.

Inside the HSS, segment analysis was completed for the following scenarios:

- **Scenario 1**: Existing Conditions (2-12' lanes, no shoulders, no median, no barrier separation, some lighting)
- **Scenario 2:** Build Conditions (4-12' lanes, 2-10' shoulders, no median, no barrier separation, no lighting)
- **Scenario 3A**: Scenario 2 + the addition of a Median
- **Scenario 3B**: Scenario 2 + Median, the addition of a Median Barrier
- **Scenario 4A**: Scenario 2 + Median, the addition of lighting
- **Scenario 4B**: Scenario 2 + Median, Median Barrier, the addition of lighting

Scenario 1 was completed using HSS Two-Lane Analysis (rural), and Scenarios 2 through 4B were completed using HSS Multi-Lane Analysis (rural).

The HSS analysis is intended to provide a high-level predictive safety analysis. HSS does have limitations within the software due to sensitivity of the measures and the simplicity of the functions used. More detailed analysis using more recent CMFs published in the online clearinghouse can be performed to differentiate between similar sub-options. Below describes the constraints within the software and the effect on the predicted crash results:

- *Addition of Shoulders:* HSS yielded the same results for an 8' to a 12' right shoulder width. For the purpose of this study, 10' shoulders were used.
- *Addition of a Median:* Once present, the impact of a median on safety does not change from smaller widths up to 15'. 12' was used for the purpose of this study.
- *Addition of a Median Barrier:* Presence of a median barrier will result in the same predicted crash frequency (per AADT) regardless of the size of median width; HSS also does not provide an opportunity to specify the type of median barrier installed. A 12' median width was used for the purpose of this study, to stay consistent with the other scenarios.
- *Lighting:* This is a pass/fail option within HSS without judgment of coverage area or gaps.

Given these assumptions, **Table 13** depicts the predicted annual crashes associated with each bridge scenario for 2021, 2050 (background growth only), and 2050 (with development) design volumes.

Table 13: Highway Safety Software Results (Bridge)

	Predicted Annual Crashes		
	2021	2050 (Background Growth Only)	2050 with Development
Scenario 1	3.3	4.7	-
Scenario 2	3.1	4.7	12.1
Scenario 3A	1.7	2.4	5.6
Scenario 3B	1.6	2.3	5.4
Scenario 4A	1.5	2.2	5.1
Scenario 4B	1.5	2.1	4.9

As more design elements are incorporated into the bridge, the anticipated number of collisions per year is reduced with Scenarios 3A through 4B reducing bridge crashes by more than 50%. Projecting through the design year, Scenario 3A through 4B would have 57 to 64 fewer total bridge crashes than Scenario 1 (No-Build) through 2050 if considered the background growth only design volumes, which includes an estimated savings of 7 to 10 fatal or injury collisions. Due to the restrictions of HSS for Scenario 1 regarding the development property volumes, predicted crash saving calculations were not attained for 2050 with Development scenarios.

Additional CMFs were identified to differentiate between limitations of the HSS, including:

- **Increasing median width** (CMF ID: 5416) from 10 feet to 15 feet would reduce crashes by an additional 4%
- **Increasing median shoulder width** (CMF ID: 7203) on a divided facility does not help to reduce crashes (increases by 3%)
- **Increasing outside shoulder width** (CMF ID: 917/919) from 6 feet to 8 feet reduces crashes by 4% and from 6 feet to 10 feet or more reduces crashes by 18%
- **Installing cable median barrier** (CMF ID: 47) reduces crashes 29%; steel median barriers (CMF ID: 46) reduce crashes by 35%

4.2 Environmental Constraints

Detailed environmental studies of streams and wetlands and hazardous materials sites were completed in December 2021. Cultural resource studies were completed in February 2022. These studies and were used to calculate impacts among the alternatives.

Environmental constraints in the project study area include wetlands, Lake Texoma and its tributaries, archeological sites, one potential hazardous materials site, and land owned by state, federal, tribal entities. These constraints are shown on the exhibits of the alternatives in **Appendix A**.

4.2.1 Wetlands and Streams

According to the waters and wetlands report dated February 2022, six wetlands, Lake Texoma and five of its tributaries were identified within the project study area, and all are considered to be potentially jurisdictional. Mitigation efforts for wetland and stream impacts would be determined in consultation with the USACE during the Section 404 permitting process. For the purposes of the alternatives analysis, a wetland or stream impact was calculated when a feature occurred within an alternative's proposed right-of-way limits. Wetland and stream impacts were calculated in acres. For streams, this was the length of the stream multiplied by the width of the ordinary high water mark (OHWM). Impacts to Lake Texoma were calculated only where new causeway would be constructed within the lake; bridge impacts were excluded. In general, alternatives with alignments near the existing will have lower impacts and new alignments will have the greatest impact on wetlands and streams.

One wetland is located on the west side of the existing bridge and north of US-70 within a small cove of the lake; the other five are on the east side occurring in the low-lying areas mainly on the south side of US-70. All six wetlands identified were located adjacent or near the lake's shoreline.

Two small tributaries to Lake Texoma are located on the west side of the existing bridge and north of US-70; one is associated with the drainage structure located under US-70, and the other runs parallel with the highway and drains into the aforementioned stream. On the east side of the bridge, two small drainage features on the north side of US-70 flow under the highway into a perennial tributary of Lake Texoma. Besides at the existing bridge, the lake enters the study area at the far east end near the Johnson Creek Public Use Area (PUA) and extends under the highway using an overflow structure when lake levels rise.

4.2.2 Archeological Sites

According to cultural resources survey report dated February 2022, there are two previously recorded archaeological sites in project study area. 34BR25 is located in a low-lying area east of the lake on the north side of US-70; 34BR11 is in Lake Texoma adjacent to the existing causeway/bridge. No other sites were identified. Impacts were calculated based on the proposed right-of-way limits of each alternative. None of the alternatives are anticipated to impact 34BR25; however, some of the alternatives are shown within the boundary of 34BR11. This site is underwater and could not be verified during field investigations. . If an alignment is selected that as the potential to affect 34BR11, ODOT will determine the best method to assess the impact to this site.

4.2.3 Hazardous Materials Site

According to the Initial Site Assessment (ISA) prepared for the project in December 2021, these is one Recognized Environmental Condition (REC) within the study limits. The gas station at the Catfish Bay Marina contains three underground storage tanks (USTs) that were assessed as having moderate risk to the project due to their age. While no releases of petroleum products have been reported, the site has had a history of violations due to water in the tanks and compliance with leak detection. Alternatives that would require property from this gas station were considered to have a potential impact to this hazardous materials site.

4.2.4 Federal Property

The USACE owns land north and south along US-70 for most of the project study area. The Johnson Creek PUA is part of the USACE property on the north side of the US-70 at the far east end of the project. Any proposed right-of-way within the limits of these federal properties was calculated as an impact. All of the proposed alternatives will require land at the Johnson Creek PUA and other USACE-owned parcels along US-70.

4.2.5 State and Tribal Property

Lake Texoma State Park is located on the west side of the lake on the south side of US-70. Land owned by the Bureau of Indian Affairs (BIA) in trust for the Chickasaw Nation is located west of Lake Texoma on the south side of US-70. Proposed right-of-way limits that encroach on these properties were calculated as an impact. In general, alternatives closer to the existing bridge alignment will have lower impacts to the State Park and tribal property when compared to the new alignment alternatives.

4.3 Roadway

This preliminary engineering study references the following publications:

- "A Policy on Geometric Design of Highways and Streets," Sixth Ed. (AASHTO, 2018)
- "Oklahoma Department of Transportation Roadway Design Manual," (ODOT, 1992)
- "Roadside Design Guide," (AASHTO, 2011)
- "ODOT Standard Specifications for Highway Construction," (ODOT, 2019)
- "ODOT Construction Standard Drawings," Latest Revision
- "Manual on Uniform Traffic Control Devices for Streets and Highways," (AASHTO, 2009)
- "Oklahoma Department of Transportation Drainage Design Manual," 2014
- "User and Non-User Benefit Analysis for Highways, 3rd Edition," (AASHTO, 2010)
- ODOT policies/procedures that are provided to the Consultant

In accordance with ODOT's Rural Functional Classification Map (RFC) Map US-70 has a classification of a Principal Arterial Highway; see **Appendix I**.

This preliminary engineering study utilizes ODOT Roadway Design Manual design criteria tables. Preliminary design of US-70 utilizes the following design criteria:

- Design Speed: 65 mph
    - (ODOT Roadway Design Speed Memo, **Appendix I**)

- Superelevation = 8% maximum superelevation
  - (AASHTO Min. Radii for superelevation Rates, emax=8%, **Table 3-10**, **Appendix I**)
- Vertical Curve K-Crest = 193, K-Sag = 157
  - (AASHTO Design Control for Vertical Curves, **Table 3-35** and **Table 3-37**, **Appendix I**)
  - (ODOT Roadway Design Manual, Section 7.2.1.3, **Appendix I)**
- Clear Zone: 30 feet with 1:6 side-slopes
  - (AASHTO Roadside Design Guide Clear Zone Distances, **Table 3-1**, **Appendix I**)
- Maximum allowable longitudinal grade of 5%
  - (ODOT Roadway Design Manual, **Table 12-8**, **Appendix I**)
- Terrain Type = "Level"

(ODOT Initiation Report, **Appendix I**)

4.3.1 Geometrics

4.3.1.1 Horizontal Alignment

US-70 utilizes rural principal arterial design standards and superelevation calculations use the eight percent superelevation design tables.

4.3.1.2 Vertical Alignment

Mainline vertical curves meet or exceed the recommended AASHTO K values for the project design speed. Grades near the existing causeways and on the bridge are zero to keep the amount of fill to a minimum on the causeways. A five-foot profile grade raise was used to accommodate a 100-year flood event. The raise will allow the roadway subgrade to be 1-foot above the 50-year design storm event. The five-foot raise was determined using current hydraulic data for the lake at the different storm events and then setting an elevation for the roadway that is a few feet above the desired storm.

4.3.2 Typical Sections

Segment 1 and 5 typical sections on all alternatives investigated on the US-70 mainline consist of four 12-foot lanes with 10-foot shoulders and 16-foot two way left turn lane (TWLTL). The edge treatment consists of an open shoulder with a 1:6 slope to the clear zone then either a cut slope to a ditch or a fill slope to existing ground. For Segment 2 typical sections, See Section 4.4. Segment 3 and 4 typical sections on all alternatives consist of four 12-foot lanes with 10-foot shoulders and guardrail on both sides. Two edge treatments were investigated to compare and contrast the use of retaining wall along the causeway. The first edge treatment consists of 1:3 fill slopes behind the guardrail to existing ground. The second edge treatment consists of a retaining wall next to the shoulder to reduce fill material into the lake. The use of a 10-foot should throughout the corridor is to increase safety with the longer bridge length and causeway with guardrail on both sides there are limited areas beyond the shoulder for refuge. Refer to **Appendix B** for typical section sheets.

4.3.3 General Considerations

The following general considerations and assumptions assisted in the design of all the alternatives:

- Improve facility from 2 lanes to 4 lanes

- Minimize impacts to lake and surrounding communities
- Minimize impacts to environmental features
- Maintain two lanes of traffic during construction

4.3.4 Construction Sequencing

All alternatives have a similar sequence of construction to provide maintenance of traffic during construction. The number of phases within each segment depends on the offset from the survey centerline. Refer to **Appendix C** for plan view of the proposed construction sequence. Typical sections are shown below to help illustrate the maintenance of traffic for the different offsets.

A zero-foot offset from the survey centerline or on the existing alignment will require three phases of construction. This proposed sequence will require partial embankment construction with temporary paving at an interim embankment elevation to maintain traffic. See **Figure 21** below. If the alignment is offset to the south the first phase of construction will be a partial embankment to the north to allow traffic to be maintained during phase 2 of construction which will be to the south.

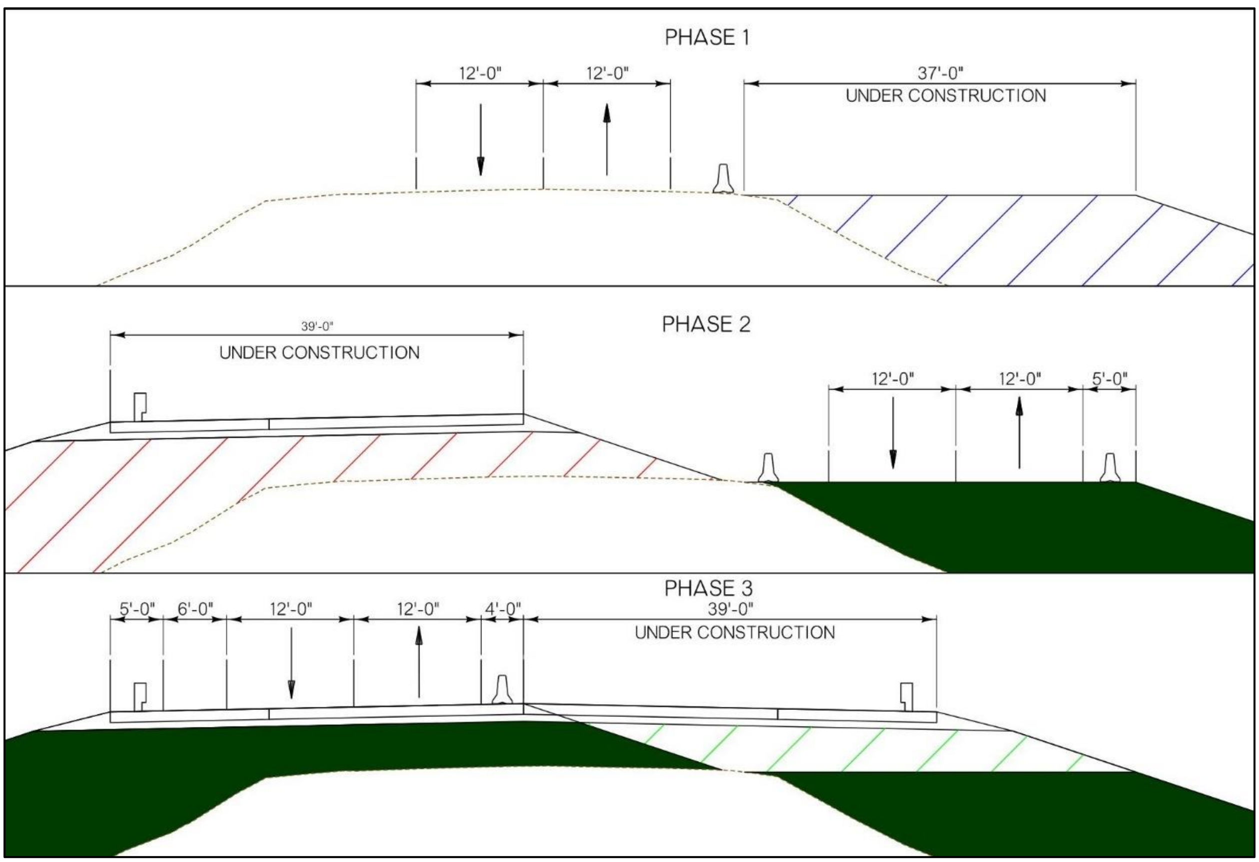


Figure 21: On Alignment Construction Sequence

Both a partial offset of 27.5-foot and a full offset of 57-foot from survey centerline were investigated. The offset distances investigated allow for at least 2 lanes to be constructed off to the side in the first phase of construction while maintaining traffic on the existing alignment. The segments of the project that are offset from the survey centerline will be constructed in two phases. The first section of the typical to be constructed will either be the north or south section depending on the offset direction. If the alignment is offset to the north the first section of the typical to be built will be the north section and if it is offset to the south the south section will be built first. The next phase of construction for the offset alignment segments will be to construct the other half of the typical not constructed in the previous phase. Refer to **Figure 22** and **Appendix B**.

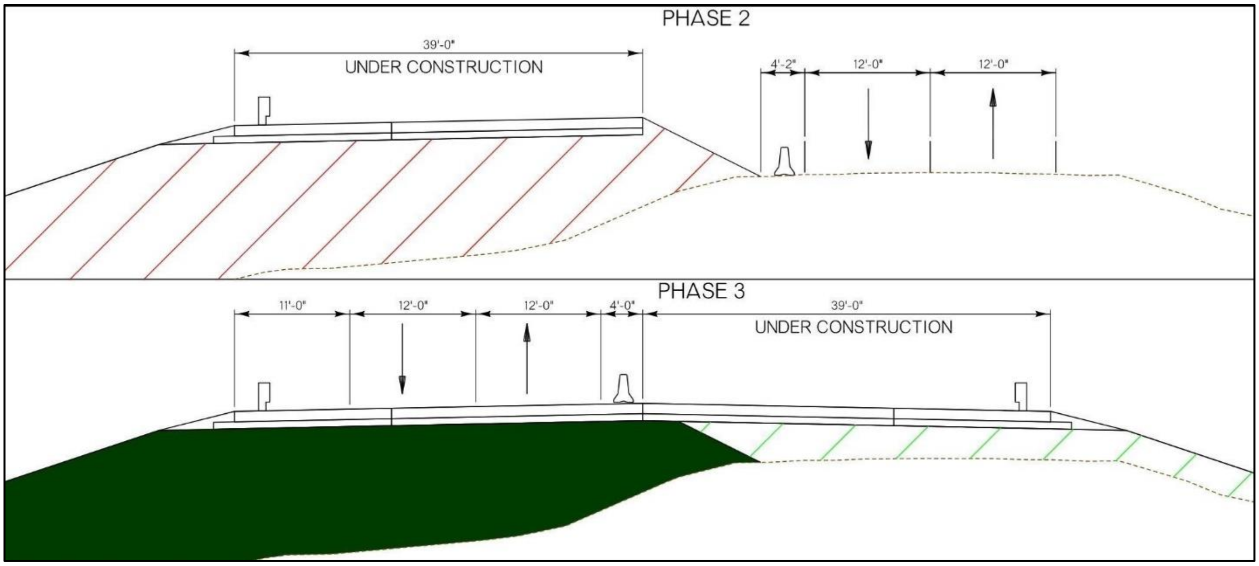


Figure 22: Offset Alignment Construction Sequence

In all the alternatives Willow Springs Road will be closed and detoured to reconstruct the roadway up to the new proposed grade of US-70. A temporary drive will need to be constructed to provide access to Johnson Creek Campground during construction. Refer to **Appendix B** for Willow Springs Road and temporary drive plan and profile.

4.3.5 Compensatory Storage

Compensatory storage may be required when there is a loss of flood storage due to fill material being placed into the floodplain for specific lakes in Oklahoma. This requirement is regulated by US Army Corps of Engineers and is usually defined as fill placed between the normal pool elevation and the flood pool elevation. The Lake Texoma average normal pool elevation is 617 ft, and the flood pool elevation is 640 ft, see **Figure 23**. The additional storage to compensate for the loss of flood storage must be within these elevations in the lake flood storage area.

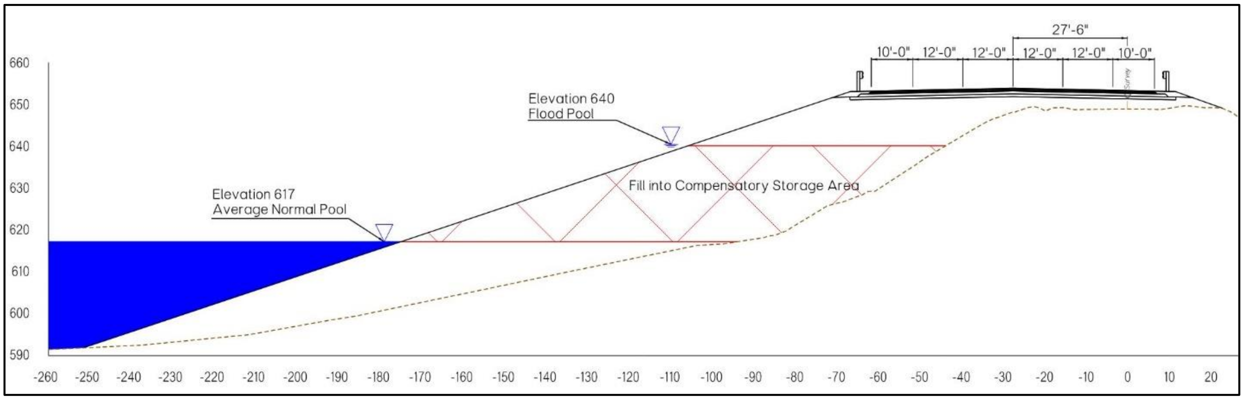


Figure 23: Compensatory Storage Partial Offset of 27.5 ft

The amount of compensatory storage needed varies with each alternative depending on the offset from the existing alignment and the raise of the vertical profile. Multiple alignments and typical sections were investigated to try and reduce the amount of compensatory storage needed. The analyzed alternatives use offsets both to the north and south of the existing alignment of zero, 27.5 feet, and 57 feet to compare the amount of compensatory storage for each alternative. The use of retaining walls was also investigated to reduce the amount of compensatory storage needed for the project, see **Figure 24**.

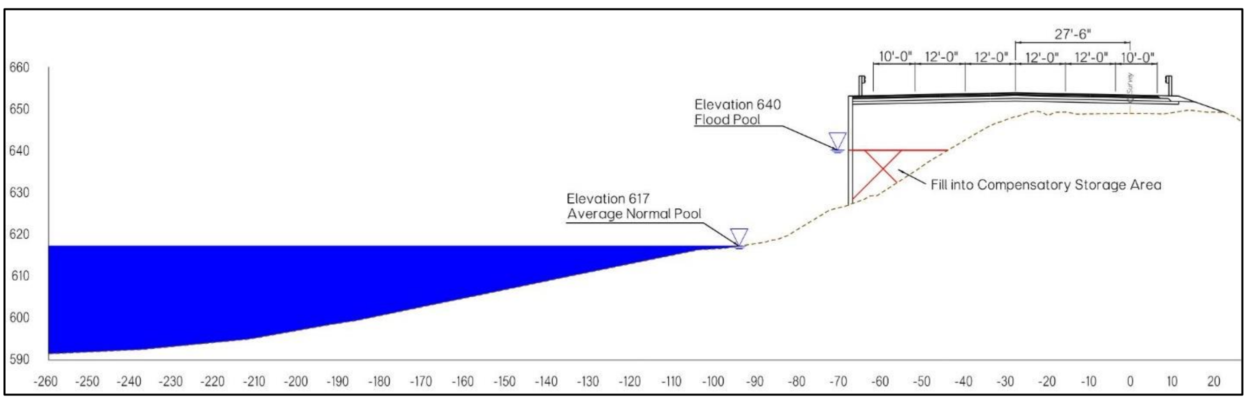


Figure 24: Compensatory Storage with Retaining Wall

Alternative 6-2B was developed to understand methods to mitigate compensatory storage. The methods developed were extrapolated to the remaining alignment alternatives as possibilities for compensatory storage mitigation. This is further defined in Section 6.0 of the report.

