DRAFT

Bridge Type Evaluation Report

FRENCH PRAIRIE BRIDGE PROJECT

October 2018

Prepared for the City of Wilsonville

WILSONVILLE OREGON

Prepared By

OBEC Consulting Engineers
5000 Meadows Road, Suite 420
Lake Oswego, OR 97035
503.620.6103

TABLE OF CONTENTS

List of Figures

APPENDICES

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.

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 County Board of 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.

This report focuses on evaluation of bridge types. The discussion below presents the 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 concludes with an assessment summary of the alternatives. Input from the October 2018 TAC meeting has been incorporated. The next steps include requesting public input, meeting with the citizen task force and finally, the BCC and the Wilsonville City Council selecting two bridge types for further evaluation.

The assessment summary for the five alternatives is included in Appendix A.

Design Criteria and Constraints

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 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 involves identifying bridge structure types that are potentially suitable for the French Prairie Bridge, given the site constraints. The second phase includes a preliminary evaluation of each type of structure. The bridge types are then compared and the two most suitable bridge types are selected for further investigation. Finally, a more rigorous investigation of the two remaining structure types will be performed in phase three. The available data will then be analyzed to determine the most suitable structure type for the French Prairie Bridge.

All potentially suitable alternatives meet the minimum functionality criteria discussed above, and were investigated considering the opportunities and constraints previously identified. The project team compared the bridge types with respect to project economics, constructability, impacts, and bridge aesthetics. A discussion of each criterion is included below. To conclude this phase of the evaluation process, the project team prepared an Assessment Summary, which is located in Appendix A.

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

Five bridge types have been identified as most suitable for this project site: steel girder, steel truss, tied-arch, cable-stayed, and suspension. The following five sections evaluate these bridge types against the criteria presented above.

Steel Girder

Steel girders consist of either I-beams or a box. Individual segments can be spliced together through bolted connections.

Springwater Trail Bridges: Johnson Creek Crossing, Portland, OR

The proposed steel girder alternative consists of I-girders cut from steel plate and welded together. The steel could be uncoated weathering steel or painted. A concrete deck would be placed on the girders. The heights of the girders can be increased at the supports, at an additional cost, to improve structural efficiency and provide architectural interest. To maintain visual consistency, the approach spans would also use welded steel plate girders.

An approximate structure layout was performed. As initially visualized, the structure consists of two frames. The north frame crosses the river and extends to the middle of the parking lot with spans of 185'-275'-275'-185'. The south frame continues from the north frame, ending south of Butteville Road with two 110-foot spans. See Figure 2 for elevation and section views.

This alternative is being evaluated as it is capable of economically achieving the necessary span lengths with appropriate structure depths and temporary impacts, given the project constraints. This structure type is commonly constructed by local bridge fabricators and contractors, and is similar to the I-5 bridges downstream.

Steel box girders could be considered, but are significantly more expensive than the I-beams. These structures are best suited for highly curved horizontal alignments, which are not required for this project. In addition to the higher construction cost, box girders are more difficult to inspect due to the enclosed space.

Economics

Design & Construction Cost and Duration

Of all the alternatives analyzed, the welded steel plate girder is the most straight-forward to design and construct. The substructures would likely be single columns on large-diameter drilled shafts. No unique analysis or design tasks are required. The design duration would be approximately one year.

Based upon input from the TAC, permitting the in-water piers will potentially require some individual approvals from regulatory agencies that add time and cost to the design phase. There could also be off-site mitigation required that would add time to locate the mitigation area and complete the design, as well as add cost to design and construct the mitigation.

The construction cost of this structure is the least of all the alternatives considered. The construction duration would be approximately two years. Due to the extensive in-water construction, there is an increased risk of delays because of the annual in-water work window that prescribe the period when the contractor is allowed to work within the river.

Maintenance

Maintenance of a steel girder pedestrian bridge is similar to maintenance of steel girder highway bridges, which are common in the area. The highest maintenance cost typically associated with steel bridges is related to the coating (paint) systems. The use of weathering steel will minimize or eliminate this consideration. Other common maintenance items are expansion joints and girder bearings.

The routine condition inspection of a steel girder bridge is similar to the regularly scheduled bridge inspections for highway bridges, except at a longer interval between inspections. There are a number of connections between various steel members, such as the splices and cross frames, that will need to be inspected regularly. Inspection access walkways and ladders can be included as part of the design to aid in this work. Under-bridge inspection trucks (UBITs, "snooper cranes") or other similar equipment would occasionally be required to closely inspect the exterior faces of the girders. Designing the superstructure as a three-girder system, as shown in Figure 2, eliminates the higher level of inspection required for fracture-critical structures.

The steel plate girder bridge would require three in-water piers, which increases the risk of debris accumulating on the bridge. It also requires underwater inspections by divers at a minimum of every five years.

Constructability

Access Requirements

There would be piers located in the river on either side of the navigation channel. The drilled shafts for these piers would need to be constructed from a work bridge or barge. With the locks at Willamette Falls currently closed, the practicality of getting a barge of adequate size to the project site needs to be investigated, but it appears that modular systems could be employed.

Access from the north shore to the pier north of the navigation channel would be via a work bridge extending from the ferry access road, approximately 400 feet downstream. Access to a work bridge for the piers in the river between the navigation channel and the south shore would be challenging to locate without impacting the use of a portion of the Boones Ferry Marina dock. This work bridge would start from the boat ramp access road, located west of the dock and east of the railroad bridge. The remaining pier locations on the south bank are all easily accessed.

Installation of the girders would require a combination of barges (if used) and cranes. Shoring towers may be required to temporarily support girder segments. Girder placement over the boat dock is the most challenging location. There are numerous ways the girders could be placed in this location with varying impacts to the dock, ramp access road, and parking lot. For this analysis, it was assumed that temporary shoring towers could be placed within the limits of the boat dock, resulting in the lowest construction cost. A work containment system and short closure windows would be required to prevent debris from falling on the dock below during a variety of work tasks.

Complexity

This bridge type is seen as relatively simple to build when there is good access. It is more complicated if barges, girder launching, and/or hanging splices are required. The girders, while large, are within the capabilities of steel fabricators located in the Portland area. Due to the slenderness of the girders, stability of the individual girder segments would likely require additional temporary shoring towers in the river. Construction of the piers in the deep portion of the river is a work item not typically accomplished by local contractors. This work also represents an increased risk to the project, because of the extensive in-water work, as previously explained.

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

<u>Permanent Impacts</u>

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.

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. The three piers within the floodway will require mitigation to avoid raising the flood elevation. Excavating along the north bank is the most likely mitigation. Since this river bank is steep and the required area of excavation to balance the area of the new bridge columns is large, the entire hillside may need to be cut back to the top of the slope.

Willamette River – There will be three piers in the river. It also may be necessary to install additional structures, such as dolphins, to protect the piers from vessel collisions.

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 will be required at the south approach span piers.

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

Temporary Impacts

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

Willamette River – To access the pier work and place girders, the navigational channel and other portions of the river will need to be partially restricted at times. Some of the additional towers required to safely place the girder segments over the river will have to be located within the limits of the boat dock. Temporary piles and cofferdams will need to be installed and removed.

Ramp Access Road, Parking Lot, and Butteville Road – Additional 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

Permanent Impacts

Boones Ferry Park – There will be bridge approaches in the park and a new path accessing Boones Ferry Road. There would be minor revisions required to the Boones Ferry Park Master Plan (MP) that is currently in development.

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

Willamette River – Remnants of the north bank ferry slip may be impacted due to construction access and placement of the work bridge (if used). There will be a new structure over the Boones Ferry Marina and dock. Pier 3 is located approximately 100 feet from the boat docks, which may impact maneuverability and access to them.

Ramp Access Road, Parking Lot, and Butteville Road – There will be a new structure over the ramp access road, the primary Boones Ferry Boat Launch parking lot, and Butteville Road. One pier column will be required in the parking lot, resulting in the loss of one parking space for a truck with trailer.

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

Temporary Impacts

Boones Ferry Park – Construction activities will increase traffic on Boones Ferry Road and increase noise levels in the park. Impacts could increase or decrease, depending on the timing for constructing park improvements identified in the MP.

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

Willamette River – Placing girders and other work over the boat dock will require temporary closures of portions of the dock. There may be a need to place temporary shoring towers within the limits 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 will be necessary for short periods of time. There will be short duration closures and construction traffic on Butteville Road.

Impact Summary

The defining permanent impact of this alternative is the anticipated need to excavate a portion of the north bank to ensure no rise in the water level upstream of the bridge during the 100-year flood.

The primary temporary impacts are related to the use and operation of the river, parking lot, ramp access road, and boat docks due to the necessary shoring towers and girder placement.

Aesthetics

For path users, this alternative would feel very open with no bridge elements extending above the bridge rail. Views upstream and downstream would be unobstructed.

For people viewing the bridge from locations other than the path, this alternative will have a relatively heavy deck appearance, but be visually simple. This alternative does not have trusses, arch ribs, cables, or towers that would increase the visual impact of the structure. The bridge would not stand out against its surroundings, given its relatively simple lines and girder color options, such as weathering steel, that could match the adjacent railroad trusses.

