Hood River – White Salmon BRIDGE REPLACEMENT PROJECT

Final Geology and Soils Technical Report

November 2020

Prepared for:

PORT OF HOOD RIVER

Prepared by:

wsp

851 SW Sixth Avenue
Suite 1600
Portland, Oregon 97204

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LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

API	area of potential impact
BMPs	best management practices
EIS	environmental impact statement
I-	Interstate
lbs.	pounds
MATS	Mt. Adams Transportation Service
mph	miles per hour
NEPA	National Environmental Policy Act
NGVD29	National Geodetic Vertical Datum of 1929
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OHWM	ordinary high water mark
SR	State Route
the Port	Port of Hood River
the Project	Hood River-White Salmon Bridge Replacement Project
TS&L	type, size, and location
U.S.	United States
USACE	U.S. Army Corps of Engineers
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation

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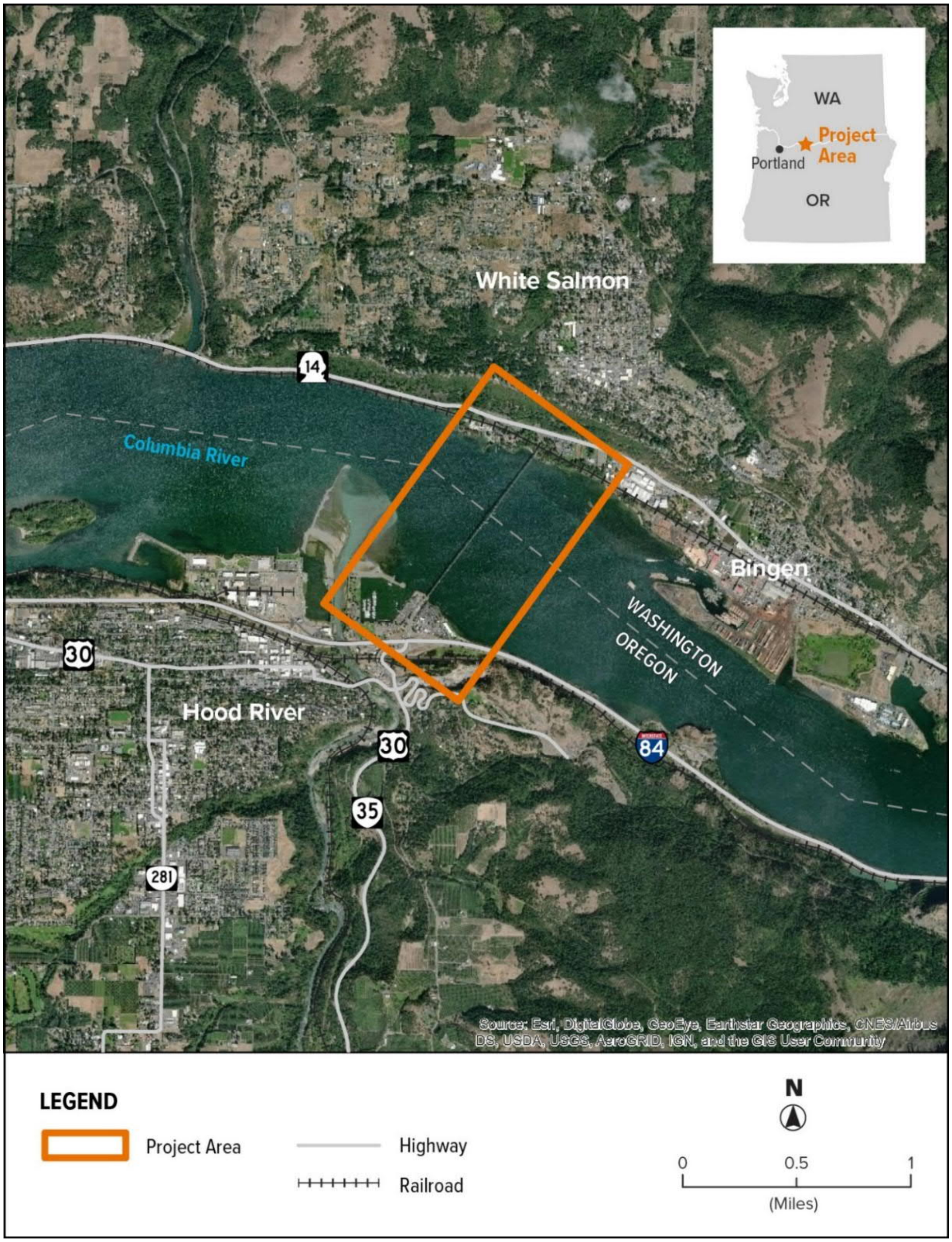
1. INTRODUCTION

The Hood River-White Salmon Bridge Replacement Project (the "Project," formerly named the SR-35 Columbia River Crossing Project) would construct a replacement bridge and then remove the existing Hood River Bridge between White Salmon, Washington, and Hood River, Oregon (Exhibit 1).The bridge is owned by the Port of Hood River (the Port), serving an average of over 4 million trips annually.

Exhibit 1. Project Area



The purpose of this Project is to improve multi-modal transportation of people and goods across the Columbia River between the communities of White Salmon and Bingen, Washington and Hood River, Oregon. The Project is intended to: a) improve traffic operations for current and future cross-river traffic and at connections to I-84 and SR 14; b) provide a cross-river connection for bicyclists and pedestrians; c) improve vehicle and freight travel safety by reducing real and perceived hazards; d) maintain and improve a transportation linkage between the White Salmon, Bingen, and Hood River communities, businesses, and services; e) fulfill the legislative directives tied to the Project funding; f) improve river navigation for vessels passing under the bridge; and g) improve the river crossing's seismic resiliency.

The overall need for the Project is to rectify current and future transportation inadequacies and deficiencies associated with the existing bridge. Specifically, these needs are to:

- Present Capacity: substandard width and operational issues are causing traffic congestion on the bridge and at both approaches
- Future Transportation Demand: the existing bridge is not designed to meet future travel demand for vehicles
- Bicycle and Pedestrian Facilities: lack of bicycle and pedestrian facilities limits multi-modal mobility
- Safety: narrow lanes and lack of shoulder create real and perceived safety hazards
- Social Demands/Economic Development: the existing bridge restricts the current and projected flow of goods, labor and consumers across the river
- Legislation: comply with federal funding obligation Transportation Equity Act for the 21st Century (TEA-21), the Washington State Legislature designation of the SR-35 corridor, and Oregon HB 2017
- River Navigation: the substandard horizontal clearance creates difficulties for safe vessel navigation
- Seismic Deficiencies: the existing bridge does not meet current seismic standards and is vulnerable to a seismic event

The Project began in 1999 with a feasibility study that ultimately resulted in the publication of the State Route (SR) 35 Columbia River Crossing Draft Environmental Impact Statement (EIS) in 2003, which identified the "EC-2 West Alignment" as the preliminary preferred alternative. In 2011, the Type, Size, and Location (TS&L) Study recommended a fixed-span concrete segmental box girder bridge as the recommended bridge type. In 2017, the Project was relaunched to complete the National Environmental Policy Act (NEPA) process. This report provides an update to the 2003 Geology and Soils Technical Report describing the existing conditions and anticipated construction, direct, and indirect impacts on geology and soils. Measures to avoid, minimize, and/or mitigate these impacts are also identified in this report.

2. PROJECT ALTERNATIVES

Four alternatives are being evaluated to address the Project's purpose and need:

- No Action Alternative
- Preferred Alternative EC-2
- Alternative EC-1
- Alternative EC-3

Exhibit 2 shows the alignment of the existing bridge, which represents the No Action Alternative, and the three build alternatives. The build alternatives connect to SR 14 in White Salmon, Washington, and Button Bridge Road in Hood River, Oregon, just north of the Interstate 84 (I-84)/United States Highway 30 (US 30) interchange (Exit 64).

Each alternative is summarized in Exhibit 3 and described in more detail in the following sections. Exhibit 4 illustrates the navigational clearance for the existing bridge and the replacement bridge (same for each build alternative).

Exhibit 2. Location of the Preferred Alternative EC-2, Alternative EC-1, and Alternative EC-3

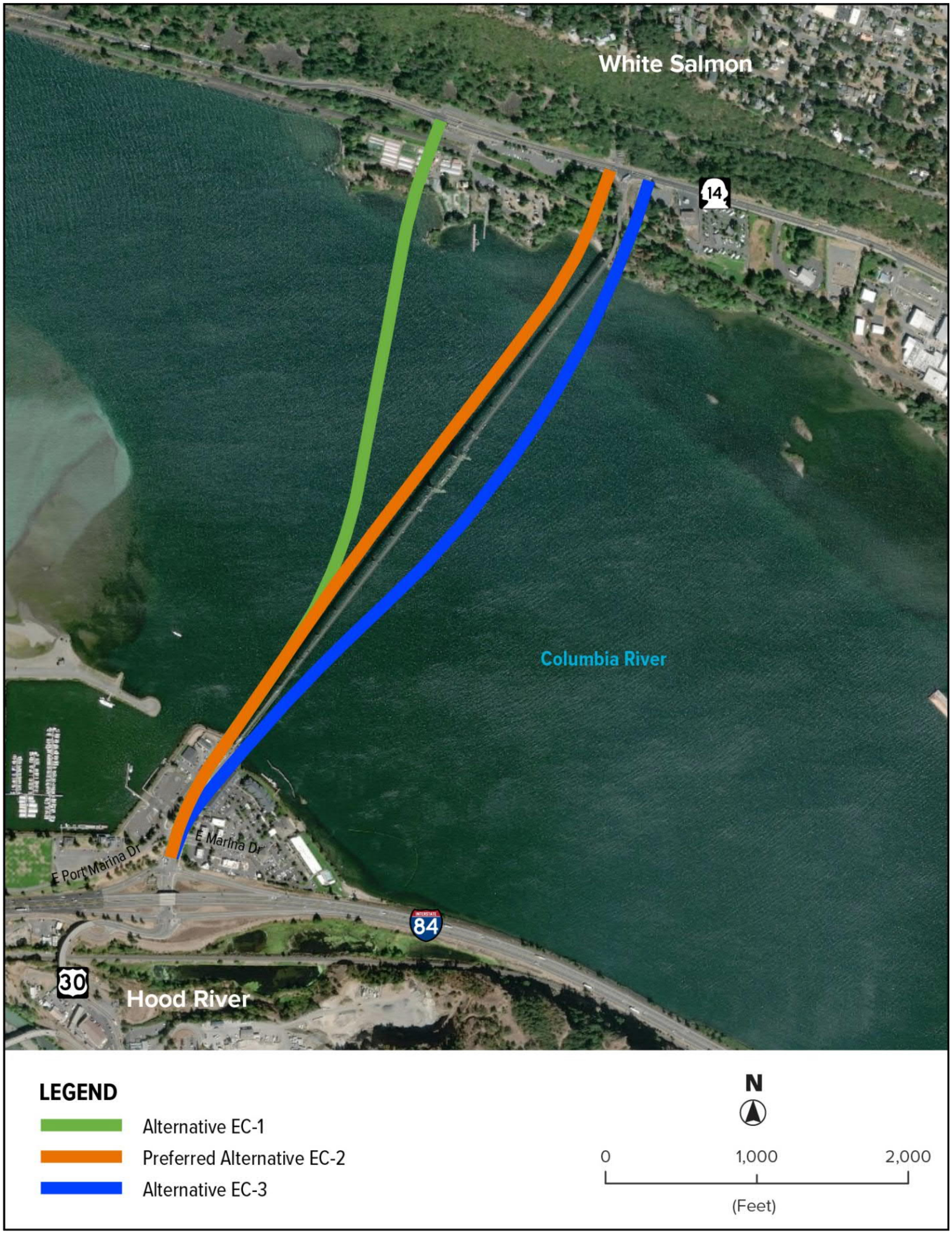
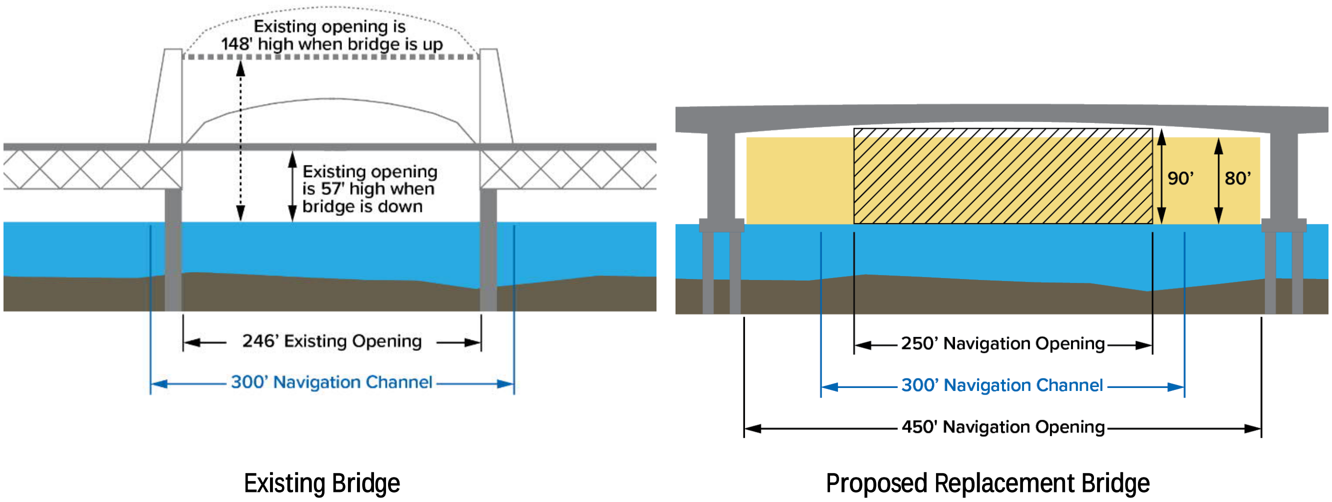


