JACOBS

Memorandum

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Date December 1, 2016

To John Vicente, PE, City of Kenmore

From Kevin Kim, PE, SE, Jacobs Engineering

Subject **Lower Swamp Creek Bridge No. 5015 Evaluation**
Jacobs Project No. W3X71000

Introduction

The Lower Swamp Creek Bridge No. 5015 was originally constructed in 1951. The existing bridge consists of three spans of 15.5-feet precast concrete tub-girders, simply supported on timber pile bents and abutments, for a total length of 47 feet. The latest bridge inspection by King County, completed in July 2014, indicated that the overall bridge substructure conditions were down-graded from 6 ("satisfactory condition") to 4 ("poor condition"), which made the bridge "structurally deficient". The bridge inspection also recommended that the bridge load rating be updated based on the change of the condition.

Because the bridge is now categorized as structurally deficient, the City has retained Jacobs to perform feasibility level evaluation of bridge repair and replacement alternatives as well as bridge load rating analysis.

Bridge Load Rating

As recommended in the latest bridge inspection, a new bridge load analysis was performed based on Load Factor Rating (LFR) method. The rating factors were lowered from the previous analysis but the Operating rating factors for all three AASHTO Legal trucks are still greater than 1.0, so no posting is required per WSDOT Bridge Inspection Manual. The new NBI Operating and Inventory Rating are 45 tons and 27 tons, respectively. The details of the load rating analysis are prepared in a separate Bridge Load Rating submittal.

Based on the history and current conditions of the bridge, the bridge is expected to continue to get deteriorated over the years and may require load restriction posting in the next 5 to 10 years. The purpose of load restriction posting is to prevent the bridge from an overload situation for safety reasons. Load restriction posting alone would not extend the remaining life of the bridge.

Evaluation of the Bridge

We have considered three different alternatives as following:

- Repair Alternative
- Replace with a single-lane bridge
- Replace with a two-lane bridge

Alternatives Analysis – Repair (Alt. 0)

Although a more in-depth bridge inspection would be required to develop repair options, some selected repairs can be done on the existing bridge to extend the service life of the bridge. Based on the information available for this scope of work, the following repair items could be considered:

- Widening the girder support width at each pier bent to prevent the girders from falling off during seismic events.
- Strengthening the embankment at each abutment against any flooding events.
- Adding new asphalt overlay on the concrete girder deck to protect the bridge joints and its substructure from water penetration from the deck through open joints.
- Adding new traffic (safety) barrier at all four corners of the bridge.

It is estimated that costs for the repair option would range from $100,000 to $200,000. These repairs would somewhat extend the life of the bridge by preventing catastrophic failure during a seismic or flooding event and protecting the deck joints. However, the extension of service life of the bridge is limited by the deteriorated timber substructure, which will reach the end of its service life in about 10 years and need to be replaced.

Considering the age and overall conditions of the bridge, repair option may not be effective for the following reasons:

- The most severe deficiencies of the bridge are in the bridge timber substructure
- Substructure repair is costly and time consuming.
- The embankments at each abutment appear to be vulnerable against any major floods or seismic events and embankment strengthening would require stringent environmental permitting and construction challenges.
- The bridge is 64 years old and the timber substructure is near the end of its services life, which would be 65 to 75 years for this type of structure. Even with repair of the bridge superstructure elements, the remaining service life of the bridge would still be limited by the timber piles and other substructure elements.

Alternatives Analysis – Replacement with Single Lane Bridge (Alt. 1)

At the request of the City, a one-lane bridge with a stop sign at both ends of the bridge was considered as a replacement alternative. The bridge would be approximately 20 feet in width (including traffic barriers) and 77 feet in length, extending 15 feet beyond each of the existing

abutments, allowing easier construction of the new bridge abutments away from the stream channel. Using precast concrete slab girders, which come in typical 4-foot wide sections, the bridge would provide one 11-foot lane with a 3-foot shoulder on each side for a total roadway width of 17 feet. The 3' wide shoulder provides enough width on a single lane bridge so the drivers do not feel they are too close to the barriers on either side.