Steel Truss

Steel trusses are formed by arranging steel members to extend the span lengths beyond the range of steel girders. For spans longer than 150 feet, box-shaped trusses are required for stability. The box-shaped trusses can be either below the deck (deck trusses) or the deck can go through the box (through trusses). Deck trusses were not considered for this location due to the required superstructure depth above the navigational channel.

Portland and Western Railroad Bridge, Wilsonville, OR

The proposed steel truss alternative consists of steel through-truss main spans. The through-trusses would be similar to the railroad bridge immediately upstream of the project. The steel could be uncoated weathering steel or painted. The approach spans at both ends would be steel plate girders, as described above for the steel girder alternative, to maintain visual consistency with the railroad bridge. A concrete deck would be placed the full length of the bridge. See Figure 3 for elevation and section views.

A preliminary structure layout was performed. As initially visualized, the structure consists of four frames. The north approach frame is a single 181-foot span of steel plate girders extending from the river bank to the first pier in the river. The steel trusses make up the middle two frames with spans of 315 feet each. The south frame of steel plate girders continues from the trusses, ending south of Butteville Road with spans of 107'-123'-107'.

This alternative is being evaluated as it is capable of achieving the necessary span lengths; can be designed with a shallower deck system compared to the steel plate girder bridge; reduces the height of the path over the navigation channel; uses construction methodologies familiar to local bridge fabricators and contractors; and is similar to the railroad bridge upstream.

Economics

Design & Construction Cost and Duration

The welded steel plate girder approach spans are straight-forward to design and construct. While trusses are familiar to some in the bridge design community, the main truss spans are slightly more complicated to design compared to the steel plate girder option. Construction of the truss spans is slightly more complicated, as well, due to the increased number of member connections. The substructures would likely be single columns on large-diameter drilled shafts. No unique analysis or design tasks are required. The design duration would be approximately one year.

Permitting costs and durations, and potential mitigation are similar to those discussed for the steel girder bridge.

The construction cost of this structure is estimated to be the second least expensive; it is about 10 to 30% more than the steel girder bridge. The construction duration would be approximately two years. Risk of delay due to in-water work is similar to that discussed for the steel girder bridge.

Maintenance

Maintenance of a steel truss pedestrian bridge is similar to maintenance of steel girder highway bridges, which are common in the area. The highest maintenance cost typically associated with steel bridges is related to the coating (paint) systems. The use of weathering steel would minimize or eliminate this consideration. Other common maintenance items are expansion joints and girder bearings.

The routine condition inspection of steel truss approach spans is similar to the regularly scheduled bridge inspections for highway bridges, except at a longer interval between inspections. Truss bridges are typically considered fracture-critical, which require more stringent and time-consuming inspections. There are a number of connections between various steel members, such as the splices and cross frames, that will need to be inspected regularly. Under-bridge inspection trucks or other similar equipment would be required to inspect the superstructure under the deck. Manlifts would be required to access the tops of the trusses and related connections.

The steel truss bridge would require three in-water piers, which increases the risk of debris accumulating on the bridge. It also requires underwater inspections by divers at a minimum of every five years.

Constructability

Access Requirements

There would be piers located in the river on either side of the navigation channel. The drilled shafts for these piers would need to be constructed from a work bridge or barge. With the locks at Willamette Falls currently closed, the practicality of getting a barge of adequate size to the project site needs to be investigated, but it appears that modular systems could be employed.

Access from the north shore to the pier north of the navigation channel would be via a work bridge extending from the ferry access road, approximately 400 feet downstream. Access to a work bridge for the piers in the river between the navigation channel and the south shore would be challenging to locate without impacting the use of a portion of the Boones Ferry Marina dock. This work bridge would start from the boat ramp access road, located west of the dock and east of the railroad bridge. The remaining pier locations on the south bank are all easily accessed.

Installation of the trusses and girders would take some combination of work bridges, barges, and cranes. Shoring towers would be required to temporarily support truss segments if not fully assembled on the ground and lifted or launched into place. The approach girder segments may also require shoring towers. Truss placement over the boat dock is the most challenging location.

There are numerous ways the girders could be placed in this location with varying impacts to the dock, ramp access road, and parking lot. For this analysis, it was assumed that temporary shoring towers could be placed within the limits of the boat dock, resulting in the lowest construction cost. A work containment system and short closure windows would be required to prevent debris from falling on the dock below during a variety of work tasks.

Complexity

This bridge type is seen as relatively straight-forward to build. The trusses and girders are within the capabilities of steel fabricators located in the Portland area. Construction of the piers in the deep portion of the river and installation of the superstructure are the only items not typically accomplished by local contractors. This work also represents an increased risk to the project, because of the extensive in-water work, as previously explained.

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

<u>Permanent Impacts</u>

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

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. The three piers within the floodway will require mitigation to avoid raising the flood elevation. Excavating along the north bank is the most likely mitigation. Since this river bank is steep and the required area of excavation to balance the area of the new bridge columns is large, the entire hillside may need to be cut back to the top of the slope.

Willamette River – There will be three piers in the river. It also may be necessary to install additional structures, such as dolphins, to protect the piers from vessel collisions.

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 will be required at the south approach span piers.

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

Willamette River – To access the pier work and place girders, the navigational channel and other portions of the river will need to be partially restricted at times. Temporary piles and cofferdams will need to be installed and removed.

Ramp Access Road, Parking Lot, and Butteville Road – Additional 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

<u>Permanent Impacts</u>

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

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

Willamette River – Remnants of the ferry slip may be impacted due to the placement of the work bridge (if used). There will be a new structure over the Boones Ferry Marina and dock. Pier 3 is located approximately 100 feet from the boat docks, which may impact maneuverability and access to them.

Ramp Access Road, Parking Lot, and Butteville Road – There will be a new structure over the ramp access road, the primary Boones Ferry Boat Launch parking lot, and Butteville Road. One pier column would be required in the parking lot, resulting in the loss of one parking space for a truck with trailer.

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 – Construction activities will increase traffic on Boones Ferry Road and increase noise levels in the park. Impacts could increase or decrease, depending on the timing for constructing park improvements identified in the MP.

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

Willamette River – Placing trusses and other work over the boat dock will require temporary closures of portions of the dock. There may be a need to place temporary shoring towers within the limits 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 will be necessary for short periods of time. There will be short duration closures and construction traffic on Butteville Rd.

Impact Summary

The defining permanent impact of this alternative is the anticipated need to excavate a portion of the north bank to ensure no rise in the water level upstream of the bridge during the 100-year flood.

The primary temporary impacts are related to the use and operation of the river, parking lot, ramp access road, and boat docks due to the necessary shoring towers and truss and girder placement.

Aesthetics

For path users, this alternative would feel the most enclosed of all options. The through trusses have significant members extending alongside the deck and overhead. Views of the river would be somewhat obstructed by the structure. The use of weathering steel for the above deck truss members may result in patches of rust colored staining on the bridge deck. Alternatively, these members could be painted to minimize staining, but that would increase the maintenance needs.

For people viewing the bridge from locations other than the path, this alternative would blend in with the railroad trusses, as they are approximately the same configuration, height, and possibly color, if weathering steel or matching paint is used.

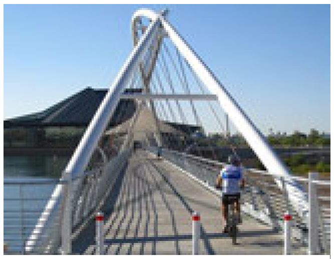
Tied-Arch

Peter Courtney Minto Island Pedestrian Bridge, Salem, OR

Arches can span significant distances by transferring the vertical deck loads into axial compression in the arch ribs. The form and construction of these structures can be extremely varied. For example, they can be formed out of concrete or steel; apply the thrust in the ribs into the foundations or be tied together on itself like a bowstring; and the ribs can be fully below the deck, fully above the deck, or some combination thereof.

Three Countries Pedestrian Bridge, Germany, Switzerland, France

The proposed tied-arch alternative consists of a single semi-through-tied-arch main span over the river. The term "semi-through" indicates that portions of the arch ribs are located both above and below the deck. Vertical hold-downs would be required at each end of the arch to help resist the lateral loads at the bases of the arch. Portions of the bridge deck below the arch rib would be supported on suspender cables. The remainder of the bridge would be ground-supported. The portion of the arch ribs above the deck could be either concrete or steel. The approach spans at both ends would be concrete slabs to maintain visual consistency. A concrete deck would be placed the full length of the bridge. The suspended portion would use precast panels. See Figure 4 for elevation and section views.



Tempe Town Lake Bridge, Tempe, AZ

A preliminary structure layout was performed. As initially visualized, the proposed structure consists of three frames. The north approach frame is a single 50-foot span of cast-in-place post-tensioned concrete extending from the river bank to the end of the arch system. The arch system has a continuous deck consisting of 552 feet of suspended precast concrete below the arch, sandwiched by twin adjoining cast-in-place post-tensioned concrete spans of 122.5 feet. The precast concrete deck panels are suspended from the arch. The arch itself has a span from support to support of 663 feet with a crown height 80 feet above the deck. The south frame of post-tensioned concrete continues from the end of the arch frame, connecting south of Butteville Road with spans of 108'-125'-108'.

