Preliminary Navigation Study

Multnomah County | Earthquake Ready Burnside Bridge Project

Portland, OR

January 29, 2021

Earthquake Ready Burnside Bridge
Preliminary Navigation Study

Prepared for

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Contract# DCS-SVCSGEN-857-2019-conv
HDR Project #10144814

CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, as a professional engineer.

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Acronyms, Initialisms, and Abbreviations

AAC	Advanced American Construction
AEP	Annual Exceedance Probability
BPS	City of Portland Bureau of Planning and Sustainability
CFR	Code of Federal Regulations
CRD	Columbia River Datum
EPA	U.S. Environmental Protection Agency
EQRB	Earthquake Ready Burnside Bridge
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FR	Federal Register
LCDC	Oregon Land Conservation and Development Commission
MHHW	Mean higher high water
MHW	Mean high water
MLLW	Mean lower low water
MLW	Mean low water
MTSRU	USCG Marine Transportation System Recovery Unit
NAVD 88	North American Vertical Datum 1988
NEPA	National Environmental Policy Act of 1969
NGVD 29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
ODOT	Oregon Department of Transportation
OHW	Ordinary high water
PNERC	Pacific Northwest Ecosystem Research Consortium
SAR	Search and rescue
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
WRM	Willamette River Mile

Executive Summary

The Burnside Bridge in Portland is being made "earthquake-ready" as part of the Earthquake Ready Burnside Bridge project. The purpose of this report is to summarize the impacts to navigation of the Burnside Bridge replacement projects during temporary and permanent bridge phases. This report provides substantial input towards the complete Navigation Impact Report prepared by HDR as part of a U.S. Coast Guard (USCG) Bridge Permit Application.

Recommended Clearances

The USCG requirement to enable 100 percent of vessel traffic to safely transit under the bridge drives the clearance recommendations within this study. The recommendations herein reflect the minimum clearances that will allow all vessel traffic to safely transit the bridge.

The recommended minimum clearance elevation for all bridge design states is 167 feet above the NAVD 88 datum. The recommended horizontal clearance for all bridge design states is 205 feet.

The recommended vertical clearance is based on the maximum air draft of all known river users above ordinary high water (OHW), the water level accepted as a design elevation by the USCG and USACE.

For short-term reductions to these clearances during construction, it is reasonable to assume that the USCG will grant temporary deviations to these clearance dimensions, as evidenced by the many recent rehabilitation projects. These temporary deviations, however, are on a case-by-case basis only and should be limited to days and a few weeks rather than months. Temporary deviations may require agreements from affected river users.

Bridge Design States

The objective of this study was to determine minimum clearance requirements independent of bridges or any other man-made obstructions. However, many river users could not articulate their clearance requirements without a starting point to consider. This starting point was provided as a set of Bridge Design States, representing minimum existing and proposed clearances. A variety of bridge designs are being considered for this project. All bridge designs fall into one of four states:

- *Existing*. The current Burnside Bridge. This bascule bridge has different vertical clearances in the lowered and raised positions.
- *Temporary*. A temporary construction phase consisting of a vertical lift bridge with limited clearances. This phase will ultimately lead to a different bridge design state.
- *Permanent Retrofit*. Earthquake retrofit of the current bascule Burnside Bridge, with no impact on existing clearances in the lowered and raised positions.
- *Permanent Replacement*. The permanent design for a replacement Burnside Bridge, with permanent changes to existing clearances.