A bridge with 16 feet in width, which would provide one 11-foot lane and 1-foot shoulder on each side for a total roadway width of 13 feet, was also considered during evaluation. It was not selected as a final alternative because it may be too narrow for driver comfort, and total construction cost would not be much lower than that of the 20-foot-wide bridge alternative.

A temporary one-lane bridge would be placed at the north side of the existing bridge to allow local traffic during construction while the existing bridge is removed and replaced. There is about 24.5 feet of clearance between the Lower Swamp Creek Bridge and the Burke Gilman Trail Bridge, giving sufficient room for a 12-foot-wide temporary bridge. There are a couple utility meter boxes and manholes at the east end, so utility coordination would be required before installing the temporary bridge. The total project cost was estimated at $1.56M, including engineering and contingencies (see attached Planning Level Project Cost Estimate sheet).

Alternatives Analysis – Replacement with Two Lane Bridge

Two-Lane Bridge Alternative with a Temporary Detour Bridge (Alt. 2A) – This option would be considered as a reasonable approach to a replacement of the existing bridge with a similar in kind. The new replacement bridge would be approximately 28 feet in width and 77 feet in length, extending 15 feet beyond each of the existing abutments, allowing wider stream base and more reasonable abutment construction.

Similar to single lane alternative described above, the bridge would be constructed with precast concrete slab girders which come in typical 4-foot sections. The bridge would accommodate two 11-foot lanes and 1.5-foot shoulder at outside of each lane for a total roadway width of 25 feet.

A temporary one-lane bridge would be placed at the north side of the existing bridge to allow local traffic during construction while the existing bridge is removed and replaced. The proposed bridge layout and a typical cross section are attached. The total project cost was estimated at $2.08M, including engineering and planning level contingencies (see Planning Level Project Cost Estimate sheet).

Two-Lane Bridge Alternative Constructed in 2 Stages (Alt. 2B) – This option would be similar to Alternative 2A, except the bridge would be constructed in two stages to allow local traffic. This alternative was considered as a no-temporary bridge option, which avoids the construction, maintenance, and removal of an additional bridge. To access the east side of the Creek without a temporary bridge, the first half of the bridge would be constructed on the south side of the

existing bridge. Then the local traffic would be moved onto the newly constructed one-lane bridge while the existing bridge is removed and the second half of the new bridge is completed.

To accommodate the staged construction, the final bridge width may be a little wider than necessary and the bridge layout may not be exactly on center of the roadway alignment. The width of the new bridge is estimated at approximately 32 feet wide. The proposed bridge layout and a typical cross section are attached. The total project cost was estimated at $2.57M, including engineering and planning level contingencies (see Planning Level Project Cost Estimate sheet).

Alternative	Pros	Cons
Repair Alt. (Alt. 0) (Est. Cost: $100K - $200K)	▪ Lowest construction cost ▪ Quick fix for selected items	▪ Not a "permanent" solution ▪ Will need to replace the bridge in the next 10 to 15 years ▪ Temporary bridge closure during construction
Single-Lane Alt. (Alt. 1) (Est. Cost: 1.56M)	▪ A permanent bridge with 75-year services life ▪ Lower construction cost than two-lane alt. ▪ Local access maintained during construction.	▪ May cause confusion/traffic impact during operation. Clear signage will be required. ▪ Need a temporary bridge. May need construction easement or ROW. ▪ Traffic is limited to single lane during construction
Two-Lane Br. with a Temp Detour Br. (Alt. 2A) (Est. Cost: $2.08M)	▪ A permanent bridge with 75-year services life ▪ Local access maintained during construction ▪ Shorter construction duration than Alt. 2B ▪ Lower construction cost than Alt. 2B	▪ Need a temporary bridge (construct, maintain and remove). May need construction easement or ROW for a temporary bridge ▪ Traffic is limited to a single lane during construction
Two-Lane Br. Constructed in 2 Stages (Alt. 2B) Est. Cost: $2.57M)	▪ A permanent bridge with 75-year service life ▪ Local access can be maintained during construction. ▪ No temporary bridge is needed	▪ Longer construction duration than Alt. 2A ▪ Higher construction cost than Alt. 2A ▪ Traffic is limited to single lane during construction.