This alternative is being evaluated as it is capable of achieving the necessary span lengths; can be designed with a very shallow deck system over the river, further reducing the height of the path over the navigation channel;

could limit in-water work to the arch foundations on each bank; and is a distinctive signature-type structure.

A river crossing consisting of two tied-arch spans was considered, but not carried forward as it has the same level of complexity as the single-span, includes a pier in the river between the navigational channel and the boat dock, and doesn't fit the site as well as a single-span. A deck arch was also investigated and dismissed due to the required raising of grade to clear the navigational channel and boat dock, the inefficient low rise-to-span ratio, and lack of competent foundation soils to resist the lateral thrust.

Economics

Design & Construction Cost and Duration

The cast-in-place concrete approach spans are straight-forward to design and construct. The main arch span is more complicated due to the height of the structure above the river and its inherent instability prior to being fully connected together. Temporary towers, either in the river and/or on the river banks, would likely be required to support the arch ribs during construction. The arch rib foundations would be large-diameter drilled shafts or driven pile groups. The approach span substructures will most likely be single columns on large-diameter drilled shafts. The vertical hold-downs at the ends of the arch frame would require either rock anchors or large-diameter drilled shafts to resist the expected uplift. The arch span and hold-downs require a level of unique analysis and design to account for construction staging and final structure balancing. The design duration would be approximately two years.

Permitting costs and durations, and potential mitigation are similar to those discussed for the steel girder bridge.

The construction cost of this structure is estimated to be the highest; it is about 90 to 100% more than the steel girder option. The construction duration would be approximately three years. Risk of delay due to in-water work is similar to that discussed for the steel girder bridge.

Maintenance

Maintenance of a tied-arch pedestrian bridge is moderate. The use of weathering steel or concrete for the arch rib to avoid painting, if selected, will minimize maintenance needs. The hanger systems for the suspended portion of the deck require additional inspection effort. Since no piers will be in the river during low-water periods, 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. Manlifts would be required to access the tops of the arch ribs and hangers.

Constructability

Access Requirements

The two main arch span piers would be located on either bank of the river. The one on the north bank is at the bottom of the steep hill and not directly accessible from the park above. A temporary work bridge from the end of the ferry slip access road would be required to access this pier. The pier on the south bank would be located between the boat dock and the boat ramp access road, and a short work bridge off the parking lot would be required to access this location. Small cofferdams would probably be required to dewater the base of the arch piers to allow forming and placement of the concrete. Temporary shoring of the boat ramp access road would be required.

Installation of the arch ribs would require some combination of work bridges, barges, and cranes. Shoring towers, either in the river or on the banks with cable supports to the arch, would be required to temporarily support the arch segments. If the arch ribs are steel or precast concrete, access is required to lift the individual pieces into place. The arch rib placement over the boat dock is the most challenging location. A work containment system and/or short closure windows would be required to prevent debris from falling on the dock below during a variety of work tasks. The approach girder segments would require ground-supported falsework, and the vertical clearance over Butteville Road may be temporarily reduced below 17 feet.

The remaining pier and vertical tie-down locations on the north and south banks are all easily accessed.

Complexity

The tied-arch bridge type is seen as very challenging to build in this location and not typically accomplished by local contractors. Based on OBEC's experience with similar structures, the construction sequence of the arch span substructure and superstructure is critical to an efficient, constructible design.

Arch span piers are located on the river bank. This work also represents an increased risk to the project, because of the extensive in-water work, as previously explained. The post-tensioned 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

<u>Permanent Impacts</u>

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.

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. The two piers within the floodway will require mitigation to avoid raising the flood elevation. Excavating along the north bank is the most likely mitigation. Since this river bank is steep and the required area of excavation to balance the area of the new bridge columns is large, the entire hillside may need to be cut back to the top of the slope.

Willamette River – Piers will be located at the edge of the ordinary high water line, resulting in a loss of riparian vegetation.

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 will be required at the south approach span piers.

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

Willamette River – Construction of the arch ribs will require work bridges and/or barges for access. Installation and removal of the temporary shoring towers (piles if required) will impact the river, as well. The navigational channel and other portions of the river will need to be partially restricted at times due to the shoring towers and during deck panel placement.

Ramp Access Road, Parking Lot, and Butteville Road – Additional 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

<u>Permanent Impacts</u>

Boones Ferry Park – There will be bridge approaches in the park and a new path access to Boones Ferry Road. There would be minor 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 – Remnants of the ferry slip may be impacted due to the placement of the work bridge (if used). 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 ramp access road, the primary Boones Ferry Boat Launch parking lot, and Butteville Road. One pier column would be required in the parking lot, resulting in the loss of one parking space for a truck with trailer.

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 Master Plan.

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

Willamette River – Placing the arch ribs, deck panels, and other work over the boat dock will require temporary closures of portions of the dock. There may be a need to place temporary shoring towers within the limits 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 will be necessary for short periods of time. There will be short duration closures and construction traffic on Butteville Road.

Impact Summary

The defining permanent impact of this alternative is the anticipated need to excavate a portion of the north bank to ensure no rise in the water level upstream of the bridge during the 100-year flood.

The primary temporary impacts are related to the use and operation of the river, parking lot, ramp access road, and boat docks due to the necessary shoring towers and arch rib placement.

Aesthetics

For path users, this alternative would feel somewhat enclosed through the arch with the large arch ribs, cross members, and hangers extending above the deck and overhead. The width of each arch rib is estimated to be 2.5 feet. Compared to the approximate 20-foot width of the superstructure, this could look out of proportion. Weathering steel, if used above the bridge deck, could stain portions of the deck an iron oxide red.

The form of the tied-arch alternative makes this a signature-type bridge. For people viewing the bridge from locations other than the path, this alternative makes a significant visual statement. This alternative would have significant visual mass and uniqueness of form compared to the adjacent bridges.

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

The proposed cable-stayed alternative consists of a cable-stayed main span over the river supported from two pylons. The form of the pylons is somewhat flexible, depending on the aesthetic appearance desired. The stays supporting the main span are balanced with back-stays at each approach. The north backstays would be tied to an anchor block or ground anchors. The south backstays would support an approach span and be supplemented with vertical hold-downs supported by a drilled shaft or ground anchor. The suspended portion of the bridge deck would be connected to cables. The remainder of the bridge would be ground-supported. The approach spans at both ends would be concrete slabs to maintain visual consistency. A concrete deck would be placed the full length of the bridge. The suspended portion would use precast panels. See Figure 5 for elevation and section views.

I-5: Gateway Pedestrian Bridge, Eugene, OR

A preliminary structure layout was performed. 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.

This alternative is being evaluated as it is capable of achieving the necessary span lengths; can be designed with a very shallow deck system over the river, further reducing the height of the path over the navigation channel; would eliminate in-water work with the pylon foundations on the top of each bank; and is a distinctive signature-type structure.

Cable-stayed structures with either one or three pylons were considered, but not carried forward as they would have the same level of complexity as the two pylon option, include at least one pier in the river between the navigational channel and the boat dock, and wouldn't fit the site as well as the two pylon structure. They would also require floodway mitigation, which is not necessary for the two pylon layout.

Economics

Design & Construction Cost and Duration

The cast-in-place concrete slab approach spans are straight-forward to design and construct. The main cable-stayed structure is more complicated due to the stay cable assembly and tensioning, and construction sequencing. Temporary towers would likely be required to support the pylons during construction. The pylon foundations would be groups of large-diameter drilled shafts. Since the cable-stayed bridge is anticipated to not have temporary or permanent in-water impacts as noted below, the permitting effort will be minimized. The approach span substructures will most likely be single columns on large-diameter drilled shafts. The cable-stayed portion of the structure requires unique analysis and design to account for construction staging and final structure balancing. The design duration would be approximately two years.

Based upon input from the TAC, the project will potentially qualify for some programmatic permits, largely since there are no in-water piers. The potential for off-site mitigation is also reduced.

The construction cost of this structure is estimated to be second highest; it is about 70 to 90% more than the steel girder bridge. The construction duration would be approximately three years. Due to the limited in-water construction, there is a lower risk of delays compared with some other bridge types.

Maintenance

Maintenance of a cable-stayed pedestrian bridge is moderate. The cables and related connection systems are typically painted or otherwise encapsulated to provide corrosion protection. These protection systems require regular maintenance. The cable-stayed systems require additional inspection effort. 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. Working the inspection equipment around the stays can be awkward and time-consuming. Accessing the tops of the pylons (160 feet above the deck) and hangers for maintenance and inspection would require special accommodations during design.

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 pylon 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 to access this location.

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. 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 will most likely take place primarily from the pylons outward across the river.

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

Complexity

The cable-stayed bridge type is seen as relatively challenging to build and not typically accomplished by 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. 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

<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

<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

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.