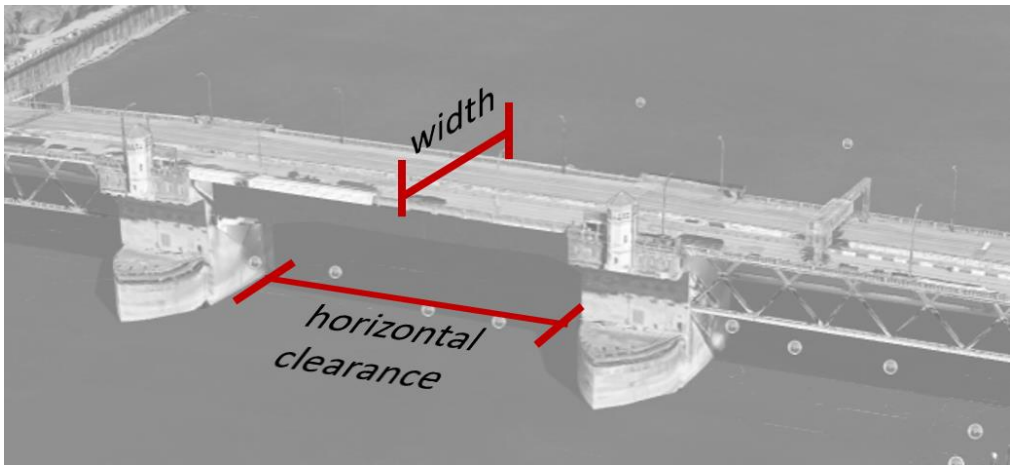
Table 1 presents the most restrictive elevation and horizontal clearance of the bridge designs being considered for each design state as communicated by the HDR Bridge Design Team[1].

Table 1. Most Restrictive Clearances of Bridge Design States

Design State	Elevation	Horizontal Clearance	Bridge Width (ft. upriver / downriver)
Existing	69 ft. above NAVD 88 (closed); Infinite (raised)	205 ft.	86 ft.
Temporary	167 ft. above NAVD 88 (raised)	165 ft.	220 ft. to 390 ft.
Permanent Retrofit	69 ft. above NAVD 88 (closed); Infinite (raised)	205 ft.	86 ft.
Permanent Replacement	69 ft. above NAVD 88 (closed); Infinite (raised)	205 ft.	150 ft. to 195 ft.

Elevation refers to distance above North American Vertical Datum 1988 (NAVD 88) or the Columbia River Datum (CRD), as noted. Horizontal clearance refers to the clear distance between bridge piers. This study assumes the center of the navigation channel will remain the same as the existing Burnside Bridge. Bridge width refers to the upriver/downriver distance for transiting under the bridge (Figure 1).

Figure 1. Horizontal Clearance between Bridge Piers and Upriver/Downriver Bridge Width



Source: Google Earth

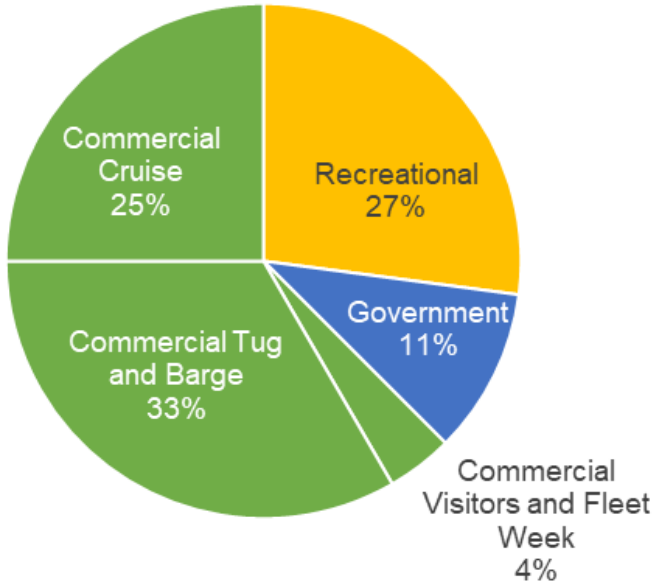
River Users

In this study, a river user is a public or private entity expected to transit the Burnside Bridge in a vessel during and/or after Burnside Bridge modification. A river user may be an individual (such as a private vessel owner) or a group (such as a company, marina, or organization).