4.4 Bridge

4.4.1 Bridge Design Criteria

A bridge design criterion was developed in accordance with standard ODOT policies and procedures for the preliminary engineering study of the various bridge options. The site conditions were determined to be comparable for the alignments investigated in this study and are reported in **Appendix J**.

The *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report* was also developed to function as a companion to this report to cover bridge specific replacement options in detail and describe the method for determining the most cost-efficient bridge replacement option for each proposed alignment. Refer to **Appendix K** for the Bridge Specific Replacement Report.

4.4.2 Bridge Options

To determine the most economical bridge design option, initial design and cost estimates were created for Alignment 6-2 to understand the relationship between superstructure costs and substructure costs and to find efficient combinations. This phase of bridge option investigation included twelve different superstructure configurations and various configurations of drilled shaft sizes, count and spacing. Refer to **Appendix M** for *Bridge Layout Sheets and Concept Details.*

4.4.2.1 Superstructure

Twelve superstructure types were investigated for the preliminary bridge design to determine the most economical bridge type. Various materials and span lengths were required to be investigated to determine the cost interaction between the superstructure and the substructure.

The steel superstructure options required optimization to determine the most economical configuration of beam spacing, beam sizing, span lengths, and number of spans per structural unit. Although steel superstructures tend to be most costly per square foot of bridge than prestressed concrete superstructures, the additional span lengths that steel structures can obtain from continuous spans allowed for a reduction in number of spans and subsequently the number of drilled shafts required.

Initially all options that were investigated included a superstructure based on a proposed 71’-0” overall typical section of four 12-foot lanes, with two 10-foot should, and two 42” F-Shaped parapet traffic rails, and an 8” thick deck slab (**Figure 25**). The phased condition of Alignment 6-6 was not considered until the most economical superstructure and substructure configuration was determined with the Alignment 6-2 bridge configuration.

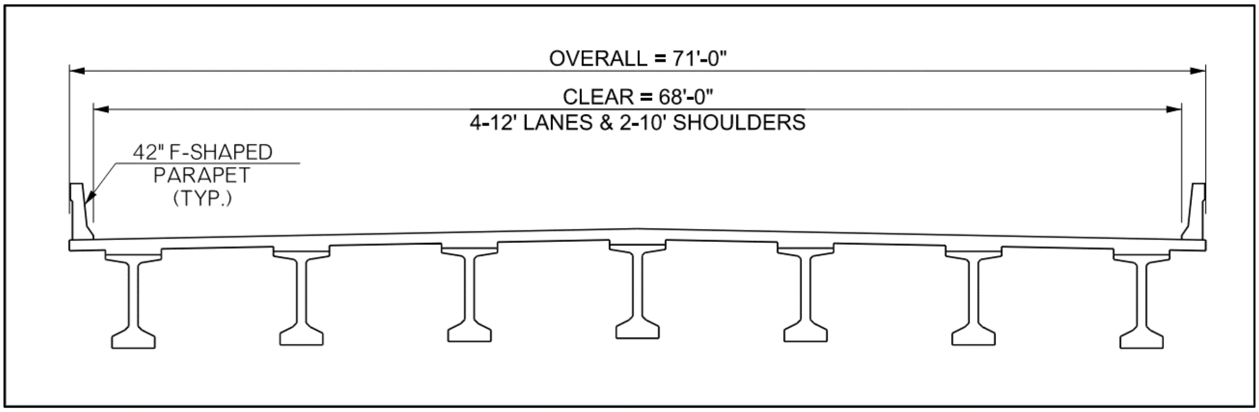


Figure 25: Bridge Typical Section

The twelve superstructure options that were evaluated during the span optimization are as follows:

1. AASHTO Type IV Prestressed Concrete Beam –105 LF spans with 7 beam lines
2. AASHTO Type J Prestressed Concrete Beam –130 LF spans with 7 beam lines
3. TxDOT Type Tx70 Prestressed Concrete Girder – 150 LF spans with 7 beam lines
4. TxDOT Type Tx70 Prestressed Concrete Girder – 160 LF spans with 10 beam lines
5. Nebraska University NU2000 Prestressed Concrete Girder – 175 LF spans with 8 beam lines
6. Nebraska University NU2000 Prestressed Concrete Girder – 180 LF spans with 9 beam lines
7. Steel Plate Girder – Three Span Continuous Unit (128-160-128) with 6 beam lines
8. Steel Plate Girder – Four Span Continuous Unit (128-160-160-128) with 6 beam lines
9. Steel Plate Girder – Four Span Continuous Unit (160-200-200-160) with 6 beam lines
10. Steel Plate Girder – Four Span Continuous Unit (256-320-320-256) with 6 beam lines
11. Steel Rolled Shape (W40x277) – 120 LF spans with 10 beams lines
12. TxDOT Tx84 Spliced Prestressed Concrete Beams – Four Span Continuous (190-250-250-190)

4.4.2.2 Substructure

Reinforced concrete piers of various column and drilled shaft configurations were investigated to determine the most economical structure. Columns were assumed to be circular with a minimum diameter of 4’-6”, and rectangular columns were analyzed if the required diameter of the column exceeded 6’-0”.

Drilled shafts were provided for each column and required permanent casing due to being constructed in open waters. For quantity purposes, the casing was assumed to extend 10’ into the overburden soil to be lower than the muck line level. Soil is assumed to be capable of self-

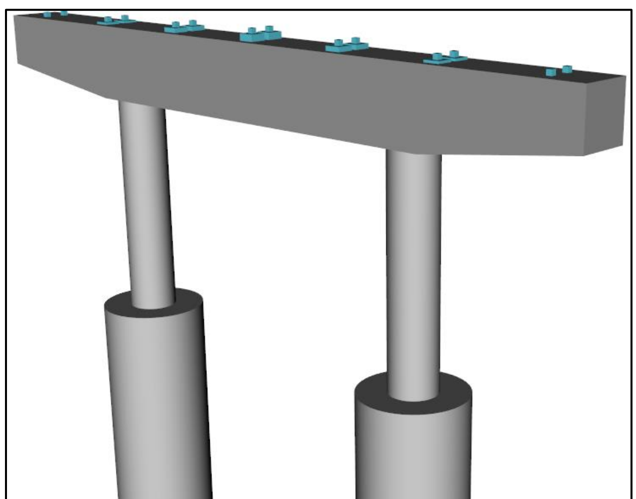


Figure 26: Typical Pier Configuration

support, which will no longer collapse, and casing would no longer be required.

Substructure calculations were calculated for each of the twelve superstructures to determine the size and configuration for each superstructure type.

4.4.2.3 Bridge Option Selection

A bridge option was selected for the overall project cost estimate by generating quantities and cost estimates for each of the twelve superstructure options and its associated substructure configuration. This was done for a 5,000' bridge and a 10,625' bridge. These two separate scenarios were investigated due of the differing site conditions for Alignment 6-17B and 6-18B, compared to all other alignments. This difference is primarily due to the rock elevation differences (Refer to **Appendix O** for geotechnical reports and findings) and the assumed efficiencies during construction that occur with constructing a bridge that is over twice in length.

4.4.2.4 Other Bridge Option Considerations

Alignment specific considerations were made based on the requirements of the preliminary design.

The adjustments made for specific alignments are as follows:

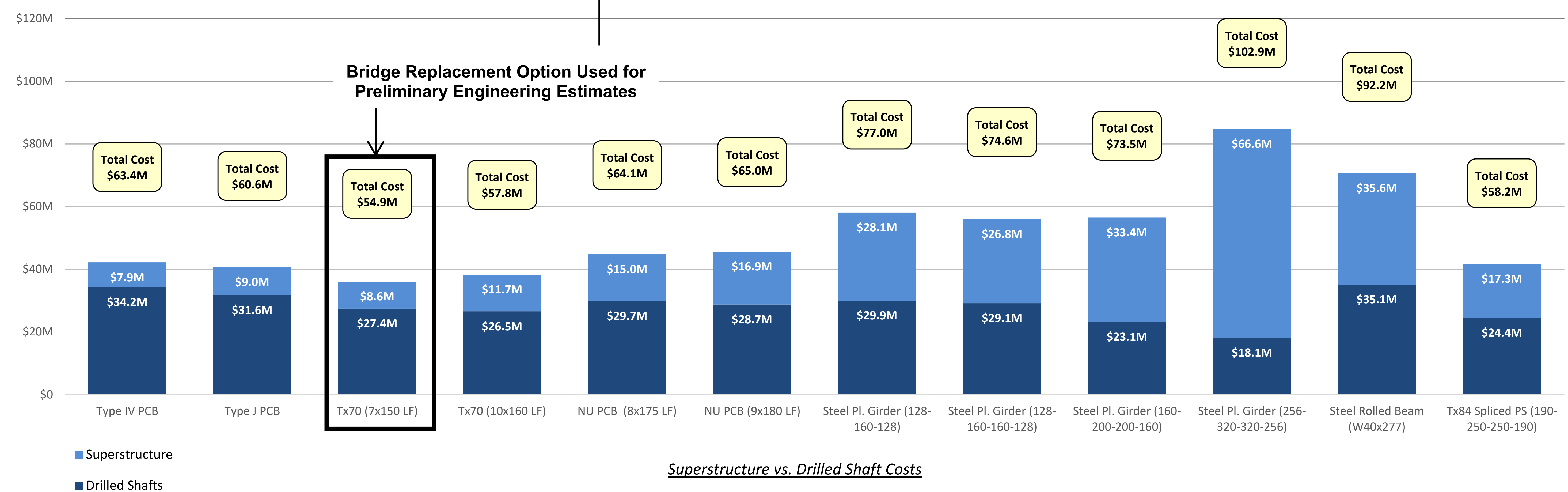
- All Alignments
    - Prestressed Concrete Girder (Tx70) – This pay item was used for the Tx84 spliced prestressed girder option and the unit cost was increased to $500 per linear foot to account for the additional material and construction requirements.
- Alignments 6-6A & 6-6B
    - The density of reinforcing steel to concrete was increased by 25% to account for phased construction; however, unit prices remained the same as the other alignment options.
    - Removal of existing structure was only included in this alignment since the proposed bridge will have to be constructed in the same location as the existing Roosevelt Bridge. Final design may include removing the existing structure, despite the alignment chosen, which would not be reflected on the other cost estimates shown.
- Alignments 6-17B & 6-18B
    - A 5% reduction was applied to all unit costs, except for piles and approach slabs, to account for construction efficiencies, due to the bridge length being approximately twice the length as all other options.
    - Two top of rock elevations were determined based on the variation in foundation material This only occurs to the south of the existing Lake Causeway and is approximately 20 feet higher than the rock elevation in the middle portion of the lake. This allows for a shorter drilled shaft length and a smaller drilled shaft diameter.

4.4.2.5 Bridge Option Summary

Quantities and cost estimates were made for twelve bridge options for the full offset of the existing alignment (**Table 14**) and for the new southern alignment (**Table 15**) for a total of twenty-four quantities and associated cost estimates.

Alternative 6 - Bridge Replacement Options - Cost Estimate Summary

Pay Item No.	Description	Type IV PCB	Type J PCB	Tx70 (7x150 LF)	Tx70 (10x160 LF)	NU PCB (8x175 LF)	NU PCB (9x180 LF)	Steel Pl. Girder (128-160-128)	Steel Pl. Girder (128-160-160-128)	Steel Pl. Girder (160-200-200-160)	Steel Pl. Girder (256-320-320-256)	Steel Rolled Beam (W40x277)	Tx84 Spliced PS (190-250-250-190)
-	*SUPERSTRUCTURE*	$ 7,903,030	$ 8,968,362	$ 8,626,350	$ 11,707,966	$ 14,989,252	$ 16,864,020	$ 28,121,717	$ 26,811,938	$ 33,360,831	$ 66,644,617	$ 35,569,478	$ 17,277,200
504(A) 5200	*APPROACH SLAB*	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020
504(E) 5520	*42" F-SHAPED PARAPET*	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360	$ 900,360
507(A) 8200	*STAINLESS STEEL FIXED BEARING ASSEMBLY*	$ 924,000	$ 731,500	$ 654,500	$ 880,000	$ 660,000	$ 693,000	$ 792,000	$ 858,000	$ 231,000	$ 429,000	$ 1,155,000	$ 231,000
507(B) 8300	*STAINLESS STEEL EXP. BEARING ASSEMBLY*	$ 924,000	$ 731,500	$ 616,000	$ 880,000	$ 616,000	$ 693,000	$ 396,000	$ 297,000	$ 231,000	$ 165,000	$ 1,155,000	$ 231,000
509(A) 0210	*CLASS AA CONCRETE*	$ 6,449,105	$ 6,728,995	$ 6,728,995	$ 6,958,055	$ 6,979,830	$ 7,077,980	$ 6,456,385	$ 6,456,385	$ 6,456,385	$ 6,456,385	$ 6,630,845	$ 6,728,995
509(B) 0320	*CLASS A CONCRETE*	$ 4,738,640	$ 3,756,000	$ 3,266,080	$ 3,206,160	$ 3,460,240	$ 3,352,560	$ 3,544,480	$ 3,446,640	$ 2,761,680	$ 3,281,760	$ 4,201,440	$ 2,380,240
511(A) 2210	*REINFORCING STEEL*	$ 191,038	$ 150,388	$ 130,063	$ 126,000	$ 113,813	$ 109,750	$ 142,263	$ 138,200	$ 109,750	$ 103,225	$ 166,650	$ 93,488
511(B) 2310	*EPOXY COATED REINFORCING STEEL*	$ 5,262,390	$ 5,241,120	$ 5,064,180	$ 5,046,810	$ 4,944,105	$ 4,912,170	$ 4,916,400	$ 4,888,185	$ 4,690,710	$ 4,899,345	$ 5,111,715	$ 4,581,555
514(A) 5210	*PILES, FURNISHED (HP 10X42)*	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400
514(A) 5220	*PILES, FURNISHED (HP 12X53)*	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410
514(B) 5310	*PILES, DRIVEN (HP 10X42)*	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600
514(B) 5320	*PILES, DRIVEN (HP 12X53)*	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085
-	*DRILLED SHAFTS*	$ 34,216,000	$ 31,635,000	$ 27,360,000	$ 26,505,000	$ 29,736,000	$ 28,674,000	$ 29,925,000	$ 29,070,000	$ 23,085,000	$ 18,054,000	$ 35,055,000	$ 24,426,000
518(B) 0300	*SEALED EXPANSION JOINTS*	$ 604,800	$ 478,800	$ 403,200	$ 403,200	$ 352,800	$ 352,800	$ 302,400	$ 226,800	$ 176,400	$ 126,000	$ 529,200	$ 151,200
-	*ITEMS NOT INCLUDED*	$ 937,183	$ 895,313	$ 811,729	$ 854,686	$ 946,769	$ 959,927	$ 1,137,938	$ 1,101,885	$ 1,101,885	$ 1,521,378	$ 1,362,603	$ 860,498
	Bridge Cost	$ 63,416,061	$ 60,582,853	$ 54,926,971	$ 57,833,752	$ 64,064,683	$ 64,955,082	$ 77,000,457	$ 74,560,909	$ 73,470,517	$ 102,946,585	$ 92,202,806	$ 58,227,051
	Bridge Unit Cost	$181 /SF	$173 /SF	$157 /SF	$165 /SF	$183 /SF	$185 /SF	$219 /SF	$212 /SF	$209 /SF	$293 /SF	$263 /SF	$166 /SF



Superstructure vs. Drilled Shaft Costs

Table 14: Bridge Replacement Options – Cost Estimate Summary (Existing Bridge Offset)

Alternative 6 (Alignment 17/18B) - Bridge Replacement Options - Cost Estimate Summary

Pay Item No.	Description	Type IV PCB	Type J PCB	Tx70 (7x150 LF)	Tx70 (10x160 LF)	NU PCB (8x175 LF)	NU PCB (9x180 LF)	Steel Pl. Girder (128-160-128)	Steel Pl. Girder (128-160-160-128)	Steel Pl. Girder (160-200-200-160)	Steel Pl. Girder (256-320-320-256)	Steel Rolled Beam (W40x277)	Tx84 Spliced PS (190-250-250-190)
-	SUPERSTRUCTURE	$ 16,144,965	$ 18,320,484	$ 17,621,954	$ 25,177,375	$ 30,621,464	$ 34,450,230	$ 57,456,683	$ 54,780,618	$ 68,160,942	$ 136,164,468	$ 72,673,522	$ 35,303,758
504(A) 5200	APPROACH SLAB	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020	$ 142,020
504(E) 5520	42" F-SHAPED PARAPET	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135	$ 1,827,135
507(A) 8200	STAINLESS STEEL FIXED BEARING ASSEMBLY	$ 1,865,325	$ 1,499,575	$ 1,316,700	$ 1,776,500	$ 1,295,800	$ 1,410,750	$ 407,550	$ 501,600	$ 407,550	$ 250,800	$ 2,351,250	$ 402,325
507(B) 8300	STAINLESS STEEL EXP. BEARING ASSEMBLY	$ 1,865,325	$ 1,499,575	$ 1,280,125	$ 1,724,250	$ 1,254,000	$ 1,410,750	$ 407,550	$ 282,150	$ 250,800	$ 156,750	$ 2,299,000	$ 219,450
509(A) 0210	CLASS AA CONCRETE	$ 13,171,831	$ 13,743,574	$ 13,743,574	$ 14,211,330	$ 14,255,914	$ 14,456,354	$ 13,186,713	$ 13,186,713	$ 13,186,713	$ 13,186,713	$ 13,543,072	$ 13,743,574
509(B) 0320	CLASS A CONCRETE	$ 9,542,788	$ 7,675,772	$ 6,648,860	$ 6,354,968	$ 6,913,264	$ 6,823,736	$ 7,178,428	$ 6,899,584	$ 5,598,236	$ 6,474,896	$ 8,435,012	$ 4,595,112
511(A) 2210	REINFORCING STEEL	$ 390,808	$ 313,422	$ 270,856	$ 255,386	$ 232,169	$ 228,302	$ 294,073	$ 282,470	$ 228,302	$ 208,095	$ 340,507	$ 185,735
511(B) 2310	EPOXY COATED REINFORCING STEEL	$ 10,751,212	$ 10,758,004	$ 10,386,133	$ 10,288,135	$ 10,093,183	$ 10,067,543	$ 10,063,668	$ 9,982,987	$ 9,606,483	$ 9,978,612	$ 10,439,358	$ 9,317,909
514(A) 5210	PILES, FURNISHED (HP 10X42)	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400	$ 32,400
514(A) 5220	PILES, FURNISHED (HP 12X53)	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410	$ 135,410
514(B) 5310	PILES, DRIVEN (HP 10X42)	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600	$ 12,600
514(B) 5320	PILES, DRIVEN (HP 12X53)	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085	$ 43,085
-	DRILLED SHAFTS	$ 55,563,600	$ 51,838,650	$ 44,648,100	$ 42,271,200	$ 49,954,800	$ 49,386,700	$ 48,649,500	$ 46,648,800	$ 37,893,600	$ 30,149,200	$ 56,216,250	$ 40,052,000
518(B) 0300	SEALED EXPANSION JOINTS	$ 1,220,940	$ 981,540	$ 837,900	$ 790,020	$ 718,200	$ 718,200	$ 311,220	$ 215,460	$ 191,520	$ 119,700	$ 1,053,360	$ 143,640
-	ITEMS NOT INCLUDED	$ 1,690,642	$ 1,632,349	$ 1,484,203	$ 1,575,627	$ 1,762,972	$ 1,817,178	$ 2,102,221	$ 2,024,595	$ 2,065,752	$ 2,983,228	$ 2,543,160	$ 1,592,342
	Bridge Cost	$ 114,400,085	$ 110,455,595	$ 100,431,054	$ 106,617,441	$ 119,294,416	$ 122,962,393	$ 142,250,255	$ 136,997,628	$ 139,782,546	$ 201,865,112	$ 172,087,139	$ 107,748,495
	Bridge Unit Cost	$152 /SF	$146 /SF	$133 /SF	$141 /SF	$158 /SF	$163 /SF	$189 /SF	$182 /SF	$185 /SF	$268 /SF	$228 /SF	$143 /SF

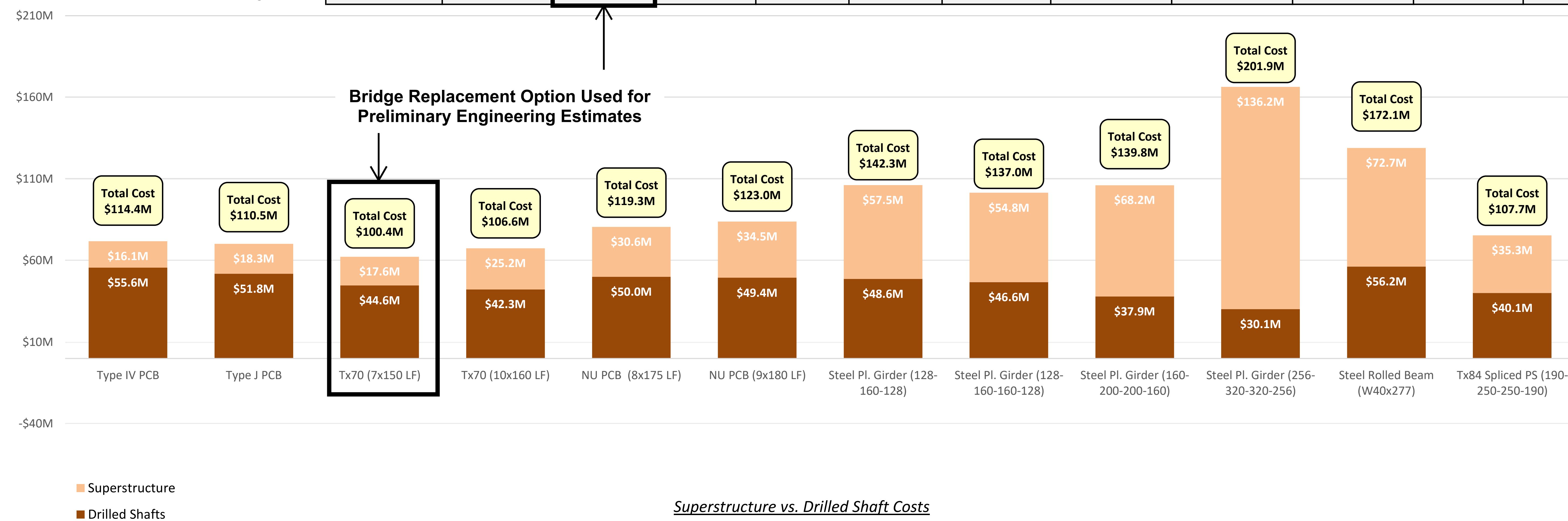


Table 15: Bridge Replacement Options – Cost Estimate Summary (Alternative 6-17B & 6-18B)

4.4.3 Retaining Walls

This study includes investigating the use of retaining walls at three locations in the study corridor to minimize the long- and short-term impacts to the right-of-way and compensatory storage. These locations include the north and south embankments of the western approach in Segment 1 prior to the Roosevelt Bridge, the embankments of the causeway in Segment 3 and Segment 4.