Public Access during Construction

One of the main challenges involved in construction of a new replacement bridge is providing access to the properties on the east side of the bridge during construction. A few alternatives considered include:

- A temporary one-lane bridge at the upstream side of the bridge (i.e., north side of the existing bridge) using steel girders with timber deck
- A temporary one-lane bridge at the downstream side of the existing bridge using steel girders with a timber deck
- Staged construction of the new bridge – build a first half at the downstream side while maintaining the traffic on the existing bridge. After completion of the first half, demolish the existing bridge and complete second half of the new bridge.

In addition, using the Burke Gilman Trail, or even SR 522 by punching through to the east, can be considered for traffic detour. These options would require significant coordination and approval from the King County, WSDOT and local residents. The feasibility of these options can be explored in the early in the preliminary design phase.

Recommendation

The Swamp Creek Bridge No. 5015, constructed in 1951 with precast concrete tub girders on timber substructure, is deteriorating and was given a "poor condition" rating in the latest bridge inspection. The bridge is currently categorized as *"structurally deficient"* and *"functionally obsolete"* with a sufficiency rating of approximately 35 out of 100. Considering the current age of the bridge and the typical life span of this type of bridge at 65 to 75 years, this bridge would reach its service life within the next 10 years and need to be replaced.

Based on our evaluation, we recommend that the Lower Swamp Creek Bridge be replaced with a new single span 2-lane concrete girder bridge and the local traffic on NE 175th Street be maintained on a temporary bridge during construction of the new bridge (Alt. 2A). The total project cost, including construction, preliminary engineering and construction engineering, is estimated at $2.08M (in 2016 dollar). This is the most feasible alternative to address the current condition of the bridge and provide a structure with a 75-year service life.

However, while the bridge is categorized as *structurally deficient*, there was no safety issue identified that need to be addressed at this time. We recommend that the City continues with annual inspection of the bridge as well as routine maintenance until such time as the bridge is replaced. Any unforeseen events such as flooding or earthquake may have impacts to the bridge that may require load restrictions or even temporary closure until the bridge condition is restored or replaced.

Photos of the Existing Bridge

Lower Swamp Creek Bridge – Deck View

Lower Swamp Creek Bridge - Elevation

Lower Swamp Creek Bridge – Abutment

City of Kenmore

Lower Swamp Creek Bridge No. 5015

Planning Level Proejct Cost Estimates

- Existing Bridge: 47' long x 24' wide (out to out).
- The proposed alternatives for replacement of the Lower Swamp Creek Bridge are a single span bridge with a superstructure composed of precast concrete voided slabs and a substructure of drilled shaft supported abutments.
- Proposed Bridge Length - 15' beyond the exist bridge abutments: 47' + 15' + 15' = 77 ft.

