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Bridge Type Evaluation Report, Bridge Type Refinement

FRENCH PRAIRIE BRIDGE PROJECT

April 2019

Prepared for the City of Wilsonville

WILSONVILLE OREGON

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Introduction

The City of Wilsonville is undertaking a project to develop preliminary designs for the French Prairie Bridge, a proposed bicycle/pedestrian/emergency vehicle crossing of the Willamette River between Interstate 5 (I-5) and the Portland and Western Railroad Bridge. The project addresses bridge location, bridge type selection, 30% design, and preliminary environmental documentation. In May 2018, City Council approved the Task Force's recommended Alignment, W1, as shown in Figure 1.

Project Chronology

Prior to preparation of this report, the project team performed preliminary investigations of the project site and compiled the resulting information into reports. These reports were prepared using the project team's best judgement, and were supplemented with guidance offered by the Technical Advisory Committee (TAC). This information is summarized in the Opportunities and Constraints Report.

Following development of the Opportunities and Constraints Report, the project team, with input from the TAC, Task Force, an open house, Wilsonville City Council, and Clackamas Board of County Commissioners (BCC), prepared a list of criteria to evaluate the relative merits of each location. These criteria are based on the needs and values of the community, including City and County goals. The Task Force assigned relative weighting to the criteria to provide for a quantitative comparison of the locations. This work is summarized in the Evaluation Criteria Memo.

The project team then prepared the Location Selection Summary, which served as a capstone document for determining and documenting the preferred bridge location using the information prepared in the technical reports, Opportunities and Constraints Memo, and Evaluation Criteria Memo.

The next step consisted of preparation of the Bride Type Evaluation Report. This document presented proposed selection criteria and range of bridge types, a description of each of the five considered bridge types, and a brief description of types considered infeasible. The report concluded with an assessment summary of the alternatives.

On October 3, 2018, the project team met with the TAC to review the draft report and bridge type evaluation process and outcome. TAC input has been incorporated into this report. Recognizing that obtaining funding for the project may prove challenging, their recommendation is to advance one bridge type that is lower cost and conventional, and one that is a signature type and also avoids locating a pier in the marina parking lot.

On December 5, 2018, the project team met with the Task Force to review the bridge type evaluation process, review TAC and public input, and develop a recommendation for the Wilsonville City Council. A complete record of the discussions at the Task Force Meeting is presented in the Meeting Summary with the key recommendations being:

- Unanimous agreement to eliminate the steel truss and tied arch from further consideration. Members cited the cost and impacts of the tied arch and the poor aesthetics of the steel truss as reasons for supporting this recommendation.
- Further evaluate the cable-stayed and suspension bridges. In a straw poll, nine of the 12 members voted for this recommendation. Members cited the importance of a signature bridge in Wilsonville, the avoidance of permanent in-water impacts, and that these two bridge types are in the middle relative to project cost as reasons for supporting this recommendation. The three members supporting inclusion of the steel girder bridge cited the lack of construction funding and opportunities for alternative decorative treatments as reasons to further evaluate the lower-cost bridge option along with either the cable-stayed or suspension bridge. No member objected to the final Task Force recommendation to further evaluate the cable-stayed and suspension bridges.

In January 2019, the Wilsonville City Council approved two bridge types for further evaluation: the cable-stay and suspension bridges. The steel girder, steel truss, and tied-arch types were not forwarded for consideration.

OBEC has further investigated the two forwarded alternatives, developing further data on each of the previously applied selection criteria of economics, constructability, impacts, and aesthetics, as described below.

Design Criteria and Constraints

As the two bridge types were further investigated, the overarching design criteria and constraints were held as the guiding requirements.

Any bridge at French Prairie must meet minimum functionality requirements and effectively address site constraints. The proposed bridge is intended to serve multiple functions. It will provide a safer river crossing for bicyclists and pedestrians than currently provided by the I-5 structures. It will also provide an alternative route for emergency vehicles when I-5 is blocked and access across the Willamette River is required. Finally, it will provide a redundant crossing in case of a major seismic event.

The design pedestrian loading for a pedestrian bridge is 90 pounds per square foot. At a minimum, the HS20 truck, a notional 3-axle, 72,000-pound design loading, will be considered for emergency and post-seismic event vehicle use. Typically, the pedestrian load, when applied over the entire structure, is heavier than a single emergency vehicle. The heavy point loads associated with emergency vehicle wheels tend to control the design of localized elements and connections. The proposed bridge will be designed to remain serviceable following a Cascadia Subduction Zone event and to avoid collapse during the 1,000-year return period earthquake.

The recommended bridge width is 17 feet, based on the potential for simultaneous emergency vehicle and recreational use. A vehicle travel lane is typically 12 feet, and Oregon Department of Transportation's (ODOT) minimum sidewalk width is five feet. These two items serve as the basis for the bridge width recommendation.

The route will need to comply with the requirements of the Americans with Disabilities Act (ADA). The maximum slope along the path cannot exceed five percent. The maximum cross slope cannot exceed two percent. Recommended maximum slopes of 4.8 percent and 1.5 percent, respectively, allow for construction tolerances.

The minimum radius of curvature used on the path needs to accommodate both the design speed for bicycle use and off-tracking of large emergency vehicles. A design speed of 20 miles per hour for cyclists using a 20-degree lean angle results in a radius of 74 feet. This radius accommodates most emergency vehicles with minimal off-tracking.

The Willamette River is a navigable waterway regulated by the United States Coast Guard (USCG). Preliminary consultation with the USCG and river users has indicated that a new crossing of the Willamette River must provide a navigational clearance comparable to the bridges located immediately upstream and downstream. This results in a minimum horizontal clearance of approximately 240 feet and a minimum overhead obstruction elevation of 130 feet, which is 76 feet above the approximate low-water surface elevation of 54 feet. Temporary reductions in the navigational channel may be negotiated with the USCG and the Oregon State Marine Board (OSMB).

The bridge will need to comply with Federal Emergency Management Agency (FEMA) Floodway regulations. This project area is within a regulated floodway. New bridge piers located within the FEMA floodway will require mitigation to prevent a rise in the 100-year flood elevation.

In addition to USCG navigational requirements, the selected alignment passes over the Boones Ferry Marina and Boones Ferry Boat Ramp access road and parking area.