[1] Bautista, R. (email) [HDR], "RE: EQRB NEPA: Navigation Study Report Rev P1 Rev 2 Package Comments," 14 June 2019

As part of this study, 84 river users potentially affected by a change in clearance of the Burnside Bridge were contacted or researched. Elevations and horizontal clearance requirements were ultimately obtained for 47 river users. These 47 users are a representative subset of the thousands of actual river users who may transit under the Burnside Bridge. They fall into three main types: commercial, recreational, or government, as shown in Figure 2.

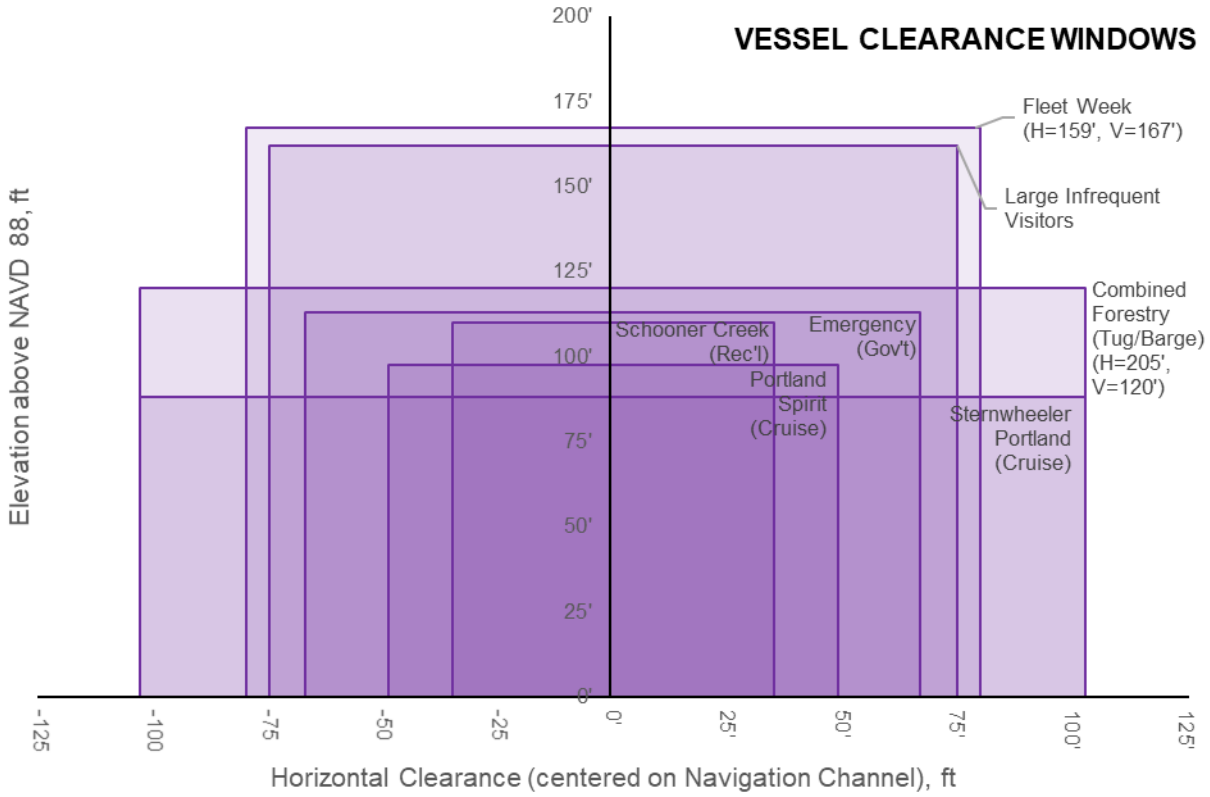
Figure 2. Distribution of River Users



Elevation and horizontal clearance requirements are provided by the river users themselves. These requirements represent their stated minimum space needed to safely transit the bridge. The basis for these requirements, such as the season and water surface elevation, varies from river user to river user.