	Alt. 1 **1-Lane Br Replacement** (1-11' lanes + 2-3' shoulders + 2-1.5' barrier seats) = 20 feet	**Alt. 2 A** **2-Lane Br Replacement** (2-11' lanes + 2-1.5' shoulders + 2-1.5' barrier seats) = 28 feet	**Alt. 2B** **2-Lane Br Replacement** (2-11' lanes + 2-3.5' shoulders + 2-1.5' barrier seats) = 32 feet *
Bridge Length (ft)	77	77	77
Width (edge of deck to edge of deck), (ft)	20	28	32
No of Piers (incl. abutments)	2	2	2
No of Spans	1	1	1
No of Girder Lines (4-ft wide PC Slab)	5	7	7
No of construction stages	I stage construction - A temp. detour bridge during construction	I stage construction A temp. detour bridge during construction	2-Stage construction Build first half to south & remove existing bridge for second half to complete
Total Deck Area (SF)	1,540	2,156	2,464
Unit cost per SF of Deck ($/SF)	$ 300	$ 300	$ 300
Bridge Construction Cost	$ 462,000	$ 646,800	$ 739,200
Removal of Existing Bridge	$ 20,000	$ 20,000	$ 20,000
Allowance for 2 Stages Construction (20%)	$ -	$ -	$ 147,840
Temporary Detour Bridge	$ 96,000	$ 96,000	$ -
Roadway Approaches (20%)	$ 92,400	$ 129,360	$ 177,408
Items Not Identified at this level (15%)	$ 83,160	$ 116,424	$ 159,667
Total Construction	**$ 754,000**	**$ 1,009,000**	**$ 1,244,000**
Preliminary Engineering (Incl. Env. Permitting & Geotech) (40%)	$ 302,000	$ 404,000	$ 498,000
Construction Engineering (25%)	$ 189,000	$ 252,000	$ 311,000
Subtotal - Project Cost	**$ 1,245,000**	**$ 1,665,000**	**$ 2,053,000**
Planning Level Contingencies (25%)	$ 311,000	$ 416,000	$ 513,000
TOTAL PROJECT COST ESTIMATE	**$ 1,560,000**	**$ 2,080,000**	**$ 2,570,000**
Project Cost Contribution			
FHWA BRAC (80%)	*$ 1,250,000*	*$ 1,660,000*	*$ 2,060,000*
City Match (20%)	***$ 310,000***	***$ 420,000***	***$ 510,000***
	$ 1,560,000	**$ 2,080,000**	**$ 2,570,000**
	Temporary bridge will likely be at north side of the existing bridge.	*Temporary bridge will likely be at north side of the existing bridge.*	** Bridge width will need be approx 32 feet to match the existing roadway.*

CITY OF KENMORE
LOWER SWAMP CREEK BRIDGE

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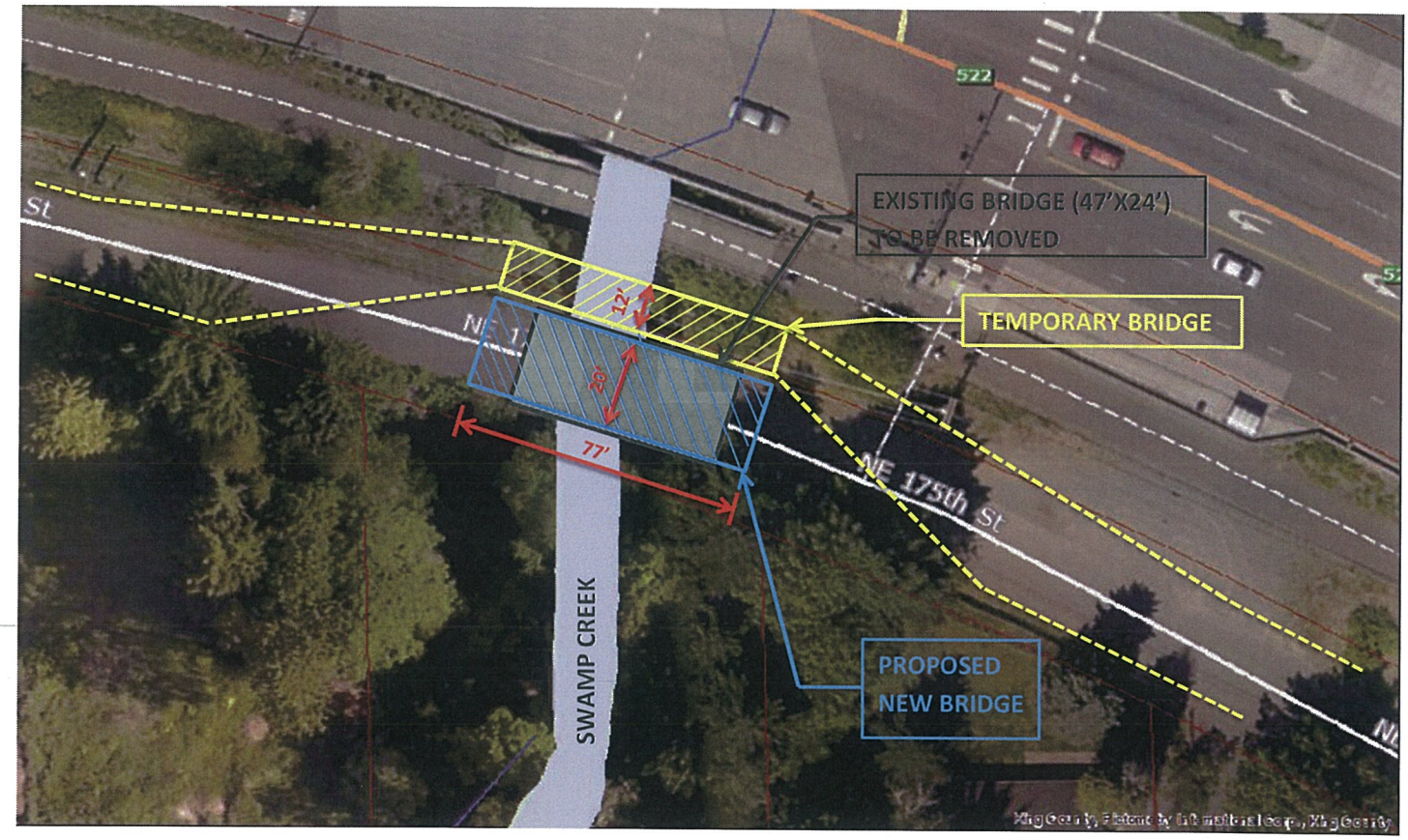
Proposed Alternative 1 (1-Lane Bridge)