Exhibit 3. Summary Comparison of Key Elements of Alternatives

	No Action Alternative	Preferred Alternative EC-2	Alternative EC-1	Alternative EC-3
Bridge alignment	No change	Slightly west of existing	WA: West of existing OR: Slightly west of existing	Slightly east of existing
Bridge structure				
Bridge type	Steel deck truss bridge with vertical lift span	Segmental concrete box girder bridge (fixed span)		
Total number of piers (in water / on land)	28 (20 / 8)	13 (12 / 1)	13 (11 / 2)	13 (12 / 1)
Structure length	4,418 feet	4,412 feet	4,375 feet	4,553 feet
Travel lanes	9-foot 4.75-inch lanes	12-foot lanes		
Roadway shoulders	No shoulders	8-foot shoulders		
Vehicle height limit	14 feet-7 inches	None		
Shared Use Path	None	12-foot wide, only on west side with overlooks		
Bridge deck	Steel-grated	Concrete		
Vehicle Gross Weight Limit	80,000 pounds (lbs.); no trip permit allowance for overweight vehicles	> 80,000 lbs., with approved trip permit		
Design speed	Unknown	50 miles per hour (mph)		
Posted speed	25 mph	35 mph		
Toll collection	Toll booth on Oregon side	Electronic tolling/No toll booth		
Stormwater treatment	None	Detention and water quality treatment		
Navigation clearance	246 feet horizontal by 57 feet vertical when bridge is down and up to 148 feet vertical when lifted	450 feet horizontal x 80 feet vertical (maximum horizontal opening) 250 feet horizontal x 90 feet vertical (centered within maximum vertical opening)		
SR 14/Hood River Bridge intersection	Signalized intersection	Roundabout slightly west of existing intersection; SR 14 raised approximately 2 feet above existing road level	Roundabout with connection to N. Dock Grade Road west of existing intersection; SR 14 raised approximately 17 feet above existing road level	Roundabout slightly east of existing intersection; SR 14 remains at existing road level
Button Bridge Road/E. Marina Way intersection	Signalized intersection	Signalized intersection		
Anticipated construction duration	None	6 years (3 years to construct the replacement bridge and 3 years to remove the existing bridge)		

Exhibit 4. Navigation Clearance of Existing Bridge and Proposed Replacement Bridge



2.1. No Action Alternative

The No Action Alternative would retain the existing bridge in its existing condition and configuration. Routine operations would continue and maintenance would be implemented to continue operations. Under the No Action Alternative, elements of the existing bridge include:

- Alignment: The bridge would continue to span the Columbia River between its northern terminus at the SR 14/Hood River Bridge intersection in White Salmon, Washington, and its southern terminus at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon, as shown in the aerial photograph in Exhibit 2.
- Type: The bridge would continue to be a 4,418-foot steel deck truss bridge with a vertical lift span. The bridge would continue to have 20 piers in the Columbia River.
- Ownership: The bridge will continue to be owned and operated by the Port.
- Vehicle lanes: The bridge will continue to have one narrow (9 feet, 4.75 inches) travel lane in each direction and no shoulders.
- Bicycle and pedestrian facilities: The bridge would continue to have no pedestrian or bicycle facilities, and signage would continue to prohibit pedestrians and bicycles on the bridge.
- Speed: The posted speed limit on the bridge would continue to be 25 mph.
- Vehicle restrictions: Vehicles would continue to be weight-restricted to 80,000 lbs.; vehicles with approved trip permits would still not be allowed to use the bridge. Wide loads would continue to be prohibited without special arrangements, and large vehicles would be encouraged to turn their mirrors in. The height limit for vehicles would continue to be 14 feet, 7 inches where the lift span occurs.
- Tolling: The bridge would continue to be tolled for all vehicles with a toll booth on the south end of the bridge and electronic tolls collected through the Port's Breezeby system. Plans to shift to all ETC are being considered, but there is no certainty they will be implemented.

- Navigational clearance: The horizontal clearance for marine vessels would continue to be 246 feet, narrower than the navigation channel width of 300 feet, as shown Exhibit 4. The vertical clearance would continue to be 57 feet when the lift span is down and 148 feet when it is raised; vessels would continue to be required to request bridge lifts in advance. The lift span section would continue to use gate and signals to stop traffic for bridge lifts.
- Seismic resilience: The bridge would continue to be seismically vulnerable and would not be cost effective to be seismically retrofitted.
- Stormwater: No stormwater detention or water quality treatment would be provided for the bridge. Stormwater on the bridge would continue to drain directly into the Columbia River through the steel-grated deck.
- Roadway connections: The bridge would continue to connect to SR 14 on the Washington side at the existing signalized SR 14/Hood River Bridge intersection. On the Oregon side, the southern end of the bridge would continue to transition to Button Bridge Road, connecting to the local road network at the existing signalized Button Bridge Road/E. Marina Way intersection north of I-84. The bridge would continue to cross over the BNSF Railway tracks on the Washington side and over the Waterfront Trail along the Oregon shoreline.
- Bicycle and pedestrian connections: The bridge would continue not to provide bicycle or pedestrian connections across the Columbia River. Bicyclists and pedestrians wanting to cross the river would continue to need to use an alternate means of transportation, such as the Mt. Adams Transportation Service (MATS) White Salmon/Bingen to Hood River bus (buses provide bicycle racks), or a private vehicle.

The Supplemental Draft EIS considers two scenarios for the No Action Alternative:

- End of bridge lifespan: assumes that the existing Hood River Bridge would remain in operation through 2045[1] and would be closed sometime after 2045 when maintenance costs would become unaffordable. At such a time, the bridge would be closed to vehicles and cross-river travel would have to use a detour route approximately 21 miles east on SR 14 or 23 miles east on I-84 to cross the Columbia River using The Dalles Bridge (US 197). Alternatively, vehicles could travel 25 miles west on SR 14 or 21 miles west on I-84 to cross the Columbia River via the Bridge of the Gods. When the bridge would be closed, the lift span would be kept in a raised position to support large vessel passage that previously required a bridge lift or the existing bridge would be removed.
- Catastrophic event: addresses the possibility that an extreme event that damages or otherwise renders the bridge inoperable would occur prior to 2045. Such events could include an earthquake, landslide, vessel strike, or other unbearable loads that the bridge structure cannot support.

[1] The year 2045 is the design horizon for the Project. The design horizon is the year for which the Project was designed to meet anticipated needs.

2.2. Preferred Alternative EC-2

Alternative EC-2 would construct a replacement bridge west of the existing bridge. The existing bridge would be removed following construction of the replacement bridge. Under Alternative EC-2, elements of the replacement bridge would include:

- Alignment: The main span of the bridge would be approximately 200 feet west of the existing lift span. The bridge terminus in White Salmon, Washington, would be located approximately 123 feet west of the existing SR 14/Hood River Bridge intersection, while the southern terminus would be in roughly the same location at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon, as shown in Exhibit 5 and Exhibit 6.
- Type: The bridge would be a 4,412-foot fixed-span segmental concrete box girder bridge with a concrete deck and no lift span. The bridge would have 12 piers in the Columbia River and one land-based pier on the Washington side of the river.
- Ownership: While the Port may own and operate the replacement bridge, other options for the ownership and operation of the replacement bridge that may be considered include other governmental entities, a new bi-state bridge authority, and a public-private partnership, depending on the funding sources used to construct the replacement bridge.
- Vehicle lanes: The bridge would include one 12-foot travel lane in each direction, an 8-foot shoulder on each side, as shown in Exhibit 7.
- Bicycle and pedestrian facilities: The bridge would include a 12-foot wide shared use path separated from traffic with a barrier on the west side, as shown in Exhibit 7. In the middle of the bridge the shared use path would widen an additional 10 feet in two locations to provide two 40-foot long overlooks over the Columbia River and west into the CRGNSA with benches; the overlook locations are shown in Exhibit 5 and Exhibit 6. The cross-section of the overlooks is shown in Exhibit 7.
- Speed: The design speed for the bridge would be 50 mph with a posted speed limit of 35 mph.
- Vehicle restrictions: Vehicles would no longer be limited by height, width, or weight. Vehicles exceeding 80,000 lbs. that have approved trip permits could use the bridge.
- Tolling: Tolls for vehicles would be collected electronically so there would be no toll booth on either side of the bridge. No tolls would be collected from non-motorized users (e.g., pedestrians, bicyclists) who travel on the shared use path.
- Navigational clearance: Vertical clearance for marine vessels would be a minimum of 80 feet. The horizontal bridge opening for the navigation channel would be 450 feet, greater than the existing 300-foot wide federally recognized navigation channel, as shown in Exhibit 4. Centered within this 450-foot opening, there would be a 250-foot wide opening with a vertical clearance of 90 feet. Similar to the existing bridge, the replacement bridge would cross the navigation channel at roughly a perpendicular angle as shown in Exhibit 5 and Exhibit 6.
- Seismic resilience: The bridge would be designed to be seismically sound under a 1,000-year event and operational under a Cascadia Subduction Zone earthquake.

- Stormwater: Stormwater from the entire Project area (bridge and improved roadways) would be collected and piped to detention and treatment facilities on both sides of the bridge as shown in Exhibit 6. On the Washington side, separate stormwater facilities would be used for the roadways and the bridge.
- Roadway connections: The bridge would connect to SR 14 on the Washington side at a new two-lane roundabout slightly west of the existing SR 14/Hood River Bridge intersection, as shown in Exhibit 6. On the Oregon side, the southern end of the bridge would transition to Button Bridge Road, connecting to the local road network at the existing signalized Button Bridge Road/E. Marina Way intersection north of I-84. The private driveway on Button Bridge Road north of E. Marina Way may be closed under this alternative. Like the existing bridge, the replacement bridge would cross over the BNSF Railway tracks on the Washington side and over the Waterfront Trail along the Oregon shoreline.
- Bicycle and pedestrian connections: The new shared use path would connect to existing sidewalks along the south side of SR 14 in Washington and to roadway shoulders (for bicyclists) on both sides of SR 14 at the new roundabout with marked crosswalks, as shown in Exhibit 6. On the Oregon side, the shared use path would connect to existing sidewalks, bicycle lanes, and local roadways at the signalized Button Bridge Road/E. Marina Way intersection.
- Cost: Total Project construction cost is estimated to be $300 million in 2019 dollars.

