MEMORANDUM

TO: Mayor and Council Members

FROM: James Snow, Interim Director
Public Works Department

DATE: November 15, 2022

SUBJECT: **Update on Barton Springs Rd. Bridge Project**

This memo provides an update on staff's efforts to address the existing bridge over Barton Springs Rd. This includes determining the condition of the existing bridge, outlining alternatives for rehabilitation or replacement, and making a recommendation on the most appropriate path forward.

Attached to this memo is a detailed summary of key concepts and technical findings on the preferred bridge alternative for the Barton Springs Road Bridge over Barton Creek.

Background:
Built in 1925, the Barton Springs Road Bridge provides access over Barton Creek along Barton Springs Road at the entrance to Zilker Park. The bridge was widened to its current form in 1946, which includes two traffic lanes in each direction. The bridge also features narrow sidewalks along each side, guard rails and a sidewalk below the bridge.

While the existing bridge is in fair condition structurally, many of its features are functionally obsolete and require rehabilitation or replacement to ensure safety and longevity. Given that the existing bridge presents mobility challenges for vehicles, bikes and pedestrians, this project will provide needed mobility enhancements for all users. Intersection improvements to nearby Barton Springs Road and Azie Morton Drive are necessary as part of this project.

In November 2020, Austin voters approved $102 million for major infrastructure projects, with the option of allocating a portion of that funding to address the Barton Springs Rd. Bridge. The project is currently funded for completion of preliminary engineering, including finalizing a Bridge Conceptual Engineering Report (BCER), as well as developing a design for a preferred solution (rehabilitation of existing bridge or reconstruction of a new structure). Future funding would need to be identified to move forward with construction.

Rehabilitation vs. Replacement: Design Considerations

The project began with the study of two Rehabilitation Alternatives (one geared towards minor rehabilitation and one more extensive) and three complete Replacement Alternatives. Based on a

2016 inspection of the bridge, the minor rehabilitation option was removed from consideration, leaving one major rehabilitation option and three replacement options.

All four remaining alternatives were considered using design concepts that were developed to accommodate bridge roadway, pedestrian, and bike users. These design concepts were vetted with various City Departments including significant input from the Austin Transportation Department. Additional input for design concepts included accommodating traffic during construction, existing and future hike/bike trail elements, as well as hillside instability issues along the nearby Umlauf property. The result is that all four alternatives would include at least: A bridge widened on both sides to keep the current four traffic lanes; Two new 10 ft. bike lanes; Pedestrian paths of 14 ft. and 18 ft. on the north and south side, respectively.

Rehabilitation Alternative
The lone rehabilitation option includes removal of deck, substructure, and columns, and leaving only the arch ribs. The existing arch ribs and abutments will require repair/resurfacing and installation of a cathodic protection system to reduce further deterioration.

Four additional lines of arch ribs will be added to accommodate the wider deck above. While the rehabilitation option will provide the appearance of keeping the existing bridge, much less than half of the original structure will remain intact and very little surficial materials will remain; furthermore, the new arch ribs will essentially block the historic/existing arch ribs from exterior view.

Replacement Alternatives
Three alternatives were developed and compared in cost, aesthetics, constructability, and visual perspective from trails, sidewalks, parkland, and the creek. Please see **Table 2.1** below for details. The preferred alternative for replacement shown below maximizes views through the bridge and maintains an open center channel in Barton Creek. This is also the most cost-effective alternative.

Preferred Replacement Alternative

This preferred Replacement Alternative was specifically compared to the Rehabilitation Alternative, with respect to various features and components, such as roadway alignment, accommodation of hike/bike trails, Barton Creek impacts, cost, maintenance requirements, constructability, and risk. A table of these factors is presented in the attached document.

Table 2-1 – Comparison of Bridge Replacement Options.