Elevation and horizontal clearance requirements combine to form a clearance window. Figure 3 displays the clearance windows for the vessels with the largest clearances in each user type.

Figure 3. Elevation and Corresponding Horizontal Clearance for Each River User Type



The height and width of each box in Figure 3 correspond to the required elevation and horizontal clearance (centered on the navigation channel) for each vessel.

Impact of Recommended Clearances on Bridge Design States

All bridge design states currently satisfy the recommended elevation of 167 feet above NAVD 88.

Three bridge design states satisfy the recommended horizontal clearance of 205 feet: existing, permanent retrofit, and permanent replacement.

The 165-foot horizontal clearance of the temporary bridge design state would impose an operations impact on three known river users, which would be mitigated via tug-assist, as stated below:

- Combined Forestry reported that they could not transit safely, but one or two tug assists could mitigate the impact. However, tug assists would not guarantee safe transit for Combined Forestry.
- Advanced American Construction (AAC) reported that they would require a tug assist for safe transit.
- Shaver Transportation reported that they would require a tug assist on a case-by-case basis.

- Table 2 summarizes the horizontal clearance requirements of these impacted tug and barge river users.

Table 2. Horizontal Clearance Requirements of Impacted Tug and Barge River Users

User	Horizontal Clearance Requirement	Temporary Bridge (considering a 165 ft. to 390 ft. width range)
Combined Forestry & Marine Services, Inc.	205 ft.	**No safe transit**, but tug assist may mitigate the impact
Shaver Transportation	200 ft.	Safe transit with 1 tug assist (on case-by-case basis)
AAC	185 ft.	Safe transit with 1 tug assist

Moreover, the Columbia River Pilots advised against narrowing the Burnside Bridge. The Burnside Bridge is the narrowest bridge in the Sellwood Reach (the Willamette River downstream of the Sellwood Bridge). The temporary bridge would become the most restrictive horizontal clearance on the waterway. Any reduction to its horizontal clearance at either the temporary or permanent phases will require negotiation with these impacted river users.

Bridge upriver/downriver width (Figure 1) also has navigation impacts. If a replacement bridge requires a temporary bridge during construction, then transit width could range from 220 feet to 390 feet, subject to how the contractor might construct the bridge. Some river users would require a tug assist due to this extensive bridge width. The transit width of the permanent bridge would range from 150 feet to 195 feet, subject to the exact length of the pier fender system to be implemented. River users do not anticipate requiring regular tug assists to navigate this bridge width. Depending on future project work and river conditions, occasional tug assist may be needed. One river user recommended widening the horizontal clearance to aid navigation through the longer bridge corridor.

Based on feedback from participating river users and vertical and horizontal clearance requirements, several recommendations are presented for the design and construction of the Earthquake Ready Burnside Bridge project:

- Clear navigation signage for both commercial and recreational vessel operators.
- Dedicated transit lane for small recreational craft such as kayaks and stand-up paddleboards.
- Real-time vertical clearance gauge to inform vessel operators whether they clear the bridge at any given moment or river level.

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1 Introduction

1.1 Overview of Navigation Requirements

According to 33 CFR Part 329, navigable waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions or events which impede or destroy navigable capacity (33 CFR §329.4, Definition of Navigable Waters of the US, 2019).

In effect, once a waterway has been deemed navigable, its navigability may not be diminished. This report analyzes the historical and possible future use of the Willamette River at the Burnside Bridge to determine the minimum clearances required to ensure navigability is not diminished, based on existing and anticipated future traffic in the Sellwood Reach (the Willamette River downstream of the Sellwood Bridge).