Exhibit 5. Preferred Alternative EC-2 Alignment

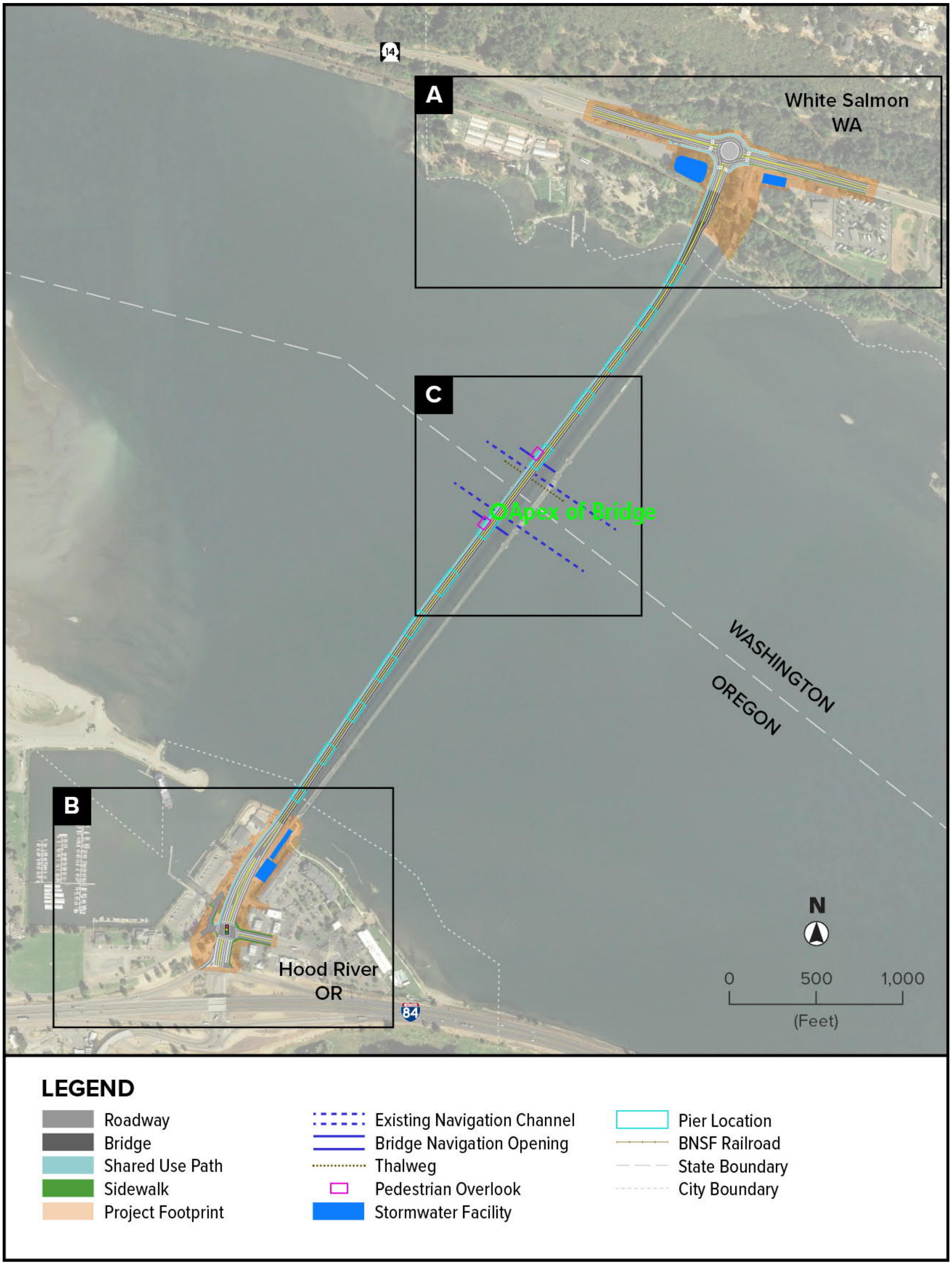


Exhibit 6. Preferred Alternative EC-2 Enlargements

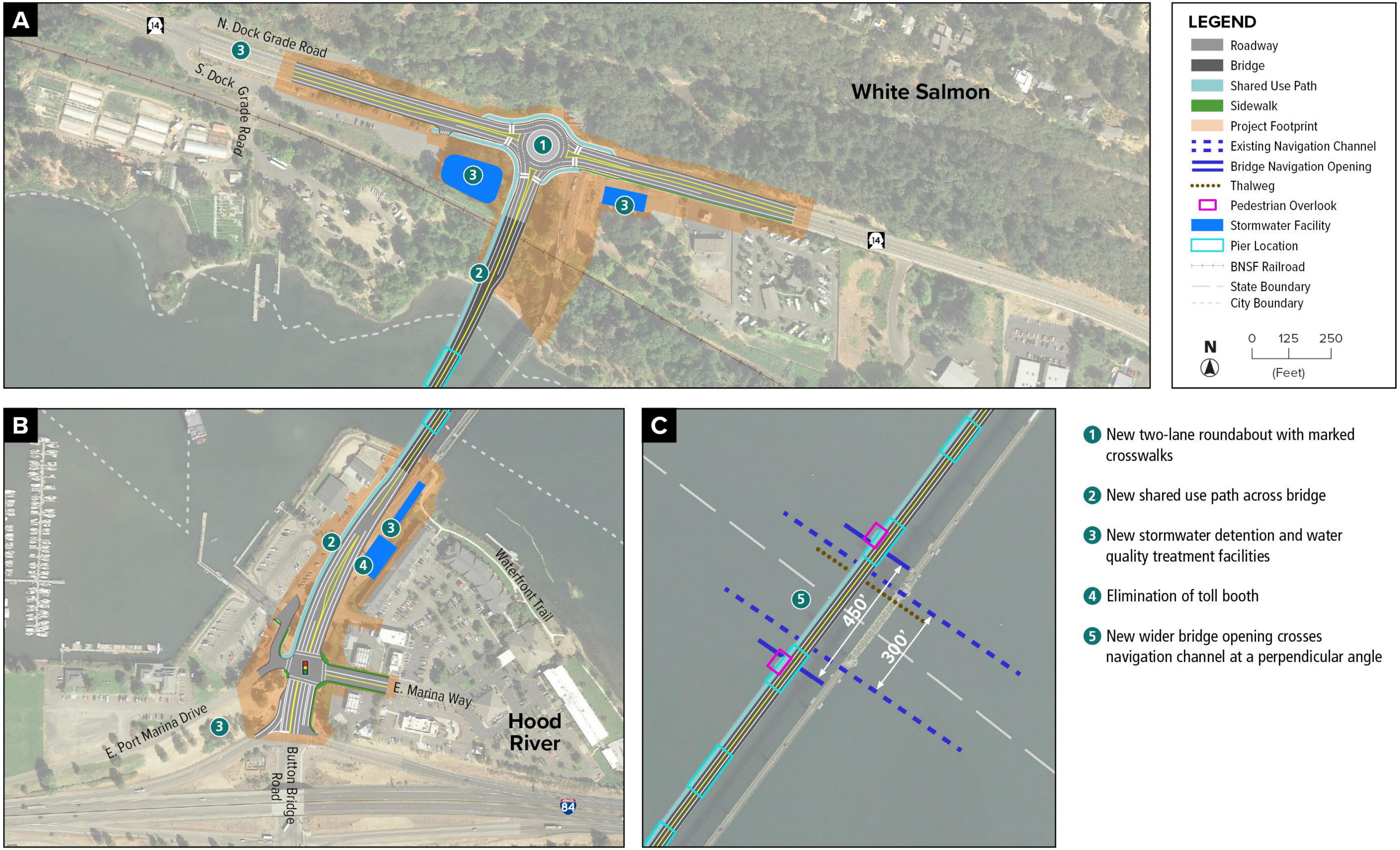


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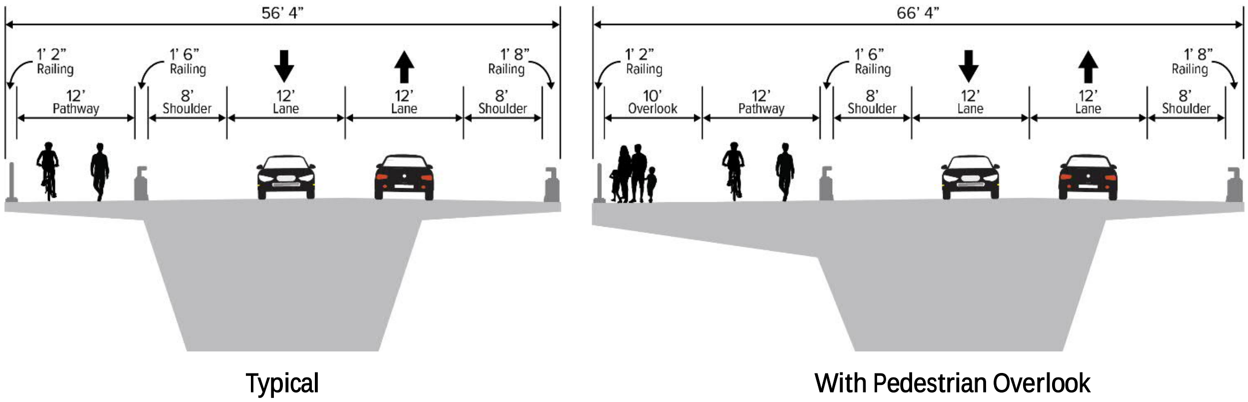
Exhibit 7. Replacement Bridge Typical Cross-Section



2.3. Alternative EC-1

Alternative EC-1 would construct a replacement bridge west of the existing bridge. Like Alternative EC-2, the existing bridge would be removed following construction of the replacement bridge. Exhibit 8 shows alignment of Alternative EC-1 and Exhibit 9 provides enlargements of the improvements that would be constructed under Alternative EC-1.

Like Preferred Alternative EC-2, the total Project construction cost for Alternative EC-3 is estimated to be $300 million in 2019 dollars. Under Alternative EC-3, elements of the replacement bridge would be the same as the elements described for Alternative EC-2 except:

- Alignment: The main span of the bridge would be approximately 700 feet west of the existing lift span. The bridge terminus in White Salmon, Washington, would be located approximately 2,309 feet west of the existing SR 14/Hood River Bridge intersection, while the southern terminus would be in roughly the same location as the existing terminus at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon.
- Type: The bridge would be a 4,553-foot fixed-span segmental concrete box girder bridge with a concrete deck and no lift span. Like Preferred Alternative EC-2, the bridge would have 12 piers in the Columbia River and one land-based pier on the Washington shore.
- Navigational clearance: The navigational opening would be the same as Alternative EC-2, but the bridge would cross the navigation channel at a more skewed angle than under Alternative EC-2.
- Roadway connections: Connections to roadways would generally be the same as Alternative EC-2, but the bridge would connect to SR 14 on the Washington side at a new two-lane roundabout at the SR 14/Hood River Bridge/N. Dock Grade Road intersection west of the existing bridge. Access to S. Dock Grade Road would be provided via the driveway east of the Mt. Adams Chamber of Commerce and Heritage Plaza Park and Ride.
- Bicycle and pedestrian connections: Connections to bicycle and pedestrian facilities would generally be the same as Alternative EC-2, but the roundabout intersection with SR 14 on the Washington side would be located further west at N. Dock Grade Road.