4.4.3.1 Retaining Wall Types

The selection of a retaining wall type is determined by the existing and proposed conditions at the wall location. Retaining walls are categorized by the method of construction of either a fill-wall, which is constructed from the bottom-up, or a cut-wall which is constructed from the top-down.

The recommended retaining wall types for this project are as follows:

Wall Type	Cut-Wall or Fill-Wall	Fill-Wall Only
Type	Soldier-Pile Wall	Mechanically Stabilized Earth (MSE)
Class	Externally Stabilized	Internally Stabilized
Mechanism	Driven Piles and Lagging	Select Backfill and Soil Reinforcing
Maximum Height	25 ft.	25 ft.

4.4.3.2 Segment 1 – Cut and Fill Walls

The roadway is proposed to be widened, and the vertical grade of the proposed approach roadway is to be raised to accommodate an increase in the bridge profile elevation for the prevention of over-topping during high-water flood events. These proposed changes to the roadway cause the toes of the embankment to extend past the current right-of-way line. The use of a fill-wall at the western approach will mitigate the right-of-way conflicts in the low area through Segment 1, which is expected to be beneficial due to the current developments to the north and the south of US-70. East of this low area, the topography begins to increase elevation on each side of the roadway, caused by a previous cut through a ridgeline immediately west of the Roosevelt Memorial Bridge. In this high-elevation area, a cut-wall could be utilized to prevent right-of-way impacts on the north and south side of US-70.

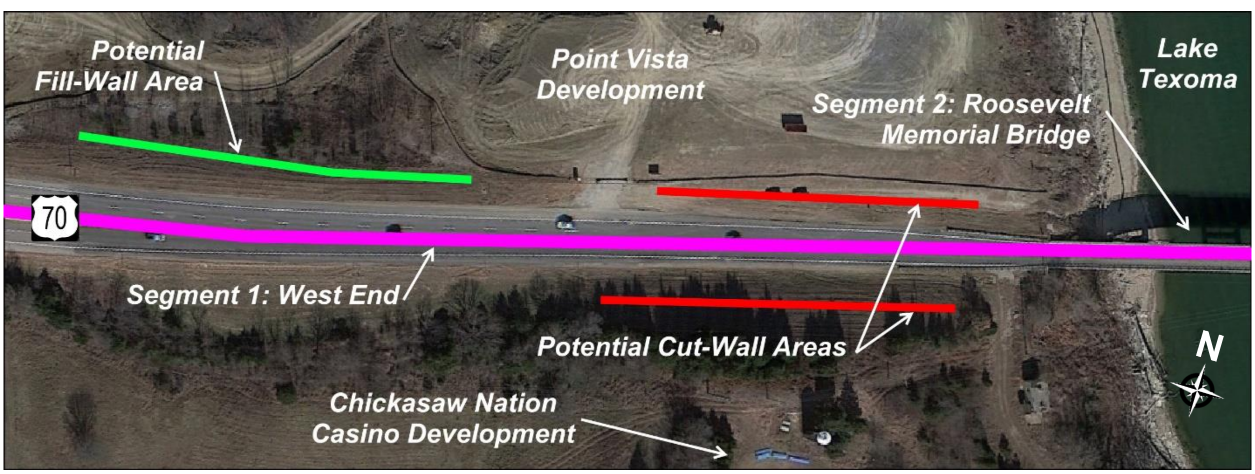


Figure 27: Potential Retaining Wall Areas

These impacts occur for both the fill and cut areas on the north side of US-70 in Alignments 6-2A, 6-2B, 6-3, 6-6A, and 6-6B, and on the south side of US-70 in alignments 6-14, 6-15, 6-17A, 6-17B, 6-18A, and 6-18B.

4.4.3.3 Segment 2 & 3 – Causeway Retaining Walls

Alignments 6-2B and 6-6B provide a possible solution for reducing the impacts to flood storage by proposed retaining walls along the northern edge of the roadway. The wall type would be required to be a solider-pile fill wall with wall heights up 25' maximum. An MSE fill wall would not be suitable for these locations due to the wall being constructed in open water.

Alignment 6-2B includes the proposed walls in Segment 3 (Land Causeway) and Segment 4 (Lake Causeway), and Alignment 6-6B only includes the proposed retaining wall in Segment 3. Refer to **Figure 29** for the proposed retaining walls in Segments 3 and 4.

Alignment Alternative 6-2B is the only alignment alternative that directly address impacts to compensatory storage. All other alignments do not account for compensatory storage impacts, but possible mitigation efforts are described in Section 6.0. Refer to **Table 2: Project Summary Matrix** for a summary of compensatory storage impacts for each proposed alignment alternative.

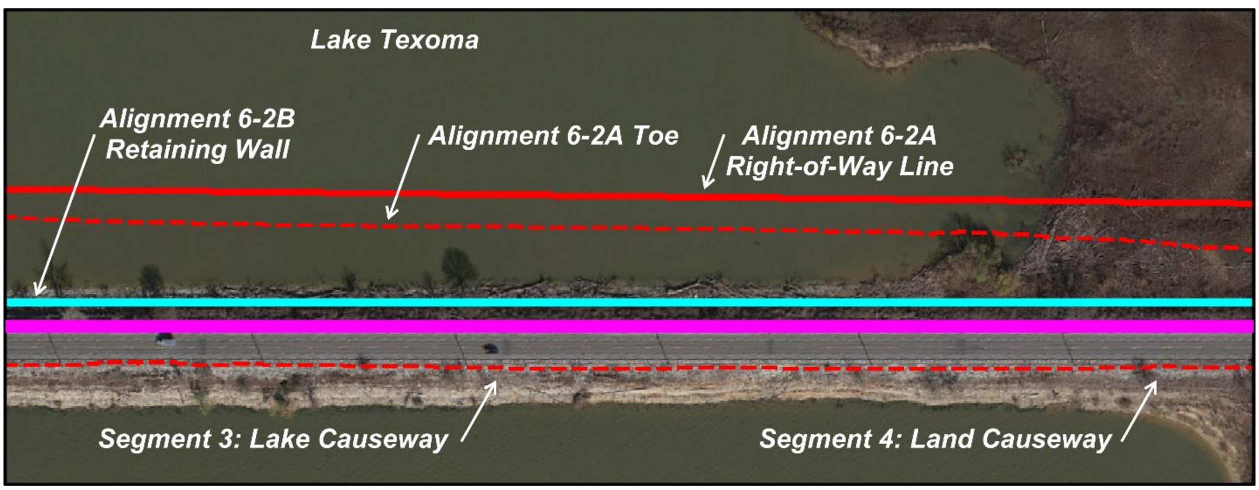


Figure 28: Segment 3 & 4 - Proposed Retaining Wall (Plan)

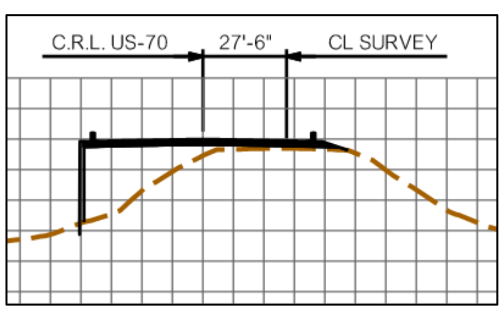


Figure 29: Typical Segment 3 & 4 Proposed Walls

4.4.4 Signature Bridge Study

At the request of ODOT, because of the high visibility of the bridge location, surrounding areas and local attractions, a signature bridge study was performed. The purpose of the study was to determine appropriate alternatives and compare relative criteria to determine the feasibility of a signature bridge. The study looked at six different signature bridge options and provided additional aesthetic elements that could be incorporated.

4.4.4.1 Bridge Types

The six bridge types that were focused on for this study are listed below. Selecting a signature bridge and aesthetic features will require extensive coordination with the stakeholders and the public.

- True Arch
- Tied Arch
- Cable Stayed
- Extradosed
- Delta Frame
- Haunched Steel Girder

More detailed descriptions and example pictures of the bridge types can be found in **Appendix S.**

4.4.4.2 Bridge Type Considerations

Selecting a signature bridge type required multiple considerations. For this study the four main items that were investigated are listed below. A more detailed explanation of each consideration can be found in **Appendix S**.

- Physical design constrains
- Aesthetic Features
- Total Cost
- Complexity

4.4.4.3 Cost Summary

The information compiled was used to determine an estimate of probable cost. At the time of the study the bridge width was assumed to be 67'. The typical section has since been modified to a width of 71', but the options explored are still valid for the price per square foot. **Figure 30** below is the Estimate of Probable Constructing Cost Matrix.

Signature Bridge Type	Bridge Length (ft)			Bridge Area (SF)		Unit Cost ($/SF)		Bridge Cost (Including Contingency)		
	Total Bridge	Signature Span(s)	Approach Spans	Signature Span(s)	Approach Spans	Signature Span(s)	Approach Spans	Signature Span(s)	Approach Spans	Total Bridge
True Arch	6000	395	5605	26,465	375,535	$ 1,000.00	$ 150.00	$ 31,758,000	$ 67,596,300	$ 99,354,300
Tied Arch	6000	450	5550	30,150	371,850	$ 850.00	$ 150.00	$ 30,753,000	$ 66,933,000	$ 97,686,000
Cable Stayed	6000	450	5550	30,150	371,850	$ 1,100.00	$ 150.00	$ 39,798,000	$ 66,933,000	$ 106,731,000
Extradosed	6000	770	5230	51,590	350,410	$ 800.00	$ 150.00	$ 49,526,400	$ 63,073,800	$ 112,600,200
Delta Frame	6000	700	5300	46,900	355,100	$ 550.00	$ 150.00	$ 30,954,000	$ 63,918,000	$ 94,872,000
Steel Girder	6000	1000	5000	67,000	335,000	$ 325.00	$ 150.00	$ 26,130,000	$ 60,300,000	$ 86,430,000
No Signature	6000	0	6000	0	402,000	$ 150.00	$ 150.00	$ -	$ 72,360,000	$ 72,360,000

Assumptions
1. Bridge Width = 67'
2. Approach Spans are assumed to be Traditional Prestressed Concrete Girders
3. 20% Contingency
4. Costs Shown are for Today

Figure 30: Estimate of Probable Construction Cost Matrix

4.4.4.4 Summary

Each signature bridge type option is conceptual, and no structural analysis or design was performed. The table below (**Figure 31**) summarizes each option in a matrix that gives relative, high-level evaluations for the signature bridge type considerations. Additional scoring for Contextual Style, Maintenance, Design Complexity, and Construction Complexity is also provided in **Appendix S,** *Signature Bridge Type Study*. Many of the considerations are subjective and should be expected to evolve as the selection process is refined. The propose of the evaluation matrix is to provide a starting point for the selection process should the Department decide to further investigate implementing a signature bridge type at this location.

ROOSEVELT SIGNATURE BRIDGE TYPE – SUMMARY EVALUATION MATRIX

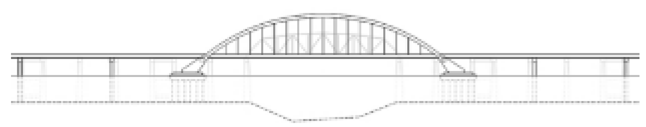
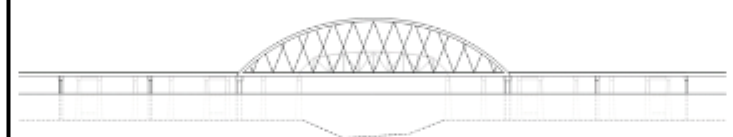
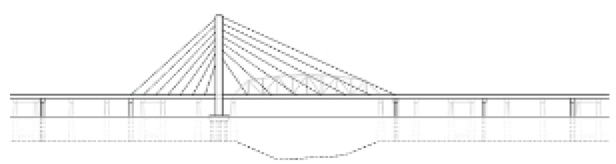
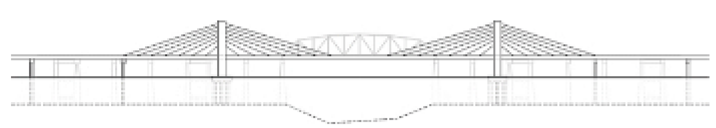
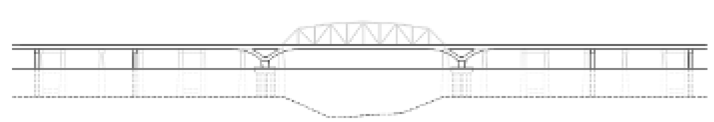
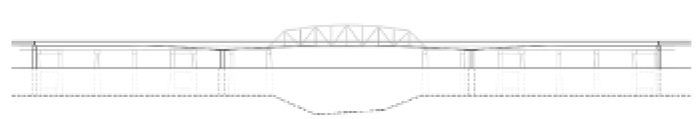
Signature Bridge Type	Concept Sketch	Physical Design Constraints			Aesthetic Features			Total Cost		Complexity	
		No. of Spans	Main Span Length	Total Span Length	Visibility	Iconic	Contextual Style	Initial Cost	Maintenance	Design	Construction
True Arch		1	395'	395'	Excellent	Excellent	Good	High	High	Medium	High
Tied Arch		1	450'	450'	Excellent	Excellent	Excellent	High	High	Medium	Medium
Cable Stayed		2	300'	450'	Excellent	Excellent	Poor	High	High	High	High
Extradosed		3	450'	770'	Excellent	Excellent	Fair	High	Medium	High	Medium
Delta Frame		3	300'	700'	Fair	Fair	Poor	Medium	Medium	Medium	Medium
Steel Girder		3	400'	1000'	Poor	Poor	Poor	Low	Low	Low	Low

Figure 31: Signature Bridge Type Evaluation Matrix

4.5 Hydrology & Hydraulics Analysis

4.5.1 Roadway Hydrology & Hydraulic Analysis

ODOT Criteria

- United States 70 (US-70) roadway classification: Principal Arterial
- Design Storm for crossing structures: 50 years
- Freeboard:
    - One foot below the finished elevation of the shoulder line at any adjacent low point. (Section 15.4.2.2 Culverts, Allowable headwater, ODOT Roadway Design Manual)

4.5.2 Roadway Hydrology and Flow Rates

If necessary, drainage areas for each roadway class crossing drainage structure will be determined for the preferred alternative using the Modified Rational Method as outlined in the ODOT Drainage Design Manual, 1988. Flow rate calculations will be developed for the 2, 5, 10, 25, 50, and 100-year storm events.

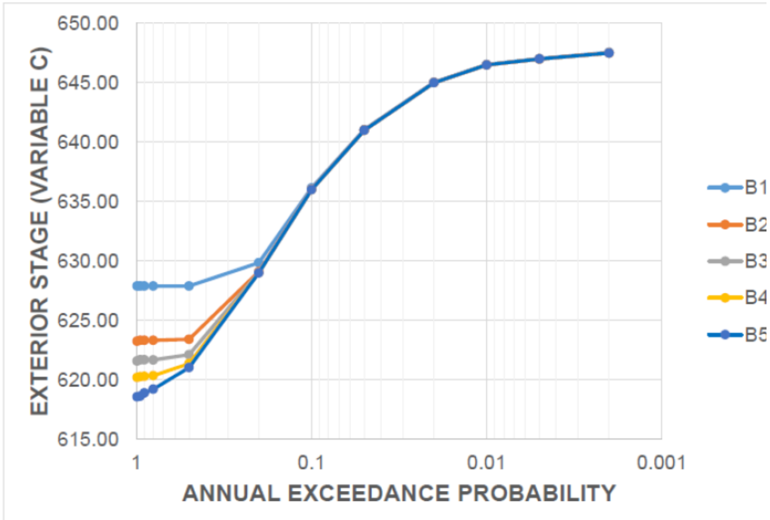
4.5.2.1 Roadway Hydraulic Analysis

A preliminary design was performed for the drainage structures of each alignment alternative. Crossing drainage structures were sized to facilitate the aforementioned drainage areas using Bentley CulvertMaster V3.3 analysis software. All structures meet or exceed the required 50-year design storm and allowable headwater requirements.

4.5.2.2 Bridge Hydrology

Figure 32 includes the Annual Exceedance Probability curve that was developed by the Tulsa District Corps of Engineers for the upper end of Lake Texoma near the Cumberland Cut. The curve reflects that when the elevations are approximately above 630, the elevations are not heavily influenced by flow rates but rather the overall lake elevation. Therefore, the frequency analysis of the Washita River at the Dickson gage was utilized for the bridge hydrology.

The tailwater at the US-70 crossing is primarily controlled by the overall lake levels and not the associated flows coming to the bridge. Therefore, the Annual Exceedance Probability curve for the lake elevation was utilized as the tailwater condition. Additional lower tailwaters were analyzed and those model runs confirmed this scenario that there are very little “hydraulics” happening at this structure. The comparison table shows that there is a slight elevation difference upstream of the bridge over natural conditions during the more frequent events but on the larger events, there is no water surface change.



AEP	FLOW (CFS)
0.002	170,714
0.005	141,176
0.01	120,502
0.02	101,195
0.05	77,627
0.1	61,138
0.2	45,600
0.5	25,697
0.8	14,242
0.9	10,392
0.95	7,983
0.99	4,826

Figure 32: Annual Exceedance Probability

4.5.2.3 Bridge Hydraulics for US-70 over Lake Texoma (Roosevelt Bridge)

Meshek & Associates performed a preliminary hydrologic and hydraulic design for this report; refer to **Appendix P** for additional design methodology and the results of the analysis.

- One hydrologic and hydraulic design was conducted for the existing condition.
- Four hydrologic and hydraulic design were performed on selected alignment alternatives to determine the impact of the study and to determine if no-rise conditions would be met.
- An additional analysis is expected during the Functional Plan development stage to assess the preferred alternative.

The hydrologic and hydraulic design was modeled based on a general profile for each studied alignment alternative. Each general profile included a general bridge that determined the elevation of the low beam and the hydraulic opening. An iterative process, between the general profile and bridge and the hydrologic and hydraulic design, was used to achieve the desired overtopping frequency and change in backwater elevation, in addition, a minimum freeboard height was not utilized in the design. The channel shapes and lake bottom surface was interpolated from a bathymetric survey by the Texas Water Resources Board and later verified by the survey performed by Keystone Engineering.

The finish grade of the causeway was selected to be 650 to prevent the subgrade of submersion during the 100-year storm event. The finish grade vertically transitions from 650' at the causeway to 655' at the bridge to allow for a freeboard of zero feet at the 200-year storm event, with an assumed structural depth of 8-feet. This allows for a low beam elevation of 647' to not be submerged during high-water flood events.

Alternatives 1 and 2 were adjacent offsets with Alternative 1 having a similar length bridge and elevated causeway and Alternative 2 had a longer bridge that shortened the causeway. Alternatives 3 and 4 were on a new alignment south of the existing bridge with Alternative 3 having a shorter bridge and long causeway where Alternative 4 had a bridge spanning the entire lake. The same tailwater conditions were utilized for the alternative analyses. All of the alternatives produced a no-rise scenario in the 1% Annual Chance event. There were slight elevation changes in the smaller events for some of the alternatives, but all of the changes were less than 0.1'.

4.6 Geotechnical and Subsurface Data

Three geotechnical surveys were performed, an embankment investigation, an in-place soil investigations, and a subsurface investigation, along the study corridor. The surveys were performed to assist in the design of proposed pavement, retaining walls, and bridge abutments near the existing Roosevelt Bridge and the proposed bridge on the new southern alignment (Alignments 6-17A/B and 6-18A/B). The surveys were also used to assist in the design of the proposed causeways and back slope and fill slope stability.

4.6.1 Preliminary Subsurface Exploration for Bridges

Subsurface exploration and geotechnical engineering evaluation was conducted for bridge structures along the new southern alignment and on the existing US-70 alignment at five boring locations (**Figure 33**).

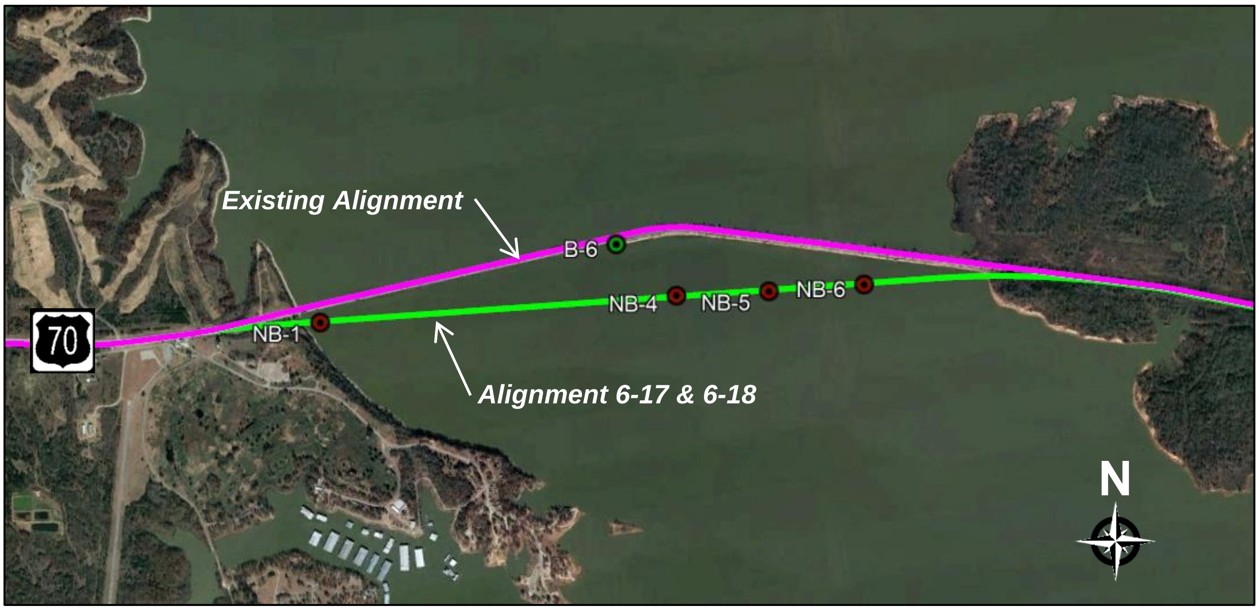


Figure 33: Bridge Boring Layout

The borings were drilled from and barge, and the samples were taken at 5-foot intervals with a split-spoon sampler to the top of the foundation material. Due to limitations of the barge equipment used for geotechnical exploration for this project, the boring locations were limited to the proximity of the embankments of the west shoreline at the beginning of the existing Roosevelt Bridge (NB-1), the east shoreline at the existing lake causeway (B-6), and to the area to the south of the existing lake causeway (NB-4 through NB-6). Additional boring locations were proposed along the existing alignment and between NB-1 and NB-4; however, the water depth was too great for the barge equipment to achieve adequate exploration results.