CITY OF KENMORE
LOWER SWAMP CREEK BRIDGE

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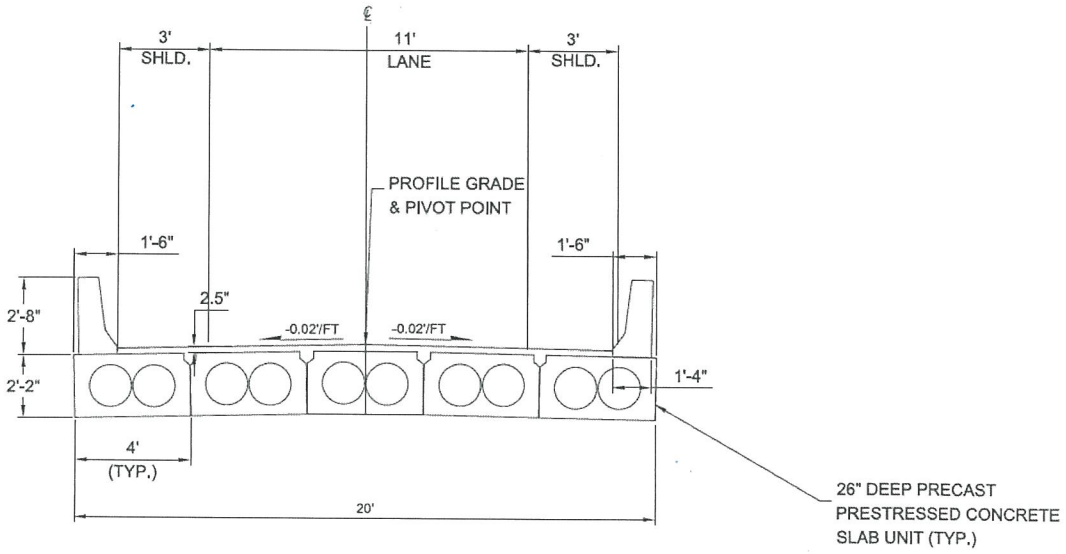
Proposed Alternative 1 (1-Lane Bridge)