Exhibit 8. Alternative EC-1 Alignment

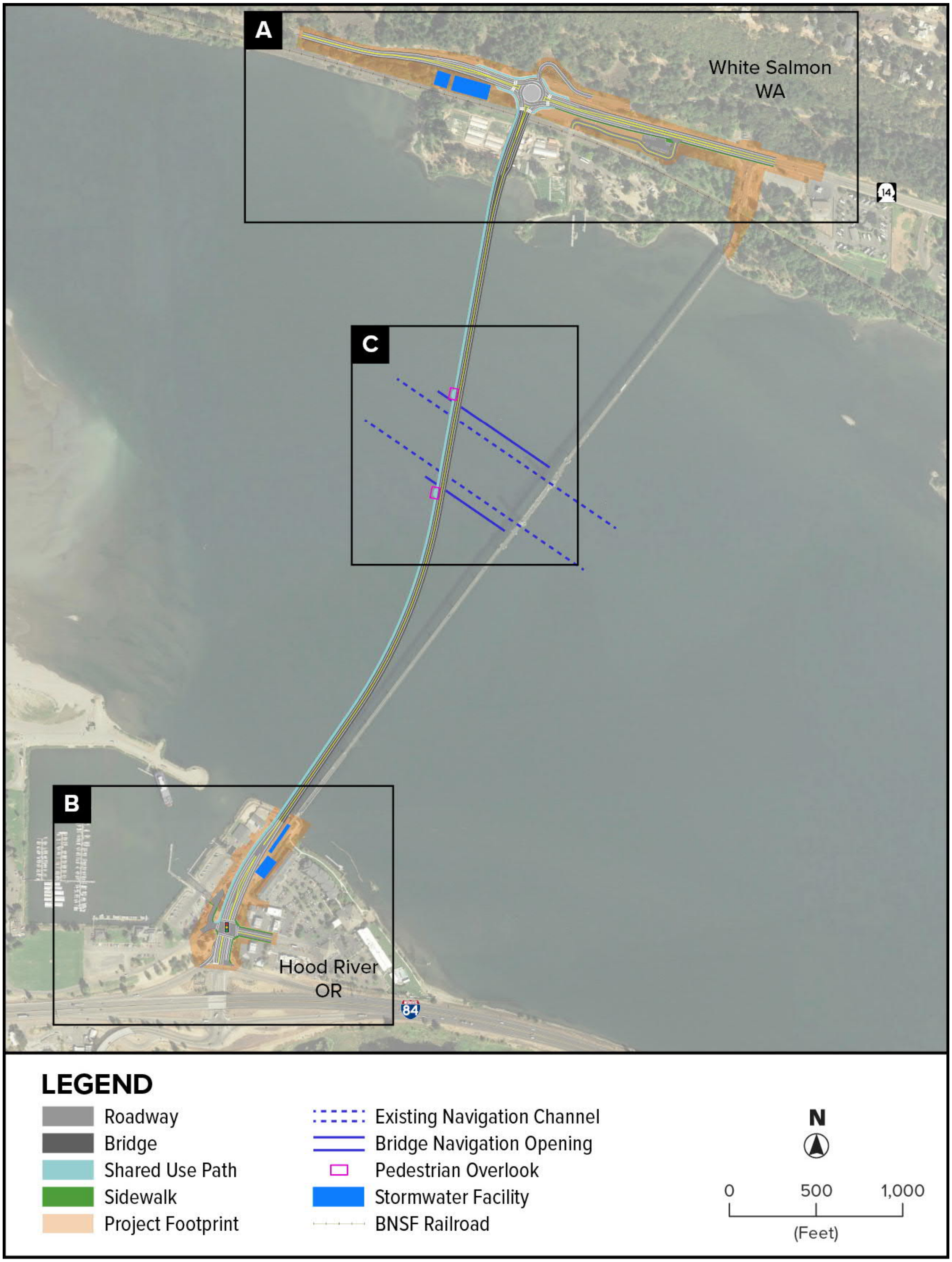
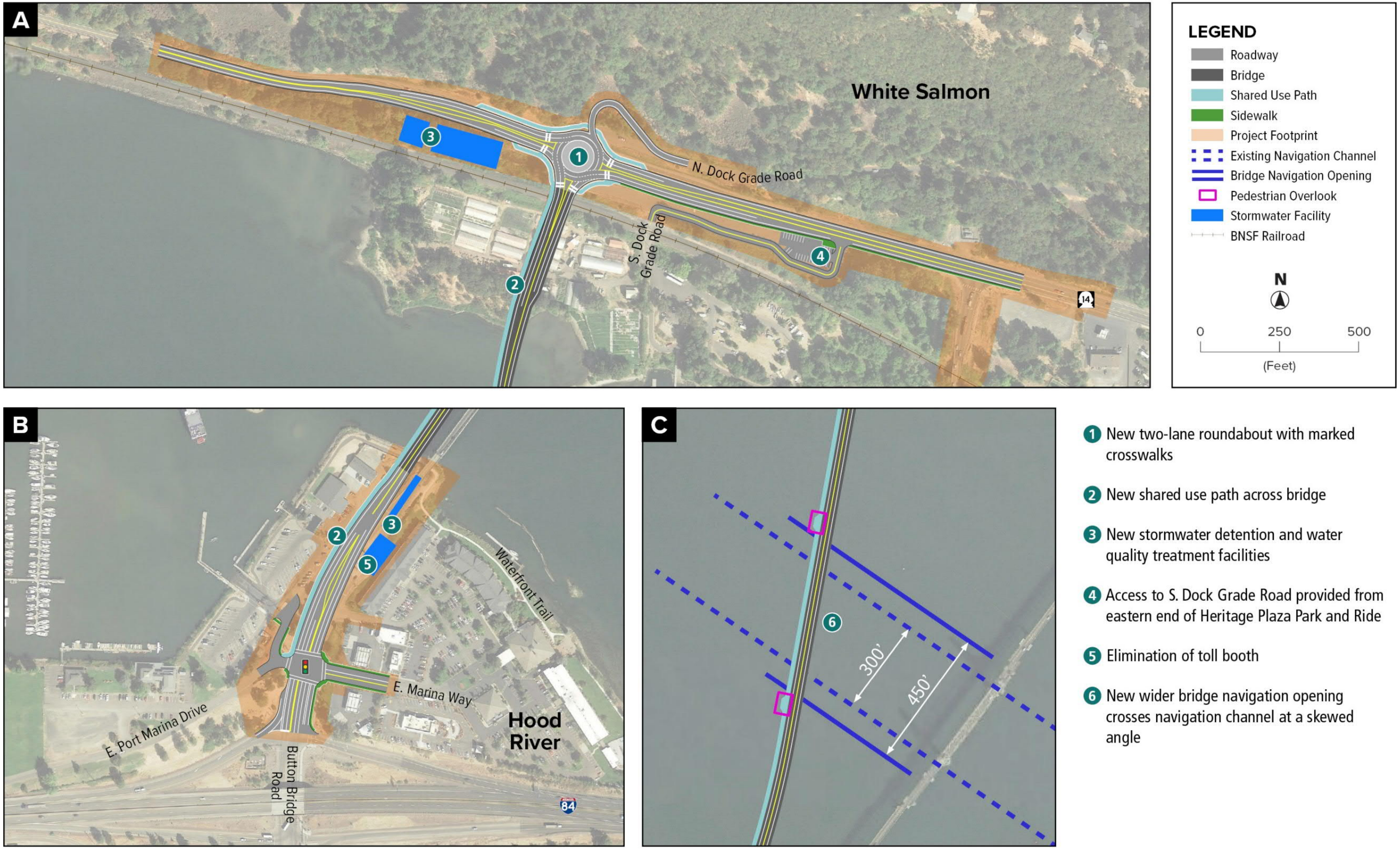


Exhibit 9. Alternative EC-1 Enlargements



1. New two-lane roundabout with marked crosswalks
2. New shared use path across bridge
3. New stormwater detention and water quality treatment facilities
4. Access to S. Dock Grade Road provided from eastern end of Heritage Plaza Park and Ride
5. Elimination of toll booth
6. New wider bridge navigation opening crosses navigation channel at a skewed angle

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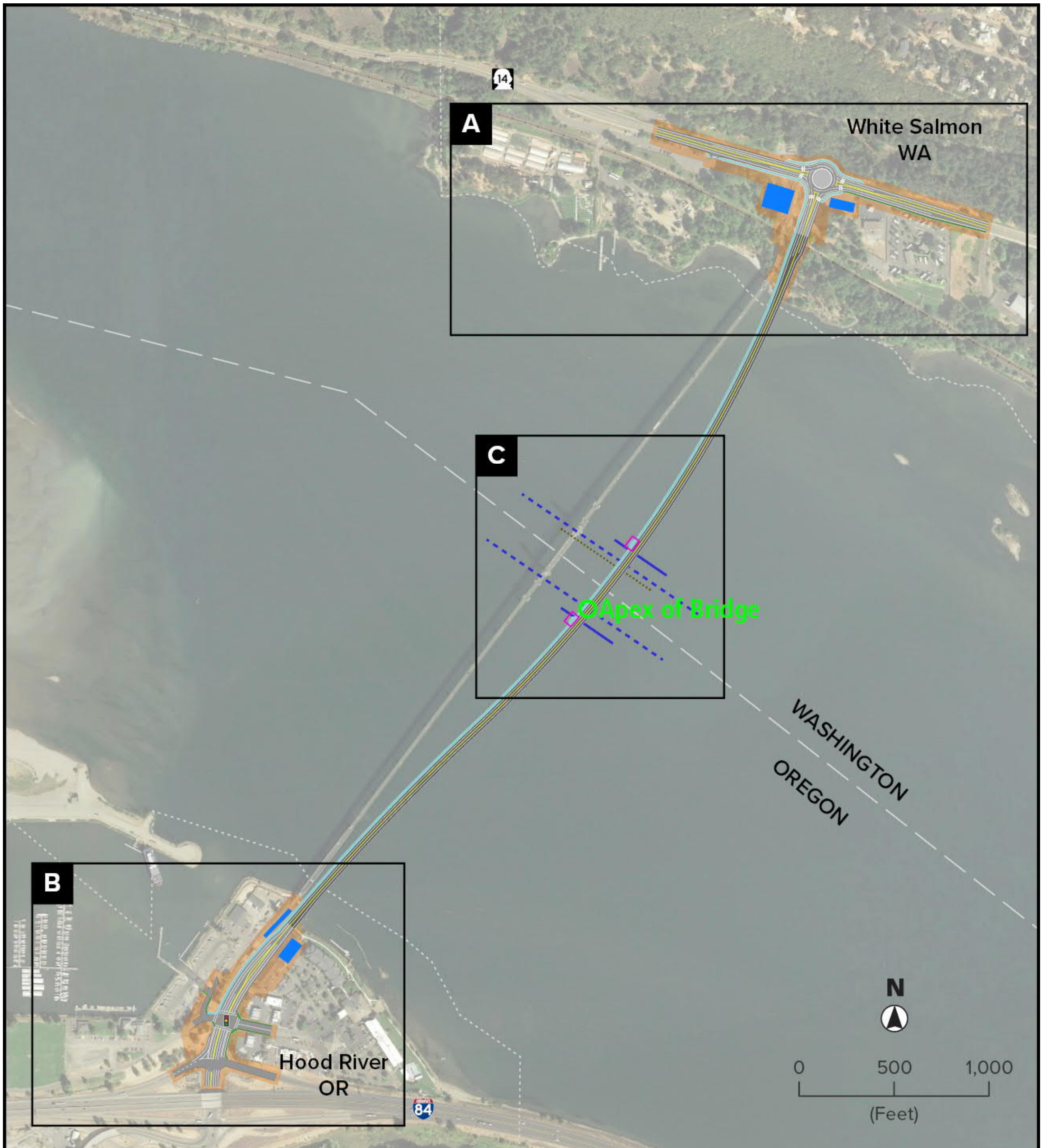
2.4. Alternative EC-3

Alternative EC-3 would construct a replacement bridge east of the existing bridge. Like Alternative EC-2, the existing bridge would be removed following construction of the replacement bridge. Exhibit 10 shows alignment of Alternative EC-3 and Exhibit 11 provides enlargements of the improvements that would be constructed under Alternative EC-3.

Like Preferred Alternative EC-2, the total Project construction cost for Alternative EC-3 is estimated to be $300 million in 2019 dollars. Under Alternative EC-3, elements of the replacement bridge would be the same as the elements described for Alternative EC-2 except:

- Alignment: The main span of the bridge would be approximately 400 feet east of the existing lift span. The bridge terminus in White Salmon, Washington, would be located approximately 140 feet east of the existing SR 14/Hood River Bridge intersection, while the southern terminus would be roughly the same as the existing terminus at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon.
- Type: The bridge would be a 4,553-foot fixed-span segmental concrete box girder bridge with a concrete deck and no lift span. Like Alternative EC-2, the bridge would have 12 piers in the Columbia River and one land-based pier on the Washington side of the river.
- Roadway connections: Connections to roadways would generally be the same as Alternative EC-2, but the bridge would connect to SR 14 on the Washington side at a new two-lane roundabout slightly east of the existing SR 14/Hood River Bridge intersection. On the Oregon side, improvements extend slightly further south to the Button Bridge Road/I-84 on and off ramps. The private driveway on Button Bridge Road north of E. Marina Way would be closed under this alternative.
- Bicycle and pedestrian connections: Connections to bicycle and pedestrian facilities would generally be the same as Alternative EC-2, but the roundabout intersection with SR 14 on the Washington side would be located approximately 264 feet further east than under Alternative EC-2.