4.6.1.1 Overburden Soil

The overburden soil found in the five bridge boring locations typically consisted of soils that were either sandy/clayey with trace amounts of gravel and silt, or shaley lean to fat clays with sand. All borings were performed in open waters, and the water elevation was approximately 615.4 during the exploration of all five locations. Two of the borings for the overburden soils were laboratory tested for the moisture content, Atterberg limits, and a sieve analysis. An unconfined compression test on the bedrock was not included in this study. A summary of the overburden soil descriptions in the three causeway borings are as follows:

Boring B-6 (Top of Overburden Elevation = 607.5)				
Range			Soil Description	Density
0'	-	5'	Clayey Sand (SC)	Loose
5'	-	10'	Sandy Lean Clay (CL)	Stiff
10'	-	15'	Poorly Graded Sand with Clay (SP-SC)	Medium Dense
15'	-	20'	Poorly Graded Sand (SP)	Medium Dense
20'	-	25'	Poorly Graded Sand With Clay and Gravel (SP-SC)	Medium Dense
25'	-	27'	Poorly Graded Sand with Gravel (SP)	Medium Dense

Boring NB-1 (Top of Overburden Elevation = 582.0)				
Range			Soil Description	Density
0'	-	10'	Shaley Lean to Fat Clay with Sand (CL/CH)	Stiff - Hard
10'	-	16'	Shaley Lean Clay	Hard

Boring NB-4 (Top of Overburden Elevation = 569.5)				
Range			Soil Description	Density
0'	-	8'	Silty Sand (SM)	Very Loose
8'	-	18'	Poorly Graded Sand (SP)	Loose-Medium
18'	-	19'	Clayed Sand (SC)	Medium Dense
19'	-	23'	Shaley Lean Clay (CL)	Stiff

Boring NB-5 (Top of Overburden Elevation = 681.5)				
Range			Soil Description	Density
0'	-	9'	Poorly Graded Sand (SP)	Very Loose
9'	-	14'	Clayed Sand (SC)	Medium Dense
14'	-	19'	Poorly Graded Sand with Clay (SP-SC)	Loose
19'	-	38'	Poorly Graded Sand (SP)	Medium Dense
38'	-	43'	Shaley Lean Clay (CL)	Stiff

Boring NB-6 (Top of Overburden Elevation = 602.0)		
Range	Soil Description	Density
0' - 10'	Poorly Graded Sand (SP)	Very Loose
10' - 16'	Shaley Lean Clay (CL)	Very Stiff

4.6.1.2 Foundation Material

The bridge boring explorations drilled a minimum of 30 feet into the foundation material in each of the five locations. Typically, the foundation material consisted of moderately hard weathered shale with consistency ranging from soft to hard, and with seams and fragments of limestone in various locations.

The rock in one of the borings was cored 30 feet into the rock formation with a core barrel, and a Texas cone penetrometer testing was performed to a depth of 30 feet into the rock after realizing the Standard Penetration Test Refusal as defined by ASTM Standard. Samples were logged with percent recovery, RQD, and the material photos logged in the core barrel. Refer to **Appendix O** for full geotechnical reports for the preliminary subsurface exploration for bridge on existing alignments and the new southern alignment.

4.6.2 Preliminary Embankment (Causeway) Survey

The preliminary embankment survey was conducted in Segment 3 and Segment 4 (Lake and Land Causeway), over four boring locations (**Figure 34**).

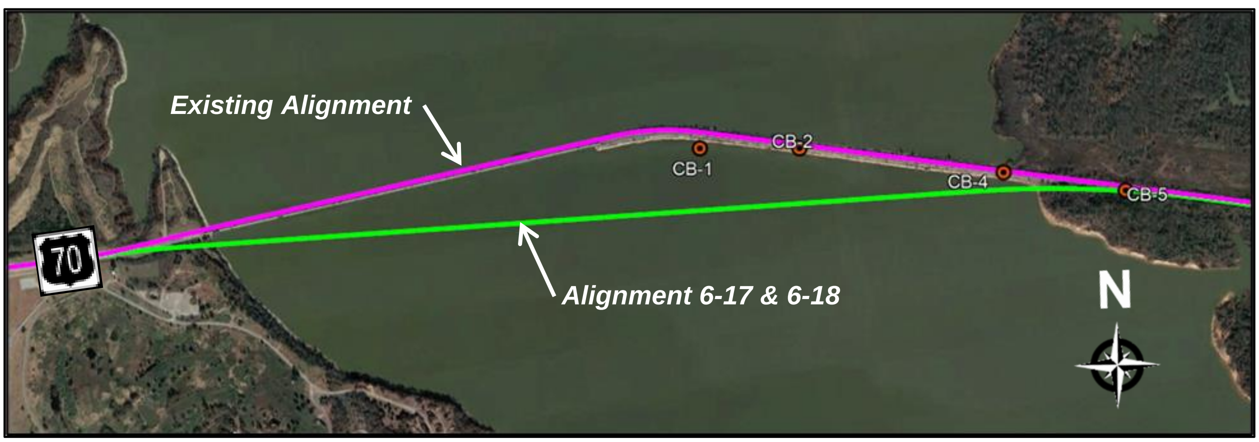


Figure 34: Preliminary Embankment (Causeway) Survey Boring Layout

The preliminary embankment survey was conducted to evaluate the native foundation soils for the proposed embankment widening for the causeway. The survey included advancing four soil borings at a minimum of 10 feet into the rock formation and five electric cone penetrometers soundings. Standard penetration tests (SPT) and Shelby tube samples were performed at five-foot intervals to the top of bedrock, and the CPT soundings extended to depths of twice the causeway height.

Laboratory testing was performed on all samples collected from the borings, which included the soil moisture content, soil classification tests, triaxial shear strength tests on Shelby tube samples, consolidation tests, and collapse potential tests.

Preliminary slope stability and settlement analysis of the embankments was also performed based on the subsurface exploration and laboratory test results. Refer to **Appendix O** for the full geotechnical report of the preliminary embankment (causeway) survey.

4.6.2.1 Overburden Soils

The overburden soil found in the three causeway boring locations typically consisted of sandy/clayey soils with trace amounts of gravel and silt, for the first 55 feet in the lake causeway, and for the first 30 feet in the land causeway.

A summary of the overburden soil descriptions in the three causeway borings are as follows:

Boring CB-2 (Top of Overburden Elevation = 646.2)		
Range	Soil Description	Density
0' - 45'	Clayey Sand (SC)	Medium Dense
45' - 50'	Poorly Graded Sand (SP)	Loose
50’ - 55’	Poorly Graded Sand (SP)	Medium Dense
55' - 60'	Poorly Graded Sand with Clay (SP)	Medium Dense

Boring CB-4 (Top of Overburden Elevation = 644.9)		
Range	Soil Description	Density
0' - 25'	Sandy Lean Clay (CL)	Very Stiff
25' - 30'	Clayey Sand (SC)	Medium
30' - 56'	Poorly Graded Sand (SP)	Medium Dense

Boring CB-5 (Top of Overburden Elevation = 643.0)		
Range	Soil Description	Density
0' - 5'	Sandy Silty Clay (CL-ML)	Very Stiff
5' - 15'	Lean Clay with Sand (CL)	Very Stiff
15' - 20'	Clayey Sand (SC)	Medium Dense
20' - 25'	Silty Sand (SM)	Medium Dense
25' 30'	Poorly Graded Sand (SP)	Medium Dense

4.6.2.2 Foundation Material

The causeway boring explorations drilled a minimum of 10 feet into the foundation material in each of the three locations. Typically the foundation material consisted of moderately hard weathered shale, soft-to-hard weathered shale with seams of sandstone, and poorly cemented weathered sandstone.

4.6.3 Retaining Wall Subsurface Investigation

Borings were drilled in Segment 1 of the study corridor for the preliminary investigations of soldier pile retaining walls on the north and south side of US-70.

4.6.4 Interpreted Subsurface Data

The subsurface data used for design and quantities were interpolated from data obtained from the bathymetric map, survey files, geotechnical exploration for the retaining walls, bridges, and embankment, and the existing Roosevelt Bridge as-built plans. Due to the relatively long distance of the project extents, these sources were all considered to provide a more accurate representation over the entire length of the project. From these sources, an assumed subsurface profile was created for the existing alignment and the new southern alignment (See **Figure 35** & **Figure 36**).

A summary of the data used for interpreting the subsurface profiles is as follows.

- Top of Rock
    - **Figure 35**: Rock elevations were taken from the plan and profile sheets of the as-built construction plans (**Appendix U**) and the values from the bottom of subsurface exploration. This data is assumed to be somewhat conservative because this assumes zero feet of penetration into the rock.
    - **Figure 36**: Extrapolated from the top of rock elevations from the borings NB-1, NB-4, NB-5, and NB-6
- Lake Bed: Lake bed elevations are values that represent the existing ground line elevation shown in the Plan and Profile sheets generated for this report (**Appendix B**)
- Pile Tips: Pile tip elevations represent the bottom of existing piles at substructure units and are taken from the bent and tower detail sheets of the as-built construction plans (**Appendix U**). The elevations were determined by subtracting the pile lengths by the bottom of footing elevations, that were both provided in the as-built plans. The pile lengths used for calculations were taken from the modified plan sheets that accounted for actual driven pile lengths. It is unknown how much rock penetration these piles were able to achieve.
- Quantity – Rock: Represents the value of rock elevation used in the generation of quantities. This is intended to represent the most realistic average value of rock elevation, so that the quantities and cost estimate can be representative the final bid values.
- Design – Rock: Value used during the preliminary design of the substructure units. This elevation was intended to be the more conservative, so that the design would represent a worst-case scenario.
- Boring: Represents the single point rock elevation as shown in the bridge borings.

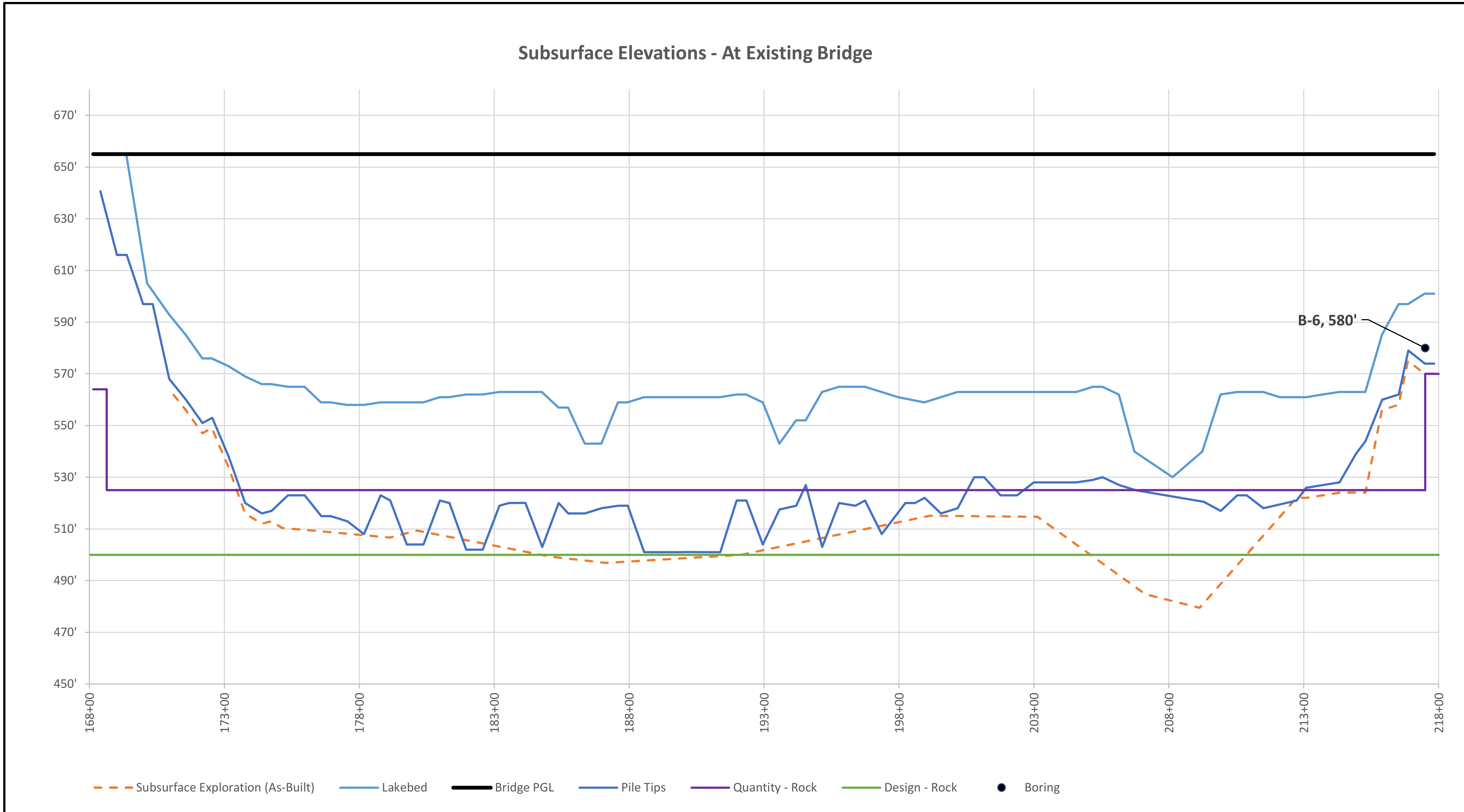


Figure 35: Assumed Subsurface Profile – At Existing Alignment

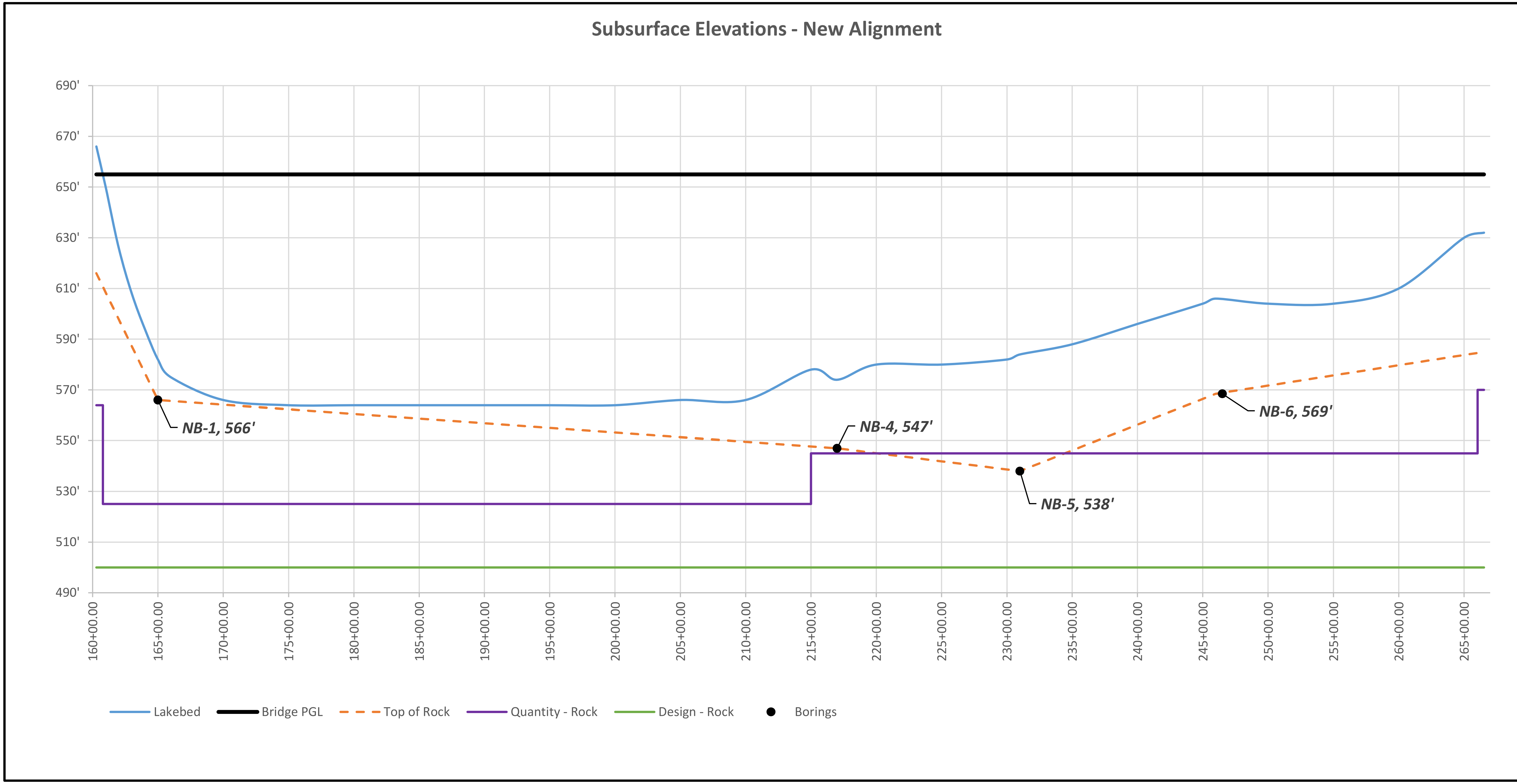


Figure 36: Assumed Subsurface Profile - At New Southern Alignment

4.7 Proposed Lighting

4.7.1 Functional Lighting

It is recommended that the proposed lighting along the US-70 corridor should at minimum match the existing lighting to maintain current roadway lighting conditions for safety purposes. Illuminated roadways not only provide additional visual clarity of the roadway for vehicular traffic but also allows for a safer passage for pedestrians that may be traveling on the roadway or stranded by their vehicle. See Section 3.5 for additional information of the existing corridor lighting.

4.7.2 Aesthetic Lighting

Aesthetic lighting is considered a potential candidate for this project due the high visibility of the bridge structure and project corridor, or the potential for a signature bridge structure. Refer to **Appendix S** for the *Signature Bridge Type Study* created for this project.

4.7.2.1 Architectural Enhancements

Aesthetic lighting can provide enhanced visual flexibility to accentuate the bridge structure, provide additional features to the surrounding environment, and bring additional appeal to tourists. LED (light emitting diode) fixtures can be designed to highlight, accent, and/or flood the bridge structure. They can also be designed to integrate into the existing surroundings to further compliment the site.

Other benefits of aesthetic lighting include:

- Assisting with increased safety
- Depth and character to static bridge features
- Illustrates the area’s rich history and respected culture by telling stories through hue and motion
- Promote wayfinding by facilitating efficient traffic flow accents
- Provide a visual experience through social color schemes for holidays and events.

Under-bridge lighting can be especially effective of displaying the bridge structure; however, if the waterway is deemed as a navigable waterway, lighting shields can be installed on the bridge to prevent visual disruptions to the waterway pilots.

4.7.2.2 Costs

Aesthetic lighting can have a substantial range of cost, which depends on factors such as where the lighting is to be attached, type of lights, and accessibility and difficulty for light installation. At this conceptual phase and based on previous similar bridge projects bids, it can be anticipated that aesthetic lighting for the entire Roosevelt Bridge replacement will likely be in the range of $2.5 to $7.2 million. If the aesthetic lighting is limited to the signature span only, the estimate cost can be significantly reduced to closer to $0.5 to $1.5 million.

4.8 Pavement Design

Pavement design was provided by the geotechnical subconsultant, Terracon, for the proposed US-70 alignments included in this report. The design was based on the data obtained from an in-place soil survey as well as existing and projected traffic data. Multiple pavement structures were provided by Terracon for consideration along this section of US-70. Two flexible options where provided that contain multiple asphalt layers with an aggregate base layer on a stabilized subgrade. Two rigid options where provided that contain Dowel Jointed Portland Concrete layer with a cement treated base on a stabilized subgrade. The multiple pavement designs for both the rigid and flexible options were investigated using traffic data with and without further development of the surrounding area. The design life of the pavement structures were based on a 30-year design life cycle starting in year 2020. See Pavement Design Report in **Appendix O.**

4.8.1 In-Place Soils Report Summary

An in-place soil survey was conducted in four roadway borings to obtain design subgrade parameters for the full depth typical sections. The soils sampled consisted of lean clays with varying amounts of sand, and a recommended subgrade resilient modulus value of 4,500 psi was recommended for full depth reconstructed sections.

Table 16 includes a summary of data obtained from the soil samples that were tested from the in-place soils survey

Table 16: In-Place Soils Report

Soil Sample	Resilient Modulus, psi		AASHTO Class	LL	PI	% Passing #200 Sieve
	OMC	OMC +2%				
Bulk	10,082	8,261	A-4(1)	24	10	43

4.8.2 Traffic Data Summary

The traffic data used for design analysis included two possible scenarios: with and without further development along the US-70 corridor. The typical sections developed are based upon a 30-year design life and includes class 9 vehicles and a combination of cars, pickup trucks, school buses, garbage trucks, and various types of delivery trucks. A summary of the design data for the four-lane, two-way traffic of the US-70 mainline is as follows:

Table 17: Design Data - US-70 4-Lane

Item	No Development	With Development
Year / AADT	2050 / 12,220	2050 / 27,260
30 Year Design AADTT	1,100	2,455
Estimated 20 Yr. Flex ESALs	9,748,761	21,747,179
Precent Heavy Trucks	9%	9%
Percent Trucks in Design Lane	80%	80%
Direction Distribution	57% (Assumed)	57% (Assumed)
Reliability Value	90%	90%
Design Resilient Modulus Value	4,500 psi	4,500 psi

4.8.3 Pavement Typical Section Recommendations

Based on the design parameters listed, the following pavement sections may be considered for this project.

Table 18: Pavement Typical Section Summary - Flexible Option (30 Yr. Design)

Layers	No Development	With Development
Layer 1	2.0 in. HMA Type S4 PG 76-28OK *	2.0 in. HMA Type S4 PG 76-28OK *
Layer 2	3.0 in. HMA Type S3 PG 76-28OK *	3.0 in. HMA Type S3 PG 76-28OK *
Layer 3	2.5 in. HMA Type S3 PG 64-22OK	3.5 in. HMA Type S3 PG 64-22OK
Layer 4	2.5 in. HMA Type S3 PG 64-22OK	3.5 in. HMA Type S3 PG 64-22OK
Layer 5	12.0 in. Aggregate Base Type A **	12.0 in. Aggregate Base Type A **
Layer 6	8.0 in. Stabilized Subgrade	8.0 in. Stabilized Subgrade
Total Depth	26.0 in.	28.0 in.