TYPICAL SECTION - ALTERNATIVE 1

CITY OF KENMORE
LOWER SWAMP CREEK BRIDGE

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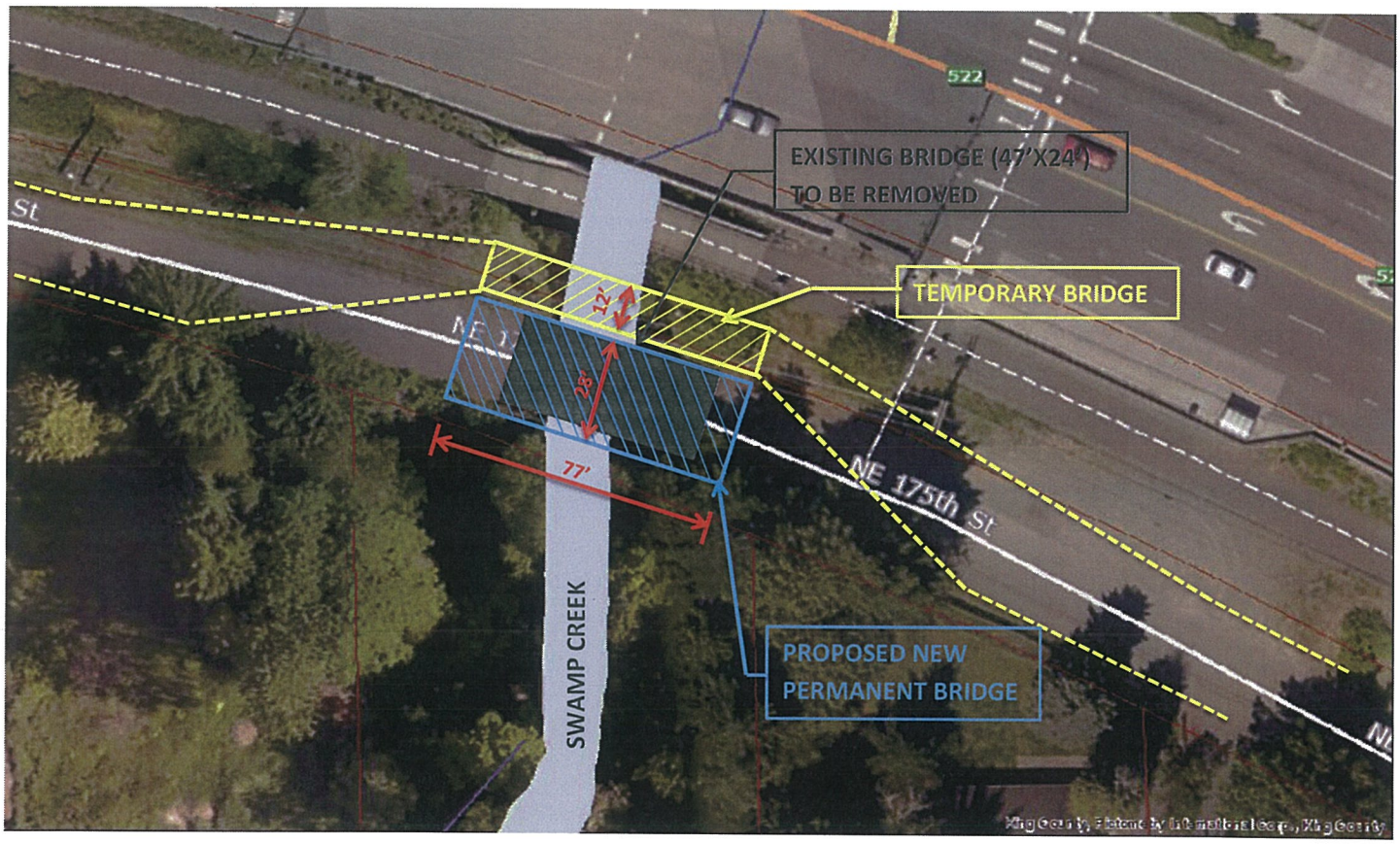
Proposed Alternative 2A (2-Lane Bridge)