A desktop study of the geotechnical site setting has been performed. This investigation researched existing records of subsurface explorations in the project area and concluded that the site is predominantly alluvial deposits (silts, gravels, and sands) over the Troutdale Formation (stiff clays). These soils will require deep foundations in the form of driven piles or drilled shafts.

The alluvial deposits vary in density and composition and may be subject to liquefaction, depending on water table elevation and intensity of shaking during an earthquake. Lateral spread and seismic-induced slope instability are risks on both river banks. The detailed bridge design will need to address these issues to comply with the seismic design criteria. Significant additional investigations, testing, and analyses will be required to determine what, if any, mitigation is necessary.

Selection Criteria

The bridge type selection process has three phases. The first phase involved identifying potentially suitable bridge structure types, given the site constraints. The second phase included a preliminary evaluation of each type of structure. The bridge types were compared and the two most suitable bridge types were selected for further investigation. Now, a more rigorous investigation of the two remaining structure types will be performed in phase three.

The project team compared the two forwarded bridge types with respect to project economics, constructability, impacts, and bridge aesthetics. The discussion of each criterion from the December 2018 Report is included below.

Economics

This criterion is related to initial and long-term project costs. It is also related to how soon the bridge could be in service measured from the time funding is secured.

Design & Construction Cost – Bridge types that are less time-consuming to design and less expensive to construct are preferred.

Design & Construction Duration – Simple bridge types, or those with fewer stages of construction and conventional access requirements, will take less time to design and build. Permits can potentially be secured more easily and quickly for bridge types with less in-water footprint. Bridges that avoid permanent in-water impacts may qualify for programmatic permitting. Bridge types that can be completed sooner provide a greater local and regional economic benefit and minimize the effect of inflation on overall project costs. Types achieving these objectives are preferred.

Maintenance – Simpler structural systems and bridge types with fewer components or that are easier to access and inspect are preferred.

Constructability

This criterion is related to how each bridge is constructed, specifically focusing on site access requirements and overall complexity. Access considerations include the necessary staging and work areas, the need for temporary work roadways and/or bridges, and whether or not cofferdams will be necessary. Complexity is considered to include overall construction sequencing, equipment and technology needs, construction materials, and anticipated contractor capabilities.

Substructure Access Requirements – Depending on the bridge type, the substructure's foundation elements and configuration may vary significantly. Different configurations and elements will have different equipment, staging, and access requirements. Foundation elements could include driven piles, prebored piles, or drilled shafts that support columns, piers, or towers. Factors affecting the score include the type, number, location, and size of foundation elements and supported members. Bridge types that avoid or minimize the number of foundation elements in the water, particularly the deeper sections of the river where access is more challenging, or at the water's edge are preferred.

Substructure Complexity – Depending on the bridge type's foundation elements and configuration, the complexity to design and construct the substructure elements can vary significantly. Factors considered include the overall arrangement and configuration of individual bridge foundation elements and supported members, any construction staging or sequencing of the elements, and the capabilities of local contractors to perform the work. Bridge types with less complex foundation elements are preferred. Bridge types with arch rib or pylon foundations are more complex than those with only typical columns.

Superstructure Access Requirements – Depending on the bridge type, the superstructure's girder and deck elements and configuration may vary significantly. Different configurations and elements will have different equipment, staging, and access requirements. Superstructure elements could include steel girders, trusses, cables, arches, and precast concrete deck panels. Factors considered include the type, number, placement method, and size of superstructure elements. Bridge types that are more readily constructible and limit access needs in or above the water are preferred.

Superstructure Complexity – Depending on the bridge type's girder and deck elements and configuration, the complexity to design and construct the superstructure elements can vary significantly. Factors considered include the overall arrangement and configuration of individual elements, how these elements connect to the substructure, any construction staging or sequencing of the elements, and the capabilities of local contractors to perform the work. Bridge types with less complex superstructure elements are preferred. Bridges with arch ribs and/or cable systems and precast deck panels are more complex than those with typical girder and deck systems.

Impacts

This criterion is related to the overall site impacts resulting from temporary construction access and staging needs, as well as the permanent project impacts associated with the bridge's footprint. A range of impacts are considered, from natural and cultural resources to physical constraints, such as navigational clearance and public and private property. The impacts will be organized and described by area, as shown in Figure 1.

Temporary Resource Impacts – Bridge types with less temporary construction impact to archeological and historic resources; terrestrial habitat and wildlife; waters and wetlands; and State and Federally managed species are preferred.

Temporary Built Environment Impacts – Bridge types with less temporary construction impact to private residences; public parks; marina property and structures; the river floodway and its navigational channel; railroad property; and existing utilities are preferred.

Permanent Resource Impacts – Bridge types with less permanent impact to archeological and historic resources; terrestrial habitat and wildlife; and waters, wetlands, and aquatic wildlife are preferred.

Permanent Built Environment Impacts – Bridge types with less permanent impact to private residences; public parks; marina property and structures; the river floodway and its navigational channel; railroad property; and existing utilities are preferred.

Aesthetics

Aesthetic considerations relate to the bridge's setting, user experience, and visual impact. Though aesthetic preferences are subjective, preference will be given to the bridge types that look appropriate within the site and relate to the surrounding natural and built environments. The team also considered whether the appearance of the bridge would be a draw to users beyond just the utilitarian function. This helps determine whether the bridge type should blend in or stand out as a signature structure.

Bridge Types Considered

Previous investigations into suitability of bridge types at this location were performed and summarized in the Bridge Type Evaluation Report (dated December 2018). Following that report, two bridge types were identified for further investigation: cable-stayed and suspension. The following sections present the findings from the additional investigations and evaluate these bridge types against the selection criteria presented above. For information generated by previous investigations, refer to the December 2018 Bridge Type Evaluation Report.

Cable-Stayed

Cable-stayed bridges are cable-supported structures where the suspenders supporting the deck system are tied back directly to tall pylons. Cable-stayed structures can support very long spans and have very shallow superstructures.

Pedestrian Bridge across the Elbe River, Celakovice, Czech Republic

OBEC performed preliminary structure layout for this bridge type. As initially visualized, the proposed structure consists of two frames. The cable-stayed frame consists primarily of precast deck panels with transitional cast-in-place segments and makes up the north 1,069 feet of the structure. The two pylons extend approximately 160 feet above the deck. The south frame, which consists of cast-in-place concrete slab, connects south of Butteville Road with two spans of 71.5 feet.