			
	Option 1 - Single Arch	Option 2 - "Y" Pier Longitudinal	Option 3 - "Y" Pier Transverse
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accommodate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
PreStructural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	Advantage Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. However, the structure does provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	Advantage Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.
Constructability	Option 1 requires temporary piers and complex falsework to form the arches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	Advantage Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The post-tensioning of the girders and post-tensioned tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$18.1M	$13.6M	Advantage $10.2M

The Replacement option offers numerous benefits over the Rehabilitation option, including better accommodations of the Zilker Eagle mini-train, enhanced trails underneath the bridge, and others highlighted in the more detailed design summary. The most significant differences between the rehabilitation scheme and the replacement scheme are cost and risk. The cost of the replacement option is 40% less than the rehabilitation option, and more risk is inherent in the rehabilitation scheme, due to the reliance on existing structural members whose true capacity can only be revealed through the subsequent design and construction process.

Recommendation: Move Forward to Update Community on Replacement Alternative
Based on the information outlined above and within the attached, staff recommends replacement of the existing bridge as the preferred alternative moving forward. Replacement offers the best choice based on value, historical preservation, and being a long term transportation solution for the community.

cc: Spencer Cronk, City Manager
Gina Fiandaca, Assistant City Manager

Attachment: Memo from Consultant re: Rehabilitation and Replacement Options for Bridge of Barton Creek

City of Austin

Barton Springs Road
Bridge over Barton Creek

Rehabilitation vs. Replacement Memorandum

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This document is released under the authority of Robert B. Anderson Texas PE No. 111066

URS

REVISIONS

Project: City of Austin – Barton Springs Road Bridge over Barton Creek

Document: Rehab vs. Replacement Memo

Revision	Date of Issue	Description
D0	08/22/2022	Draft Issue for Internal Comment
D1	09/12/2022	Revised Draft Issue post PWD comments
D2	09/19/2022	Revised Draft Issue cost table and replacement comparison
F1	09/28/2022	Final Issue

Contents

Statement of Limitations

This report is intended for the City of Austin and is distributed to third parties outside the City’s organization, with their consent.

This interim memo provides a direct comparison between the rehabilitation and replacement options for the Barton Springs Road Bridge over Barton Creek and provides a recommendation from the design team. This report is intended to outline the current design approach and highlight the pros and cons associated with the rehabilitation and replacement concepts. To limit the size and focus of this memo, the detailed work associated with existing bridge inspection and preliminary concept development and analysis are incorporated by reference.

1. INTRODUCTION

This section of the report summarizes the purpose and need for the project and provides some Cultural and Historical Background.

1.1 Purpose and Need

The purpose and need for this project is centered on safety-related bridge improvements that address the following items:

- Age of structure / structural degradation;
- Insufficient bike / pedestrian paths (functionally obsolete);
- Bridge roadway lanes not aligned with lanes east of Azie Morton;
- Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection;
- Elevated / overhanging sidewalk integral to intersection – past movement / cracking; and
- Bridge / intersection congestion.

1.2 Bridge Cultural / Historical Background / Existing Condition

The original Barton Springs Road bridge was built in 1925 and widened to its current configuration in 1945. The bridge is located adjacent to Zilker Park, which is listed in the National Register of Historic Places (NRHP); and is considered a contributing resource to the Park. The Barton Springs Archeological and Historical District (formed in 1985) is also located within the Zilker Historic District and the downstream boundary of this district is in close proximity to the bridge.

The age of the south and north structures is 97 and 76 years, respectively. The bridge overall has a condition rating of "Fair," and most structural components generally have a condition rating of "Good", based on the *FHWA Condition Rating Guidelines*.

Given the advanced age of the deck, and the fact that the most serious deterioration is found within the vicinity of the longitudinal deck joint, it is necessary to replace the deck entirely and eliminate the longitudinal joint and transverse joints where practical. This precludes efforts to keep and repair all of the existing bridge components. In addition, the spandrel columns exhibit low concrete compressive strength and severe cracking, spalling, and/or delamination (2017 *On-Site Sampling and Laboratory Investigation*). The cracking of the shorter spandrel columns is further exacerbated by their structural configurations (moment connections at both the top and bottom), which attract an inordinately large amount of shear loading.