* *Use PG-22OK on Shoulders*

** *Shoulder with TBSC Type Geogrid – ODOT Type I*

Table 19: Pavement Typical Section Summary - Rigid Option (30 Yr. Design)

Layers	No Development	With Development
Layer 1	9.0 in. Dowel Jointed PC Pavement *	10.0 in. Dowel Jointed PC Pavement *
Layer 2	4.0 in Cement Treated Base	4.0 in Cement Treated Base
Layer 3	8.0 in. Aggregate Base Type A **	8.0 in. Aggregate Base Type A **
Layer 3	8.0 in. Stabilized Subgrade	8.0 in. Stabilized Subgrade
Total Depth	21.0 in.	22.0 in.

* *With Tied PC Shoulders 15 oz/SY Non-Woven Geotextile Separator Fabric*

** *Shoulder with TBSC Type Geogrid – ODOT Type I*

4.9 Right-of-Way Evaluation Methodology

To evaluate the need for proposed right-of-way for each high alternative alignment within the corridor, a proposed toe of slope needs to be established for each alignment. To display this toe, each alternative was designed horizontally and vertically and then modeled using the proposed typical sections. The proposed top of cut and toe of slopes where then displayed for each alternative. If the proposed slopes extended over the existing utility locations or outside the existing right-of-way boundaries, new right-of-way will need to be acquired. The amount of right-of-way acquired outside the proposed toes depends on the number of utilities in the area. The more utilities running parallel to the alignment the more right-of-way that will need to be acquired. If there are not utilities in the area but the proposed toes go outside the existing right-of-way boundary a minimum of 10 feet will be acquire from the edge of the toe.

Proposed right-of-way was established for each alternative using the above procedure then exhibit sheets and the amount of acreage acquired for each alternative was calculated. Six alternatives were then provided to the Oklahoma Department of Transportation (ODOT) Right-of-Way division for right-of-way costs. The Right-of-Way division then provided Garver with an estimated cost per alternative for the proposed right-of-way. The remaining alternatives right-of-way cost were then interpolated from the alternatives provided to ODOT. Refer to **Appendix F** for *Right-of-Way Impact Tabulations*.

4.10 Utility Evaluation Methodology

The methodology used to establish the cost to relocate a utility is to identify the utility that may need to be relocated, identify the individual owner, utility type and the linear foot of utility that will need to be relocated. At the time of this submittal, costing information was not provided for utility relocation for any of the alignment alternatives. The remaining alternatives utilized similar methodology to determine the utility relocation costs. **Appendix G** is provided as a placeholder for the utility relocation costs once they have been provided.

5.0 Proposed Alternatives

5.1 Summary

Nineteen alignments were evaluated to varying degrees and are described based on the impacts to the corridor's three main features: the land causeway, lake causeway, and proposed replacement bridge.

A preliminary decision matrix was created to rate each alternative as having a low, medium, or high potential of selection for final design, and rated on corridor improvements, construction costs, user costs, impacts to environmental features, tribal properties, utilities, existing right-of-way, future improvements, and maintenance of traffic during construction. Of the nineteen alternatives, seven were rated as having low potential for selection, six as medium potential, and seven as high potential. Only the seven high-potential options were fully investigated in this preliminary engineering study, with four of the seven options including sub-options (Option A or Option B). See *Sections 5.2 through 5.12* for further information on alignments and their sub-options.

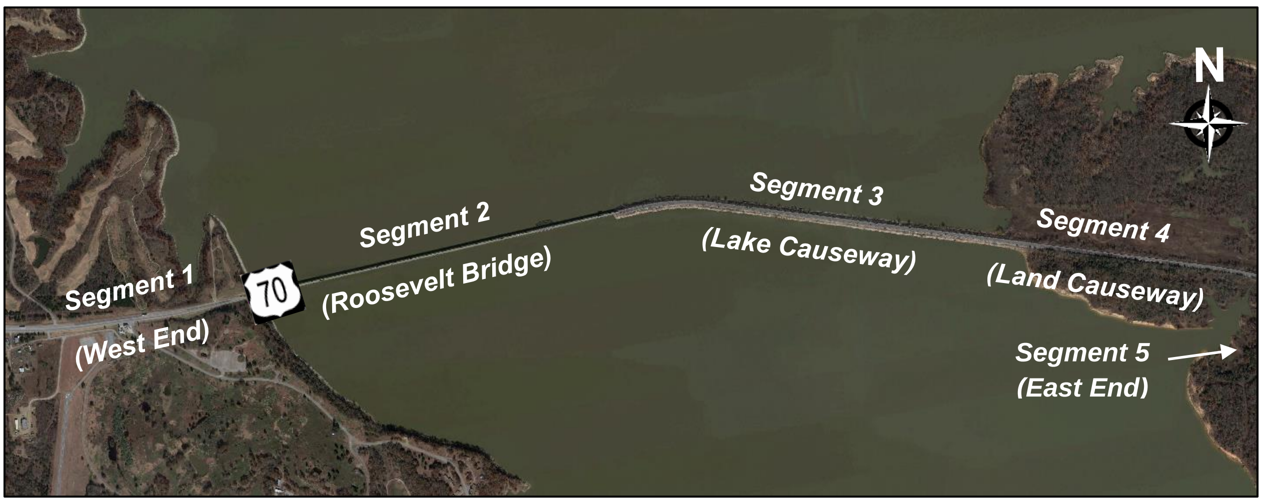


Figure 37: Corridor Study Features


Figure 38: Roosevelt Bridge


Figure 39: Lake Causeway


Figure 40: Land Causeway

Each alternative is defined by two typical characteristics: the horizontal offset of the new alignment compared to the existing alignment, and the extent of widening and construction of new causeways. The vertical profiles are similar for all alternatives and were not considered significant for the alignment selection. On-existing alignment utilizes the existing roadway and requires phased construction, partial offsets are 27'-6" from the existing survey centerline, and full alignment offsets measure 57' from the existing survey centerline. Alternatives 6-17, 6-18, and 6-19 utilize a new southern alignment which connects US-70 from west of the Roosevelt Bridge to the Land Causeway. The study corridor east of the bridge includes two portions of the existing causeway defined as the Lake Causeway and the Land Causeway. **Table 20** summarizes each alignment by the direction of the offset of the proposed alignment from the existing alignment and the magnitude of offset at each of the three main corridor characteristics.

Table 20: Alignment Alternative Summary

Alignment Alternative	*Offset*			
	Direction	*Bridge*	*Lake Causeway*	*Land Causeway*
6-1	*North*	*Full*	*Full*	*Full*
6-2A	*North*	*Full*	*Partial*	*Partial*
6-2B	*North*	*Full*	*Partial*	*Partial*
6-3	*North*	*Full*	*Partial*	*Existing*
6-4	*North*	*Full*	*Existing*	*Existing*
6-5	*North*	*Partial*	*Full*	*Full*
6-6A	*North*	*Partial*	*Partial*	*Partial*
6-6B	*North*	*Partial*	*Partial*	*Partial*
6-7	*North*	*Partial*	*Partial*	*Existing*
6-8	*North*	*Partial*	*Existing*	*Existing*
6-9	*South*	*Partial*	*Full*	*Full*
6-10	*South*	*Partial*	*Partial*	*Partial*
6-11	*South*	*Partial*	*Partial*	*Existing*
6-12	*South*	*Partial*	*Existing*	*Existing*
6-13	*South*	*Full*	*Full*	*Full*
6-14	*South*	*Full*	*Partial*	*Partial*
6-15	*South*	*Full*	*Partial*	*Existing*
6-16	*South*	*Full*	*Existing*	*Existing*
6-17A	*South*	*New*	*New*	*Existing*
6-17B	*South*	*New*	*New*	*Existing*
6-18A	*South*	*New*	*New*	*Partial*
6-18B	*South*	*New*	*New*	*Partial*
6-19	*South*	*New*	*New*	*Full*

Partial Offset = 27'-6"
Full Offset = 54'-0"

5.1.1 Low-Potential Options

Seven of the alignment alternatives were determined to have a low potential for final design selection. In some cases, this was due to the high costs of fully offsetting the lake and land causeways and associated impacts. In other cases, sequencing and maintenance of traffic were relatively impactful.

The low-potential alignments include the following alternatives:

- Alternative 6-1
- Alternative 6-5
- Alternative 6-8
- Alternative 6-9
- Alternative 6-12
- Alternative 6-13
- Alternative 6-19

Full offsets of the causeway require a significant amount of additional material compared to on-existing and partial causeway offsets resulting in higher costs. Alignment Alternatives 6-12 and 6-13 also require the bridge to have phased construction, making for these options to be less favorable for further investigation.

5.1.2 Medium-Potential Options

Five of the alignment alternatives were determined to have a medium potential for final design selection due to more favorable conditions for causeway construction than the Low-Potential Options and some benefits for the maintenance of traffic in the causeway sections. These options typically have the smallest overall project footprint, but still have a significantly higher impact and considerations for the maintenance of traffic during construction when compared to the high-potential options.

The medium-potential alignments include the following alternatives:

- Alternative 6-4
- Alternative 6-7
- Alternative 6-10
- Alternative 6-11
- Alternative 6-16

Alternative 6-4 is similar to Alternatives 6-2 and 6-3, except both causeways are to be constructed on the same alignment as existing. This minimizes causeway construction costs, but multiple construction phases would be required to complete the project. Alternative 6-7 similarly requires less material for causeway construction, but construction phasing would still be required for the causeway and for the bridge. Partial offset alignments options also assume a complete remove and replacement of the existing bridge. Alternatives 6-10, 6-11, and 6-16 have the same characteristics as the previous alternatives but are offset to the south side of the existing alignment.

5.1.3 High-Potential Options

Seven of the alignment alternatives were determined to a have a high potential for final design selection. These options typically have the smallest overall project footprint and costs, while minimizing the impacts on maintenance of traffic. Of the seven alignment alternatives, three alignments have sub-options that either include retaining walls to minimize impacts to compensatory storage, or different bridge and causeway lengths.

The high-potential alignments, including alignment sub-options, include the following alternatives:

- Alternative 6-2A (without retaining wall)
- Alternative 6-2B (with retaining wall)
- Alternative 6-3
- Alternative 6-6A (without retaining wall)
- Alternative 6-6B (with retaining wall)
- Alternative 6-14
- Alternative 6-15
- Alternative 6-17A (bridge and causeway)
- Alternative 6-17B (bridge only)
- Alternative 6-18A (bridge and causeway)
- Alternative 6-18B (bridge only)

See *Sections 5.2 through 5.12* for additional information for each alignment alternative including typical sections, layouts, hydraulic data, bridge details, impacts to compensatory storage, right-of-way, utilities, and environmental resources, and an overall cost estimate.

All retaining walls defined in the high-potential alignments are soldier pile causeway retaining walls. Additionally, it is likely that retaining walls will be considered on the western extents of the project to minimize impacts and would potentially be applied to the preferred alternative. See *Section 4.4.3* for additional information.

Alternative 6-2B is considered the compensatory storage alternative. It was developed to understand methods to mitigate compensatory storage and is further defined in *Section 6.0*. The difference between 6-2A and 6-2B is the compensatory storage methods.

Alternative 6-6B uses causeway retaining walls to understand what benefits might be gained from a pure construction cost standpoint compared to Alternative 6-6A. Although 6-6B does reduce the compensatory storage impacts, its purpose was to better understand the efficiency gained for the use of causeway retaining walls.

Alternative 6-17A constructs a new causeway along a new south offset alignment. Alternative 6-17B uses the same alignment but no new causeway construction. The purpose of these sub-options is to better understand the impacts of constructing a new causeway.

5.1.4 Selection Potential of Alignment Alternatives

The following table summarizes each alignment alternative and sub-option by the direction of alignment offset and the amount of offset at each of the three defining characteristics of the proposed roadway, and includes the category for selection potential. All high-potential options are explained further in *Sections 5.2 through 5.12*.

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-1	North	Full	Full	Full	Low
6-2A	North	Full	Partial	Partial	High
6-2B	North	Full	Partial	Partial	High
6-3	North	Full	Partial	Existing	High
6-4	North	Full	Existing	Existing	Medium
6-5	North	Partial	Full	Full	Low
6-6A	North	Partial	Partial	Partial	High
6-6B	North	Partial	Partial	Partial	High
6-7	North	Partial	Partial	Existing	Medium
6-8	North	Partial	Existing	Existing	Low
6-9	South	Partial	Full	Full	Low
6-10	South	Partial	Partial	Partial	Medium
6-11	South	Partial	Partial	Existing	Medium
6-12	South	Partial	Existing	Existing	Low
6-13	South	Full	Full	Full	Low
6-14	South	Full	Partial	Partial	High
6-15	South	Full	Partial	Existing	High
6-16	South	Full	Existing	Existing	Medium
6-17A	South	New	New	Existing	High
6-17B	South	New	New	Existing	High
6-18A	South	New	New	Partial	High
6-18B	South	New	New	Partial	High
6-19	South	New	New	Full	Low

High-Potential Alignment Alternative

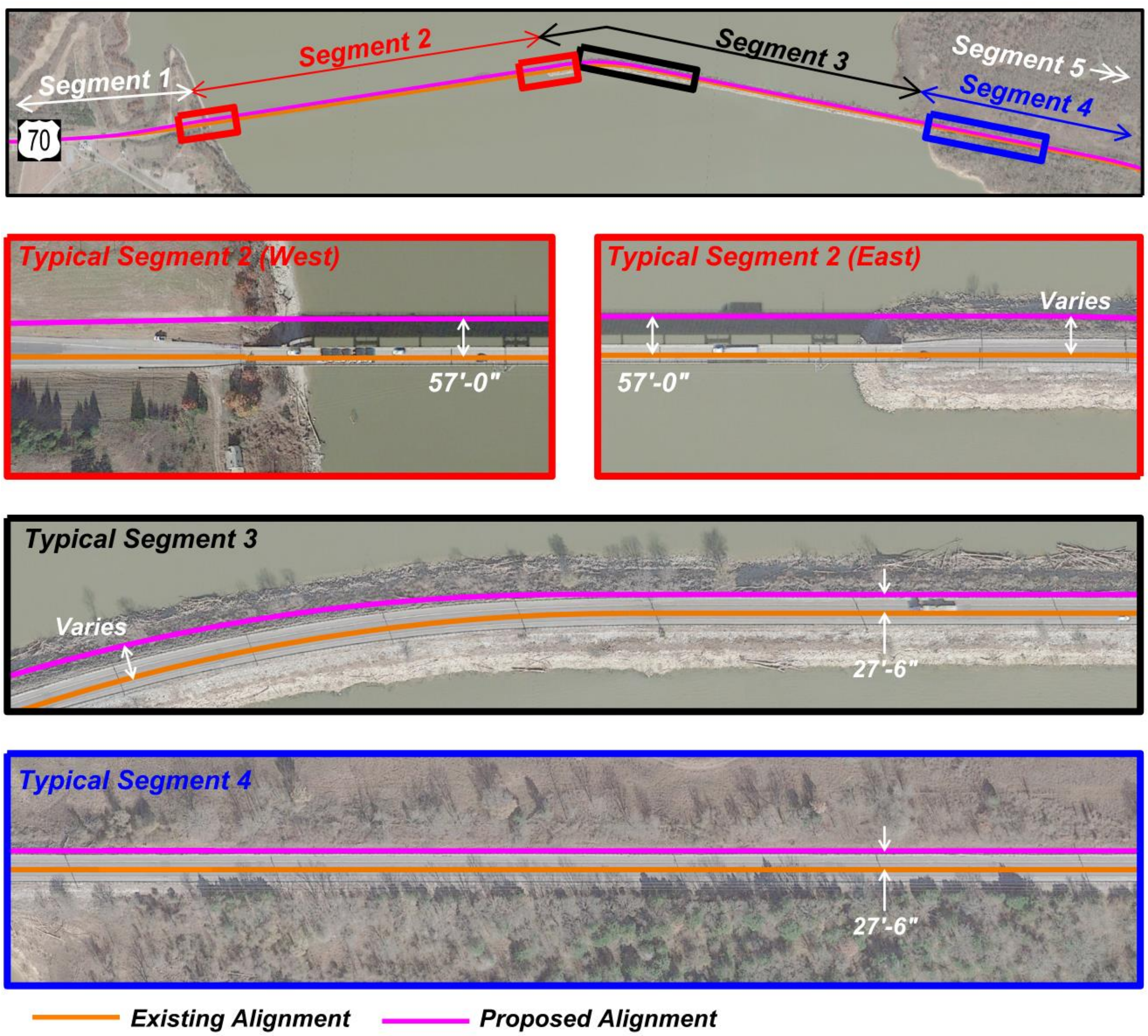
Partial Offset = 27'-6"

Full Offset = 54'-0"

5.2 Alternative 6-2A

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	**Lake Causeway**	Land Causeway	
6-2A	North	Full	Partial	Partial	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.2.1 Roadway

The horizontal alignment for US-70 (Alt. 6-2A) is offset to the north of the existing alignment with varying distances for the different segments. At the west end of the study area, the horizontal alignment transitions from existing survey centerline to a 57’ northern offset alignment by the begin of bridge. The west extent also transitions the two-way middle turn lane from 16’ to 0’ over 520’ just west of the bridge. After the Roosevelt Bridge the alignment transitions from a parallel 57’ offset to 27’-6” offset and continues this offset through the lake and land causeways before transitioning back to the existing alignment before the Willow Springs Road intersection. A two-way middle turn lane is reintroduced to the corridor 520’ west of the Willow Spring Road intersection to allow for a left turn lane into the Johnson Creek Campground.

The proposed vertical alignment is flat at an elevation of 655.00 ft throughout the length of the proposed bridge, which is approximately six feet higher than the existing bridge to avoid superstructure submersion during high-water flood events. After the bridge, the proposed vertical alignment transitions to 650.00 ft, which is approximately five feet higher than the existing causeway to prevent overtopping during flood-events. The vertical grade is flat throughout the remainder of the corridor until it transitions to match existing grade at the project extents.

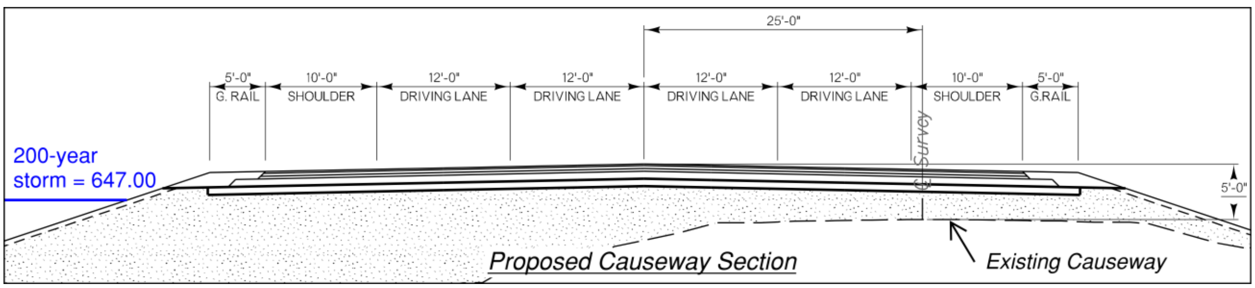


Figure 41: Typical Section through Lake Causeway

5.2.2 Bridge

Note: Bridge characteristics are similar for Alternatives 6-2A, and 6-3.

The anticipated bridge will span approximately 4,492' from the west embankment of Lake Texoma to the Lake Causeway, with a 57' northern offset of the centerline of existing and proposed bridges, and a 7'-9" clear distance between the edge of decks. With this alignment the existing Roosevelt Memorial Bridge can be completely preserved for the use of Alternative 4 (Pedestrian Bridge) or Alternative 5 (Monument Bridge) as described in the *US-70 over Lake Texoma (Franklin D. Roosevelt Memorial Bridge) Section 4(f) Alternatives Analysis & Report* (**Appendix Q**).

For a summary of characteristics of the proposed bridge option for this alignment, refer to **Table 21.**

Table 21: Alignment 6-2A Bridge Summary

General	*Bridge Length*	*4,942 ft.*
	Bridge Area	*350,882 ft²*
	Span Count	*32*
Superstructure	*Beam Lines & Type*	*7 - Tx70 Prestressed Girders*
	Max Span Length	*150 ft.*
	Total Beam Length	*34,505 ft.*
Substructure	*Pier Cap Dimensions*	*69.5' x 5' x 7'*
	Column Dimensions	*2 - 4'-6"Ø x 24 LF*
	Drilled Shaft Dimensions	*2 - 10'-0" Ø*
	Total Drilled Shaft Length	*7,296 ft.*

Additional bridge design criteria, bridge design options, span optimization, estimated costs, and additional studies for the proposed bridge options are included in the *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report* (**Appendix K**).

5.2.3 Compensatory Storage

590,165 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alternative has a fill slope of 1:3 into the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.2.4 Right-of-Way

Alternative 6-2A will require an acquisition of 64.50 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. Several different techniques could be used to help reduce the amount of right-of-way acquired such as retaining walls and steepen backslopes outside of clear zone. Refer to **Appendix F** for additional right-of-way information.

5.2.5 Utilities

For Alternative 6-2A most of the utilities are located to the south of the existing survey centerline. The overhead power lines and the telephone utilities on the northside of the alignment will need to be relocated as well as the overhead power on the bridge and causeways. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. A new development that is planned for the area may also have utilities that are not identified at the time this report is submitted but may be present when the new roadway is constructed. Refer to **Appendix G** for additional information on utilities.