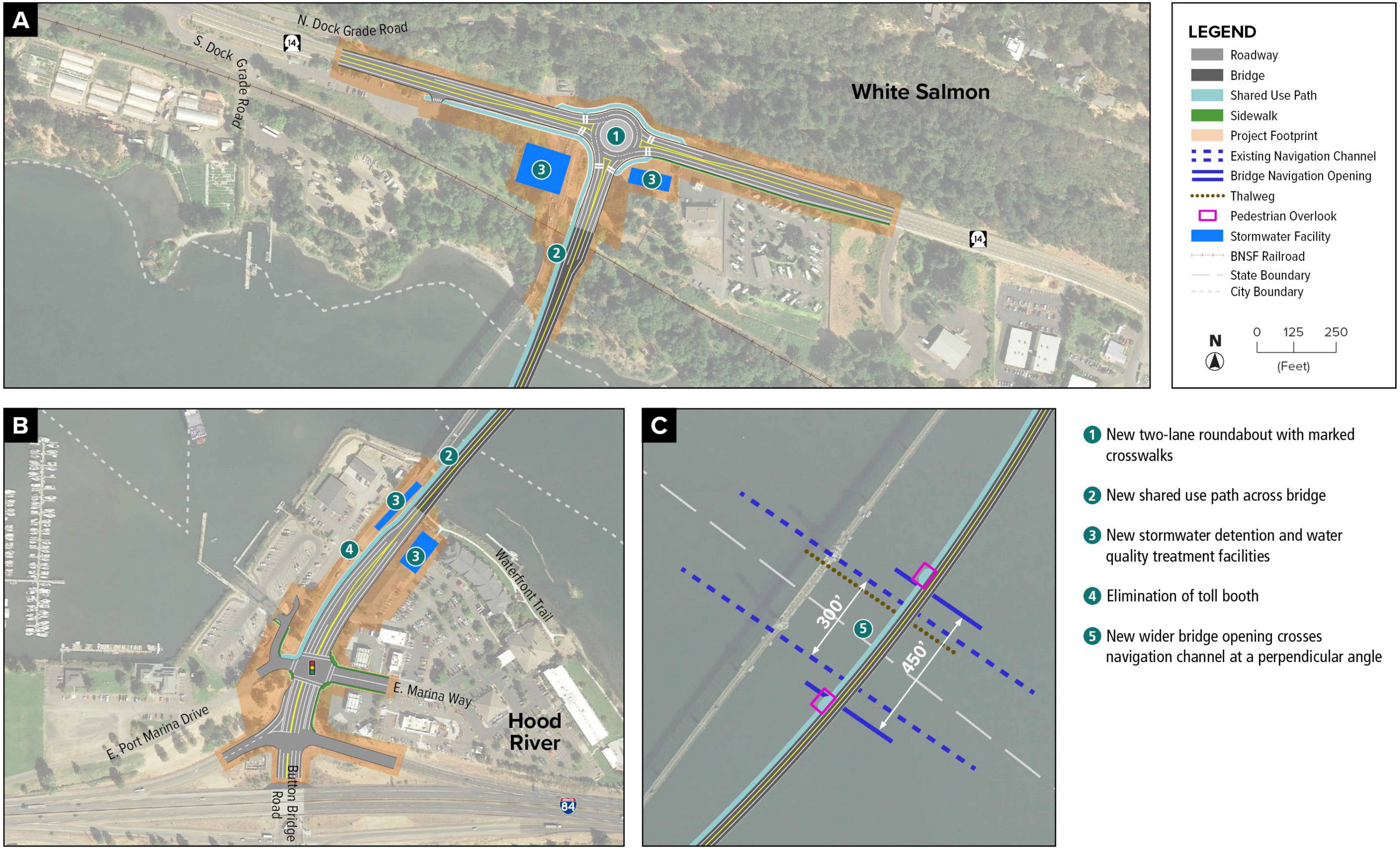
Exhibit 10. Alternative EC-3 Alignment



LEGEND

- Roadway
- Bridge
- Shared Use Path
- Sidewalk
- Project Footprint
- Existing Navigation Channel
- Bridge Navigation Opening
- Thalweg
- Pedestrian Overlook
- Stormwater Facility
- BNSF Railroad
- State Boundary
- City Boundary

Exhibit 11. Alternative EC-3 Enlargements



1. New two-lane roundabout with marked crosswalks
2. New shared use path across bridge
3. New stormwater detention and water quality treatment facilities
4. Elimination of toll booth
5. New wider bridge opening crosses navigation channel at a perpendicular angle

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2.5. Construction of the Build Alternatives

Construction of the build alternatives would be similar in duration and approach.

- Timeline and sequencing: The NEPA process is anticipated to be complete in 2021; subsequent phases of the Project would be dependent on funding availability. Construction would take approximately 6 years and would require work during approximately six in-water work windows (IWWWs). Approximately three IWWWs would be necessary to construct the replacement bridge, and approximately three additional IWWWs would be necessary to complete the removal of the existing bridge.
- In-water work window: Certain construction and removal activities conducted below the OHWM of the Columbia River would be restricted to an IWWW established for the Project. The IWWW would be established in permits for the Project through inter-agency coordination including Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), NOAA Fisheries, and USFWS. Preliminary discussions with these agencies indicate that the authorized IWWW would likely be October 1-March 15 of each year. In-water work activities that would be restricted to this IWWW would include vibratory and impact pile installation, installation of drilled shaft casings, installation of cofferdams, and unconfined wiresaw removal of the existing pier foundations. Vibratory pile removal would not be restricted to the IWWW.
- Mobilization and site preparation: The contractor would likely mobilize equipment to the construction site via barges and trucks. Erosion control measures (e.g., silt fences, etc.) and debris containment devices (i.e., floating debris booms) would be installed and clearing and grubbing limits would be established prior to vegetation removal. Barges would require anchoring, tethering, and spudding.
- Construction staging: At least two staging areas would be necessary for staging and storage of materials and equipment; the location of these areas would be determined later in the design process, including obtaining all relevant environmental permits and land use approvals. It is estimated that a minimum of 2 acres would be necessary for staging and storage of materials and equipment. Materials arriving by barge may be offloaded to upland staging areas or may be temporarily stored on barges. All staging areas and equipment fueling areas would be located above the OHWM and outside of environmentally sensitive areas. Staging and temporary access areas will occur in upland locations, on areas that are either already disturbed or that will be restored post-Project.
- Temporary work structures: The Project would likely require the installation of several temporary in-water structures during construction and removal of the existing bridge. These structures would include temporary work bridges, cofferdams, drilled shaft casings, and temporary piles. These temporary features would be designed by the contractor after a contract is awarded, but prior to construction.

  Three temporary work bridges would likely be installed to support construction activities. One temporary work bridge would be installed at each end of the replacement bridge alignment. A third temporary work bridge would be constructed on the Washington side of the river to support the removal of the existing bridge. These temporary structures would likely be supported by 24-inch steel pipe piles.

Additional temporary piles would be necessary throughout construction and removal of the existing bridge for a variety of purposes, including supporting falsework and formwork, pile templates, reaction piles, and for barge mooring. These temporary piles would also likely be 24-inch steel pipe piles.

Barges would be used as platforms to conduct work activities and to haul materials and equipment to and from the work site. Three barges would typically be needed at each pier during drilled shaft construction, and at least one barge would remain at each pier after shaft construction to support column and superstructure construction.

Temporary cofferdams would likely be installed to create isolated in-water work areas for certain activities. A temporary cofferdam would likely be installed to create an isolated in-water work area for construction of a spread footing foundation on the Washington shoreline. Sheet pile cofferdams may also be installed at one or more piers on the existing bridge to create an isolated work area for removal of the existing bridge foundations.

Drilled shaft shoring casings would also be installed as temporary work structures to create isolated work areas for drilled shaft construction. An outer steel casing, with a diameter approximately 12-inches larger than that of the finished drilled shaft, would be installed to act as an isolation structure. The outer cases will be 84 inches in diameter for the 72-inch shafts, and 108 inches in diameter for the 96-inch shafts.

- Work area isolation and fish salvage: To minimize impacts to fish, fish salvage measures would be employed to remove fish from temporarily isolated in-water work areas during and after the installation of drilled shaft shoring casings and cofferdams. Fish salvage would follow the best management practices (BMPs) established in the biological opinion for FHWA and ODOT's Federal Aid Highway Program programmatic consultation and would be supervised by a fish biologist. A fish biologist with the experience and competence to ensure the safe capture, handling, and release of all fish will supervise all fish capture and release. To minimize take, efforts will be made to capture ESA-listed fish known or likely to be present in an in-water isolated work area using methods that are effective, minimize fish handling, and minimize the potential for injury. Attempts to seine and/or net fish, or the use of minnow traps shall precede the use of electrofishing equipment. Isolation structures will be installed such that they will not be overtopped by high water. A reasonable effort would be made to re-locate threatened or endangered fish using methods that minimize the risk of injury.
- Bridge foundation installation: The foundations for the replacement bridge would consist of three different foundation types: 1) pile-supported foundations; 2) drilled-shaft-supported foundations; and 3) spread footings. In general, pile-supported foundations would be used at locations where the depths to bedrock are relatively deep (greater than 50 feet below ground surface) while drilled shaft-supported foundations would be more economical in locations where depths to bedrock are nearer to the surface (less than 50 feet below ground surface). Spread footings would be used where bedrock is located at or near the surface and deep foundations are not required.

  Pile-supported foundations would be supported by 48-inch diameter steel pipe piles. The typical in-water foundation would require 25 piles, where-as smaller terrestrial pile-supported foundations would require fewer piles. Piles would be installed with a vibratory hammer to the extent practicable, as a means of minimizing impacts associated with underwater noise. An impact hammer would be used to drive the piles to the final tip elevation, and/or to proof the piles to verify load-bearing capacity.

Drilled shaft-supported foundations would be supported by either 72-inch-diameter drilled shafts or 96-inch-diameter drilled shafts. The larger-diameter drilled shafts would be used on the bents that flank the navigation channel. Installation of drilled shafts would be conducted by first oscillating an outer steel casing to a specified design depth. As the casing is being advanced to the design depth, soil would be removed from inside the casing using an auger and clamshell. Excavated soils would be temporarily placed onto a barge with appropriate containment and ultimately placed at an approved upland site. Once the interior of the casing has been excavated to the design depth, an interior steel casing of the finished diameter of the shaft would be installed. This casing would be installed either with an oscillator or vibratory hammer. Once the interior casing has been installed to final depth, a steel reinforcement cage would be installed within the casing, and the shaft would be filled with concrete.

Construction of spread footing foundations below the OHWM of the river would be conducted within a temporarily dewatered work area within a cofferdam. Once the cofferdam is installed and the work area established, formwork would be installed for the spread footing, steel reinforcing would be installed within the forms, and the concrete for the footing would be poured. The cofferdam would remain in place until the concrete is fully cured to allow the concrete to cure in a dewatered environment. Once the concrete for the footing is fully cured, the formwork would be removed followed by the temporary cofferdam.

- Bridge superstructure construction: Once the foundation piles and drilled shafts are installed, a concrete pile cap would be installed atop the shafts at the waterline, and the concrete pier and superstructure would be installed atop the pile cap. Pile caps may be either precast or cast-in-place.

  The superstructure would consist of both precast and cast-in-place concrete segments. Additional finish work would also be conducted, including surfacing, paving, and installation of other finish features, such as striping and signage.

  Work on the superstructure would be conducted either from the bridge deck, from the deck of temporary work bridges, or from barges. It is anticipated that the superstructure would be constructed using a balanced cantilever method that uses paired sets of form travelers to build outwards from each pier. It is assumed that a contractor may operate up to four pairs of form travelers at a given time to expedite the construction of the superstructure.