Therefore, any proposed bridge rehabilitation strategy that provides a substantial increase in service life requires "stripping" the structure down to the arch ribs and reconstructing the spandrel columns, floor system, and deck. Sliding bearings at the tops of the new spandrel columns will decouple the deck from the supporting structure.

Figure 1. Deterioration of Longitudinal Beam

In addition to the condition of the existing bridge, the site presents a number of challenges and constraints. Many of these are illustrated in the issues map below:

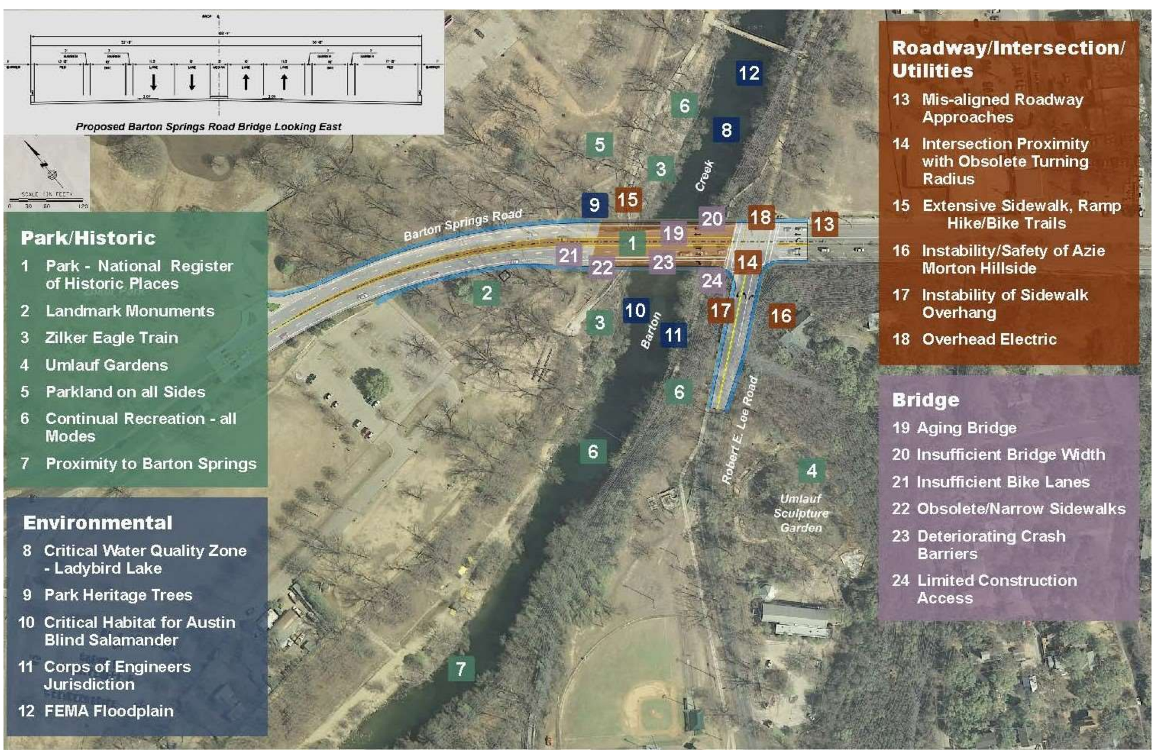

Figure 2. Barton Springs Rd. Bridge Challenges and Constraints

2. DESIGN CONCEPTS

2.1 Design Elements Common to Both Rehabilitation and Replacement

Barton Springs Road serves as a vital roadway connector. Improvements include the realignment of the travel lanes to improve or eliminate the current offset movement at the Azie Morton Road interchange.