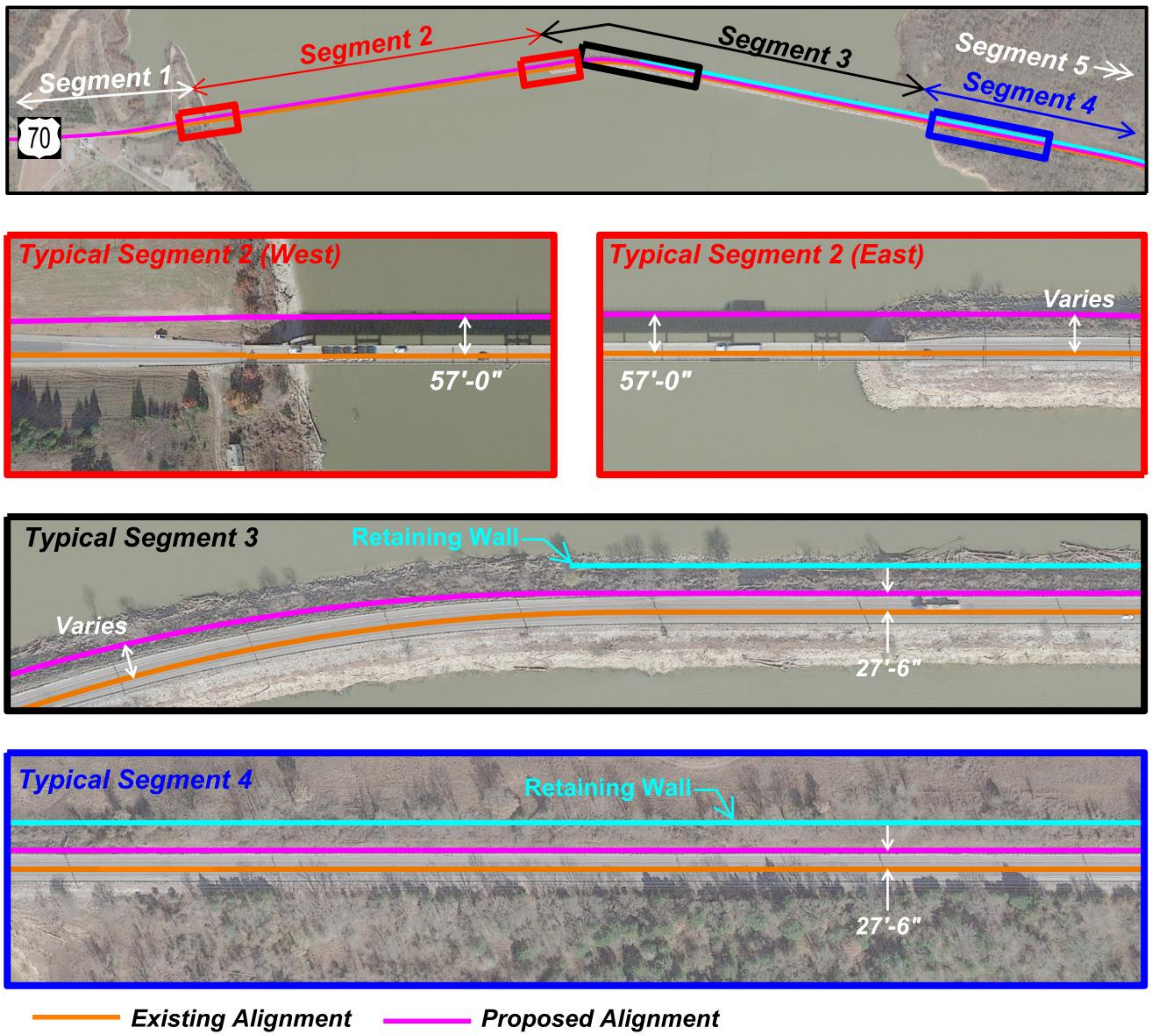
5.2.6 Environmental

Alternative 6-2A has relatively low impacts to streams and wetlands, but is among the highest impacts to the Johnson Creek PUA. Approximately 63 acres of USACE property will be required which is relatively high compared to the other alternatives. No tribal land will be impacted by this alternative. Alternative 6-2A will not impact the Catfish Bay Marina gas station. Archeological site 34BR11 has the potential to be affected..

5.3 Alternative 6-2B

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-2B	North	Full	Partial	Partial	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.3.1 Roadway

Alternative 6-2B alignment and profile matches that described for Alternative 6-2A. The primary difference of 6-2B is the use of retaining walls to mitigate impacts to flood storage. See Figure 41 below.

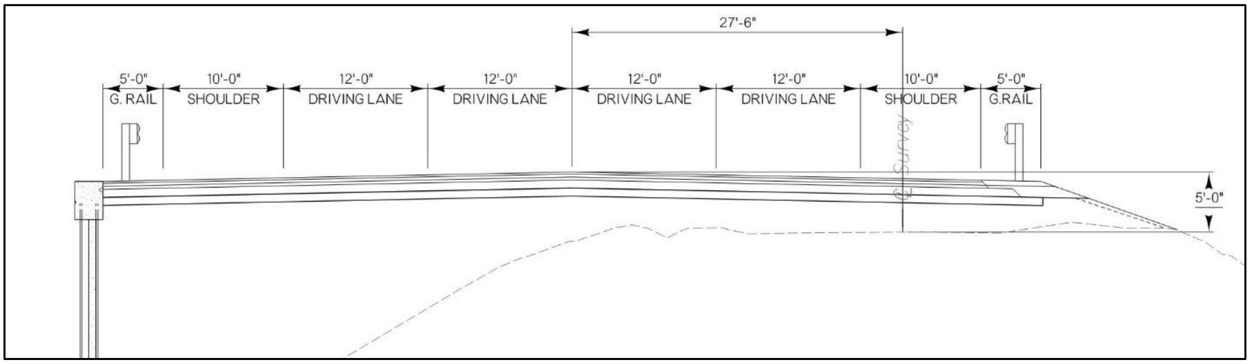


Figure 42: Typical Section through Causeway

5.3.2 Bridge

The anticipated bridge will span approximately 6,146' from the west embankment to the Lake Causeway, with a 57' northern offset of the centerline of existing and proposed bridges, and a 7'-9" clear distance between the edge of decks. With this alignment the existing Roosevelt Bridge can be completely preserved for the use of Alternative 4 (Pedestrian Bridge) or Alternative 5 (Monument Bridge) as described in the *US-70 over Lake Texoma (Franklin D. Roosevelt Memorial Bridge) Section 4(f) Alternatives Analysis & Report* (**Appendix Q**). The proposed bridge in this option is extended further than the proposed bridge in Alignment 6-2A to meet the point at which a retaining wall can be constructed on the north side of the proposed roadway to limit the amount of fill being placed in the compensatory storage flood area.

For a summary of characteristics of the proposed bridge option for this alignment, refer to **Table 22**.

Table 22: Alignment 6-2B Bridge Summary

General	*Bridge Length*	*6,146 ft.*
	Bridge Area	*436,366 ft²*
	Span Count	*41*
Superstructure	*Beam Lines & Type*	*7 - Tx70 Prestressed Girders*
	Max Span Length	*150 ft.*
	Total Beam Length	*42,912 ft.*
Substructure	*Pier Cap Dimensions*	*69.5' x 5' x 7'*
	Column Dimensions	*2 - 4'-6"Ø x 24 LF*
	Drilled Shaft Dimensions	*2 - 10'-0" Ø*
	Total Drilled Shaft Length	*9,348 ft.*

Additional bridge design criteria, bridge design options, span optimization, estimated costs, and additional studies for the proposed bridge options are included in the *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report* (**Appendix K**).

5.3.3 Compensatory Storage

There is a net zero impact to compensatory flood storage area for this alternative. 119,178 cubic yards of material can be excavated from the existing lake causeway within the compensatory flood storage area where a new bridge will be constructed. The typical section for this alternative has a retaining wall along the causeways to reduce the amount of fill within the compensatory flood storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.3.4 Right-of-Way

Alternative 6-2B will require an acquisition of 22.00 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. The amount of right-of-way acquired on the west end of the project could be reduced with retaining walls and steepen backslopes outside of clear zone. Refer to **Appendix F** for right-of-way information.

5.3.5 Utilities

Most of the utilities are located to the south of the existing survey centerline. The overhead power lines and the telephone utilities on the northside of the alignment will need to be relocated as well as the overhead power on the bridge and causeways. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. A new development that is planned for the area may also have utilities that are not identified at the time this report is submitted but may be present when the new roadway is constructed. Refer to **Appendix G** for additional information on utilities.

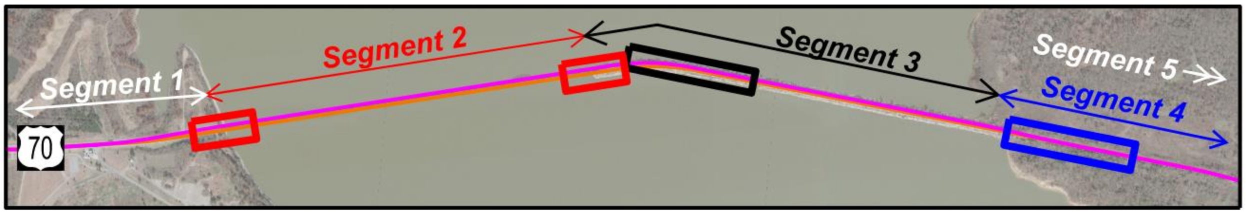
5.3.6 Environmental

Due to the use of retaining walls, Alternative 6-2B has among the lowest impacts to wetlands and streams. Impacts to the Johnson Creek PUA and other USACE property are also the lowest among the alternatives by a relatively large margin. No tribal land will be impacted by this alternative and, like Alternative 6-2A, impacts to Lake Texoma State Park are among the lowest of the alternatives. Alternative 6-2B will not impact the Catfish Bay Marina gas station. Archaeological site 34BR11 has the potential to be impacted.

5.4 Alternative 6-3

Alignment Alternative	*Offset*				*Selection Potential*
	Direction	***Bridge***	***Lake Causeway***	***Land Causeway***	
6-3	*North*	*Full*	*Partial*	*Existing*	*High*

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



Existing Alignment ***Proposed Alignment***

5.4.1 Roadway

The horizontal alignment for US-70 (Alt 6-3) is offset to the north of the existing alignment with varying distances for the different segments. At the west end of the study area, the horizontal alignment transitions from an existing survey centerline to a 57' northern offset alignment by the begin of bridge. The west extent also transitions the two-way middle turn lane from 16' to 0' over 520' just west of the bridge. After the Roosevelt Bridge the alignment transitions from a parallel 57' offset to a 27'-6" offset and continues this offset along the lake causeway. The alignment then transitions back to the existing alignment along the land causeway. A two-way middle turn lane is reintroduced to the corridor 520' west of the Willow Spring Road intersection to allow for a left turn lane into the Johnson creek campground.

5.4.2 Bridge

Alternative 6-3 bridge matches that described for Alternative 6-2A.

5.4.3 Compensatory Storage

595,520 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alternative has a fill slope of 1:3 into the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.4.4 Right-of-Way

Alternative 6-3 will require an acquisition of 65.30 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. A few different techniques could be used to help reduce the amount of right-of-way acquired such as retaining walls and steepen backslopes outside of clear zone. Refer to **Appendix F** for additional right-of-way information.

5.4.5 Utilities

Most of the utilities are located to the south of the existing survey centerline. The overhead power lines and the telephone utilities on the northside of the alignment will need to be relocated as well as the overhead power on the bridge and causeways. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. A new development that is planned for the area may also have utilities that are not identified at the time this report is submitted but may be present when the new roadway is constructed. Refer to **Appendix G** for additional information on utilities.

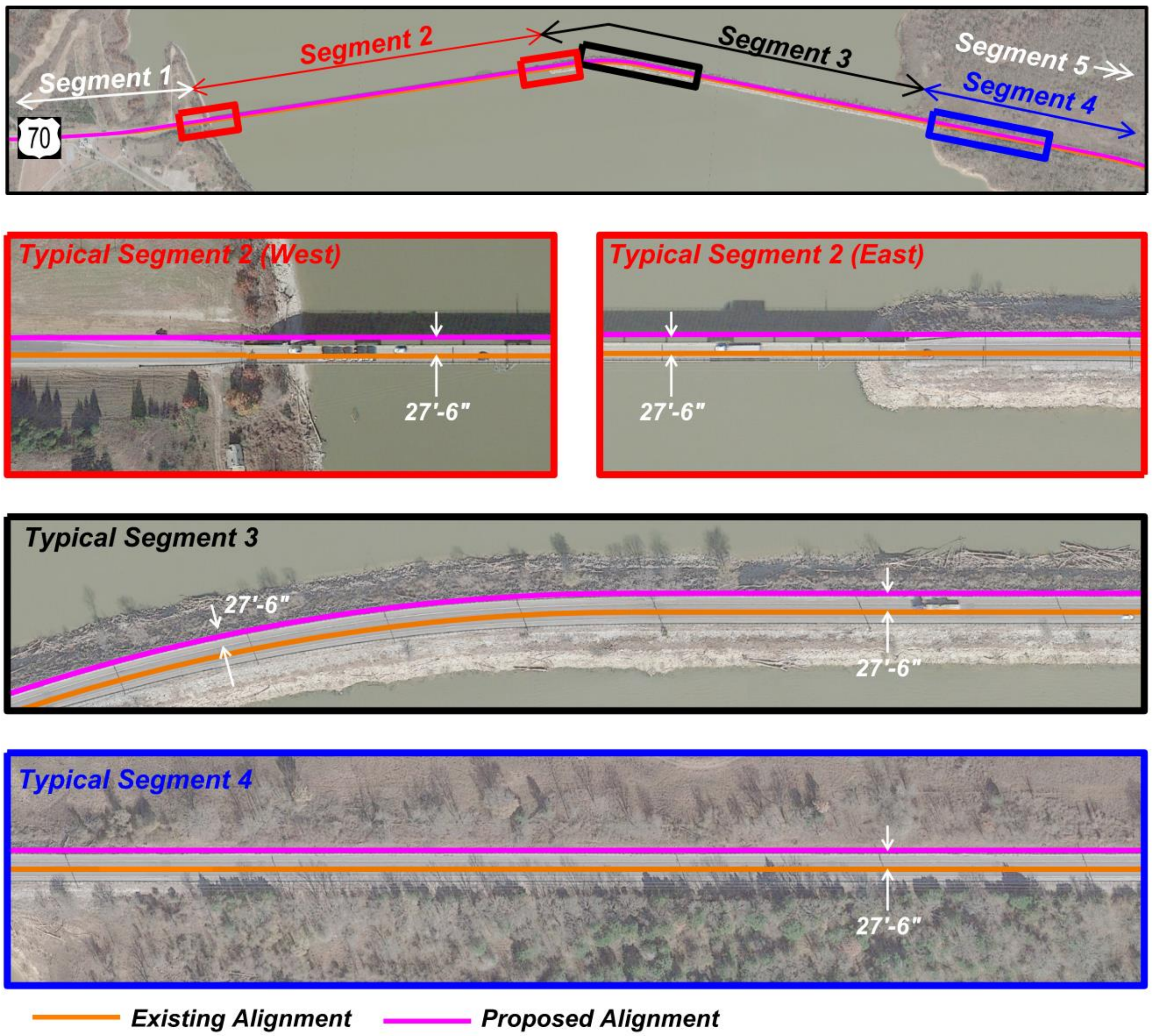
5.4.6 Environmental

Impacts of Alternative 6-3 are comparable to Alternative 6-2A. Wetland and stream impacts are slightly higher, while impacts to Johnson Creek PUA and Lake Texoma State Park are slightly lower. Approximately 64.3 acres of USACE property will be required. No tribal land will be impacted by this alternative. Alternative 6-3 will not impact the Catfish Bay Marina gas station. Archaeological site 34BR11 has the potential to be impacted.

5.5 Alternative 6-6A

Alignment Alternative	*Offset*				*Selection Potential*
	Direction	***Bridge***	***Lake Causeway***	***Land Causeway***	
6-6A	*North*	*Partial*	*Partial*	*Partial*	*High*

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.5.1 Roadway

The horizontal alignment for US-70 (Alt 6-6A) is offset to the north of the existing alignment and follows parallel throughout the corridor. At the west extent of the study area, the horizontal alignment transitions from existing to a 27'-6" northern offset by the begin of bridge. The west extent also transitions the two-way middle turn lane from 16' to 0' over 520' just west of the bridge. After the Roosevelt Bridge the alignment continues a 27'-6" offset through the lake and land causeways. The alignment then transitions back to the existing alignment before the willow spring road intersection. A two-way middle turn lane is reintroduced to the corridor 520' west of the Willow Spring Road intersection to allow for a left turn lane into the Johnson Creek Campground.

5.5.2 Bridge

The anticipated bridge will span approximately 4,492' from the west embankment to the Lake Causeway, with a 27'-6' northern offset of the centerline of existing and proposed bridges. The partial northern offset throughout the bridge portion requires demolition of the existing Roosevelt Bridge and the proposed replacement bridge will be required to be constructed in three phases.

For a summary of characteristics of the proposed bridge option for this alignment, refer to **Table 23**.

Table 23: Alignment 6-6A Bridge Summary

General	*Bridge Length*	*4,942 ft.*
	Bridge Area	*350,882 ft²*
	Span Count	*32*
Superstructure	*Beam Lines & Type*	*8 - Tx70 Prestressed Girders*
	Max Span Length	*150 ft.*
	Total Beam Length	*39,435 ft.*
Substructure	*Pier Cap Dimensions*	*69.5' x 5' x 7'*
	Column Dimensions	*2 - 4'-6"Ø x 24 LF*
	Drilled Shaft Dimensions	*2 - 12'-0" Ø*
	Total Drilled Shaft Length	*7,552 ft.*

Additional bridge design criteria, bridge design options, span optimization, estimated costs, and additional studies for the proposed bridge options are included in the *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report.*

5.5.3 Compensatory Storage

595,169 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alternative has a fill slope of 1:3 into the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.5.4 Right-of-Way

Alternative 6-6A will require an acquisition of 53.06 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. A few different techniques could be used to help reduce the amount of right-of-way acquired such as retaining walls and steepen backslopes outside of clear zone. Refer to **Appendix F** for additional right-of-way information.

5.5.5 Utilities

Most of the utilities are located to the south of the existing survey centerline. The overhead power lines and the telephone utilities on the northside of the alignment will need to be relocated as well as the overhead power on the bridge and causeways. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. A new development that is planned for the area may also have utilities that are not identified at the time this report is submitted but may be present when the new roadway is constructed. Refer to **Appendix G** for additional information on utilities.

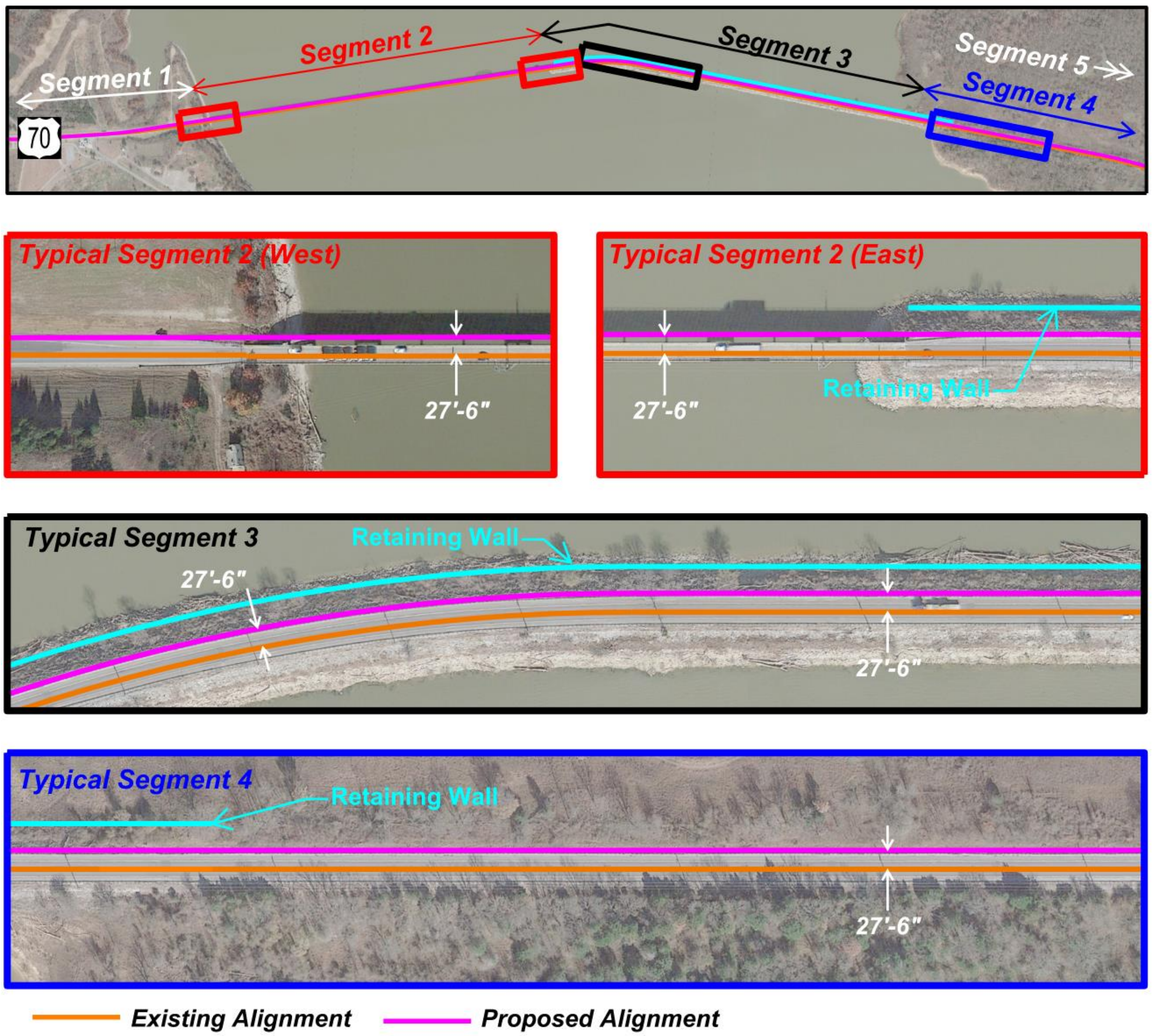
5.5.6 Environmental

Alternative 6-6A has the lowest wetland impact and the lowest stream impact outside of Alternative 6-6B. Impacts to USACE property, Johnson Creek PUA and Lake Texoma State Park are among the lowest of the alternatives. No tribal property will be affected. Alternative 6-6A has the potential to affect the Catfish Bay Marina gas station and archaeological site 34BR11.

5.6 Alternative 6-6B

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-6B	North	Partial	Partial	Partial	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.6.1 Roadway

Alternative 6-6B profile matches that described for Alternative 6-6A. The primary difference of 6-6B is the use of retaining walls to mitigate impacts to compensatory flood storage.

5.6.2 Bridge

Alternative 6-6B bridge matches that described for Alternative 6-6A.

5.6.3 Compensatory Storage

279,876 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical sections for this alternative has a retaining wall on the lake causeway section and a fill slope of 1:3 on the land causeway section that fills into the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.6.4 Right-of-Way

Alternative 6-6B will require an acquisition of 33.88 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. The amount of right-of-way acquired on the west end of the project could be reduced with retaining walls and steepen backslopes outside of clear zone. Refer to **Appendix F** for additional right-of-way information.

5.6.5 Utilities

Most of the utilities are located to the south of the existing survey centerline. The overhead power lines and the telephone utilities on the northside of the alignment will need to be relocated as well as the overhead power on the bridge and causeways. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. A new development that is planned for the area may also have utilities that are not identified at the time this report is submitted but may be present when the new roadway is constructed. Refer to **Appendix G** for additional information on utilities.