Code of Federal Regulations

33 CFR Subchapter J sets the requirements for the locations and clearances of bridges and causeways over navigable waters (33 CFR §33.114-116, Navigation and Navigable Waters, 2019). Part 114 establishes the District Commander (USCG) as the reviewer of bridge permit applications, and details permitting procedures. Special protocols are provided in Part 115 if a bridge is determined to be an unreasonable obstruction to navigation. Drawbridges and bridge lighting are also reviewed in Part 116.

33 CFR Subchapter P governs Ports and Waterway Safety (33 CFR §33.162-163, Navigation and Navigable Waters, 2019). Specific detail concerning the Willamette River is provided in Part 162. The District Commander of the Thirteenth Coast Guard District is given administrative supervision and the responsibility to enforce emergency regulations concerning navigation, such as speed regulations during flooding or construction. Part 163 limits the length of seagoing barge tows in inland waters.

U.S. Coast Guard Bridge Permit Application

The USCG provides written approval of the location and plans for proposed bridges or causeways over navigable waterways (USCG 2016). The Bridge Permit Application is the medium for the USCG written approval. The three primary components of the Bridge Permit Application are:

1. Proposed bridge description.
2. Environmental documentation.
3. Plan sheets.

In addition to the above, applicants must provide a **Navigation Impact Report**. This report summarizes current and prospective navigation on a waterway and analyzes the

navigational impacts of the proposed bridge designs. Data for this report is collected by both Bridge Permit applicants and the USCG, and may include:

- **Visits**, including site visits, ride-alongs, and public meetings.
- **Written Communications**, such as public notices for comment, advertisements, and surveys.
- **Research**, including review of bridge tender logs, USACE Engineer Manuals design guidance, and waterborne commerce statistics.

The Navigation Impact Report draws on this data to describe key navigation aspects:

- Nearby structures, including bridges, federal navigation projects, marine facilities, and harbors of refuge.
- Waterway characteristics, including bends in the waterway, hydraulic conditions, atmospheric conditions, and guide clearances.
- Waterway users, including service facilities, and vessels for emergency response, defense, maintenance, commerce, and recreation.
- Alternate waterway routes.

Proposed developments that will affect navigation aspects are also discussed.

U.S. Coast Guard Direct Guidance

In developing this Navigation Study, USCG has advised key study elements through meetings and email communication. Based on this guidance, the navigable waterway is assumed to run from bank to bank on the Willamette River. No federally maintained channel exists near the Burnside Bridge to restrict the width of the navigable waterway (Section 2.2.6).

USCG stated that 100 percent of vessel traffic must be able to safely transit the permanent and temporary bridge, unless a compelling reason exists otherwise. An example compelling reason would be a written agreement between the City of Portland, Multnomah County, and the river user unable to pass. The agreement would state all parties agree that the restricted river user will not be able to transit the Burnside Bridge for the foreseeable life of the permanent or temporary bridge. As part of the user survey, restricted use was discussed with the river users and some users may be unwilling to reduce their transit rights if it affects their projects at that time. Formal restricted use agreements were not pursued as part of this study.

Ultimately, the USCG requirement to enable 100 percent of vessel traffic to safely transit the permanent and temporary bridge led to the vertical and horizontal clearance requirements in this report. These clearance requirements reflect the minimum clearances that will allow all known river users to safely transit the bridge. The USCG stresses that a bridge replacement or modification project of this duration and with this many stakeholders will have evolving stakeholder needs over time. Establishing navigability requirements is necessarily an iterative process. Navigability requirements must be periodically revisited throughout the project to ensure no previously unknown river users have become known, or known river user needs have changed.

Single-Leaf Closures

Temporary single-leaf closures are a possibility during the construction of any bascule bridge. USCG grants permission for a temporary single-leaf closure via two mechanisms:

- *Temporary Deviation*, for closures under 180 days in duration (minimum 90-day application period).
- *Temporary Rule*, for closures exceeding 180 days in duration with no maximum duration (minimum three or four month application period).