The bridge provides a vital bicycle and pedestrian link to the Zilker Park and the existing bike/ pedestrian facilities are inadequate. The redesigned bridge provides dedicated bike lanes as well as a 14 ft. wide sidewalk on the south side of the bridge and an 18 ft. wide shared use path on the north side of the bridge. The design also links the sidewalks to the park trail system and accommodates the trails underneath the bridge.

Lastly, the design will maintain space for the "Zilker Eagle" train that will be refurbished in the near future.

Both the rehabilitation scheme and the replacement scheme share the same above-deck configuration, resulting in an overall bridge width increase from 59 ft. to 109 ft. Therefore, either approach will provide the same result with respect to traffic and bike/ pedestrian movements.

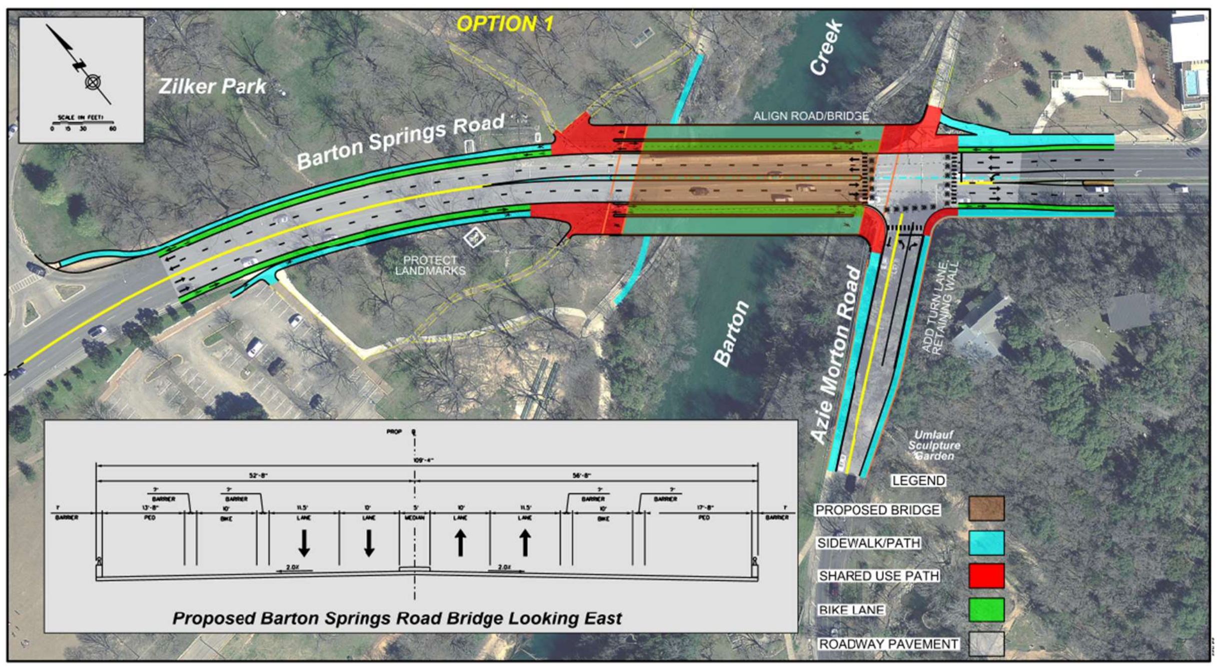

Figure 3. Bridge and Roadway Proposed Geometric Plan

2.2 Rehabilitation Option

The Rehabilitation Option will reuse portions of the existing bridge structure (with rehabilitation measures implemented) and widen each side to provide the ultimate width necessary for proposed multi-modal travel ways.

Due to the deterioration of the existing bridge, only the existing arch ribs will remain.

Figure 4. Bridge Rehabilitation – Remove Deck and Spandrel Columns; Remediate Remaining Structures

Once the arches are exposed, work will include reinforcement of the existing abutments, repairs to the arches and installation of a cathodic protection system to reduce further deterioration of the steel rebar in the arch ribs.