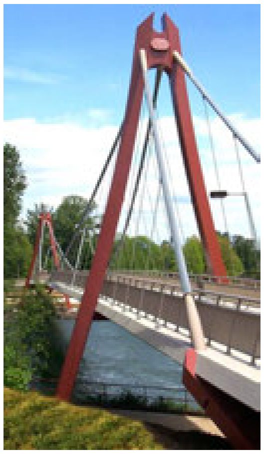
Aesthetics

For path users, this alternative would feel open, with only the pylons and hangers extending above the deck and overhead. The pylons would extend approximately 180 feet above the bridge deck. With a superstructure width of only 20 feet, the towers may appear out of proportion to the pylons. The form of the cable-stayed alternative makes this a signature-type bridge. For people viewing the bridge from locations other than the path, this alternative would not particularly stand out from its surroundings due to the minimal mass of the suspended deck system and stay systems and the location of the pylons on the river banks in line with the riparian vegetation.

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

For the proposed suspension alternative, the form of the pylons is somewhat flexible, depending on the aesthetic appearance desired. The back spans of the main suspension cables would support some of the approaches and be tied to anchor blocks with ground anchors. The suspended portion of the bridge deck would be connected to hanger cables. The remainder of the bridge would be ground-supported. The approach spans at both ends would be concrete slabs to maintain visual consistency. A concrete deck would be placed the full length of the bridge. The suspended portion would use precast panels. See Figure 6 for elevation and section views.

A preliminary structure layout was performed. 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.

This alternative is being evaluated as it is capable of achieving the necessary span lengths; can be designed with a very shallow deck system over the river, further reducing the height of the path over the navigation channel; would eliminate in-water work with the pylon foundations on the top of each bank; and is a distinctive signature-type structure.

Economics

Design & Construction Cost and Duration

The cast-in-place concrete slab approach spans are straight-forward to design and construct. The main suspension structure is more complicated due to the suspender cable connections and erection of the suspended spans without falsework. 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. Since the suspension bridge will not have permanent in-water impacts as noted below, the permitting effort will be minimized. The approach span substructures will be single columns on large-diameter drilled shafts. The suspended portion of the structure requires unique analysis and design to account for construction staging. The design duration would be approximately two years.

Permitting costs and durations, and potential mitigation are similar to those discussed for the cable-stayed bridge.

The estimated construction cost of this structure is estimated to be second highest; it is about 70 to 90% more than the steel girder bridge.. The construction duration would be approximately three years. Risk of delay due to in-water work is similar to that discussed for the cable-stayed bridge.

Maintenance

Maintenance of a suspension pedestrian bridge is moderate. The cables and related connection systems typically are painted or otherwise encapsulated to provide corrosion protection. These protection systems require regular maintenance. The suspension system requires additional inspection effort. 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. Working the inspection equipment around the hangers can be awkward and time-consuming. Accessing the tops of the pylons (80 feet above the deck) and hangers for maintenance and inspection would require special accommodations during design.

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.

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. 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. 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

<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 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

<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

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

For path users, this alternative would feel open with only the pylons, main suspension cable, and hangers extending above the deck and overhead. The form of the suspension alternative makes this a signature-type bridge. For people viewing the bridge from locations other than the path, this alternative would not particularly stand out from its surroundings due to the minimal mass of the suspended deck system and hanger systems and the location of the pylons on the river banks in line with the riparian vegetation.

Bridge Types Considered Infeasible

Concrete Girders

Concrete girders could be either precast, cast-in-place, or a combination of both. The maximum span length for precast I- or T-girders is limited to just over 200 feet. Precast segmental girders consist of discrete box-shaped sections tied together and can span significantly further than the I- or T-girders. However segmental girders require a complicated placement apparatus. The concrete girder options were not selected for further analysis for a number of reasons:

Owosso Pedestrian Bridge, Eugene, OR

- Precast concrete I- or T-girders have maximum spans of approximately 200 feet, which is not adequate to clear span the Willamette's approximately 240-foot-wide navigational channel and meet USCG requirements.
- Segmental post-tensioned concrete bridges can achieve the required spans, but are only economical when the bridge is long enough overall to realize savings due to repetition of superstructure segments.
- Traditional cast-in-place concrete, typically box, beams require significant falsework and associated access to construct. The height of the falsework would be more than 100 feet over the bottom of the river and could significantly restrict the navigational channel during a multi-year construction period.
- In all cases, the concrete girders would be deep, at five percent of the span, for the span lengths considered. This would require raising the path to clear the navigational channel and extending the approaches at each end.

Stress Ribbon

Stress ribbon bridges are tension structures with suspension cables embedded in the deck that follow a catenary curve between supports. The main spans sag between supports, much like power lines between poles. Stress ribbon options were not selected for further analysis for a number of reasons:

Rogue River Pedestrian Bridge, Grants Pass, OR

- To meet the ADA requirement to limit slopes along the path to five percent maximum and to meet USGS vertical clearance requirements, the tension in the supporting cables would have to be excessively high.

- The low point of the structure is also at mid-span due to the catenary curve, which would require raising the grade much like the concrete girders above.

Summary

In this report OBEC has: identified the possible bridge types for a crossing of the Willamette River along the identified alignment; identified the five types that best meet the needs of the project and site; developed preliminary layouts for the five types; broadly examined and evaluated the bridge types against the four criteria (economics, constructability, impacts, and aesthetics); and completed a comparison of bridge types.

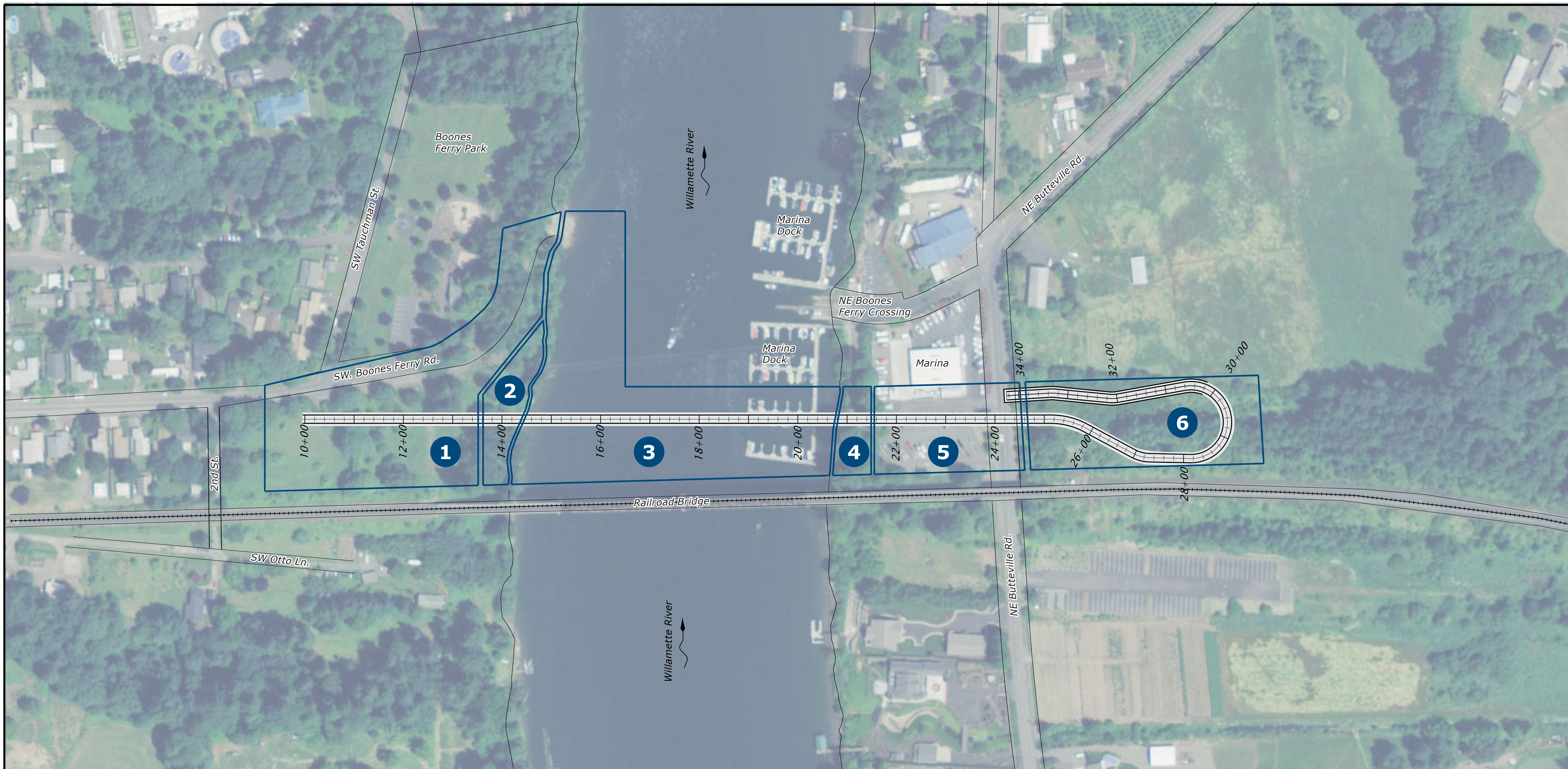
On October 3, 2018, the project team met with the TAC to review the draft report and bridge type evaluation process and outcome. TAC input has been incorporated into this report. Recognizing that obtaining funding for the project may prove challenging, their recommendation is to advance one bridge type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

The project team's evaluation and the TAC's input to this report are presented in Appendix A – Bridge Type Assessment Summary. This appendix provides a concise comparison of the bridge types in three areas: cost and complexity, temporary impacts, and permanent impacts.