I-5: Gateway Pedestrian Bridge, Eugene, OR

Preliminary analyses were performed for the cable-stayed bridge alternative based on the known project information, including assumed geometry, design loads, and limited geotechnical information. These analyses included preliminary sizing of major bridge components and an evaluation of construction methods required to build the structure. The result is a project cost range and footprint accompanied by renderings of the structure to illustrate the proposed concept.

Economics

Design & Construction Cost and Duration

The cast-in-place concrete slab approach spans are straight-forward to design and construct. As a result, the majority of the additional investigations that were made focused on the cable-stayed bridge system spanning the Willamette River.

Analysis of the cable-stayed system confirmed that the preliminary pylon height and dimensions are feasible. Analysis indicated that the stays for the proposed arrangement will vary in size from 3-inch-diameter to 4-inch-diameter galvanized steel bridge strands – sizes that are readily available and can be anchored with common open sockets and pins. Deck panels were sized based on the design loads. The member sizes used to prepare a preliminary construction cost estimate were based on OBEC's experience with similar bridges and input from component fabricators. In addition to the bridge spans, the cable-stayed bridge system requires a structural slab on-grade on the north river bank to balance the horizontal stay forces.

The analysis of the cable-stayed bridge system also approximated foundation loads. These loads were used to determine approximate sizes and depths of foundation elements. The quantitative foundation investigation was limited to axial loads with conceptual considerations given to seismic loads. The result was 12-foot-diameter, 110-foot-long shafts to support the pylon legs with 6-foot-diameter, 90-foot-long shafts used to support the approach spans.

Cable-stayed bridges are most efficient when main span and back span ratios allow the structure's weight to approximately balance on the pylons. Analysis of the span arrangement required for this bridge indicates that the site is not optimal for a cable-stayed bridge. The span arrangement does not allow for efficient self-anchoring of the cable forces. This results in foundation elements on the river banks to resist uplift forces.

The large foundations on the river bank may resist the lateral forces induced by seismic slope instability and lateral spreading. The smaller foundations in the approaches, integral to the bridge system, are less likely to perform well. If some or all of the foundations are unable to resist these lateral forces, techniques to increase the soil's shear strength and/or stiffness will be required. These techniques are also referred to as ground improvements.

At this time, insufficient information is available to determine whether or not construction of ground improvements to mitigate this risk is appropriate. The risk has been qualitatively considered, and a planning-level cost estimate has been prepared for inclusion in project planning efforts.

Given the number of unknown considerations at this time, a range of project costs has been developed. The low- and high-range cost estimates are $39.1 million and $51.6 million, respectively. The portions of the cost attributable to the main span bridge system were generated based on quantities and unit prices. The portions of the cost attributable to the approaches were based on a square-foot cost estimate, including the quantifiable elements identified at this time.

The cost estimate includes the bridge, approach path and retaining walls, and some surrounding infrastructure improvements, which are explain further below. Ground improvement costs are only included for the high-range estimate.

The cost estimate includes $1 million for the low range and $2 million for high range cost estimate to cover infrastructure improvements that are required as part of the project. These improvements include additional parking on each side of the bridge, and limited park and on-street improvements to create safe and functional connections between the new bridge and path, and existing streets.

The cost estimate does not include other infrastructure that may be added to the project in future phases as the funding is secured, the design is developed in greater detail and stakeholders are further engaged. Examples of these improvements could include additional improvements to connecting parks and streets, interpretive areas, and lighting, aesthetic, or wayfinding features. These infrastructure items will be captured in the next phase of the project.

Preliminary and construction engineering costs are determined as a percentage of the construction items. The low-range cost estimate uses a construction contingency of 20 percent, while the high-range uses 40 percent, except no contingency is applied to the ground improvements.

Maintenance

This structure type requires very tall pylons, with the upper-most cable connections located approximately 155 feet above the bridge deck. Inspection and maintenance of these connections would require specialized equipment and techniques. Routine bi-annual bridge inspections would be performed. The design process would need to incorporate special accommodations to facilitate this inspection.

Cable-stayed bridges use a moderate number of primary cable members to carry structure loads. Several methods for constructing the stay cables exist. The cables will be designed to be low-maintenance, including double corrosion protection measures, such as galvanizing of all wires, and painted coating of the outside of the cables to prevent moisture intrusion. Additionally, each cable will be designed with basic redundancy in mind and could be individually replaced in the future if required. This redundancy and replaceability reduces the emphasis on continuous rigorous maintenance for the primary cable members and their connections to assure a long service life.

Since no piers will be in the river, no underwater diver inspections would be required. Other common maintenance items are expansion joints and girder bearings.

Under-bridge inspection trucks or other similar equipment would be required to inspect the superstructure under the deck. This equipment is typically rented on an as-needed basis for similar bridge inspections throughout Oregon. Working the inspection equipment around the cable stays could be awkward and time-consuming.

Constructability

Access Requirements

Temporary work areas and access points are required on both banks of the river. The construction contractor will require a work area either on-site or adjacent to this section of the river to construct the main span deck panels.

Installation of the pylons would require large cranes. Shoring towers would be required to temporarily support the pylons. The first deck segments constructed away from each pylon will require falsework. Construction is seen as likely beginning on the bank side of the pylons and then incrementally building out towards the middle of the river. The use of barges to deliver materials to the bridge construction site seems probable.

The approach spans on the south bank of the river will require falsework for construction. This falsework can be removed once the segments are self-supporting, which will occur incrementally as the main span over the river is completed.

Complexity

The cable-stayed bridge type is seen as relatively challenging to build and not typically accomplished by local contractors. However, this type of construction has been previously used in Oregon and performed by local contractors. The size of this bridge means that some components are larger than can be accommodated by locally available equipment. Deck panel, cable, pylon, and drilled shaft members, in particular, may present issues for local contractors.

Based on OBEC's experience with similar structures, the construction sequence of the cable-stayed portion of the substructure and superstructure is critical to an efficient, constructible design, and requires close coordination between the engineers and contractor. Some local contractors have staff experienced in this type of construction.

The approach spans are relatively straight-forward, common construction.

Impacts

The various impacts to the project site resources and built environment are summarized below as permanent or temporary. Impacts are discussed according the six areas identified on Figure 1.