CITY OF KENMORE
LOWER SWAMP CREEK BRIDGE

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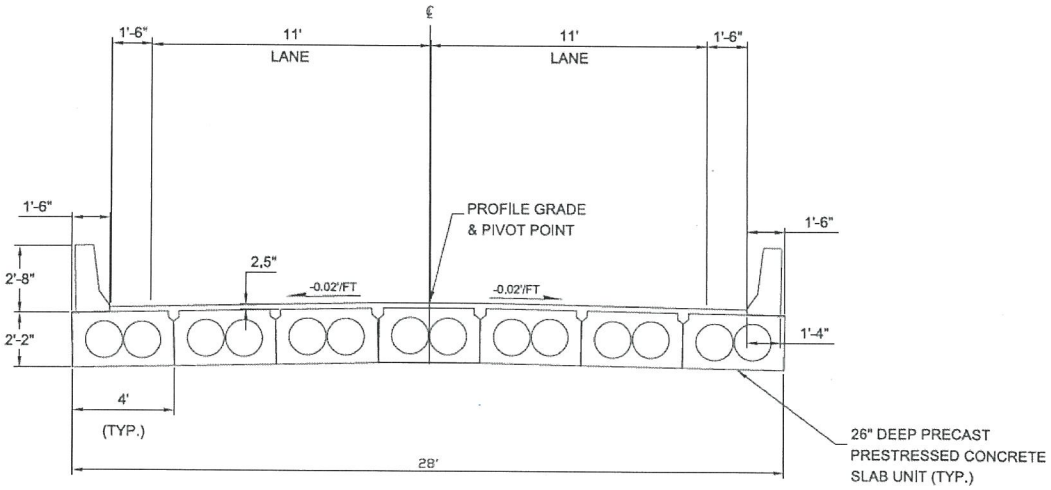
Proposed Alternative 2A (2-Lane Bridge)