These mechanisms are fully detailed in 33 CFR §117.35. They represent deviation from the normal operating rules of the Burnside Bridge, detailed in 33 CFR §117.897(c)(3)(iii). Temporary Rules and Temporary Deviations are totally separate from the USCG Bridge Permit Application described above.

Both Temporary Deviations and Temporary Rules require 100 percent consent from vessel traffic. For example, if a particular river user cannot safely transit the bridge during the single-leaf closure, the Temporary Deviation or Temporary Rule application must include permission from that affected user to forego transit during the closure period. USCG will independently check potentially affected users to confirm the applicant has sufficiently canvassed river users. River users who are anticipated to be affected by single leaf closures of the Burnside Bridge are detailed in Section 4.5.2.

USCG approval does not depend on time of year or the number of consecutive Rules/Deviations. USCG approval does depend on consent from affected users. To this end, the Temporary Rule / Temporary Deviation applicant is encouraged to consider mitigation with affected users. For example, if the applicant provides alternate moorage for affected users, these users may be more likely to consent to forego transit during the closure period.

1.2 Purpose

This report summarizes the impacts to navigation of the Burnside Bridge replacement projects during temporary and permanent bridge phases. This report provides substantial input towards the complete Navigation Impact Report prepared by HDR as part of a USCG Bridge Permit Application.

1.3 Methods and Data Sources

1.3.1 Literature Review

Glosten reviewed background materials in three areas: regulations, river hydrology, and urban development. Key materials in each area include:

- Regulations
  - USCG Bridge Permit Application Guide.
  - USCG Guide Clearances.
  - Code of Federal Regulations.
  - Oregon Department of State Lands.

- Oregon Department of Land Conservation and Development.

- River Hydrology
  - USGS tidal and flood elevations.
  - National Geodetic Survey vertical datums.
  - National Oceanic and Atmospheric Administration Charts.
  - Department of the Army Corps of Engineers Waterborne Commerce Statistics.
- Urban Development
  - City of Portland River Renaissance.
  - City of Portland River Plan.
  - Oregon Department of Land Conservation and Development Oregon's Statewide Planning Goals & Guidelines.
  - Portland-Milwaukie Light Rail Project Final Environmental Impact Statement, Navigation Study.

Glosten also summarized existing bridge clearances upstream and downstream of Burnside Bridge. The literature provided a foundational understanding of the Willamette River. Multnomah County bridge opening data was researched but the data obtained did not prove to be valuable.

1.3.2 Site Visit

On 26 March 2019, Glosten conducted a site visit to physically assess the Burnside Bridge, traffic patterns, and local vessels. The site visit was comprised of a 20-mile pontoon boat cruise from the St. John's Bridge (Willamette River Mile (WRM) 5.8) to the Willamette Falls (approximately WRM 26). On the cruise, Glosten staff visually inspected the Burnside Bridge, other bridges, local sites and businesses, and vessel traffic. Staff also visited businesses and marinas on Multnomah Channel and the Columbia River near the mouth of the Willamette. The visit provided a current snapshot of operations on the Willamette River. Glosten staff also performed land-based visual inspections of the Burnside Bridge, other nearby bridges, and sites and businesses in the area.

Figure 4. Glosten Staff on River Survey Near Ross Island and St. John's Bridge

1.3.3 River User Master List

The Literature Review and Site Visit informed development of the River User Master List. The List contains 84 river users potentially affected by changing Burnside Bridge clearances. Users without significant marine assets in the project area or who declined response were typically omitted from further study (Appendix B).

Required information was found via other methods for some unresponsive users. Those users were included in the evaluation of elevation and horizontal clearance requirements despite being unresponsive.

The List provides the following information (as available) for each river user:

- Brief description.
- Contact information (phone and email).
- Contact history for this Navigation Study.
- Elevation requirement at the Burnside Bridge.
- Horizontal clearance requirement at the Burnside Bridge.