Resource Impacts

No changes to impacts to resources were noted during the additional analysis. The following impacts are summarized from the December 2018 Report.

<u>Permanent Impacts</u>

No hydraulic impact is expected for this alternative; therefore, no mitigation will be required.

Boones Ferry Park – There will be a loss of upland vegetation and open space in the undeveloped portion of Boones Ferry Park west of Boones Ferry Road, including in the historic orchard further north. One of the main pylon piers will be located at the edge of the north bank.

North Bank – There will be a loss of riparian vegetation where the bridge crosses, both at the top of the bank and under the bridge.

Willamette River – No permanent impacts are anticipated.

South Bank – There will be a loss of riparian vegetation where the bridge crosses the top of the bank and under the bridge.

Ramp Access Road, Parking Lot, and Butteville Road – Some ground disturbance and riparian and upland vegetation removal will be required at the south pylon footing and approach span piers. The ramp access road may need to be relocated to provide room for the pylon.

South Approach Path – This on-grade segment will have upland vegetation removal and ground disturbance under its footprint.

<u>Temporary Impacts</u>

There will be a local increase in construction traffic, noise, emissions, and dust.

Boones Ferry Park – Additional upland vegetation loss and ground disturbance over that included in the permanent impacts above will be necessary to access the work.

North Bank – No temporary impacts are anticipated on the north bank.

Willamette River – The navigational channel and other portions of the river will need to be partially restricted at times during deck panel placement.

Ramp Access Road, Parking Lot, and Butteville Road – Additional riparian and upland vegetation loss and ground disturbance over that included in the permanent impacts above will be necessary to access the work.

South Approach Path – Additional upland vegetation loss and ground disturbance over that included in the permanent impacts above will be necessary to access the work.

Built Environment Impacts

No changes to impacts to the built environment were noted during the additional analysis. The following impacts are summarized from the December 2018 Report.

<u>Permanent Impacts</u>

Boones Ferry Park – There will be bridge approaches and backstay anchors in the park and a new path access to Boones Ferry Road. There would be minor to moderate revisions required to the Boones Ferry Park MP that is currently in development.

North Bank – There is no built environment present to be impacted.

Willamette River – There will be a new structure over the Boones Ferry Marina and dock.

Ramp Access Road, Parking Lot, and Butteville Road – There will be a new structure over the primary Boones Ferry Boat Launch parking lot, and Butteville Road. One tie-down column would be required in the parking lot for the configuration shown in Figure 5, resulting in the loss of one parking space for a truck with trailer. Alternatively, a larger tie-down south of Butteville Road and an asymmetrical stay arrangement could be used to eliminate piers in the parking lot.

South Approach Path – The approach path will partially be constructed on the existing fill for the railroad bridge approach.

<u>Temporary Impacts</u>

Boones Ferry Park – There will be construction traffic on Boones Ferry Road. Impacts could increase or decrease, depending on the timing for constructing park improvements identified in the MP.

North Bank – There is no built environment present to be impacted.

Willamette River – Placing the deck panels and other work over the boat dock will require temporary closures of portions of the dock.

Ramp Access Road, Parking Lot, and Butteville Road – There will be occasional closures of portions of the parking lot and the ramp access road to construct the piers and install the superstructure. There is a possibility that full closures of the parking lot and/or ramp road will be necessary for short periods of time. The ramp road would likely need to be temporarily realigned to construct the Pier 3 pylon and foundation. There will be short duration closures and construction traffic on Butteville Road.

Impact Summary

No changes to project impacts were noted during the additional analysis. The following impacts are summarized from the December 2018 Report.

The defining permanent impact of this alternative is the anticipated need to relocate a portion of the ramp access road to provide room for the south pylon between the ramp and the parking lot.

The primary temporary impacts are related to the use and operation of the parking lot and ramp access road.

Aesthetics

Renderings are provided in Appendix A to aid in visualization of the structure's appearance.

Suspension

Fort Edmonton Park Pedestrian Bridge, Edmonton, AB, Canada

Suspension bridges are cable-supported structures where the suspenders supporting the deck system are tied to the primary suspension cables spanning between pylons. The pylons for a suspension bridge are approximately one-half as tall as those for a cable-stayed bridge with a similar span. Suspension bridges support the longest spans in the world and can have very shallow superstructures.

DeFazio Bridge, Eugene, OR

OBEC performed a preliminary structure layout for this bridge type. As initially visualized, the proposed structure consists of two frames. The suspension frame consists primarily of precast deck panels with transitional cast-in-place segments and makes up the north 1,088 feet of the bridge. The two pylons extend approximately 80 feet above the deck. The south frame of cast-in-place concrete slab connects south of Butteville Road with two spans of 71.5 feet.

Preliminary analyses were performed for the suspension bridge alternative based on the known project information, including assumed geometry, design loads, and limited geotechnical information. These analyses included preliminary sizing of major bridge components and an evaluation of construction methods required to build the structure. The result is a project cost range and footprint accompanied by renderings of the structure to illustrate the proposed concept.

Economics

Design & Construction Cost and Duration

The cast-in-place concrete slab approach spans are straight-forward to design and construct. As a result, the majority of the additional investigations that were made focused on the suspension bridge system and spanning the Willamette River.

Analysis of the suspension system confirmed that the preliminary pylon height and dimensions are feasible. Analysis of the suspension bridge system confirmed that the preliminary pylon heights and dimensions and the precast deck panel arrangement were appropriate. The size of the main suspension cables, based on the design loads, will be a bundle of seven 3½-inch-diameter steel bridge strands each. Similarly, the hanger cables were sized as 1⅛-inch-diameter bridge strands. These strands are galvanized, plus additional costs were assumed for further corrosion protection. These cable sizes are readily available from multiple suppliers and can be anchored with common open sockets and pins. The dimensions of the precast deck panels were refined based on the design loads.

Temporary towers would likely be required to support the pylons during construction. The pylon foundations would be groups of large-diameter drilled shafts. At the ends of the suspension bridge cables, anchorages are required to resist the horizontal forces of the structure. These anchorages are likely to be constructed from drilled shafts with large concrete caps. Preliminary analysis indicates two 12-foot-diameter drilled shafts per main suspension cable anchorage to resist the expected horizontal and vertical forces. The drilled shafts for the towers, also 12-foot-diameter, and cable anchorages are estimated to be approximately 100 to 120 feet deep. The drilled shafts for the smaller approach span columns are anticipated to be 8-foot-diameter and 80 feet deep.