Once the public has provided input and the project team meets with the Task Force, the BCC and the Wilsonville City Council will select two bridge types for further investigation. Three-dimensional renderings will be prepared for those two bridge types.

Following the additional investigation, the BCC and City Council will select the preferred bridge type.

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

CORPORATE OFFICE:
920 COUNTRY CLUB ROAD, SUITE 100B EUGENE, OREGON 97401-6089
REGIONAL OFFICES:
LAKE OSWEGO; SALEM; MEDFORD, OREGON ; VANCOUVER, WASHINGTON

CONSULTING ENGINEERS
www.obec.com

OREGON DEPARTMENT OF TRANSPORTATION

FRENCH PRAIRIE BRIDGE PROJECT
BOONES FERRY ROAD
MARION AND CLACKAMAS COUNTY

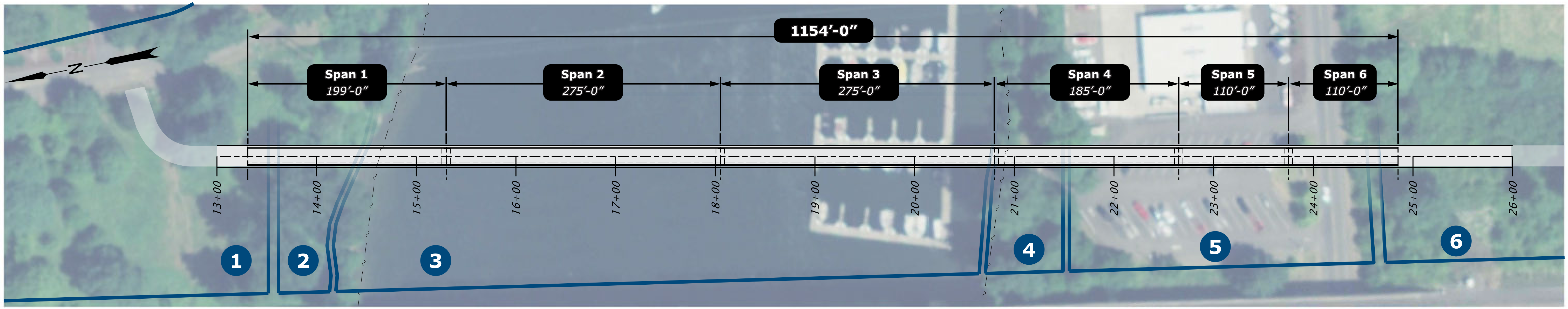
Designer: Eric E. Bonn, P.E.
Reviewer: Bob Goodrich, P.E.
Drafter: OBEC CAD
Checker: Andy Howe, P.E.

ALIGNMENT

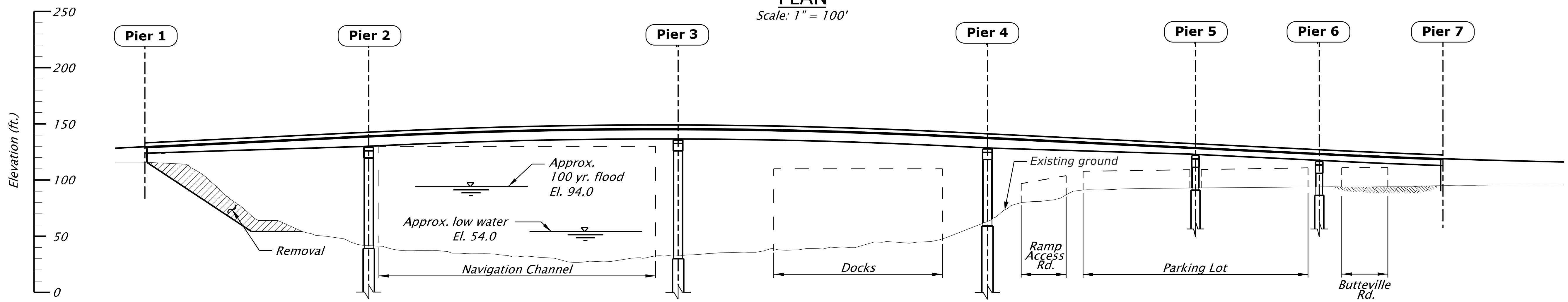
SHEET NO. FIG. 1

BR_Alignment_PE_01.dgn :: border 9/4/2018 2:13:44 PM LWilhelm

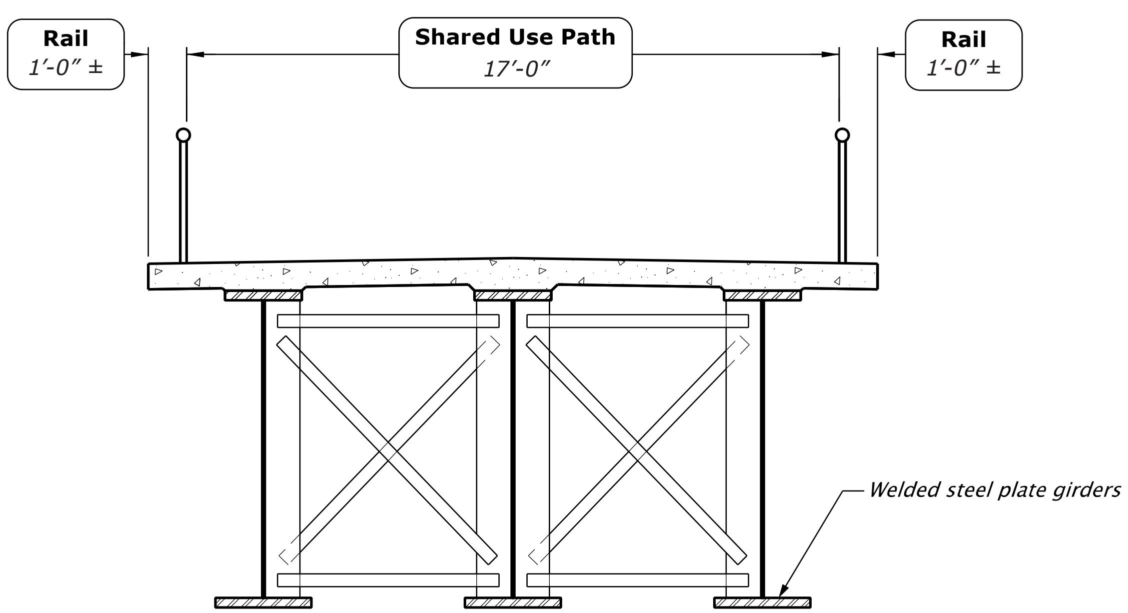
Rotation: 0° Scale: Full Size 1=1



PLAN
Scale: 1" = 100'



ELEVATION
Scale: 1" = 100'



TYPICAL 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

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

CONCEPT PLANS
NOT FOR CONSTRUCTION

OBEC
CORPORATE OFFICE:
920 COUNTRY CLUB ROAD, SUITE 100B EUGENE, OREGON 97401-6089
REGIONAL OFFICES:
LAKE OSWEGO; SALEM; MEDFORD, OREGON ; VANCOUVER, WASHINGTON
CONSULTING ENGINEERS
www.obec.com