Four additional lines of arch ribs will be added to accommodate the wider deck above. Therefore, the existing arch ribs will only be visible when viewed from underneath the structure.

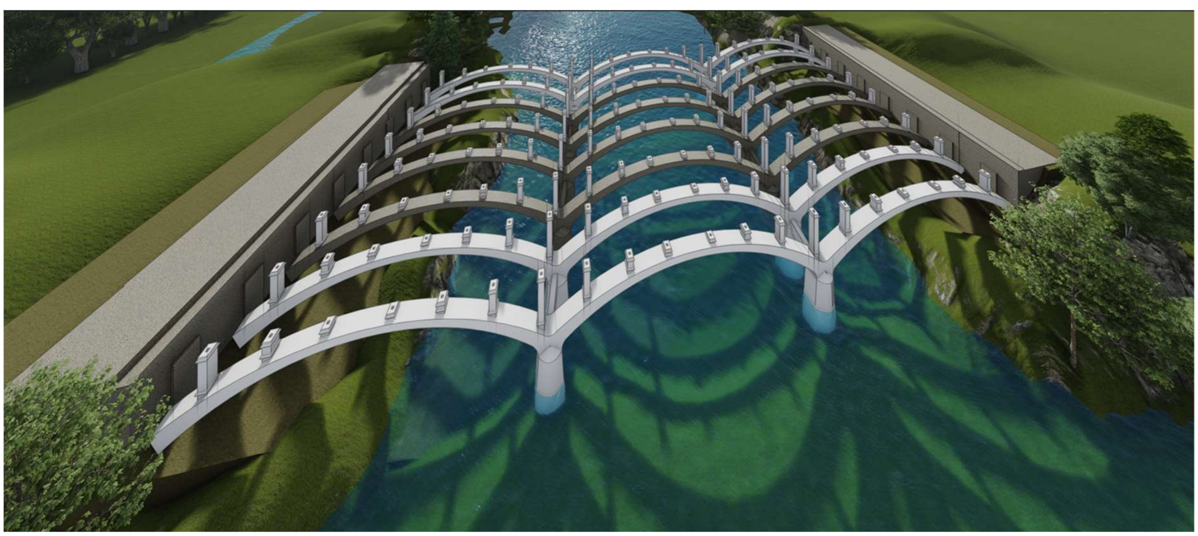

Figure 5. Install New Arch Ribs, Spandrel Columns and Extend Abutments

The fully rehabilitated bridge will maintain the overall appearance and configuration of the existing bridge, utilizing similar details for the arches, spandrel columns, longitudinal beams, etc. In accordance with current design practices, it is anticipated that the level of remediation and future corrosion mitigation methods will be employed to achieve an additional 50 to 75 years of bridge service life subsequent to the rehabilitation.

While the rehabilitation option will provide the appearance of keeping the existing bridge, less than half of the original structure will remain intact and very little surficial materials will remain. Furthermore, very little of the original structure will be plainly visible after the new rib extensions on both sides and the installation of new spandrel columns and deck. As such, what will be predominantly in view is new bridge structure and materials.

Figure 6. Rehabilitation Option Rendering

2.3 Replacement Option

The Replacement Option will remove the existing bridge structure in its entirety and provide a new structure with the ultimate width necessary for proposed multi-modal travel ways.

This option allows for lengthening the bridge by moving the western abutment to the west. In so doing, the Replacement Option provides additional space to facilitate improvements to existing Zilker Park facilities, such as walking paths and the Zilker Eagle miniature railroad, both of which pass under the Barton Springs Road Bridge on the west bank. This additional space for improvements is not feasible with the Rehabilitation Option.

A number of design options for the replacement bridge were developed and vetted with the City of Austin and various stakeholders. Table 2-1 provides a summary of the comparison of rehabilitation options.

Table 2-1 – Comparison of Bridge Replacement Options.