The large foundations on the river bank may resist the lateral forces induced by seismic slope instability and lateral spreading. The cable anchorages, integral to the bridge system, require stable foundations to support the main cable forces generated by the suspension bridge system. If some or all of the foundations and anchorages are unable to resist these lateral forces, techniques to increase the soil's shear strength and/or stiffness will be required. These techniques are also referred to as ground improvements.

At this time, insufficient information is available to determine whether or not construction of ground improvements to mitigate this risk is appropriate. The risk has been qualitatively considered and a planning-level cost estimate has been prepared for inclusion in project planning efforts.

Given the number of unknown considerations at this time, a range of project costs has been developed. The low- and high-range cost estimates are $37.1 million to $49.3 million, respectively. The portions of the cost attributable to the main span bridge system were generated based on quantities and unit prices. The portions of the cost attributable to the approaches were based on a square-foot cost estimate, including the quantifiable elements identified at this time.

The cost estimate includes the bridge, approach path and retaining walls, and some surrounding infrastructure improvements, which are explain further below. Ground improvement costs are only included for the high-range estimate.

The cost estimate includes $1 million for the low range and $2 million for high range cost estimate to cover infrastructure improvements that are required as part of the project. These improvements include additional parking on each side of the bridge, and limited park and on-street improvements to create safe and functional connections between the new bridge and path, and existing streets.

The cost estimate does not include other infrastructure that may be added to the project in future phases as the funding is secured, the design is developed in greater detail and stakeholders are further engaged. Examples of these improvements could include additional improvements to connecting parks and streets, interpretive areas, and lighting, aesthetic, or wayfinding features. These infrastructure items will be captured in the next phase of the project.

Preliminary and construction engineering costs are determined as a percentage of the construction items. The low-range cost estimate uses a construction contingency of 20 percent, while the high-range uses 40 percent, except no contingency is applied to the ground improvements.

Maintenance

This structure type requires relatively tall pylons with the main suspension cable saddles and upper hanger connections located approximately 100 feet above the bridge deck. Inspection and maintenance of these connections would require specialized equipment and techniques. Routine bi-annual bridge inspections would be performed. The design process would need to incorporate special accommodations to facilitate these inspections.

The cables and related connection systems are typically galvanized then painted or otherwise encapsulated to prevent moisture intrusion, thus providing corrosion protection. These protection systems require regular maintenance.

The hanger cables would be designed with basic redundancy that would allow replacement of individual ones in the future if required. The main suspender cables would not be replaceable in the same manner and would thus require vigilant inspection and maintenance to assure a long service life.

Since no piers will be in the river, no underwater diver inspections would be required. Other common maintenance items are expansion joints and girder bearings.

Under-bridge inspection trucks or other similar equipment would be required to inspect the superstructure under the deck. This equipment is typically rented on an as-needed basis for similar bridge inspections throughout Oregon. Working the inspection equipment around the hangers can be awkward and time-consuming.

Constructability

Access Requirements

The pylons on both banks would be located on the top of the river banks. The one on the north bank is in the currently undeveloped portion of the park and is directly accessible from Boones Ferry Road. The one on the south bank would be between the boat ramp access road and the parking lot. Temporary relocation and/or closure of the boat ramp access road would be required.

Construction is likely to begin on the bank side of the pylons then incrementally build out towards the middle of the river.

Installation of the pylons would require large cranes. Shoring towers would be required to temporarily support the pylons. The approach girder segments would require ground-supported falsework, and the vertical clearance over

Butteville Road may be temporarily reduced below 17 feet. This falsework can be removed once the segments are self-supporting. The deck panel and hanger placement over the boat dock is the most challenging location. A work containment system would be required to prevent debris from falling on the dock below. Deck panel placement for the main span will probably take place primarily from the middle of the river outward towards the pylons.

The remaining pier locations on the south banks are all easily accessed.

Complexity

The suspension bridge type is seen as relatively challenging to build and not typically accomplished by local contractors. This type of construction has previously been used in Oregon and performed by local contractors, but not recently. The size of this bridge means some components are larger than can be accommodated by locally available equipment. Deck panel, cable, pylon, and drilled shaft members, in particular, may present challenges for local contractors.

Based on OBEC's experience with similar structures, the construction sequence of the suspended portion of the substructure and superstructure is simpler than the cable-stayed bridge, but still requires specialty equipment. The approach spans are relatively straight-forward, common construction.

Impacts

The various impacts to the project site resources and built environment are summarized below as permanent or temporary. Impacts are discussed according the six areas identified on Figure 1.

Resource Impacts

No changes to impacts to resources were noted during the additional analysis. The following impacts are summarized from the December 2018 Report.

Permanent Impacts

No hydraulic impact is expected for this alternative; therefore, no mitigation will be required.

Boones Ferry Park – There will be a loss of upland vegetation and open space in the undeveloped portion of Boones Ferry Park west of Boones Ferry Road and in the historic orchard further north. One of the main pylon piers will be located at the edge of the north bank.

North Bank – There will be a loss of riparian vegetation where the bridge crosses, both at the top of the bank and under the bridge.

Willamette River – No permanent impacts are anticipated.

South Bank – There will be a loss of riparian vegetation where the bridge crosses the top of the bank and under the bridge.

Ramp Access Road, Parking Lot, and Butteville Road – Some ground disturbance and riparian and upland vegetation removal will be required at the south pylon footing and approach span piers. The ramp access road may need to be relocated to provide room for the pylon.

South Approach Path – This on-grade segment will have upland vegetation removal and ground disturbance under its footprint.

<u>Temporary Impacts</u>

There will be a local increase in construction traffic, noise, emissions, and dust.

Boones Ferry Park – Additional upland vegetation loss and ground disturbance over that included in the permanent impacts above will be necessary to access the work.

North Bank – No temporary impacts are anticipated on the north bank.

Willamette River – The navigational channel and other portions of the river will need to be partially restricted at times during deck panel placement.

Ramp Access Road, Parking Lot, and Butteville Road – Additional riparian and upland vegetation loss and ground disturbance over that included in the permanent impacts above will be necessary to access the work.