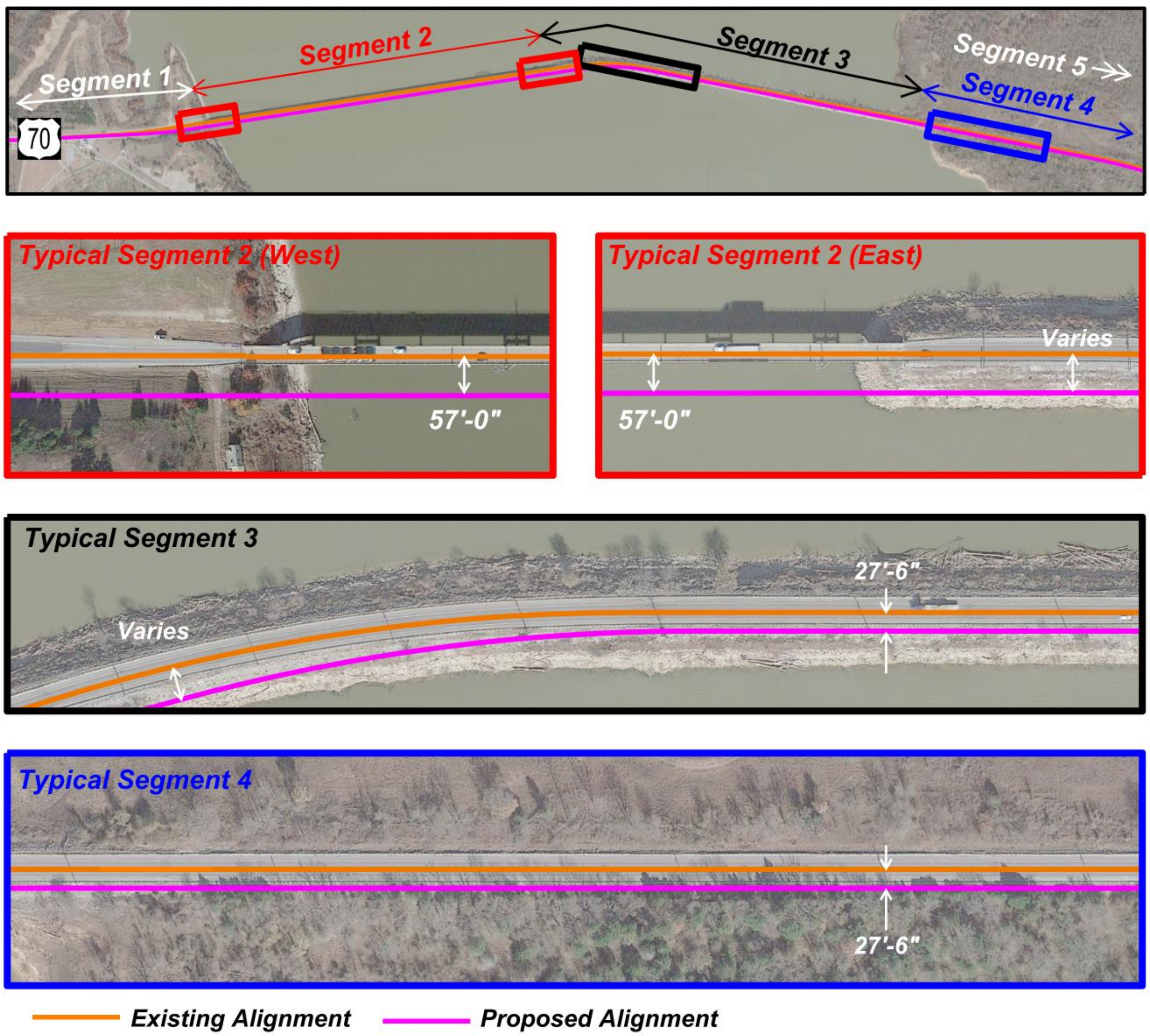
5.6.6 Environmental

Alternative 6-6B has the lowest impacts of all of the alternatives, with the exception of impacts to USACE property which are higher only than Alternative 6-2B. Alternative 6-6B does have the potential to impact the Catfish Bay Marina gas station and archaeological site 34BR11.

5.7 Alternative 6-14

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-14	South	Full	Partial	Partial	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.7.1 Roadway

Alternative 6-14 alignment and profile matches that described for Alternative 6-2A.

5.7.2 Bridge

Alternative 6-14 bridge matches that described for Alternative 6-2A.

5.7.3 Compensatory Storage

590,165 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alignment has a fill slope of 1:3 on the lake and land causeways that fills into the compensatory storage area. See *Section 6.0* for proposed methods for compensatory storage mitigation.

5.7.4 Right-of-Way

Alternative 6-14 will require an acquisition of 72.09 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. A few different techniques could be used to help reduce the amount of right-of-way acquired such as retaining walls and steepen backslopes outside of clear zone Refer to **Appendix F** for additional right-of-way information.

5.7.5 Utilities

Alternative 6-14 most of the utilities are located to the south of the existing survey centerline. These utilities such as fiber optic and overhead electric lines will need to be relocated as well as the utilities on the lake and land causeways. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. Refer to **Appendix G** for additional information on utilities.

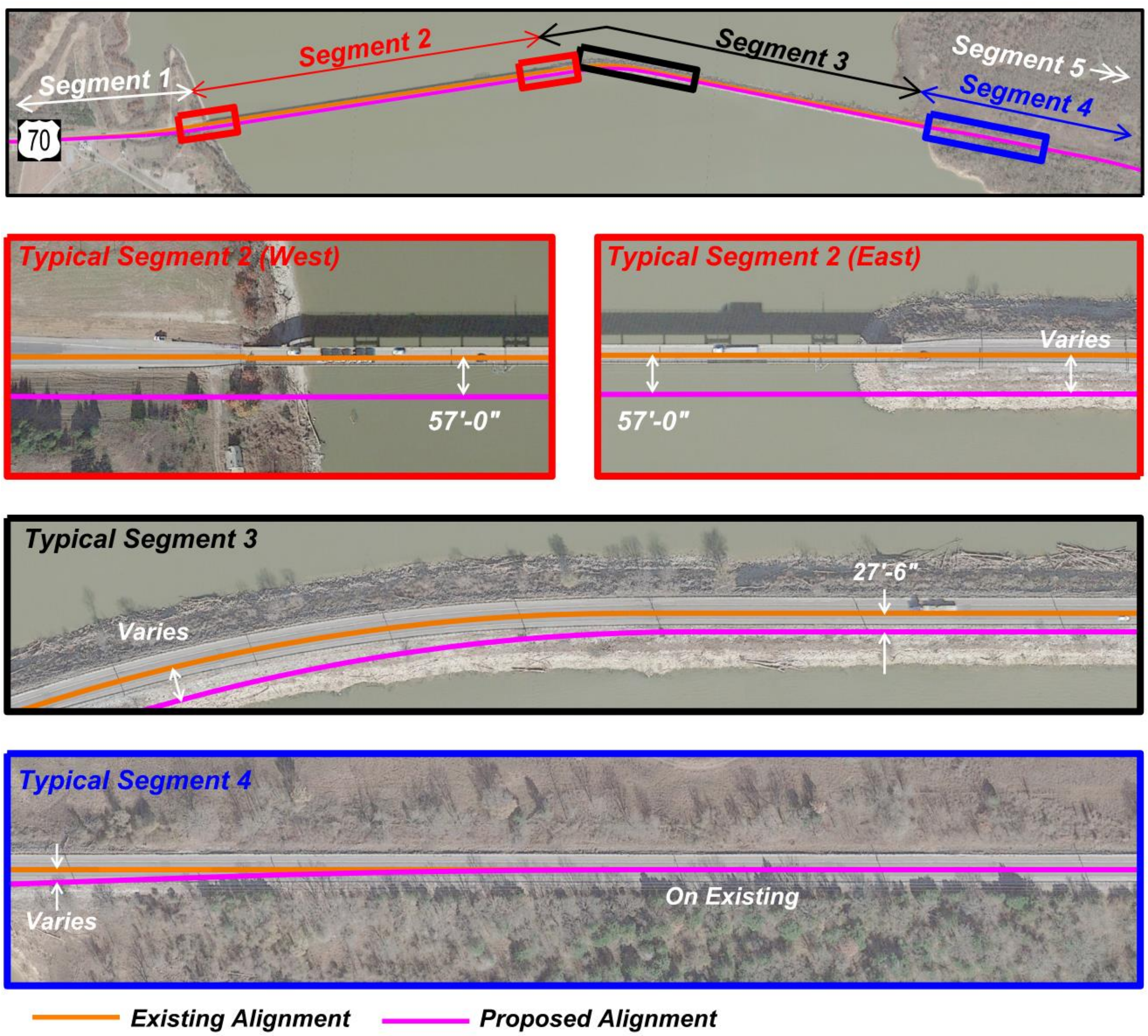
5.7.6 Environmental

Wetland impacts for Alternative 6-14 are the second highest of all alternatives, and stream impacts are also relatively high. Alternative 6-14 also has among the highest impact to Johnson Creek PUA and Lake Texoma State Park. USACE property impacts are moderate at approximately 64.8 acres Approximately 1.16 acres of tribal land will be impacted by this alternative. Alternative 6-14 has the potential to impact the Catfish Bay Marina gas station and archaeological site 34BR11.

5.8 Alternative 6-15

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-15	South	Full	Partial	Existing	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.8.1 Roadway

Alternative 6-15 alignment and profile matches that described for Alternative 6-3.

5.8.2 Bridge

Alternative 6-15 bridge matches that described for Alternative 6-14.

5.8.3 Compensatory Storage

595,520 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alignment has a fill slope of 1:3 on the lake and land causeways that fills into the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.8.4 Right-of-Way

Alternative 6-15 will require an acquisition of 71.56 acres along the project corridor. A majority of the acres are along the lake and land causeways with 0 relocations. A few different techniques could be used to help reduce the amount of right-of-way acquired such as retaining walls and steepen backslopes outside of clear zone. Refer to **Appendix F** for additional right-of-way information.

5.8.5 Utilities

Alternative 6-15 most of the utilities are located to the south of the existing survey centerline. These utilities such as fiber optic and overhead electric lines will need to be relocated. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. Refer to **Appendix G** for additional information on utilities.

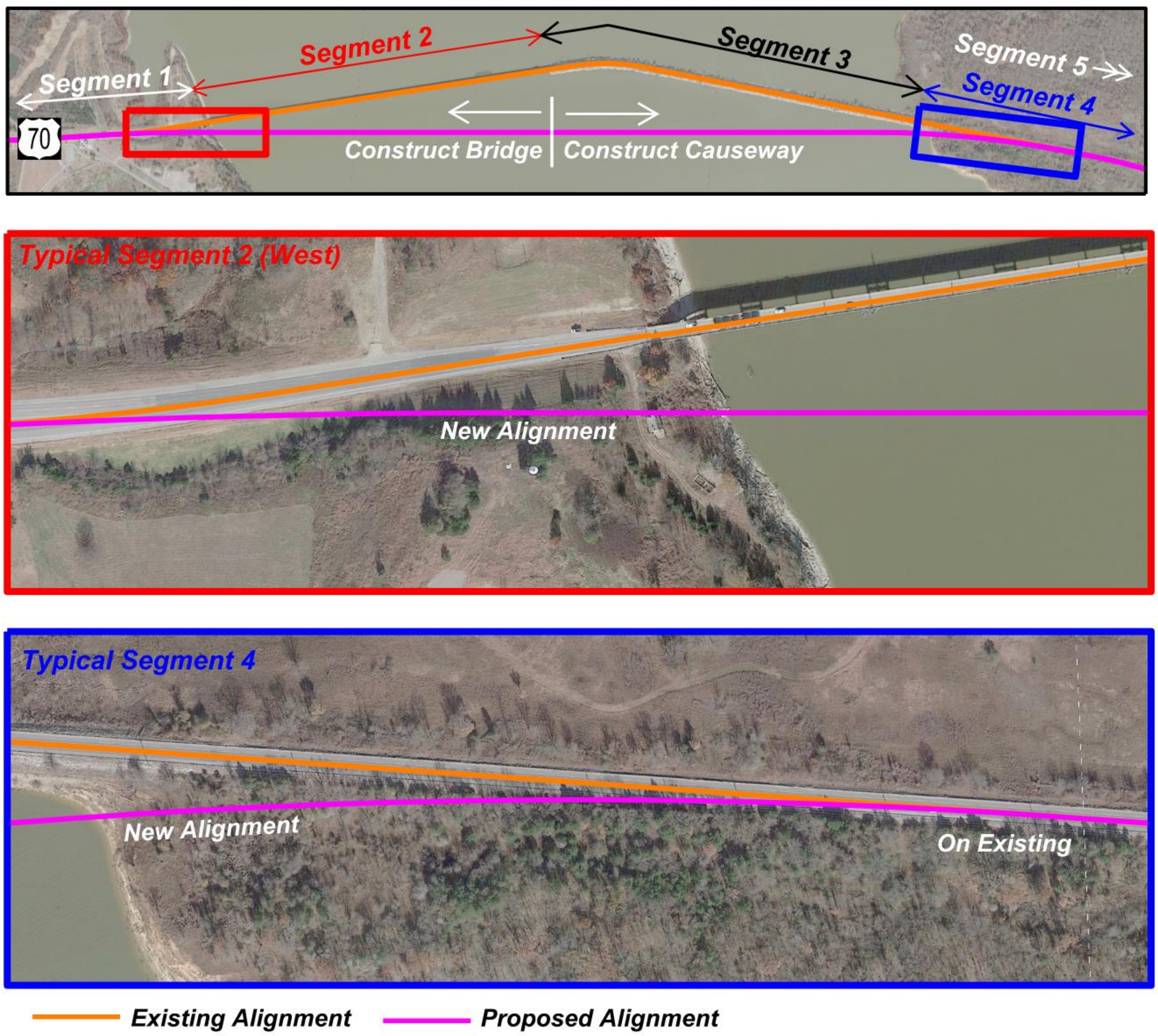
5.8.6 Environmental

Alternative 6-15 environmental impacts are nearly identical to Alternative 6-14. Wetland and stream impacts are slightly lower

5.9 Alternative 6-17A

Alignment Alternative	*Offset*				*Selection Potential*
	Direction	***Bridge***	***Lake Causeway***	***Land Causeway***	
6-17A	*South*	*New*	*New*	*Existing*	*High*

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



5.9.1 Alignment Overview

Alternative 6-17A comprises of a new full alignment that connects US-70 from segment 1 (west end) of the Roosevelt Bridge to a new segment 3 (lake causeway) the alignment then returns to the existing alignment through segment 4 (land causeway) before terminating at the intersection of Willow Springs Road. This alternative was designed to avoid impacts to the northern properties and limit impacts to users by constructing most of the alignment along a new alignment. This alignment will also allow for the existing lake causeway to be removed to help negate the addition of material into compensatory storage with the new causeway. The drawback of this option is the on-alignment causeway requires multiple phases of construction for maintenance of traffic. The new causeway will require more material into the flood storage area then any of the other alignments and will also impact more of the surrounding environment with its larger footprint.

5.9.2 Roadway

The horizontal alignment for US-70 is offset to the south of the existing alignment and follows a new alignment over lake Texoma to the existing land causeway on the eastside of the lake. At the west extent of the study area, the alignment horizontally transitions from an existing survey centerline to a new southern offset alignment by the begin of bridge. The west extent also transitions the two-way middle turn lane from 16’ to 0’ over 520’. After the new Roosevelt Bridge the alignment continues on to a new lake causeway. The alignment then transitions back to the existing alignment along the land causeway. A two-way middle turn lane is reintroduced to the corridor 520’ west of the Willow Spring Road intersection to allow for a left turn lane into the Johnson creek campground.

The proposed vertical alignment is flat at an elevation of 655.00 throughout the length of the proposed bridge, which is approximately six feet higher than the existing bridge to avoid superstructure submersion during high-water flood events. After the bridge, the proposed vertical alignment transitions to 650.00, which is approximately five feet higher than the existing causeway to prevent overtopping during flood-events. The vertical grade is flat throughout the remainder of the corridor until it transitions to match existing at the project extents.

The proposed causeway consists of large boulders/quarry rock from the bottom of the lake to an elevation of 620’ which is 3 feet above the normal pool elevation of Lake Texoma. The remainder of the causeway is select borrow to the subgrade line. The causeway is then armored with riprap to an elevation of 645’ which is 5’ above the top of the flood pool. The material for the proposed causeway is similar to a project in Delaware County on SH-10.

5.9.3 Bridge

The anticipated bridge will span from the west embankment to the Land Causeway or a new Lake Causeway, on the new southern alignment and has two options for the bridge length. One option includes constructing an approximate 5,422’ bridge for the entire length between the west embankment to the existing Land Causeway. The second option for this alignment is constructing an approximate 5,000’ bridge with a newly constructed causeway for the remainder of the lake portion of the corridor.

With this alignment the existing Roosevelt Bridge can be completely preserved for the use of Alternative 4 (Pedestrian Bridge) or Alternative 5 (Monument Bridge) as described in the *US-70 over Lake Texoma (Franklin D. Roosevelt Memorial Bridge) Section 4(f) Alternatives Analysis & Report* (**Appendix Q**).

For a summary of characteristics of the proposed bridge option for this alignment, refer to **Table 24.**

Table 24: Alignment 6-17A Bridge Summary

General	*Bridge Length*	*5,422 ft.*
	Bridge Area	*384,962 ft²*
	Span Count	*37*
Superstructure	*Beam Lines & Type*	*7 - Tx70 Prestressed Girders*
	Max Span Length	*150 ft.*
	Total Beam Length	*37,854 ft.*
Substructure	*Pier Cap Dimensions*	*69.5' x 5' x 7'*
	Column Dimensions	*2 - 4'-6"Ø x 24 LF*
	Drilled Shaft Dimensions	*2 - 10'-0" Ø*
	Total Drilled Shaft Length	*8,436 ft.*

Additional bridge design criteria, bridge design options, span optimization, estimated costs, and additional studies for the proposed bridge options are included in the *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report* (**Appendix K**).

5.9.4 Compensatory Storage

1,101,425 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alignment has a fill slope of 1:3 on the lake and land causeways that fills into the compensatory flood storage area. 454,076 cubic yards of material could be removed from the existing lake causeway to help reduce the compensatory flood storage volume. If the existing lake causeway is removed the new volume increase would be 647,350 cubic yards of material in the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.9.5 Right-of-Way

Alternative 6-17A will require an acquisition of 108.74 acres along the project corridor. A majority of the acres are in the lake and along the land causeway with 0 relocations. Refer to **Appendix F** for additional right-of-way information.

5.9.6 Utilities

Alternative 6-17A most of the utilities are located to the south of the existing survey centerline such as fiber optic and overhead electric lines will need to be relocated. The utility lines currently run along the existing causeways and bridge and may need to be relocated to the new bridge and causeway. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. Refer to **Appendix G** for additional information on utilities.

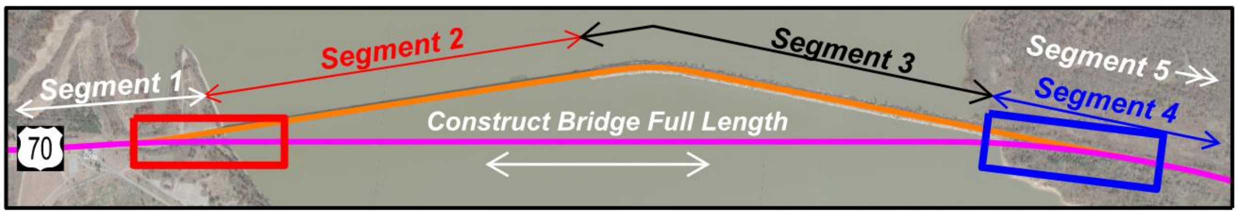
5.9.7 Environmental

Impacts of Alternatives 6-17A are relatively high in comparison to the other alternatives. Wetland and stream impacts are among the highest, and this alternative will require 105.2 acres of USACE property. Impacts to Johnson Creek PUA are the highest of all alternatives. This alternative will require 1.43 acres of tribal land and has the potential to affect the Catfish Bay Marina gas station. Site 34BR11 will be avoided.

5.10 Alternative 6-17B

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-17B	South	New	New	Existing	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



Existing Alignment **Proposed Alignment**

5.10.1 Roadway

Alternative 6-17B alignment and profile matches that described for Alternative 6-17A.

5.10.2 Bridge

The anticipated bridge will span from the west embankment to the Land Causeway or a new Lake Causeway, on the new southern alignment and has two options for the bridge length. One option includes constructing an approximate 10,625' bridge for the entire length between the west embankment to the existing Land Causeway. The second option for this alignment is constructing an approximate 5,000' bridge with a newly constructed causeway for the remainder of the lake portion of the corridor.

With this alignment the existing Roosevelt Bridge can be completely preserved for the use of Alternative 4 (Pedestrian Bridge) or Alternative 5 (Monument Bridge) as described in the *US-70 over Lake Texoma (Franklin D. Roosevelt Memorial Bridge) Section 4(f) Alternatives Analysis & Report* (**Appendix Q**).

For a summary of characteristics of the proposed bridge option for this alignment, refer to **Table 25**.

Table 25: Alignment 6-17B Bridge Summary

General	*Bridge Length*	*10,625 ft.*
	Bridge Area	*754,375 ft²*
	Span Count	*72*
Superstructure	*Beam Lines & Type*	*7 - Tx70 Prestressed Girders*
	Max Span Length	*150 ft.*
	Total Beam Length	*74,198 ft.*
Substructure	*Pier Cap Dimensions*	*69.5' x 5' x 7'*
	Column Dimensions	*2 - 4'-6"Ø x 24 LF*
	Drilled Shaft Dimensions	*2 - 10'-0" Ø*
	Total Drilled Shaft Length	*14,616 ft.*

Additional bridge design criteria, bridge design options, span optimization, estimated costs, and additional studies for the proposed bridge options are included in the *US-70 over Lake Texoma (Franklin D. Roosevelt Bridge) Preliminary Engineering Study – Bridge Replacement Report* (**Appendix K**).

5.10.3 Compensatory Storage

226,348 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alignment has a fill slope of 1:3 on the lake and land causeways that fills into the compensatory storage area. 226,248 cubic yards of material could be removed from the existing lake causeway to help reduce the compensatory storage volume. If the existing lake causeway is removed the new volume increase would be a net-zero impact of fill material in the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.10.4 Right-of-Way

Alternative 6-17B will require an acquisition of 62.57 acres along the project corridor. A majority of the acres are in lake Texoma and along the land causeway with 0 relocations. Refer to **Appendix F** for additional right-of-way information.

5.10.5 Utilities

Alternative 6-17B most of the utilities are located to the south of the existing survey centerline such as fiber optic and overhead electric lines will need to be relocated. The utility lines currently run along the existing causeways and bridge and may need to be relocated to the new bridge and causeway. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. Refer to **Appendix G** for additional information on utilities.