  Many of the bridge superstructure components would be composed of precast concrete. Precast elements would likely include bridge columns, beams, girders, and deck panels. Precast bridge elements would be constructed in upland controlled environments and would be transported to the Project site by either barge or truck.

- Dismantling and removal of the existing bridge: The existing bridge would remain open until the replacement bridge is constructed and operational, at which point it would be dismantled and removed. This work would be conducted via barges and/or temporary work platforms and may require in-water isolation.

  Removal of the superstructure would most likely be conducted by barge-mounted cranes. Removal of the superstructure would likely begin with removal of the counterweights, followed by the lift towers and the individual truss sections. The lift towers and truss sections would be cut into manageable pieces and loaded onto barges or trucks by a crane. Each section would then be either transported to an upland site for further dismantling or disposed of directly at an appropriately permitted upland facility.

Removal of the existing foundations would be conducted by one of the following two methods:

- o Wiresaw removal to mudline, without a cofferdam. A diamond wire/wire saw would be used to cut the foundation into manageable pieces that would be transported to a barge and disposed of in a permitted off site upland location. The foundations would be removed to the mudline and the substrate would be naturally restored with surrounding sediments.
- o Wiresaw or conventional pier removal techniques within a cofferdam. Conventional removal techniques consist of using a hydraulic ram to break the piers into rubble, and torches or other cutting methods to cut reinforcement. Materials would then be transported to a barge and disposed of in a permitted off site upland location. The foundations would be removed to the mudline and the substrate would be naturally restored with surrounding sediments.

It is assumed that the cofferdam removal option would be used at both piers that flank the navigation channel, but may also be used in other pier locations. At the two navigation channel piers, once cofferdams are installed and fish salvage has occurred, approximately 7,800 cubic yards of existing riprap would be removed. Riprap would be removed via a barge mounted clamshell, and loaded onto barges, and disposed of at an off-site permitted upland location. Once riprap has been removed, the existing piers would either be removed using one of the methods described above.

- Post-Project site restoration: Construction of the Project would result in temporary impacts to native and non-native vegetation on both the Oregon and Washington sides of the river. Areas temporarily disturbed during construction would be restored upon completion of the Project consistent with state and local regulations.

  On the Oregon side of the river, most temporary disturbance would occur within areas that are either impervious or already developed. Temporary disturbance would occur within areas that consist of landscaping, lawns, or similar heavily managed vegetation. Post-Project site restoration in these areas would likely consist of replacement landscaping with similar ornamental species. No native plant communities would be disturbed on the Oregon side of the river.

  On the Washington side of the river, vegetation would be cleared within temporary work zones to allow construction equipment to access the site, to construct the replacement bridge abutments and stormwater treatment facilities, and to remove the existing bridge. A portion of the area to be cleared would be within a forested riparian area that is within the 200-foot shoreline jurisdiction of the Columbia River, and is regulated by the City of White Salmon under its Shoreline Master Program (City of White Salmon 2016). A large oak tree that is present east of the existing bridge would be preserved and would not be affected.

  Temporarily disturbed areas within ODOT and WSDOT rights-of-way would be replanted consistent with applicable ODOT and WSDOT requirements and design standards. Temporarily disturbed vegetation within the riparian shoreline buffer on the Washington side of the river would be conducted consistent with requirements in the City of White Salmon Critical Areas Ordinance (White Salmon Municipal Code Chapter 18.10) (and Shoreline Master Program (City of White Salmon 2016).

- Compensatory Mitigation: The Project would result in permanent impacts to wetland and aquatic habitats, and a compensatory mitigation plan would likely be required by federal, state and local regulations to offset these permanent impacts. The compensatory mitigation plan would be developed during the permitting phase of the project. The mitigation plan would identify the amount, type, and specific locations of any proposed compensatory mitigation actions, specific impact avoidance and minimization measures to be implemented, as well as the goals, objectives, and performance standards for measuring success. Full implementation of the compensatory mitigation plan would be a condition of the applicable permits of the agencies with jurisdiction (i.e., USACE Section 404 permit, the Oregon Department of Environmental Quality [DEQ] and the Washington State Department of Ecology [Ecology] Section 401 permits, the Oregon Department of State Lands [DSL] Removal-Fill permit, WDFW Hydraulic Project Approval, and City of White Salmon Shorelines and Critical Areas permits), and the mitigation would comply fully with all applicable permit terms and conditions.

The method of delivery for Project final design and construction has not been determined at this time. Traditional delivery methods, such as design-bid-build, and alternative delivery methods, such as design-build and public-private-partnerships to name a few, will continue to be considered by the Port. As part of Oregon's HB 2017, the Port was provided legal authority by the state to enter into a public-private-partnership.

3. METHODOLOGY

Geology and soils were previously analyzed in the Project's Draft EIS and Geology and Soils Technical Report (Parsons Brinckerhoff 2003). The impact analysis for geology and soils analysis was updated with current data and information.

3.1. Area of Potential Impact

The area of potential impact (API) for the geology and soils analysis is shown below in Exhibit 12. The API encompasses the area anticipated for direct and indirect impacts to geology and soils resulting from the Project.

3.2. Regulations, Standards, and Guidelines

There have been no substantive changes in federal, state or local laws, regulations or policies that would significantly change the impact analysis approach for geologic and soil resources. The bridge would be designed to comply with the latest seismic design criteria:

- Oregon Department of Transportation (ODOT) Bridge Design Manual, May 2018
- Washington Department of Transportation (WSDOT) Bridge Design Manual (LRFD [Load and Resistance Factored Design]) M23-50.18, June 2018.

Exhibit 12. Geology and Soils API

3.3. Sources of Existing Data

The Draft EIS and prior Geology and Soils Technical Report was used to provide the initial framework for the affected environment section of this report. Updated geologic hazards were identified through mapping developed by the Oregon Department of Geology and Mineral Industries and the Washington Geologic Survey. Existing data from a regional perspective were also reviewed to identify geological hazards, such as localized faulting in Hood River, Klickitat, and Skamania counties, that may impact the API. The regional geologic setting was updated using the May 2011 Final Geotechnical Foundation Recommendation included with the 2011 TS&L study, the Geotechnical Data Report and the Foundations Recommendations Technical Memorandum (Parsons Brinckerhoff 2011).

3.4. Data Collection or Development

The following data was reviewed to assess the Project's impacts to soils and geology:

- Existing impervious surfaces within public right-of-way
- New impervious surface within public right-of-way
- The amount of upland ground disturbance during construction expressed in acres
- The depth of the proposed foundations below top of mudline of the Columbia River
- Seismic Design Criteria

3.5. Impact Analysis Techniques

3.5.1. Construction Impacts

The construction impacts section was updated based upon the bridge foundation types identified in the TS&L study and any geotechnical work completed as part of preliminary engineering. The potential for soil erosion from upland grading activities was also addressed. The plans were reviewed to identify areas where temporary excavations, fill slopes, or embankments may require shoring or laid back slopes.

3.5.2. Direct Impacts

Long-term direct impacts are primarily related to erodible soils near the water's edge and sloughing or settlement of soils from fill embankments. The Project was analyzed for potential seismic hazards. A seismic design criterion will need to be developed for the Project as ODOT and WSDOT have differing seismic design criteria.

3.5.3. Indirect Impacts

Indirect impacts are related to grading fill slopes too steeply or establishing high-maintenance exposed soil slopes that can lead to long-term erosion problems.

3.6. Agency Coordination

Coordination with natural resource agencies occurred regarding the methods and means related to in-water work for foundation construction and foundation removal. The Project team coordinated with ODOT and WSDOT to determine the seismic design criteria that will be applied to the Project.

4. AFFECTED ENVIRONMENT

4.1. Setting

4.1.1. Climate

The project is in the transition zone between the wet western sides of Washington and Oregon and the arid central and eastern sides. The north side of the Columbia River Gorge near the City of White Salmon is dominated by oak, Douglas fir, Ponderosa pine and shrubs, while a mixture of Douglas fir, Ponderosa pine, and shrubs exists along the southern side of the Columbia River Gorge near the City of Hood River. The north side of the Columbia River Gorge has a dry microclimate due to the southern exposure of the steep Columbia River Gorge wall. The south side is wetter because the amount of sunlight is less on the north slopes. Rainfall averages approximately 30 inches per year, compared to approximately 77 inches per year at Bonneville Dam (20 miles west) and approximately 14 inches per year at The Dalles (20 miles east). The area is characterized by partially vegetated thin, rocky soils with lots of exposed bedrock outcroppings and talus slopes.

4.1.2. Geology

The following discussions of the regional and local geology are derived from the 2003 Geology and Soils Technical Report and from a variety of geologic mapping efforts and hazard analyses. Huntting et al. (1961) conducted geologic mapping for Washington and Walker and MacLeod (1991), Wells and Peck (1961), and Walsh et. al. (1987) conducted geologic mapping for Oregon. Alt and Hyndman (1984) and Waters (1973) describe the overall geology of the Columbia River Gorge.

The oldest basement rocks defined in the stratigraphic column in the Columbia River Gorge are part of the Ohanapecosh formation, composed of a mixture of old andesitic lava flows and the sedimentary debris eroded from them. The Eagle Creek formation overlies this formation and is composed of silts and sandstones derived from volcanic sources. These formations are exposed on the west end of the Columbia River Gorge; however, in the Project area, they are covered by sequences of Miocene basalt flows of the Columbia River Basalt Group and Pleistocene basalt flows of the High Cascades. The Ohanapecosh and Eagle Creek formations slope gently to the south and are almost impervious to water. Water percolates down through the overlying rocks and collects in the ancient soils on top of these formations, creating an unstable saturated layer where the overlying rocks are susceptible to mass movements to the south.

A series of massive basalt flows beginning about 15 million years ago formed the Columbia River Basalt Group, which constitutes five distinct formations and reaches a maximum thickness 16,000 feet near the Pasco Basin. These flows spilled into ancient Columbia River canyons multiple times, each time changing its course, and over time pushed the river north into its current location. Growth of the Cascade Mountains subsequently uplifted and folded the basalt flows, but the Columbia River continued to cut through these flows as they uplifted.

During the last ice age (approximately 12,000 years to 16,000 years ago) repeated catastrophic flooding, known as the Missoula Floods and originating from periodic glacial outbursts of the Clark Fork River in Montana, continued to carve the steep-walled Columbia River Gorge through the layers of basalt and created enormous depositional features. Since the last of the Missoula Floods, erosion of the Columbia River Gorge walls and seasonal flooding of the Columbia River and tributary rivers have added unconsolidated sediments to the bottom of the Columbia River Gorge and re-worked some of the earlier flood deposits. A series of ancient and relatively recent landslides exist near Bonneville Dam where basalt and Eagle Creek formations overlying the Ohanapecosh formation moved downslope (to the south) along a weak boundary layer.

Land based features within the API would be located just above the water level of the Bonneville Pool of the Columbia River (approximately 74 feet National Geodetic Vertical Datum of 1929 (NGVD29)). On the north side of the API, features would be partially located on the downstream end of a large flood-deposited bar. Erosional deposits overlie the top of this bar, primarily consisting of weathered basalt of the Grande Ronde Basalt Formation derived from the steep talus slope immediately to the north. SR 14 lies at the immediate bottom of this talus slope and N. Dock Grade Road is cut into it.

On the south side of the API, near surface materials are composed of Columbia Plateau basalts that were scoured by the Missoula Floods. This area was then filled by alluvial deposits from the Hood River and more recently by imported fill associated with human development.

4.1.3. Soils

The soils on the Washington side of the Project are silt loams. Per the Natural Resources Conservation Services (unpublished), the API lies within mapped soil unit 49A-Kiakus silt loam, 2 percent to 5 percent slopes. These soils formed in loess and materials weathered from basalt and are found on benches and terraces (in this case an old Missoula Flood bar). These soils are moderately deep and well drained, although when wet they have a slow infiltration rate. Runoff potential is moderate.

Two subsurface boring studies have also been conducted near the north end of the bridge (Geoengineers 1996; Fujitani Hilts 1999). Where present, soils exist as an alluvial cover consisting of silty fine- to medium-grained sand with some gravel. Several layers of gravel were found beneath this sand and above the basalt at some locations. In one boring under the north bridge approach approximately 12 feet of gravel was found. Several of the borings conducted in the river found sand overlying the basalt and one found gravel underneath the sand.