South Approach Path – Additional upland vegetation loss and ground disturbance over that included in the permanent impacts above will be necessary to access the work.

Built Environment Impacts

No changes to impacts to the built environment were noted during the additional analysis. The following impacts are summarized from the December 2018 Report.

<u>Permanent Impacts</u>

Boones Ferry Park – There will be bridge approaches and main suspension cable anchors in the park and a new path access to Boones Ferry Road. There would be minor to moderate revisions required to the Boones Ferry Park MP that is currently in development.

North Bank – There is no built environment present to be impacted.

Willamette River – There will be a new structure over the Boones Ferry Marina and dock.

Ramp Access Road, Parking Lot, and Butteville Road – There will be a new structure over the primary Boones Ferry Boat Launch parking lot, and Butteville Road.

South Approach Path – The approach path will partially be constructed on the existing fill for the railroad bridge approach.

<u>Temporary Impacts</u>

Boones Ferry Park – There will be construction traffic on Boones Ferry Road. Impacts could increase or decrease, depending on the timing for constructing park improvements identified in the MP.

North Bank – There is no built environment present to be impacted.

Willamette River – Placing the deck panels and other work over the boat dock will require temporary closures of portions of the dock. Deck panel installation may also require use of barges.

Ramp Access Road, Parking Lot, and Butteville Road – There will be occasional closures of portions of the parking lot and the ramp access road to construct the piers and install the superstructure. There is a possibility that full closures of the parking lot and/or ramp road will be necessary for short periods of time. The ramp road would likely need to be temporarily realigned to construct the Pier 3 pylon and foundation. There will be short duration closures and construction traffic on Butteville Road.

Impact Summary

No changes to project impacts were noted during the additional analysis. The following impacts are summarized from the December 2018 Report.

The defining permanent impact of this alternative is the anticipated need to relocate a portion of the ramp access road to provide room for the south pylon between the ramp and the parking lot.

The primary temporary impacts are related to the use and operation of the parking lot and ramp access road.

Aesthetics

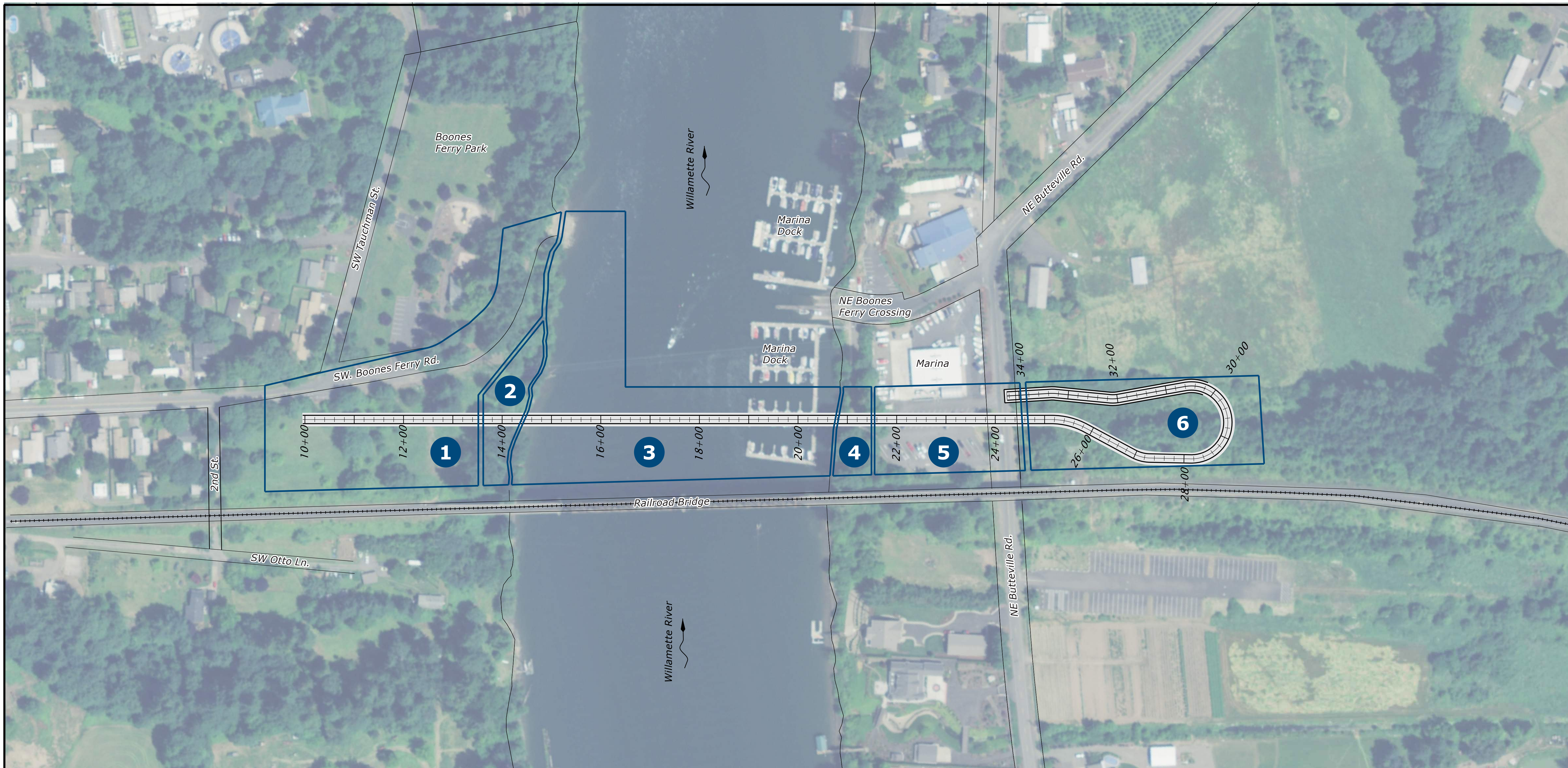
Renderings are provided in Appendix A to aid in visualization of the structure’s appearance.

Summary

In this report, OBEC has refined the cable-stayed and suspension bridge alternatives by updating preliminary layouts; creating photo-realistic renderings; completing additional evaluation against the four criteria (economics, constructability, impacts, and aesthetics); and developing project cost estimate ranges.

The next steps include City and ODOT review, conducting a Task Force Meeting, obtaining approval from the BCC and City Council, and if facilitated by the environmental process and project funding, prepare a 30-percent design, including additional engineering and environmental investigations.