			
	Option 1 - Single Arch	**Option 2 - "Y" Pier Longitudinal**	**Option 3 - "Y" Pier Transverse**
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accommodate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
PrStructural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	**Advantage** Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. However, the structure does provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	**Advantage** Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.
Constructability	Option 1 requires temporary piers and complex falsework to form the arches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	**Advantage** Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The post-tensioning of the girders and post-tensioned tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$18.1M	$13.6M	**Advantage** **$10.2M**

The preferred alternative for replacement is depicted below and utilizes a concrete beam superstructure with two lines of "Y" piers oriented parallel to the channel and at a slight skew to the bridge's beam elements. This configuration maximizes the views through the bridge and maintains an open center channel in Barton Creek below. The unique pier design pays homage to the arches of the existing bridge, while utilizing the most current methods of design and construction.

Figure 7. Replacement Option Rendering

2.4 Bridge Option Cost Comparison

Table 2-2 provides a comparison of estimated life-cycle costs of the Rehabilitation Option and the three Replacement Options. The cost includes a preliminary construction cost estimate, as well as life cycle cost from estimated maintenance /rehabilitation costs throughout the 75-year design life, and then brought back to today's dollars. A range of discount rates (expected interest minus inflation) can be used; Table 2-2 uses 3%. The initial construction cost and life cycle costs did not alter the ranking of alternatives.

Table 2-2 Cost Comparison of Bridge Options.

Bridge Alternative	Initial Const. Bridge Est. Total ($M)	Life Cycle Est. Bridge Total ($M) *	Bridge ($/sq. ft.)**	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	18.1	21.2	825	1.59	7.9	4
Option 2 - Concrete Single Pier (New)	13.6	16.7	648	1.25	3.4	2
Option 3 - Concrete Dual Pier (New)	10.2	13.3	519	1.00	N/A	1
Option 4 - Rehabilitation	14.5	17.8	787	1.34	4.5	3

** Note 1: Comparison of Options Using 3% Discount Rate*
*** Note 2: Replacement bridges have 13.3% more square feet of deck area than rehabilitated bridge. (New = 25,693 sq. ft. versus Rehab = 22,668 sq. ft.)*
**** Note 3: Cost only for Bridge Construction; not roadway, utilities, retaining walls, or other disciplines*

3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS

A summary and comparison of various features and components of both rehabilitation and replacement bridge concepts are provided in Table 3-1.