The soils on the Oregon side of the Project are composed of xerofluvents. Per the Natural Resource Conservation Service (2003), the API lies within mapped soil unit 30A-Xerofluvents, nearly level. These soils formed in recently deposited alluvium from sandy and ashy outwash (originating from the Hood River). These soils are generally well drained and permeable with only slight erosion hazard. The area around the south end of the existing bridge was a pear orchard from about 1919 until Bonneville Dam was constructed and the reservoir flooded the area, creating a swamp (Dames and Moore 1965). In the 1950s a dike was constructed around the area to retain sand pumped from the Columbia River as fill material.

Two subsurface boring studies were conducted near the south end of the bridge (Dames and Moore 1965; Shannon and Wilson 1988). These borings encountered fill materials in some cases up to 18 feet deep consisting mostly of fine- to medium-grained sand. Some areas of sand and gravel were also found. Native alluvial soils were encountered below the fill, varying from about 6 feet to 26 feet deep and consisting mostly of fine, silty sand. Where these materials are saturated, they are considered susceptible to liquefaction.

4.1.4. Geologic Hazards

The geologic hazards within the Project area fall into three major categories: erosional hazards, earthquake hazards, and volcanic hazards. Scott, et. al. (1997 and 1995) and Beaulieu (1977) describe geologic hazards for Mt. Hood, Mt. Adams, and parts of Hood River County. Areas of slope stability and liquefaction concern are mapped in Exhibit 13.

Erosion

Erosional hazards are associated with normal erosion processes. The areas of greatest hazard from this type of process are associated with the steep slopes on the north side of API. The north wall of the Columbia River Gorge rises approximately 400 feet above the river and is composed of steep basalt cliffs. Rocks and boulders falling from these cliffs have built steep talus slopes at their bases. These slopes lie at the angle of repose and are susceptible to movement, especially if the toe is disturbed or cut, such as by road construction. Rockfall from the steeper cliffs above the slope is a low, but constant hazard.

Flooding may also cause erosion. However, because dams control much of the Columbia River system, serious flooding is unlikely. Although flooding in the Hood River system does occur, floodwaters typically disperse by the time they reach the Project area and the likelihood that they would cause substantial damage is low. In a major flood on the Hood River, some sedimentation near the south end of the bridge may occur.

Earthquakes

Part of the Hood River fault complex sits east of the API. These faults are considered to be inactive over the past 1.6 million years (University of Oregon 2003). No major earthquake activity has been associated with the API or surrounding areas in recent history. Moderate earthquakes centered in the Willamette Valley and in areas to the east may periodically affect the API. Periodic massive subduction zone earthquakes would affect most of the Pacific Northwest. Within the API, the hazards most likely to occur from earthquakes include damage to structures from liquefaction, ground motion amplification, and landslides.

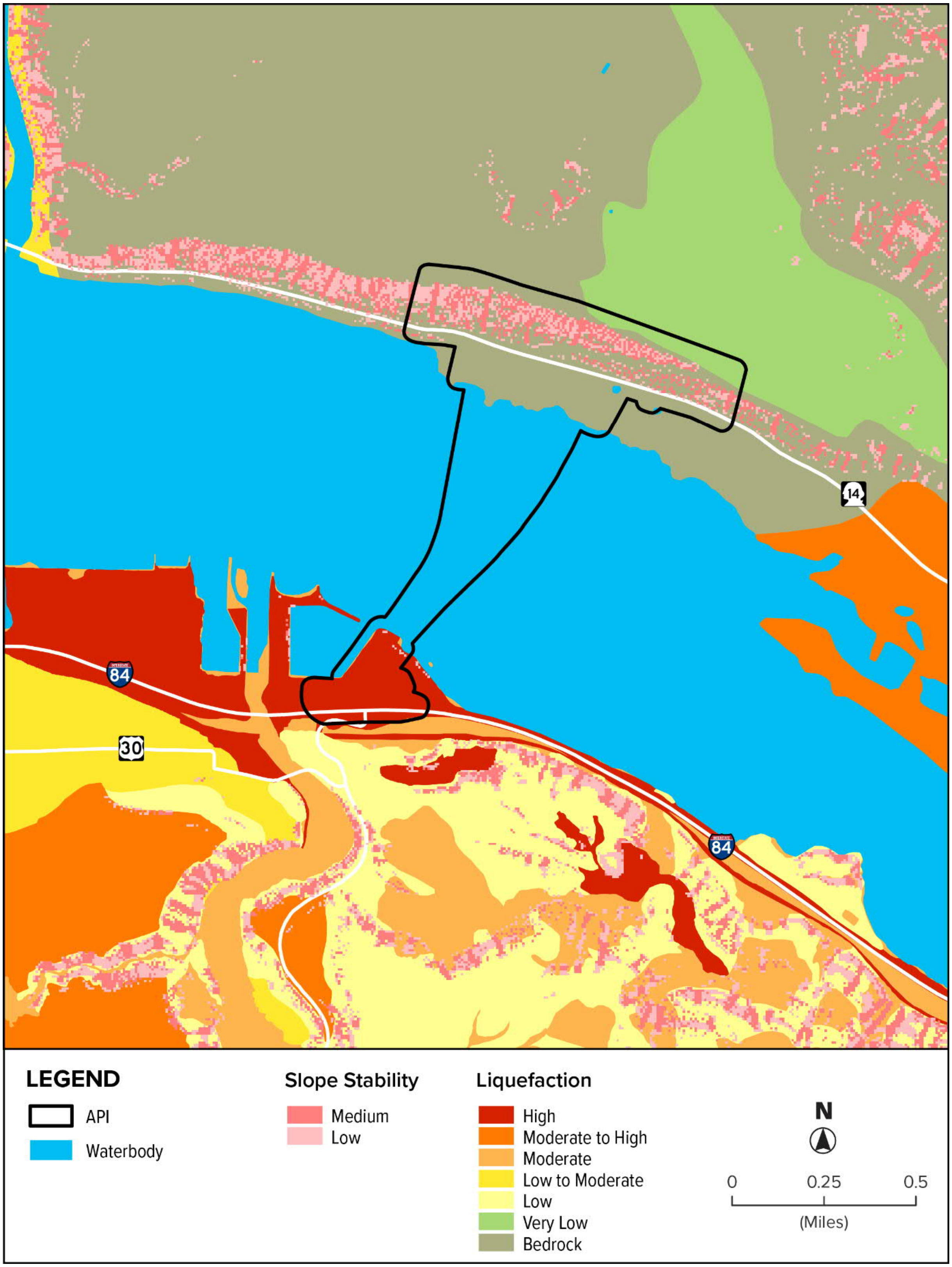
Liquefaction

Liquefaction is a process whereby saturated, non-plasticity to low plasticity soils lose shear strength during and immediately after seismic shaking. Shear stresses transmitted through the soil column cause particles to dislodge and contract or collapse, increasing pore pressures if the water cannot drain quickly enough. This increase in pore pressure causes a decrease in frictional resistance at particle interfaces, resulting in an effective loss of shear strength and ground settlement. The strength loss and ground movement associated with liquefaction can cause structures to tilt, sink, or collapse.

The risk of liquefaction appears to be less on the north side, where talus materials and exposed bedrock are present. Also, the north side is generally higher above the river, with less potential for saturated soils. The south side of the bridge approach is built on fill materials and weak soils only slightly above the water level of the Columbia River. This area is considered susceptible to liquefaction if an earthquake of sufficient magnitude were to occur.

If a large subduction zone earthquake were to hit, it is likely that extensive liquefaction would occur along the south end of the bridge and in the sediments on the river bottom. The probability of either type of earthquake occurring in the foreseeable future is moderate.

Exhibit 13. Slope Stability and Liquefaction Areas in the Project Area



Ground Motion Amplification

Seismic waves traveling through bedrock can be amplified and have their period altered when being transmitted into softer/looser materials, such as those that overlie the API. These higher amplitude, longer period waves can be more damaging to structures than the higher frequency movements in bedrock or bedrock overlain with very shallow or well consolidated soils. Since much of the API is overlain by softer alluvial and fill materials, the risk for ground motion amplification to occur in those areas is moderate.

Landslides

Seismic shaking may also trigger small or medium landslides near or within the API. The steep talus slope along the northern edge of the Project is considered susceptible to landslides if subject to strong seismic shaking.

The threat of a major subduction zone earthquake (a magnitude 9 or greater) exists. The last major subduction zone earthquake is thought to have occurred in 1700 and is estimated to have been a magnitude 9 (Pacific Northwest Seismograph Network 2003). Although there is conflicting evidence, some researchers believe that this earthquake may have been responsible for the enormous Bonneville landslide in the western Columbia River Gorge (Hill 2002). If another earthquake of similar magnitude were to occur, it is likely that widespread damage would occur in the Columbia River Gorge, including the potential for large landslides in the API. Due to the great depth of the unstable Ohanapecosh and Eagle Creek layers near the Project area, a catastrophic landslide like the Bonneville landslide is not likely to occur near the API.

Other Earthquake Effects

Other seismic hazards include fault rupturing and seiches (large waves) in the Columbia River. A series of faults do exist near the Hood River area; however, none are considered to be recently active (University of Oregon 2003). Although the likelihood of fault rupture within the Columbia River Gorge is considered low, there is greater potential for seiches due to landslides terminating in the river. Due to the relatively shallow depth of the river and its narrow width, it is unlikely that a seiche large enough to cause major destruction would be generated, however, some local erosion could occur.

Volcanoes

Two nearby volcanoes, Mt. Hood and Mt. Adams, may also pose a geologic hazard to the API. A large eruption, landslide, or debris flow on Mt. Hood could cause a lahar (a watery flow of volcanic rock and mud) to rush down the Hood River valley and, depending on its size, cause catastrophic damage to the Hood River area. A large event could cause bank erosion and flooding on the north side of the Project area and extensive sedimentation in the Columbia River. Eruptions, landslide, or debris flows on Mt. Adams could cause a lahar to rush down the White Salmon River, approximately 1 mile downstream of the API (Scott et. al. 1995). Scott, et. al (1997) indicate that a large lahar originating from Mt. Hood could inundate the south edge of the API and create a large depositional delta. The API is considered much less susceptible to damage from an event on Mt. Adams or surrounding areas than from an event on Mt. Hood, due to its distance from Mt. Adams and its location upstream of the mouth of the White Salmon River.

5. ENVIRONMENTAL CONSEQUENCES

5.1. No Action Alternative

5.1.1. Direct Impacts

There would be no impacts to geology and soils from the continued operation and maintenance of the existing bridge and bridge approaches under the No Action Alternative. No ground-disturbing activities would occur with the No Action Alternative. The existing bridge does not meet current seismic design standards and the Oregon side is underlain by liquefiable soils. The risk to the existing bridge from geologic hazards is currently low to moderate. The No Action Alternative should not substantially increase this risk.

If a catastrophic geologic event occurs such as an earthquake, landslide, or lahar flows from a Mt. Hood volcanic event prior to the close of the bridge in 2045, direct impacts could include bridge damage or failure and premature bridge closure. Vehicles would no longer be able to use the bridge sending them on circuitous routes and the bridge lift could be stuck or inoperable following a catastrophic geologic event preventing some vessels from passing.

5.1.2. Indirect Impacts

There would be no indirect impacts to geology and soils from the No Action Alternative.

5.2. Preferred Alternative EC-2

5.2.1. Construction Impacts

On the Washington side of the river, Alternative EC-2 would lie west of and roughly parallel with the existing bridge. A small embankment, potentially held up by retaining walls, would be built north of the railroad tracks to provide the approach to the bridge and clearance over the railroad tracks. New piers would be built close to the edge of the Columbia River south of the railroad tracks. Some additional fill materials would be required to bring the approach along SR 14 to the new roundabout intersection to the proper grade. The major earthwork locations are flat, so the erosion potential is slight. However, a number of large cottonwoods and pine trees would be removed by bridge construction and could lead to an increase in potentially erosive surfaces. The bridge pier construction would also require tree removal around the work area, which is close to the Columbia River. The risk of soil erosion would be high in this area during construction. The total area of disturbance for Alternative EC-2 on the Washington side would be approximately 8.4 acres (Exhibit 14).