FIGURES



Project Areas of Assessing Impacts

1. **Boones Ferry Park**
2. **North Bank**
3. **Willamette River**
4. **South Bank**
5. **Ramp Access Rd., Parking Lot, Butteville Rd.**
6. **South Approach Area**

FRENCH PRAIRIE BRIDGE PROJECT IN WILSONVILLE

WILSONVILLE OREGON

SCALE WARNING
If scale bar doesn't measure one inch then drawing is not to scale

STRUCTURE NO. --------
BDS DWG NO. 0000x
CALC. BOOK ----
HWY:
M.P.:
COUNTY Clackamas
DATE Sept. 2018

CONCEPT PLANS NOT FOR CONSTRUCTION

OBEC
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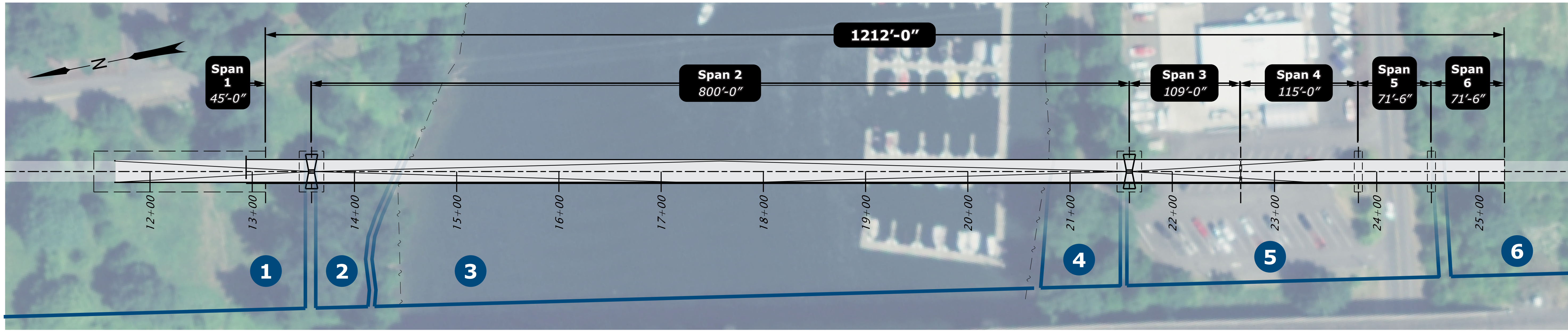
OREGON DEPARTMENT OF TRANSPORTATION

FRENCH PRAIRIE BRIDGE PROJECT
BOONES FERRY ROAD
MARION AND CLACKAMAS COUNTY

Designer: Eric E. Bonn, P.E. — Reviewer: Bob Goodrich, P.E.
Drafter: OBEC CAD — Checker: Andy Howe, P.E.

ALIGNMENT — SHEET NO. Fig. 1



PLAN
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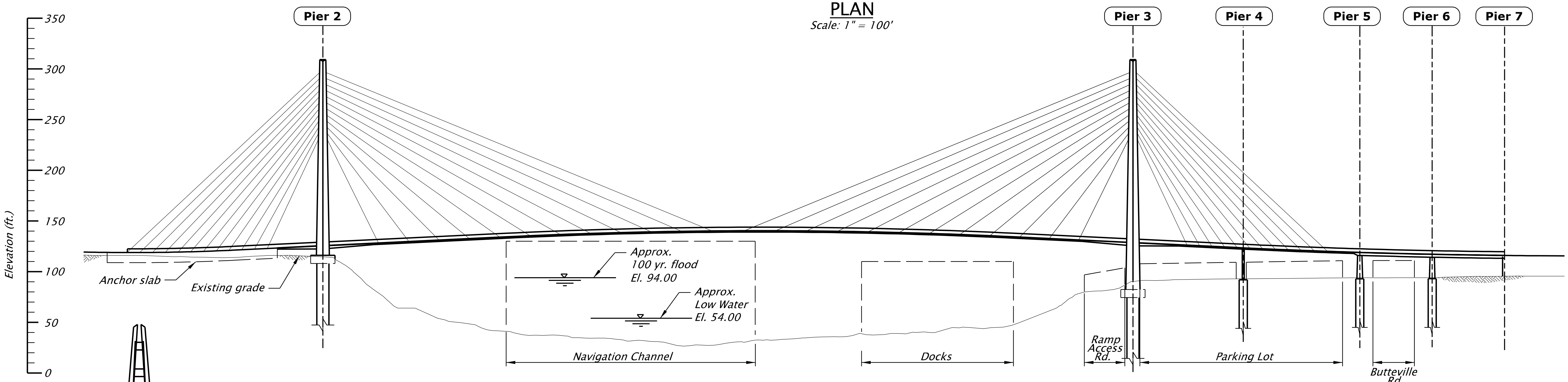

ELEVATION
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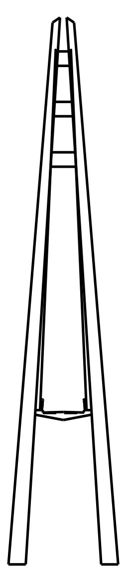

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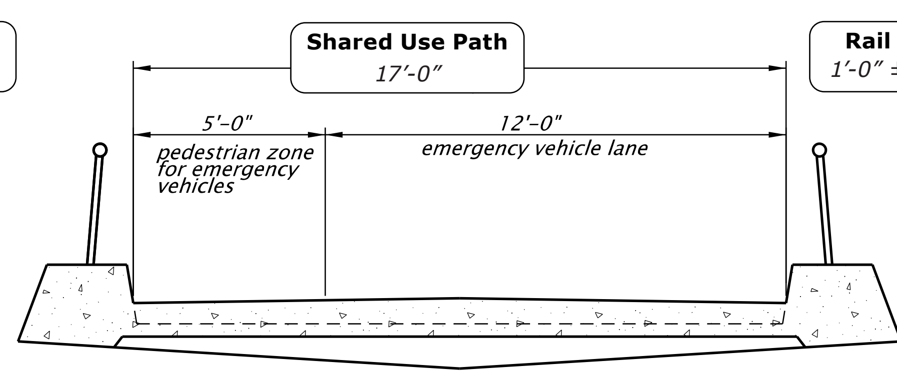