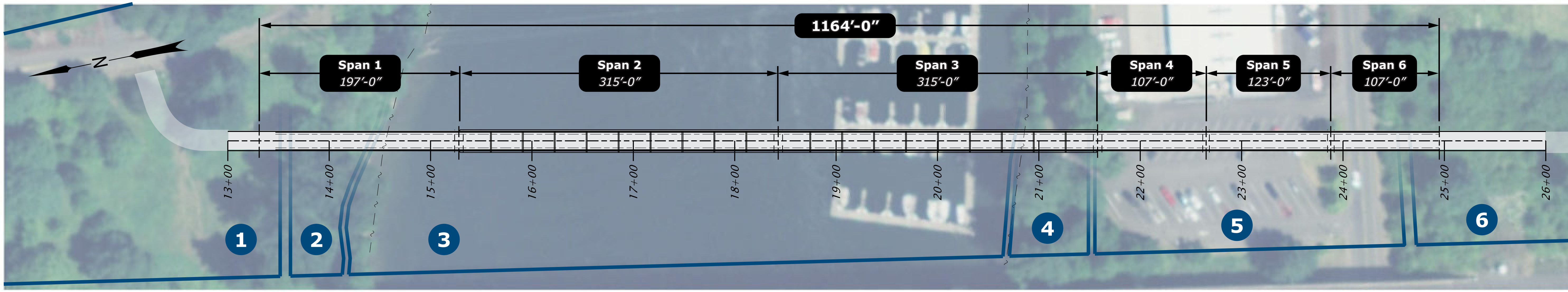
OREGON DEPARTMENT OF TRANSPORTATION

FRENCH PRAIRIE BRIDGE PROJECT
BOONES FERRY ROAD
MARION AND CLACKAMAS COUNTY

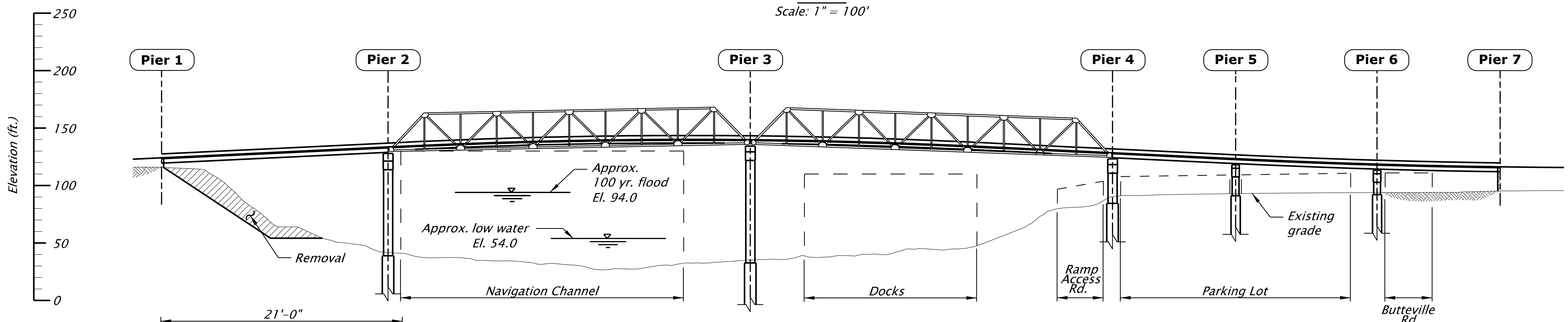
Designer: Eric E. Bonn, P.E.
Reviewer: Bob Goodrich, P.E.
Drafter: OBEC CAD
Checker: Andy Howe, P.E.

STEEL GIRDER

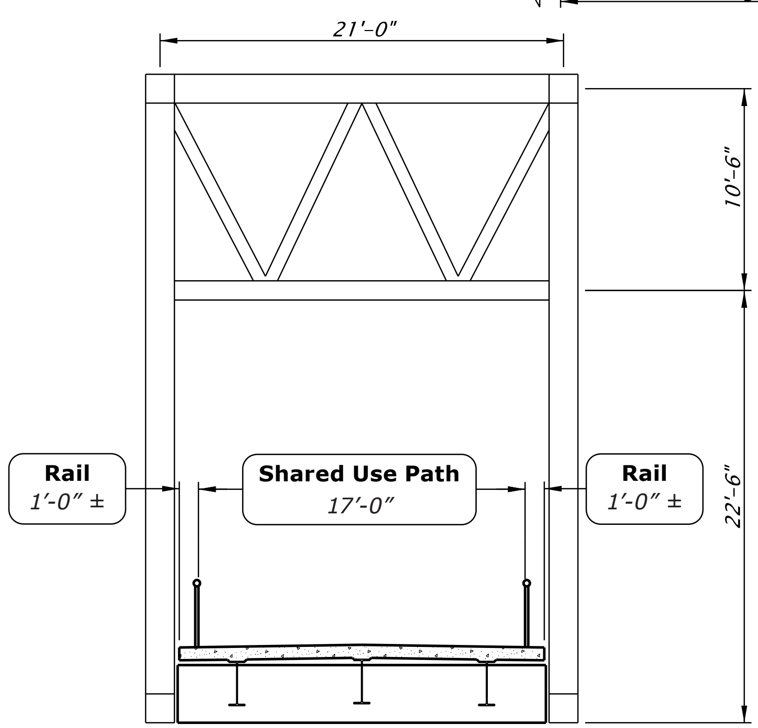
SHEET NO.
FIG. 2



PLAN
Scale: 1" = 100'



ELEVATION
Scale: 1" = 100'



TYPICAL SECTION
Scale: 1" = 10'

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
CORPORATE OFFICE:
920 COUNTRY CLUB ROAD, SUITE 100B EUGENE, OREGON 97401-6089
REGIONAL OFFICES:
LAKE OSWEGO; SALEM; MEDFORD, OREGON ; VANCOUVER, WASHINGTON
CONSULTING ENGINEERS
www.obec.com

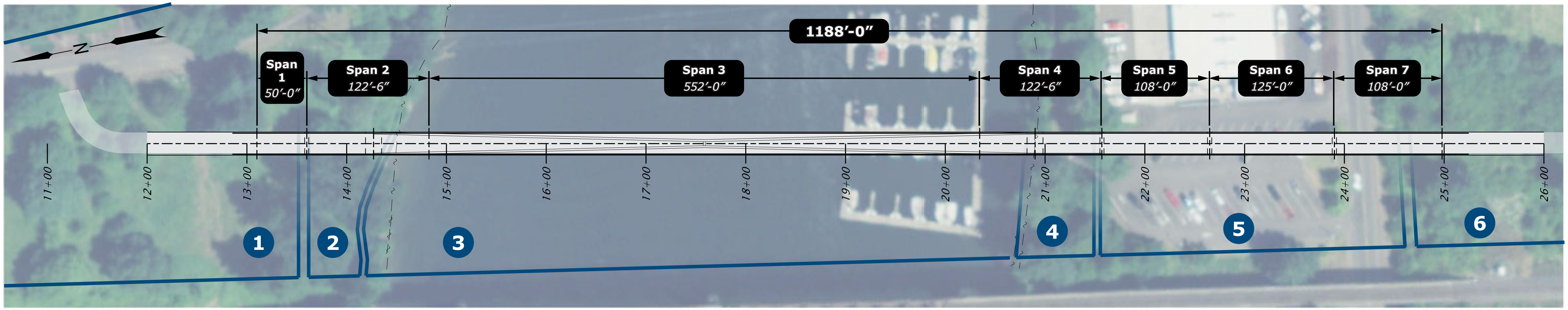
OREGON DEPARTMENT OF TRANSPORTATION

FRENCH PRAIRIE BRIDGE PROJECT
BOONES FERRY ROAD
MARION AND CLACKAMAS COUNTY

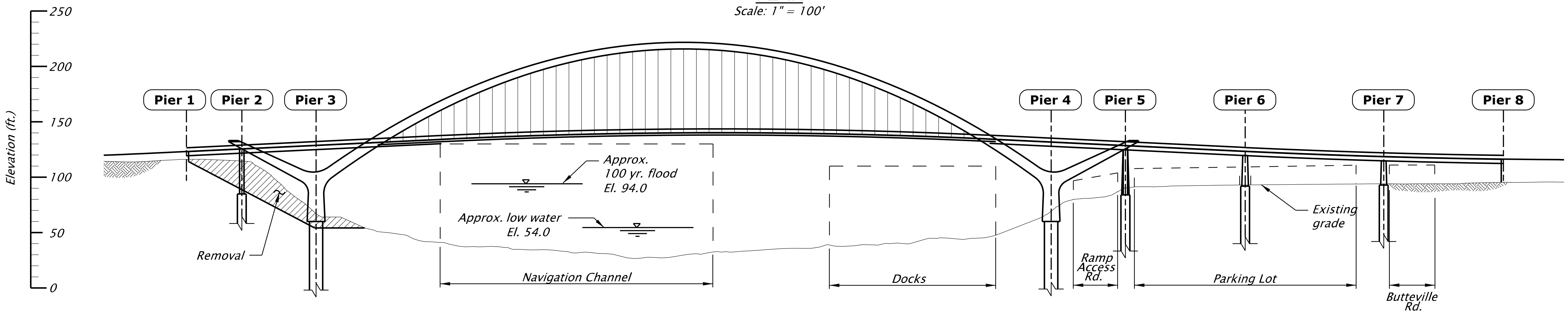
Designer: Eric E. Bonn, P.E.
Reviewer: Bob Goodrich, P.E.
Drafter: OBEC CAD
Checker: Andy Howe, P.E.