Within the river, 12 piers would be constructed using a variety of foundation types depending on the location within the river and the depth to bedrock from the top of river bottom. On the Washington half of the bridge (north half from mid-span over the navigation channel), the foundations would be drilled shafts with embedment depths ranging from 18 feet to 39 feet below top of mudline. On the Oregon half of the bridge the embedment depths are quite deeper and range from 19 feet to 139 feet below top of mudline and are a combination of drilled shafts, where bedrock is shallower, and driven pipe piles where the bedrock is substantially deeper.

Exhibit 14. Preferred Alternative EC-2 Areas of Upland Disturbance

On the Oregon side of the river, Alternative EC-2 would require the bridge approach be re-aligned slightly to the west. This would require vegetation removal and grading on the site and placement of fill materials. Depending on the nature of the fill materials, the erosion hazard from stormwater runoff could be moderate, because the approach would be a sloped embankment. The total area of disturbance for Alternative EC-2 on the Oregon side would be approximately 2.5 acres (Exhibit 14).

5.2.2. Direct Impacts

On the Washington side, the risk of ground motion amplification or liquefaction during an earthquake would be moderate and only slightly increased by the addition of fill materials. The risk of damage from lahars is low. Bridge piers and infrastructure in the Columbia River would be subject to low flood risk, the soils would be subject to low to moderate risk from earthquake-induced liquefaction and ground motion amplification, and sedimentation or damage from lahars moving from Mt. Adams or Mt. Hood down the White Salmon River or Hood River would be subject to low risk.

On the Oregon side, the soils have a high risk of liquefaction and ground motion amplification from a large magnitude earthquake. There is a moderate risk that volcanic activity on Mt. Hood could trigger lahars that, if large enough, could cause damage to the bridge structure. Other earthquake effects such as seiches and fault ruptures have a low risk of impacting the Project area.

A benefit of Alternative EC-2 as compared with the No Action Alternative is that the bridge would be designed to be seismically sound under a 1,000-year event and remain operational under a Cascadia Subduction Zone earthquake.

5.2.3. Indirect Impacts

No indirect impacts to geology and soil resources from Alternative EC-2 have been identified. It is anticipated that this alternative would not cause a lack of local material sources for future projects. Hood River Sand and Gravel has multiple locations of operations in Hood River County and Klickitat County and has completed large projects for both the Bonneville and The Dalles dams in the past.

5.3. Alternative EC-1

5.3.1. Construction Impacts

On the Washington side of the Columbia River, the bridge would cross west of the existing bridge and require extensive modifications at the intersection of the replacement bridge, SR 14 and N. Dock Grade Road. The intersection and approaches along SR 14 would need to be brought up approximately 14 feet, requiring large amounts of fill materials. A retaining wall would be added to the existing retaining wall on the south side of SR 14 and on the west side of the replacement bridge to create the northern bridge terminus and eliminate disturbance to the BNSF railroad tracks. Two new piers would be built south of the railroad. The addition of fill materials would expose soil surfaces that could be eroded by stormwater flows. The risk of erosion and sediment runoff depends on the nature of fill materials, but is not expected to be substantial because the areas to be raised are flat road surfaces. The pier sites are at an existing commercial greenhouse and nursery farm operation with a gravel surface. Disturbance to soils in this site would be minimal due to the site already being disturbed from business operations. Little vegetation exists within the proposed alignment, so vegetation removed by bridge construction and the resultant shading by the bridge superstructure should not change the existing conditions much.

N. Dock Grade Road would be realigned and elevated to connect with the proposed roundabout. This would require excavation and fill at the toe of a steep talus slope. The total area of disturbance for Alternative EC-1 on the Washington side would be approximately 18.9 acres (Exhibit 15). The talus slopes are very unstable, and the risk of movement or failure of the slope increases considerably if the toe of the slope is cut. Construction in this area could result in a high impact to the stability of the slope. Special engineering solutions such as retaining walls or other anchoring devices to stabilize the toe of the slope would be necessary in this area.

Bridge construction for Alternative EC-1 would be similar to Alternative EC-2 except that due to the shorter bridge length, one less in-water pier (11) would be required. The pier foundation embedment depths for Alternative EC-1 would be expected to be similar to Alternative EC-2.

Construction on the Oregon side of the Columbia River for Alternative EC-1 would require the bridge approach be re-aligned slightly to the west. This would require vegetation removal and grading on the site and placement of fill materials. Depending on the nature of the fill materials, the erosion hazard from stormwater runoff could be moderate, because the approach would be a sloped embankment. The total area of disturbance for Alternative EC-1 on the Oregon side would be approximately 2.5 acres (Exhibit 15).

5.3.2. Direct Impacts

On the Washington side, the risk of damage to the road and/or vehicles from rockfall is high in this area under the talus slope. Moderate to strong earthquakes could cause the talus slope to move or fail, causing great damage to N. Dock Grade Road, SR 14, and parts of the bridge approach and spans. The risk of damage from lahars is low. Geologic hazards on the north side of the river would be related to slope failure and possibly some minor liquefaction and ground motion amplification hazards during an earthquake. The addition of fill materials would slightly increase the ground motion amplification hazard.

A smaller risk from volcanic activity exists on the north side of the river, however large events on Mt. Adams or Mt. Hood could cause sedimentation or damage to the bridge structure. Bridge piers and infrastructure in the Columbia River would be subject to low flood risk soils would be subject to low to moderate risk from earthquake-induced liquefaction and ground motion amplification, and sedimentation or damage from lahars moving from Mt. Adams or Mt. Hood down the White Salmon River or Hood River would be subject to low risk.

On the Oregon side, the soils would be subject to a high risk from liquefaction and ground motion. There is a moderate risk that volcanic activity on Mt. Hood could trigger lahars that, if large enough, could cause damage to the bridge structure. Other earthquake effects such as seiches and fault ruptures have a low risk of impacting the Project area.

A benefit of Alternative EC-1 as compared with the No Action Alternative is that the bridge would be designed to be seismically sound under a 1,000-year event and remain operational under a Cascadia Subduction Zone earthquake.

Exhibit 15. Alternative EC-1 Areas of Upland Disturbance

5.3.3. Indirect Impacts

No indirect impacts to geology and soil resources from Alternative EC-1 have been identified. It is anticipated that this alternative would not cause a lack of local material sources for future projects. Hood River Sand and Gravel has multiple locations of operations in Hood River County and Klickitat County and has completed large projects for both the Bonneville and The Dalles dams in the past.

5.4. Alternative EC-3

5.4.1. Construction Impacts

On the Washington side of the river, Alternative EC-3 would lie just east of the existing bridge. Impacts to this side of the river would be similar to those described for Alternative EC-2, although there would be slightly more land surface that could be disturbed, depending on the number of bridge foundations constructed on land (estimated to be one pier and one abutment). The bridge foundation construction would also require tree removal around the work area, which is close to the Columbia River. The risk of soil erosion would be high in this area during construction. The total area of disturbance for Alternative EC-3 on the Washington side would be approximately 7.4 acres (Exhibit 16).

Bridge construction and the pier foundation embedment depths for Alternative EC-3 would be similar to Alternative EC-2.

Construction on the Oregon side of the Columbia River would require the bridge approach be re-aligned slightly to the east. This would require vegetation removal and grading on the site and placement of fill materials. Depending on the nature of the fill materials, the erosion hazard from stormwater runoff could be moderate because the approach would be a sloped embankment. The total area of disturbance for Alternative EC-3 on the Oregon side would be approximately 1.7 acres (Exhibit 16).

5.4.2. Direct Impacts

On the Washington side, the risk of ground motion amplification or liquefaction during an earthquake would be moderate and only slightly increased by the addition of fill materials. The risk of damage from lahars is low. Bridge piers and infrastructure in the Columbia River would be subject to low flood risk, soils would be subject to low to moderate risk from earthquake-induced liquefaction and ground motion amplification, and sedimentation or damage from lahars moving from Mt. Adams or Mt. Hood down the White Salmon River or Hood River would be subject to low risk.

On the Oregon side, the soils would be subject to a high risk from liquefaction and ground motion There is a moderate risk that volcanic activity on Mt. Hood could trigger lahars that, if large enough, could cause damage to the bridge structure. Other earthquake effects such as seiches and fault ruptures have a low risk of impacting the Project area.

A benefit of Alternative EC-3 as compared with the No Action Alternative is that the bridge would be designed to be seismically sound under a 1,000-year event and remain operational under a Cascadia Subduction Zone earthquake.

Exhibit 16. Alternative EC-3 Areas of Upland Disturbance

5.4.3. Indirect Impacts

No indirect impacts to geology and soil resources from Alternative EC-3 have been identified. It is anticipated that this alternative would not cause a lack of local material sources for future projects. Hood River Sand and Gravel has multiple locations of operations in Hood River County and Klickitat County and has completed large projects for both the Bonneville and The Dalles dams in the past.

5.5. Summary of Impacts by Alternative

Exhibit 17 provides a comparison of anticipated geology and soils impacts by alternative.

Exhibit 17. Summary of Geology and Soils Impacts by Alternative

Impacts	No Action Alternative	Preferred Alternative EC-2	Alternative EC-1	Alternative EC-3
Construction Impacts	• None	• Area of disturbance in WA - 8.4 acres • Area of disturbance in OR - 2.5 acres • 12 in-water piers, 1 pier on land, and 2 abutments • Low rockfall/slope instability risk	• Area of disturbance in WA - 18.9 acres • Area of disturbance in OR - 2.5 acres • 11 in-water piers, 2 piers on land, and 2 abutments • High rockfall/slope instability risk	• Area of disturbance in WA – 7.4 acres • Area of disturbance in OR - 1.7 acres • 12 in-water piers, 1 pier on land, and 2 abutments • Low rockfall/slope instability risk
Direct Impacts	• None	• Designed for seismic resiliency		
Indirect Impacts	• None			

6. AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

6.1. Construction Impacts

The following measures would be implemented by the bridge owner to avoid, minimize, or mitigate construction impacts to/from geology and soils:

- Minimizing the amount of vegetation removal on the Washington side of the Project. (The amount of vegetation removal on the Oregon side of the Project would be minimal due to existing developed or paved areas.)
- BMPs appropriate to the context would be developed for the Project prior to construction. These BMPs would take into account the practices set forth in ODOT and WSDOT regulations and guidance documents, including ODOT standard specification Section 00280 (Erosion and Sediment Control) and WSDOT standard specification Section 8.01 (Erosion Control and Water Pollution Control); and these BMPs would be implemented during construction to prevent the erosion of exposed soils and eliminate the off-site transport of sediment laden stormwater.
- Performing site stabilization and restoration, such as replanting and reseeding, for those areas of exposed soils that are no longer under active construction.

6.2. Long-Term Impacts

The following measures would be implemented by the bridge owner to avoid, minimize, or mitigate long-term impacts to geology and soils:

- Designing the bridge foundations following the most current version of the American Association of State Highway and Transportation Officials (AASHTO) load and resistance factor design bridge design specifications.
- Excavating unsuitable and/or liquefiable soils beyond the footprint of each embankment and replace with engineered fill as necessary.
- Design the bridge to withstand anticipated ground shaking associated with a 1,000-year seismic event and remain operable following ground shaking associated with a 500-year Cascadia Subduction Zone event.
- Designing and constructing stormwater treatment facilities in accordance with applicable stormwater regulations in Washington and/or Oregon that would collect, treat, and disperse stormwater runoff from the bridge so runoff will not create an erosion hazard.
- For Alternative EC-1, the N. Dock Grade Road intersection with SR 14 will be designed and constructed to ensure that the steep talus slope immediately above it will be stabilized.

7. PREPARERS

Individuals involved in preparing this technical report are identified in Exhibit 18.

Exhibit 18. List of Preparers

Name	Role	Education	Years of Experience
Peter Geiger	Geology and Soils Task Lead	MSc, Physics BS, Physics	31
Angela Findley	Project Manager; QC	MS, Forest Resources BA, Mathematics	25
Scott Polzin, PMP	Environmental Task Lead; QC	MCRP, Planning BS, Finance	24

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