DECK SECTION
Scale: 1" = 5'

FRENCH PRAIRIE BRIDGE PROJECT IN WILSONVILLE

WILSONVILLE OREGON

SCALE WARNING
If scale bar doesn't measure one inch then drawing is not to scale

CONCEPT PLANS NOT FOR CONSTRUCTION

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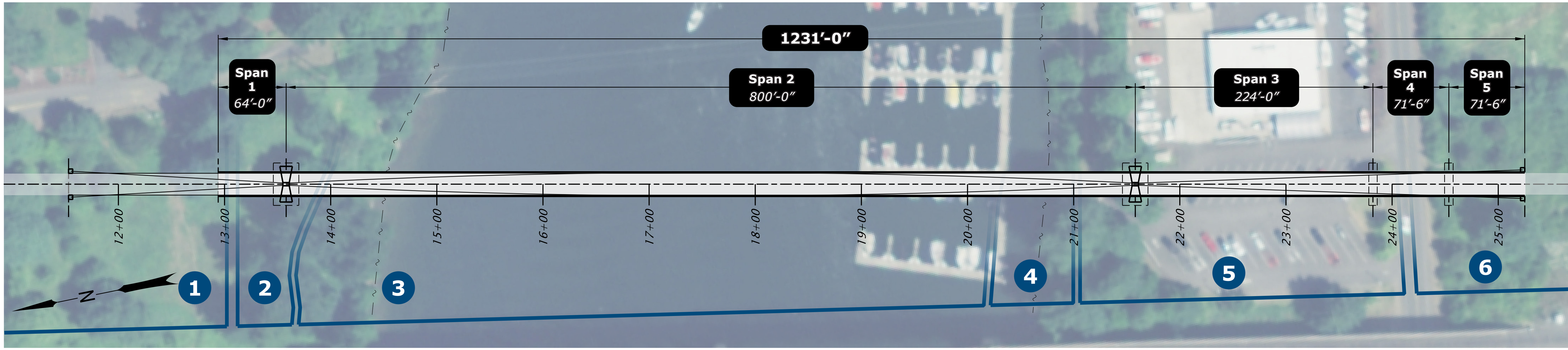
CABLE STAYED

SHEET NO. Fig. 2



PLAN
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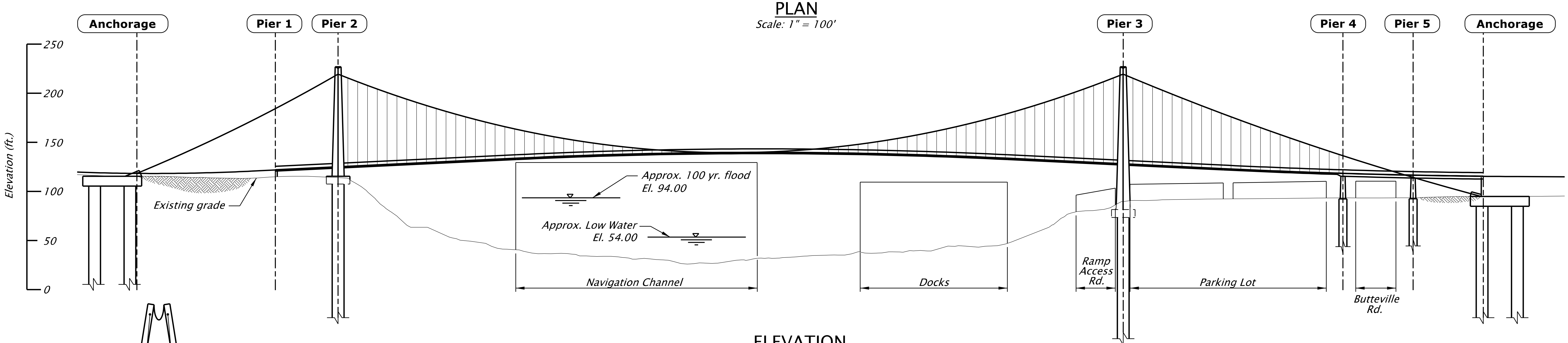

ELEVATION
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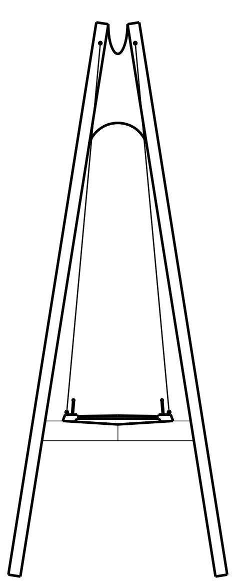

TYPICAL SECTION
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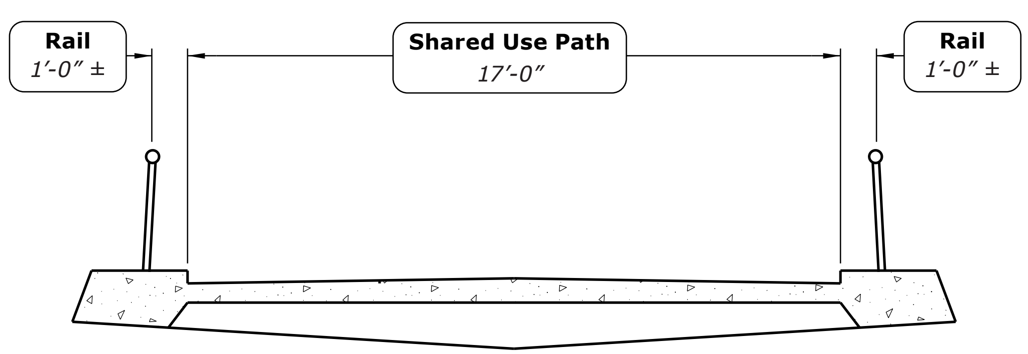

DECK SECTION
Scale: 1" = 5'

FRENCH PRAIRIE BRIDGE PROJECT IN WILSONVILLE

WILSONVILLE OREGON

SCALE WARNING
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SUSPENSION — SHEET NO. Fig. 3

APPENDIX A

Cable-Stayed Bridge Renderings


ABE
HUMEN ZENKO


HUMEN ZENKO

Suspension Bridge Renderings


ABE
HUMEN ZENKO


HUMEN
ZENKO