STEEL TRUSS

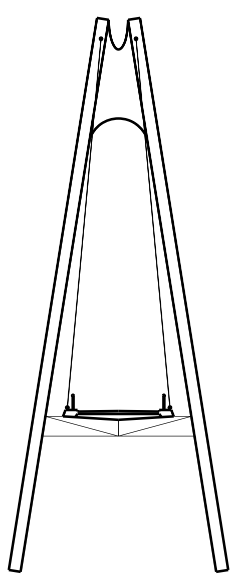
SHEET NO.
FIG. 3



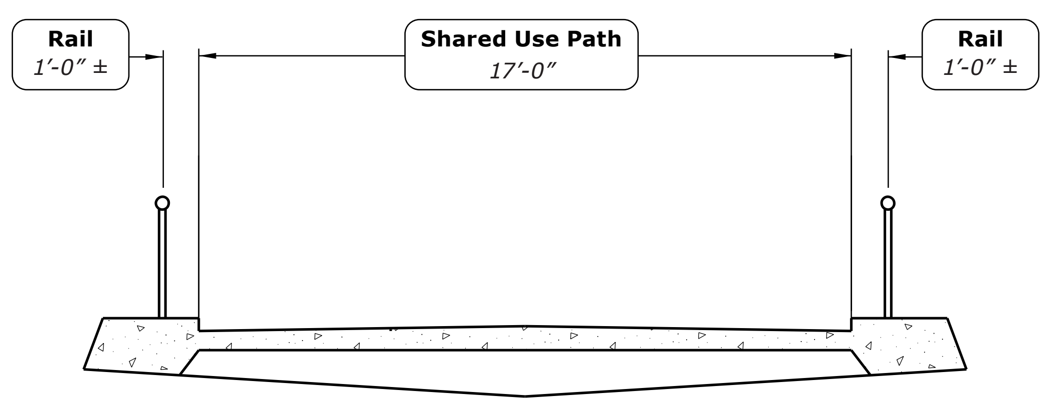
PLAN
Scale: 1" = 100'



ELEVATION
Scale: 1" = 100'



TYPICAL SECTION
Scale: 1" = 40'



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

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

CONCEPT PLANS NOT FOR CONSTRUCTION

OBEC CONSULTING ENGINEERS
CORPORATE OFFICE: 920 COUNTRY CLUB ROAD, SUITE 100B EUGENE, OREGON 97401-6089
REGIONAL OFFICES: LAKE OSWEGO; SALEM; MEDFORD, OREGON ; VANCOUVER, WASHINGTON
www.obec.com

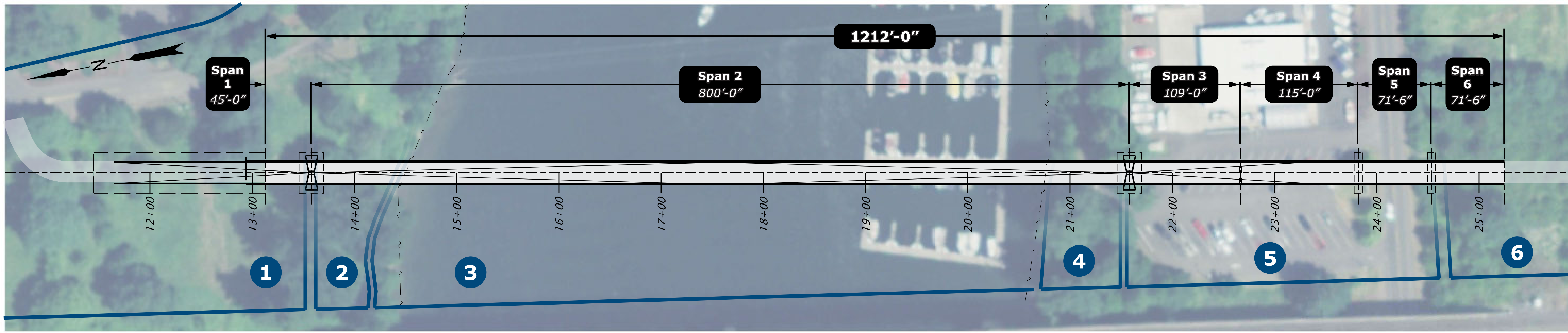
OREGON DEPARTMENT OF TRANSPORTATION

FRENCH PRAIRIE BRIDGE PROJECT
BOONES FERRY ROAD
MARION AND CLACKAMAS COUNTY

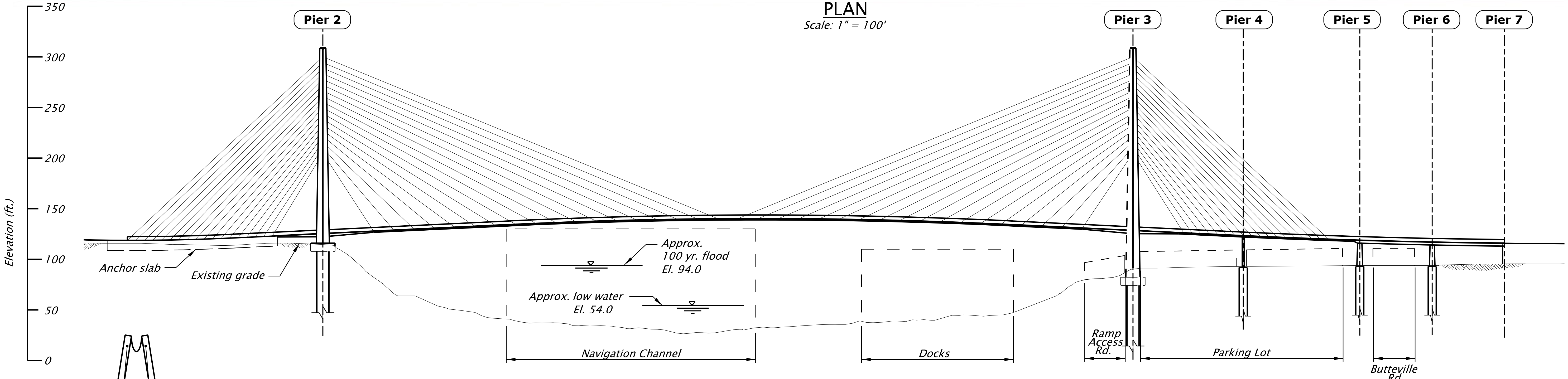
Designer: Eric E. Bonn, P.E. Reviewer: Bob Goodrich, P.E.
Drafter: OBEC CAD Checker: Andy Howe, P.E.

SINGLE ARCH

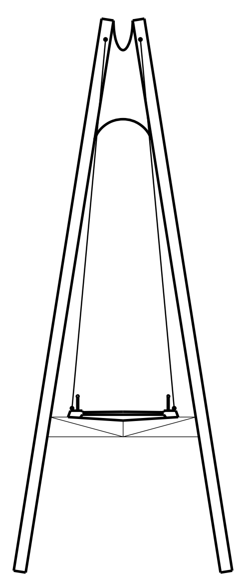
SHEET NO. FIG. 4



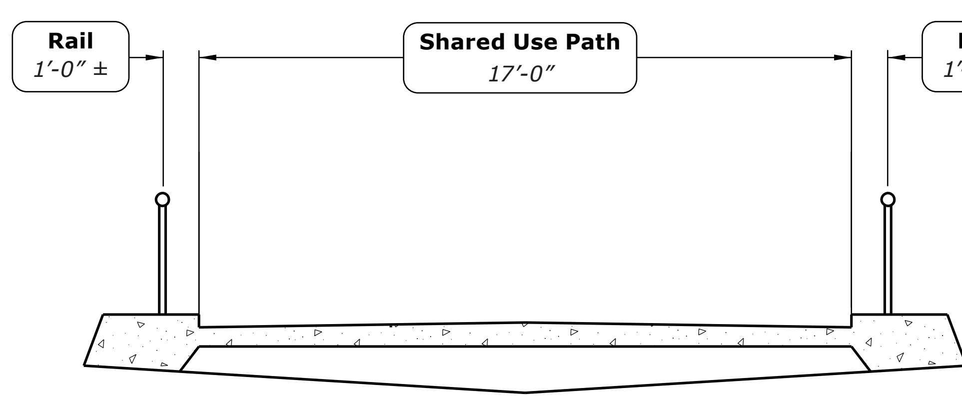
PLAN
Scale: 1" = 100'



ELEVATION
Scale: 1" = 100'



TYPICAL SECTION
Scale: 1" = 40'



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

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

CONCEPT PLANS NOT FOR CONSTRUCTION

OBEC
CORPORATE OFFICE: 920 COUNTRY CLUB ROAD, SUITE 100B EUGENE, OREGON 97401-6089
REGIONAL OFFICES: LAKE OSWEGO; SALEM; MEDFORD, OREGON; VANCOUVER, WASHINGTON
CONSULTING ENGINEERS
www.obec.com