TYPICAL SECTION - ALTERNATIVE 2A

CITY OF KENMORE
LOWER SWAMP CREEK BRIDGE

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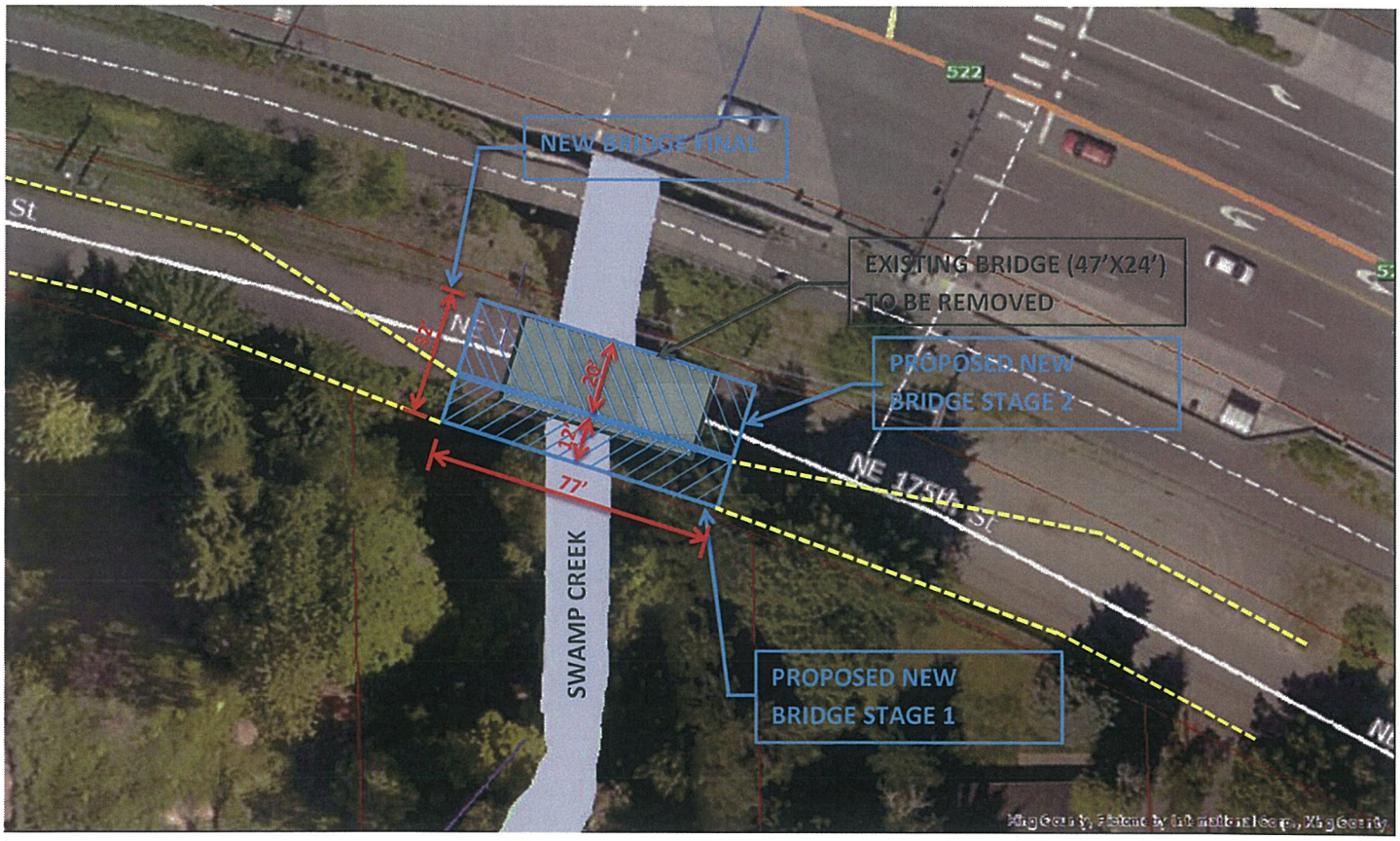
Proposed Alternative 2B (2-Lane Bridge)



CITY OF KENMORE
LOWER SWAMP CREEK BRIDGE

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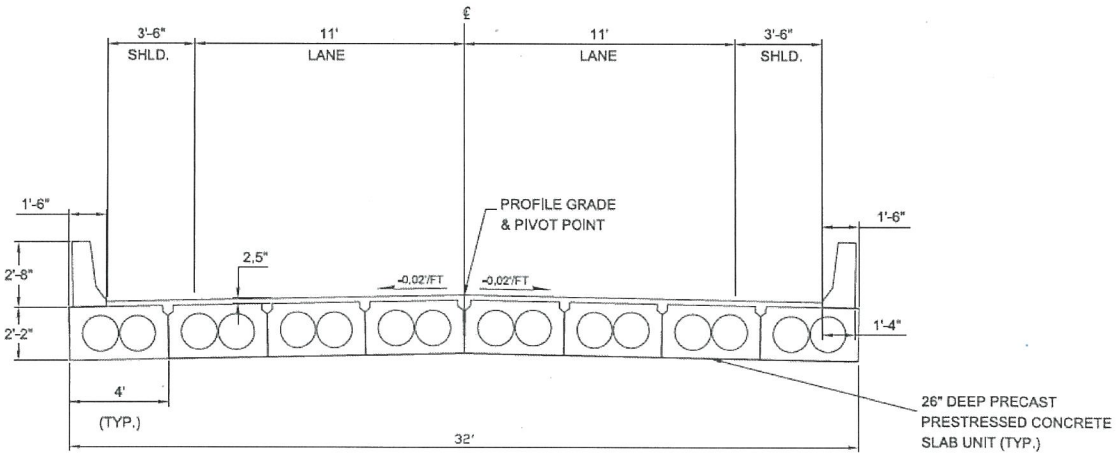
Proposed Alternative 2B (2-Lane Bridge)



TYPICAL SECTION - ALTERNATIVE 2B