Table 3-1. Comparison of Bridge Rehabilitation / Replacement Concepts

Highlighted Boxes Represent Benefit Over Other Option

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Roadway Geometry		
Azie Morton Road extended Right Turn lane onto Barton Springs Road	Included	Included
Barton Springs Road Alignment	Barton Springs Rd. will be improved but still unaligned; the required "zig zag" by west bound traffic will be much less abrupt. Rehabilitation requires the new structure to be built on the existing centerline alignment.	**Advantage** Barton Springs Rd. will have the point of inflection removed from the alignment. The result will be a straight intersection, with no conflict in east- or westbound traffic and no "zig zag".
Park Amenities / Improvements		
Zilker Eagle Train	The train will have to be replaced under the bridge, in a similar configuration to current layout.	**Advantage** Moving the western abutment further west provides additional horizontal space. The train can be replaced similar to the current layout, or relocated with additional space for rider room and safety.
West bank hike/bike trail pedestrian bridge under Barton Springs Rd	The pedestrian bridge will need to be removed and replaced in a similar manner to existing layout.	**Advantage** The pedestrian bridge will need to be removed. It can either be replaced similar to current layout, or it may be able to be relocated as a path on the additional space allowed by moving the western abutment.
Hike / Bike Trail passage below the bridge	Passage length under bridge will be roughly twice as wide as existing. Passage space and headroom will be similar to existing layout.	**Advantage** Passage length will be similar to rehab length. Passage space will see combination of new structures and abutments to allow opportunity for added vertical and horizontal open space underneath bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Bridge Structure		
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with Texas Historical Commission. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines	Existing arches will be removed. Replacement concepts will include 4 arch lines. New bridge aesthetic can be complementary to the existing bridge (3 span) type/span arrangement. Replacement concept to consist of 4 substructure elements at two locations in lieu of 8 continuous elements providing more open view sheds.
Impacts to Historic Structure	**Advantage** Rehabilitation of the existing bridge preserves some of the existing historic bridge elements.	Replacement removes the existing historic elements and relies on mitigation strategies to offset impacts.
Bridge Length and Abutment Locations	For rehab, existing abutment locations will remain, and will expand or widen to the north and to the south to accommodate the additional arches for a wider bridge, in a similar geometric arrangement to existing.	**Advantage** Replacement concept will shift the west abutment to the west, to provide more space and safety for pedestrian trail and the Zilker Eagle train on the West Bank.
Bridge foundation work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concept includes 8 foundations – for 4 substructure elements at 2 locations.
Temporary Construction in Barton Creek	Extensive foundations for temporary works will be required	**Advantage** Assuming bridge can be constructed by barge mounted cranes, foundations for temporary works will not be required.
Bicycle Elements on Bridge	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Pedestrian Elements on Bridge	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	**Advantage** Target Service Life of 75 years This can be extended to 100 years with durability enhancements to the design basis and prescribed materials. This would entail an increase in cost of roughly 10% or more.
Bridge Maintenance	Increased long term maintenance cost and requirements	**Advantage** Less maintenance cost and staffing labor required
Engineer's Estimate of Probable Bridge Construction Cost *(range indicating minimum and maximum cost including 50% inflation over course of design and bidding of the project)*	$14.5M - $22M	**Advantage** $10.2M – 15.5M
Constructability / Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	**Advantage** Comparatively less construction and project risk.

4. SUMMARY AND RECOMMENDATIONS

The existing Barton Springs Bridge is an historic structure that contributes to the urban and historic fabric of Zilker Park and Austin, Texas. The bridge is also a part of the larger transportation infrastructure system that serves the community. This project is difficult because we must strike a proper balance between historic preservation, public safety and the use of public funds. The Section 106 process of "Avoid – Minimize – Mitigate" helps to identify the best path forward.

The deterioration of the existing bridge has reached a stage that cannot be ignored and the level of repair that is required eliminates the possibility of a "light-touch" restoration. Thus, historic impact avoidance and historic impact minimization are simply not possible. Therefore, the focus of the investigation has centered on the development of feasible restoration and replacement schemes that meet the current transportation demands while providing a structure with a lifespan of at least 75 additional years of service.

Both rehabilitation and replacement can accommodate the transportation needs in a similar fashion. The replacement scheme offers numerous additional benefits (highlighted cells in the above table) including better accommodations of the Zilker Eagle mini-train and enhanced trails underneath the bridge.

The most significant differences between the rehabilitation scheme and the replacement scheme are cost and risk. The particular replacement bridge alternative selected is not the least expensive design possible, it includes enhanced features such as unique piers and upgraded abutments. Even with these enhancements, the cost of the replacement bridge is 40% less than the rehabilitation scheme. Furthermore, ongoing maintenance cost and labor requirements are less with the replacement scheme. There is also a great deal of risk associated with the rehabilitation scheme. While the bridge condition survey was thorough, there are many things that could increase the cost of rehabilitation once the initial demolition exposes all of the "hidden" elements of the bridge.

We understand the significance of the existing bridge and the importance of preserving historical assets. However, as stewards of the taxpayer's money there is an obligation to make the best value decision for the community. If the bridge is rehabilitated, very little of the existing structure will remain and those remaining elements will be almost entirely concealed by the new construction. This fact coupled with the significant increase in cost and risk leads the design team to recommend replacement as the path forward.

The project is continuing an on-going coordination with the Texas Historical Commission (THC); and it is intended that input from both the THC and U.S. Army Corps of Engineers will be forthcoming as coordination continues.