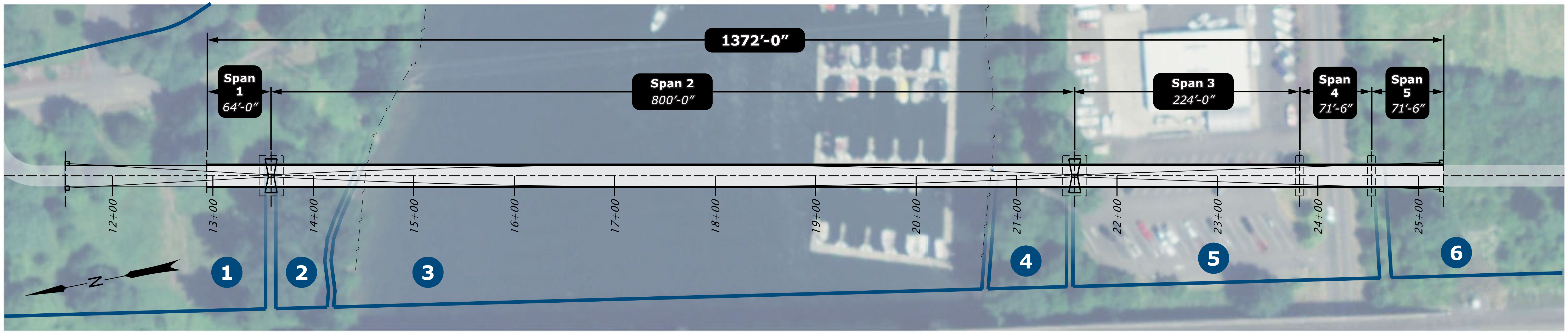
OREGON DEPARTMENT OF TRANSPORTATION

FRENCH PRAIRIE BRIDGE PROJECT
BOONES FERRY ROAD
MARION AND CLACKAMAS COUNTY

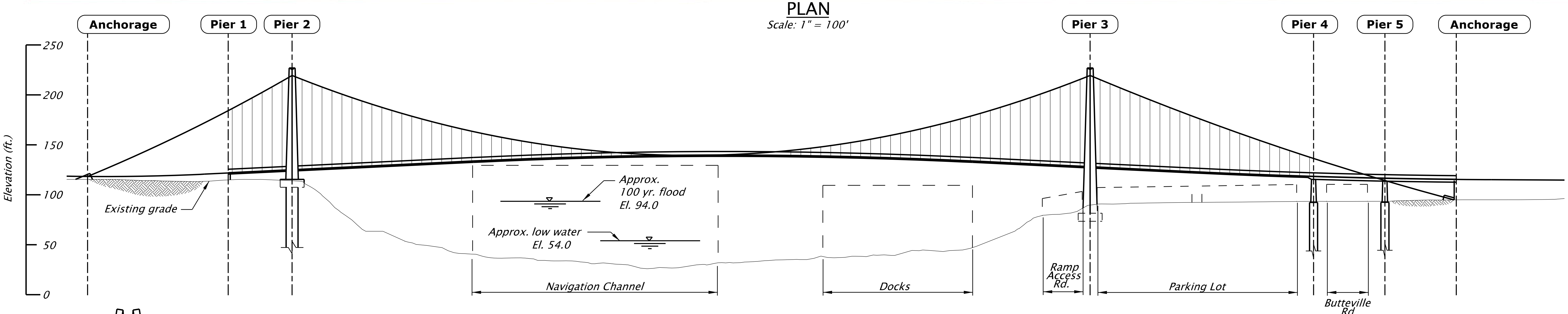
Designer: Eric E. Bonn, P.E. Reviewer: Bob Goodrich, P.E.
Drafter: OBEC CAD Checker: Andy Howe, P.E.

CABLE STAYED
SHEET NO. FIG. 5

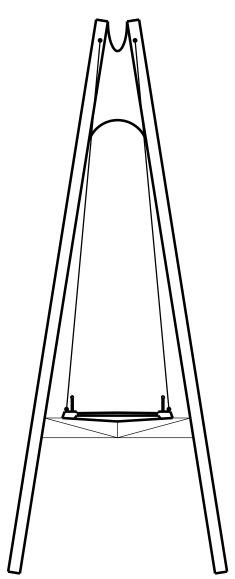
BR_CableStay_PE_01.dgn :: border 9/5/2018 4:15:32 PM LWilhelm Rotation: 0° Scale: Full Size 1=1



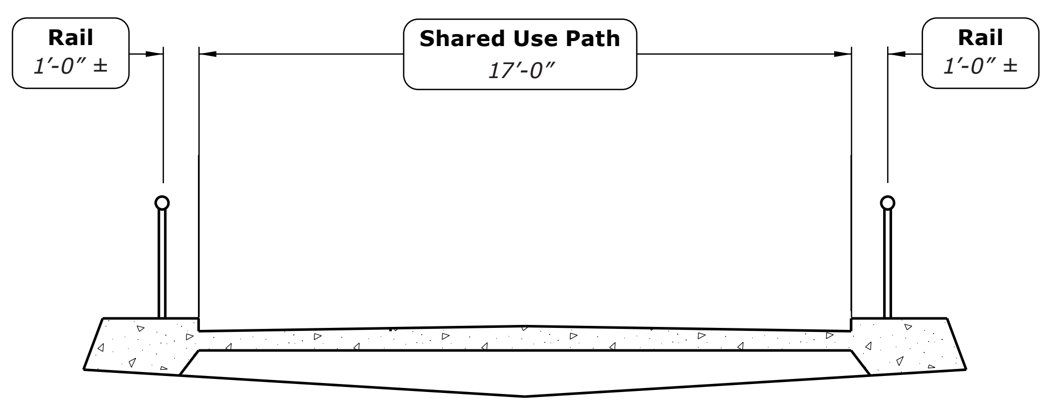
PLAN
Scale: 1" = 100'



ELEVATION
Scale: 1" = 100'



TYPICAL SECTION
Scale: 1" = 40'



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

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

CONCEPT PLANS NOT FOR CONSTRUCTION

OBEC
CORPORATE OFFICE: 920 COUNTRY CLUB ROAD, SUITE 100B EUGENE, OREGON 97401-6089
REGIONAL OFFICES: LAKE OSWEGO; SALEM; MEDFORD, OREGON ; VANCOUVER, WASHINGTON
CONSULTING ENGINEERS www.obec.com

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.

SUSPENSION

SHEET NO. FIG. 6

BR_Suspension_PE_01.dgn :: border 9/5/2018 4:16:55 PM LWilhelm Rotation: 0° Scale: Full Size 1=1

APPENDIX A
Bridge Type Assessment Summary

French Prairie Bridge Project

Bridge Type Assessment

October 2018

The table summarizes how well the bridge type meets project evaluation criteria and compares against other bridge types. Filled circles indicate best suitability and least adverse impact while empty circles indicate least suitability and most adverse impact.

	Steel Girder		**Steel Truss**		**Tied-Arch**		**Cable-Stayed**		**Suspension**	
Cost & Complexity	Least cost	●	Cost is ~15-30% greater than steel girder	●	Cost is ~90-100% greater than steel girder	○	Cost is ~70-90% greater than steel girder	◉	Cost is ~70-90% greater than steel girder	◉
	~2 year construction duration	●	~2 year construction duration	●	~3+ year construction duration	○	~3 year construction duration	○	~3 year construction duration	○
	Longest permitting duration	○	Longest permitting duration	○	Long permitting duration	○	Shortest permitting duration	●	Shortest permitting duration	●
	Most risk to cost and schedule for in-water work	○	Most risk to cost and schedule for in-water work	○	Most risk to cost and schedule for in-water work	○	Least risk to cost and schedule for in-water work	●	Least risk to cost and schedule for in-water work	●
	Constructable by local contractors	●	Requires some specialty fabrication	◉	Requires specialty contractors	○	Requires specialty contractors	○	Requires specialty contractors	○
Temporary Impacts	Foundation construction in the river channel	○	Foundation construction in the river channel	○	Foundation construction in the river channel	○	No foundation construction in the river	●	No foundation construction in the river	●
	Temporary bridge supports in the river, reducing navigational channel and impacting marina	○	Temporary bridge supports in the river, reducing navigational channel and impacting marina	○	Temporary bridge supports in the river, reducing navigational channel and impacting marina	○	No temporary bridge supports in the river, sporadic impacts to navigational channel and marina	●	No temporary bridge supports in the river, sporadic impacts to navigational channel and marina	●
	Access and staging on both sides of the river, causing moderate impacts to Boones Ferry Park and high impacts to dock area and marina parking	◉	Access and staging on both sides of the river, causing minor impacts to Boones Ferry Park and high impacts to dock area and marina parking	◉	Access and staging on both sides of the river, causing minor impacts to Boones Ferry Park, high impacts to dock area and moderate impacts to marina parking	●	Access and staging on both sides of the river, causing the highest impacts to Boones Ferry Park, and moderate impacts to dock area and marina parking	◉	Access and staging on both sides of the river, causing the highest impacts to Boones Ferry Park, and moderate impacts to dock area and marina parking	◉
Permanent Impacts	Three piers in river channel	○	Two piers in river channel	○	Two piers on river banks	◉	No piers in river	●	No piers in the river	●
	One pier in marina parking lot	○	One pier in marina parking lot	○	One pier in marina parking lot	○	Potentially one pier in marina parking lot	◉	No pier in marina parking lot	●
	Grading in Boones Ferry Park for higher bridge deck/deeper girders	◉	Minor grading in Boones Ferry Park	●	Minor grading in Boones Ferry Park	●	Anchorage for stay cable in the north end of Boones Ferry Park	○	Anchorage for suspension cable in the north end of Boones Ferry Park	○
	Potential dock area impacts due to proximity of new pier	○	Potential dock area impacts due to proximity of new pier	○	No dock area impact	●	No dock area impact, but boat launch road must be realigned	◉	No dock area impact, but boat launch road must be realigned	◉
	Regrade river banks to mitigate floodway impacts	○	Regrade river banks to mitigate floodway impacts	○	Regrade river banks to mitigate floodway impacts	○	No floodway impacts	●	No floodway impacts	●