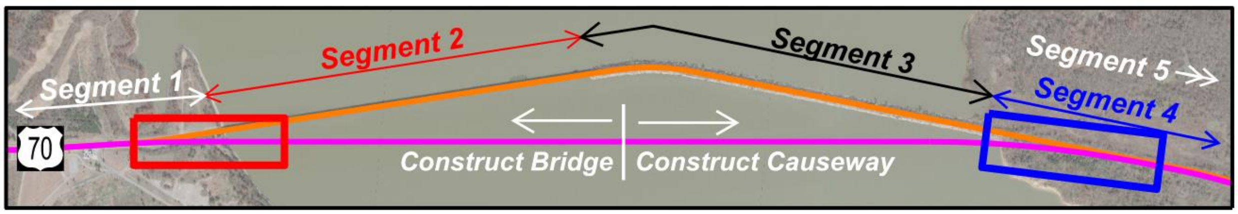
5.10.6 Environmental

Environmental impacts for Alternative 6-17B are the same as 6-17A except for streams and USACE property, and both are greatly reduced by the use of retaining walls. Impacts to Johnson Creek PUA, Lake Texoma State Park, and the tribal property remain high. The Catfish Bay Marina gas station could be affected. Site 34BR11 will be avoided.

5.11 Alternative 6-18A

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-18A	South	New	New	Partial	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



Existing Alignment **Proposed Alignment**

5.11.1 Alignment Overview

Alternative 6-18A comprises of a new full alignment similar to that shown on 6-17, with the exception of the partial offset along segment 4 (land causeway) before returning to the existing alignment on the west side of the intersection of Willow Springs Road. This alternative was designed to avoid impacts to the northern properties and limit impacts to users by constructing most of the alignment along a virgin alignment and offset on the land causeway. This alignment will allow for the existing lake causeway to be removed to help negate the addition of material into compensatory storage with the new causeway.

5.11.2 Roadway

The horizontal alignment for US-70 is offset to the south of the existing alignment and follows a new virgin alignment over lake Texoma to the existing land causeway on the eastside of the lake. At the west extent of the study area, the alignment horizontally transitions from an existing survey centerline to a new southern offset alignment by the begin of bridge. The west extent also transitions the two-way middle turn lane from 16’ to 0’ over 520’. After the new Roosevelt Bridge the alignment continues to a new lake causeway. The alignment then transitions to a southern offset of 27’-6” from the existing survey centerline along the land causeway. The alignment transitions back to the existing alignment west of the willow spring road intersection. A two-way middle turn lane is reintroduced to the corridor 520’ west of the Willow Spring Road intersection to allow for a left turn lane into the Johnson creek campground.

5.11.3 Bridge

Alternative 6-18A bridge matches that described for Alternative 6-17A.

5.11.4 Compensatory Storage

1,120,416 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alignment has a fill slope of 1:3 on the lake and land causeways that fills into the compensatory storage area. 454,076 cubic yards of material could be removed from the existing lake causeway to help reduce the compensatory storage volume. If the existing lake causeway is removed the new volume increase would be 647,350 cubic yards of material in the compensatory storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.11.5 Right-of-Way

Alternative 6-18A will require an acquisition of 109.42 acres along the project corridor. A majority of the acres are in lake Texoma and along the land causeway with 0 relocations. Refer to **Appendix F** for additional right-of-way information.

5.11.6 Utilities

Alternative 6-18A most of the utilities are located to the south of the existing survey centerline such as fiber optic and overhead electric lines will need to be relocated. The utility lines currently run along the existing causeways and bridge and may need to be relocated to the new bridge and causeway. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. Refer to **Appendix G** for additional information on utilities.

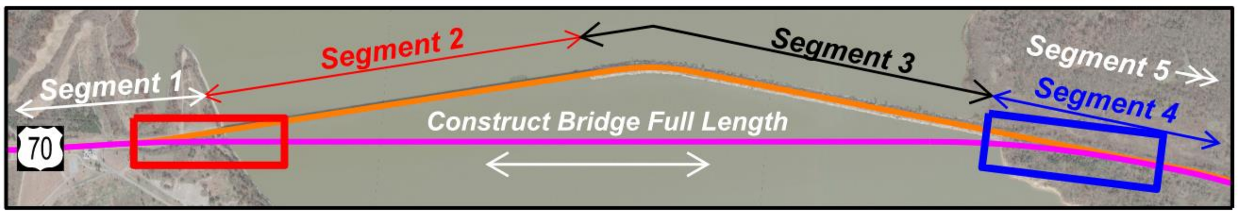
5.11.7 Environmental

Alternative 6-18A has the highest wetland and stream impacts and the greatest impact to USACE property (106.2 acres). Impacts to Lake Texoma State Park are just slightly lower than Alternative 6-17. Like Alternatives 6-17A and 6-17B, impacts to tribal land are the highest at 1.43 acres. Alternative 6-18A has the potential to affect the gas station at Catfish Bay Marina; Site 34BR11 will be avoided.

5.12 Alternative 6-18B

Alignment Alternative	Offset				Selection Potential
	Direction	Bridge	Lake Causeway	Land Causeway	
6-18B	South	New	New	Partial	High

The following figures are intended only to present the typical proposed alignment offsets in comparison to the existing alignment. Refer to **Appendix A** for general alignment alternative overviews and exhibits. Refer to **Appendix B** for detailed plan, profile, and typical sections for each alignment alternative.



Existing Alignment — Proposed Alignment

5.12.1 Roadway

Alternative 6-18B alignment and profile matches that described for Alternative 6-17B.

5.12.2 Bridge

Alternative 6-18B bridge matches that described for Alternative 6-17B.

5.12.3 Compensatory Storage

226,348 cubic yards of material will be added into the compensatory flood storage area for this alternative and would require mitigation. The typical section for this alignment has a fill slope of 1:3 on the land causeway that fills into the compensatory flood storage area. 454,076 cubic yards of material could be removed from the existing lake causeway to help reduce the compensatory flood storage volume. If the existing lake causeway is removed the new volume decrease would be 227,728 cubic yards of material out of the compensatory flood storage area. See Section 6.0 for proposed methods for compensatory storage mitigation.

5.12.4 Right-of-Way

Alternative 6-18B will require an acquisition of 63.40 acres along the project corridor. A majority of the acres are in lake Texoma and along the land causeway with 0 relocations. Refer to **Appendix F** for additional right-of-way information.

5.12.5 Utilities

Alternative 6-18B most of the utilities are located to the south of the existing survey centerline such as fiber optic and overhead electric lines will need to be relocated. The utility lines currently run along the existing causeways and bridge and may need to be relocated to the new bridge and causeway. A few crossing overhead electrical lines will be relocated at the east and west ends of the projects. Refer to **Appendix G** for additional information on utilities.

5.12.6 Environmental

Environmental impacts for Alternative 6-18B are the same as 6-18A except for streams and USACE property, both of which are greatly reduced by the use of retaining walls.

6.0 Impacts

6.1 Right-of-Way

6.1.1 Impacts

The proposed alternatives impact the right-of-way to varying degrees depending on the alignment alternative. The right-of-way impacts in Segment 1 are due to the toes of the required roadway embankment slopes that extend past the current right-of-way. Portions of these impacts are from areas of fill embankment (north of US-70 and just east of State Park Road), and areas of required cut (north and south of US-70 immediately before the Roosevelt Memorial Bridge). These areas are described further in *Section 4.4.3.2*.

The extents of right-of-way impacts in these three areas are listed in **Table 26**.

Table 26: Segment 1 Right-of-Way Impacts

Alignment Alternative	Right of Way Impact		
	Area of Fill	Areas of Cut	
	North	North	South
6-2A	0.62 ac.	0.36 ac.	-
6-2B	0.62 ac.	0.36 ac.	-
6-3	0.62 ac.	0.36 ac.	-
6-6A	0.08 ac.	0.36 ac.	0.15 ac.
6-6B	0.08 ac.	0.36 ac.	0.15 ac.
6-14	-	-	2.30 ac.
6-15	-	-	2.30 ac.
6-17A	-	-	2.28 ac.
6-17B	-	-	2.28 ac.
6-18A	-	-	2.28 ac.
6-18B	-	-	2.28 ac.

6.1.2 Retaining Wall

Right-of-way impacts can be reduced by the construction of retaining wall at each of the areas of fill and areas of cut. It is anticipated that the most economical retaining wall systems are mechanically stabilized earth systems in the areas of fill, and soldier pile retaining walls in the areas of cut. For additional information of the retaining wall types see Section 4.4.3.1, and for approximate location for each retaining wall type see **Figure 27.**

The required length and area of retaining walls to eliminate impacts to the right-of-way in each of the three areas are listed in **Table 27**.

Table 27: Segment 1 - Required Retaining Wall

Alignment Alternative	Length of Retaining Wall					
	MSE Wall		Soldier Pile Wall			
	North		North		South	
6-2A	600 ft.	(939 SY)	425 ft.	(981 SY)	-	-
6-2B	600 ft.	(939 SY)	425 ft.	(981 SY)	-	-
6-3	600 ft.	(939 SY)	425 ft.	(981 SY)	-	-
6-6A	595 ft.	(687 SY)	455 ft.	(817 SY)	340 ft.	(386 SY)
6-6B	595 ft.	(687 SY)	455 ft.	(817 SY)	340 ft.	(386 SY)
6-14	-	-	-	-	460 ft.	(1433 SY)
6-15	-	-	-	-	460 ft.	(1433 SY)
6-17A	-	-	-	-	460 ft.	(1680 SY)
6-17B	-	-	-	-	460 ft.	(1680 SY)
6-18A	-	-	-	-	460 ft.	(1680 SY)
6-18B	-	-	-	-	460 ft.	(1680 SY)

6.1.3 Retaining Wall Cost Estimate

The cost difference to eliminate right-of-way acquisition for each alignment accounted for the additional cost to construct each retaining wall and accounted for the reduction of costs for not having to obtain right-of-way. The costs were calculated based on the wall type and how much right-of-way would need to be obtained. Costs do not account for the current development of the Pointe Vista Development and the Chickasaw Nation Casino to the north and south of US-70 in Segment 1. See *Section 2.4* for additional information of the current development that is in the proximity of the project area.

The assumed unit costs for the associated items for right-of-way elimination are as follows:

- Mechanically Stabilized Earth Wall: $700 per square yard
- Soldier Pile Retaining Wall: $2,200 per square yard
- Right-of-Way Acquisition: $30,225 per acre

The method of measurement for each of the retaining walls is the area of retaining wall from the top of footing to the wall top, and the unit cost includes all material, labor, and equipment that would be required for construction.

The cost of efforts to eliminate right-of-way impacts for each of the alignments are listed in **Table 28**.

Table 28: Retaining Wall Cost Summary

Alignment Alternative	Mitigation Cost				
	Fill Wall (MSE)	Cut Wall (Soldier Pile Wall)		Right of Way	Total
	North Wall	North Wall	South Wall		
6-2A	$ 657,475	$ 2,157,826	$ -	$ (29,620.50)	$ 2,785,681
6-2B	$ 657,475	$ 2,157,826	$ -	$ (29,620.50)	$ 2,785,681
6-3	$ 657,475	$ 2,157,826	$ -	$ (29,620.50)	$ 2,785,681
6-6A	$ 480,900	$ 1,797,224	$ 848,254	$ (17,832.75)	$ 3,108,545
6-6B	$ 480,900	$ 1,797,224	$ 848,254	$ (17,832.75)	$ 3,108,545
6-14	$ -	$ -	$ 3,152,534	$ (69,517.50)	$ 3,083,017
6-15	$ -	$ -	$ 3,152,534	$ (69,517.50)	$ 3,083,017
6-17A	$ -	$ -	$ 3,695,582	$ (68,913.00)	$ 3,626,669
6-17B	$ -	$ -	$ 3,695,582	$ (68,913.00)	$ 3,626,669
6-18A	$ -	$ -	$ 3,695,582	$ (68,913.00)	$ 3,626,669
6-18B	$ -	$ -	$ 3,695,582	$ (68,913.00)	$ 3,626,669

6.2 Compensatory Storage

6.2.1 Impacts

The proposed alternatives impact the flood storage of Lake Texoma to varying degrees. The degree of impact is primarily affected by the offset distance from the existing alignment and the amount of proposed embankment. In order to eliminate the compensatory storage impact, several adjustment categories were developed and applied to chosen alternatives to produce a zero-net change in the overall total compensatory storage of Lake Texoma. The impacts were measured based on the additional volume of fill material that would be added between the elevations of normal pool elevation and the base flood elevation (617 to 640 feet).

The following table summarizes the alignment costs for causeway grading, construction of retaining walls and bridge structures, overall costs, and the impact to the compensatory storage. The current total costs for each alignment does not include efforts to reduce compensatory storage impacts.

Alignment	Overall Project Cost				Compensatory Storage Impact (1)
	Grading	Retaining Wall	Bridge	Total Project Cost	
6-2A	$ 43,589,575	$ -	$ 54,926,971	$ 142,821,070	590,165 CY
6-2B	$ 5,713,331	$ 58,814,800	$ 69,455,151	$ 188,860,756	0 CY
6-3	$ 43,502,244	$ -	$ 54,926,971	$ 142,704,683	595,520 CY
6-6A	$ 37,279,450	$ -	$ 65,563,173	$ 148,153,951	595,169 CY
6-6B	$ 7,320,654	$ 35,305,600	$ 65,563,173	$ 155,276,896	279,876 CY
6-14	$ 47,104,830	$ -	$ 54,926,971	$ 147,503,986	590,165 CY
6-15	$ 46,891,498	$ -	$ 54,926,971	$ 147,219,824	595,520 CY
6-17A	$ 254,840,782	$ -	$ 62,220,771	$ 419,998,231	1,101,425 CY
6-17B	$ 6,565,170	$ -	$ 100,431,054	$ 145,013,257	226,348 CY
6-18A	$ 255,150,296	$ -	$ 62,220,771	$ 419,043,434	1,101,425 CY
6-18B	$ 6,565,170	$ -	$ 100,431,054	$ 145,005,244	226,348 CY

(1) Positive values indicate a decrease of compenastory storage. Negative values indicate an increase of compensatory storage.

The total project cost does not include efforts to reduce compensatory storage, and it is the intent of the project matrix to evaluate both the construction costs and compensatory storage impacts as metrics for alignment selection. *Section 6.2.2* includes potential methods to reduce the impacts to compensatory storage with their associated costs.

6.2.2 Methods to Reduce Compensatory Storage

Several options to reduce compensatory storage impacts were investigated. Four options produced the most volume of compensatory storage savings. The methods are extending the length of the bridge, removal of the existing causeway, adding a length of retaining wall along the lake causeway, and adding a length of retaining wall along the land causeway.

6.2.2.1 Lengthening Existing Bridge

By extending the proposed bridge, less roadway embankment will be required, and an equivalent length of existing lake causeway can be removed. The average unit cost of proposed bridge construction was used to determine the mitigation cost for the lengthened bridge section.

Unit costs used for bridge extensions are as follows:

- $10,850 per LF (Alignments 6-2A, 6-2B, 6-3, 6-14, 6-15, 6-17A, & 6-18)
- $13,263 per LF (Alignments 6-6A & 6-6B)
- Alignments 6-17B and 6-18B do not have associated bridge costs because these options are already a full bridge length option.

6.2.2.2 Causeway Removal

Causeway removal methods included the removal of existing causeway (all alignment alternatives), or a reduction of the proposed causeway (Alignment Alternatives 6-17A and 6-18A). Costs associated with the removal of existing causeway include removals from the top of causeway to the normal pool elevation and calculation of volume mitigation only considers material removed from the normal pool elevation to the base flood elevation.

Values used for causeway removal is as follows:

- Top of Causeway Elevation: 646’
- Base Flood Elevation: 640’
- Normal Pool Elevation: 617’
- Causeway Removal Cost: $1,023 per LF
- Causeway Construction Adjustment: -$10,691 per LF

6.2.2.3 Retaining Wall Construction

The use of retaining walls reduces the amount of fill by limiting the extents of the embankment toe. Retaining walls constructed in the lake causeway portion were considered as a different condition as retaining walls constructed in the land causeway segment due to constructability issues. The mitigation benefit for a reduction in fill volume only considered the amount of embankment that would be reduced on the outside of the retaining wall face and excluded the fill that would be placed behind the wall to support the roadway.

Unit costs for retaining wall construction are as follows:

- $6,300 per LF (Lake Retaining Wall)
- $3,710 per LF (Land Retaining Wall)

6.2.2.4 Summary

The **Table 29** summarizes the methods for each alignment to get to a net-zero fill condition in the compensatory storage flood plain.

Table 29: Compensatory Storage Mitigation Method Summary

Alignment	Mitigation Methods				Mitigation Cost Difference
	Lengthen Bridge	Causeway Removal	Lake Retaining Wall	Land Retaining Wall	
6-2A	3,184 FT	3,184 FT	2,016 FT	9,450 FT	$59,540,546
6-2B	-	-	-	-	$0
6-3	3,298 FT	3,298 FT	1,902 FT	9,450 FT	$60,158,383
6-6A	3,291 FT	3,291 FT	1,909 FT	9,450 FT	$68,058,653
6-6B	2,544 FT	2,544 FT	-	-	$9,146,830
6-14	3,184 FT	3,184 FT	2,016 FT	9,450 FT	$59,540,546
6-15	3,298 FT	3,298 FT	1,902 FT	9,450 FT	$60,158,383
6-17A	2,530 FT	7,730 FT	-	-	-$106,602,291
6-17B	-	2,286 FT	-	-	$2,338,926
6-18A	2,530 FT	7,730 FT	-	-	-$106,602,291
6-18B	-	2,286 FT	-	-	$2,338,926

The causeway removal of Alignment 6-17A and 6-18A includes the total removal of the existing lake causeway, as well as reducing the length of the proposed causeway by 2,530 feet. Causeway removal of all other alignments only include the partial removal of the existing lake causeway.

The adjustment to the land retaining wall length was solely made to reach a net-zero fill condition, which would increase the amount of fill placed in the compensatory storage area compared to the proposed alignment. The primary purpose of these mitigation methods shown is to obtain a net-zero fill condition and does not consider other impacts to the project such as hydraulics, utilities, right-of-way, environmental, constructability, or maintenance of traffic.

6.2.3 Compensatory Storage Impact Summary

The preliminary design of the alignment alternatives did not attempt to limit the amount of fill placed that would subsequently affect the flood storage of Lake Texoma, and it is the intent of the project summary matrix (**Table 2**) to have the impacts to the compensatory storage as a metric during selection.

Table 30 summarizes the impacts to the compensatory storage, the potential costs that would be associated with each alignment to provide a net-zero fill condition in the lake, and what the adjusted Total Project Cost would be when considering mitigation efforts.

Table 30: Compensatory Storage Impact Summary

Alignment	Overall Project Cost			Compensatory Storage (1)	
	Current	Mitigation Cost Difference	Adjusted Total Project Cost	Without Mitigation	With Mitigation
6-2A	$ 142,821,070	$ 59,540,546	$ 202,361,615	590,165 CY	0 CY
6-2B	$ 188,860,756	$ -	$ 188,860,756	0 CY	0 CY
6-3	$ 142,704,683	$ 60,158,383	$ 202,863,066	595,520 CY	0 CY
6-6A	$ 148,153,951	$ 68,058,653	$ 216,212,604	595,169 CY	0 CY
6-6B	$ 155,276,896	$ 9,146,830	$ 164,423,726	279,876 CY	0 CY
6-14	$ 147,503,986	$ 59,540,546	$ 207,044,532	590,165 CY	0 CY
6-15	$ 147,219,824	$ 60,158,383	$ 207,378,207	595,520 CY	0 CY
6-17A	$ 419,998,231	$ (106,602,291)	$ 313,395,940	1,101,425 CY	0 CY
6-17B	$ 145,013,257	$ 2,338,926	$ 147,352,183	226,348 CY	0 CY
6-18A	$ 419,043,434	$ (106,602,291)	$ 312,441,143	1,101,425 CY	0 CY
6-18B	$ 145,005,244	$ 2,338,926	$ 147,344,170	226,348 CY	0 CY

(1) Positive values indicate a decrease of compenastory storage. Negative values indicate an increase of compensatory storage.

Refer to **Appendix Z** for the adjustment categories descriptions, project cost and compensatory storage adjustment for each alternative.

6.2.4 Project Matrix

To present the results of the analysis in a clear format, a Project Evaluation Matrix was created. The Project Evaluation Matrix is present below in **Table 2: Project Summary Matrix**.

(See Fold Out Next Page)

JP No. 33873(04), US-70 over Lake Texoma (Roosevelt Bridge), Project Summary Matrix																
Alternative Name and Description		Sub-Option	Construction Cost (1)	Right-of-Way Cost (2)	Utility Relocation Cost (3)	Total Bridge Length (ft)	Total Retaining Wall Cost	Flood Storage Impacts (cy)	Wetlands (ac)	Streams (ac)	Johnson Creek PUA (ac)	Texoma State Park (ac)	USACE Property (ac)	Tribal Land (ac)	Hazardous Materials Site	Archeological Site 34BR11
6-2	North Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - 27.5'	A	$144.55 M	$1.73 M	$ -	4,942	-	590,165	0.77	0.11	3.8	2.83	62.96	0	N	Y
		B	$189.56 M	$.7 M		6,146	$58.81 M	-811	0.67	0.06	2.2	2.83	20.65	0	N	Y
6-3	North Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - On Existing Alignment	-	$144.37 M	$1.67 M	$ -	4,942	-	595,520	0.81	0.09	3.74	2.65	64.3	0	N	Y
6-6	North Offset with Phased Bridge Construction Bridge - 27.5' Lake Causeway - 27.5' Land Causeway - 27.5'	A	$149.84 M	$1.69 M	$ -	4,942	-	595,169	0.49	0.07	3.18	3.39	51.8	0	Y	Y
		B	$156.35 M	$1.08 M		4,942	$35.31 M	279,876	0.49	0.07	3.18	3.39	32.61	0	Y	Y
6-14	South Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - 27.5'	-	$150.2 M	$2.7 M	$ -	4,942	-	590,165	1.32	0.09	3.74	6.19	64.76	1.16	Y	Y
6-15	South Offset Bridge - 57' Lake Causeway - 27.5' Land Causeway - On Existing Alignment	-	$149.9 M	$2.68 M	$ -	4,942	-	595,520	0.89	0.08	3.73	6.19	64.79	1.16	Y	Y
6-17	New Southern Alignment Land Causeway - On Existing Alignment	A	$423.45 M	$3.45 M	$ -	5,422	-	1,101,425	1.09	0.09	3.73	6.56	105.16	1.43	Y	N
		B	$148.89 M	$1.99 M		10,625		226,348	1.09	0.09	3.73	6.56	58.97	1.43	Y	N
6-18	New Southern Alignment Land Causeway - 27.5' Offset	A	$422.5 M	$3.46 M	$ -	5,422	-	1,120,416	1.49	0.08	3.74	6.34	106.15	1.43	Y	N
		B	$147.02 M	$2.01 M		10,625		226,348	1.49	0.08	3.74	6.34	60.06	1.43	Y	N

(1) 20% Contingency. Mitigation costs not included.
(2) 5% Contingency. ODOT provided values.
(3) Utility relocation costing information not provided at the time of the report submittal. Information is to be provided at a later date.

Table 2: Project Summary Matrix

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