1.4 Maximum River User Clearance Requirements

Elevations and horizontal clearance requirements were ultimately obtained for 47 users (Appendix A). Table 3 presents the maximum requirements from that group.

Table 3. Maximum River User Elevations and Horizontal Clearance Requirements

User	Clearance	Controlling River User
Maximum River User Vertical Clearance Elevation	147 ft air draft (Elevation 167 ft. above NAVD 88 at Burnside Bridge)	Fleet Week (USCG Waesche)
	142 ft air draft (Elevation 162 ft. above NAVD88 at Burnside Bridge)	M/V *The World*
Maximum River User Horizontal Clearance Requirement	205 ft.	Combined Forestry and Marine Services, Inc.

The maximum river user elevation equals the minimum bridge elevation requirement. The maximum river user horizontal clearance requirement equals the minimum bridge horizontal clearance requirement. The requirements in Table 3 reflect river user needs at the time of this study. River users and their requirements may change over time as the project develops. Thus, the maximum requirements are subject to change during the course of the project.

Bridge upriver/downriver width (Figure 1) also has navigation impacts. The transit width of the alternative with a temporary bridge could range from 220 feet to 390 feet, subject to how the contractor might construct the bridge. Some river users would require a tug assist due to this extensive bridge width. The transit width of the permanent bridge would

range from 150 feet to 195 feet, subject to the exact length of the pier fender system to be implemented. River users do not anticipate requiring regular tug assists to navigate this bridge width. Depending on future project work and river conditions, occasional tug assist may be needed. One river user recommended widening the horizontal clearance to aid navigation through the longer bridge corridor.

1.5 Bridge Design States

The objective of this study was to determine minimum clearance requirements independent of bridges or any other man-made obstructions. However, many river users could not articulate their clearance requirements without a starting point to consider. This starting point was provided as a set of Bridge Design States, representing minimum existing and proposed clearances.

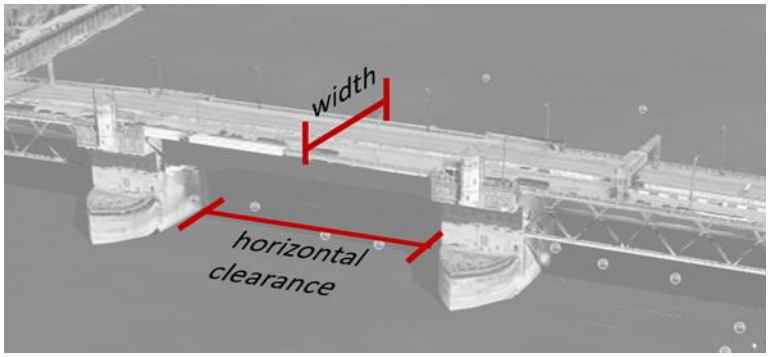
The bridge designs for the Earthquake Ready Burnside Bridge project fall into one of four states. Table 4 presents those states and their dimensions, which represent the most restrictive elevation and horizontal clearance of all bridge designs within each state.

Table 4. Required Burnside Bridge Clearances at Various Design States

Design State	Vertical Clearance (Elevation)	Horizontal Clearance	Bridge Width (ft. upriver/downriver)
Existing	69 ft. above NAVD 88 (closed); Infinite (raised)	205 ft.	86 ft.
Temporary	167 ft. above NAVD 88 (raised)	165 ft.	220 ft. to 390 ft.
Permanent Retrofit	69 ft. above NAVD 88 (closed); Infinite (raised)	205 ft.	86 ft.
Permanent Replacement	69 ft. above NAVD 88 (closed); Infinite (raised)	205 ft.	150 ft. to 195 ft.

Elevation refers to vertical clearance above North American Vertical Datum 1988 (NAVD 88) or the Columbia River Datum (CRD), as noted. Horizontal clearance refers to the clear distance between bridge piers. Width refers to the upriver/downriver distance for transiting under the bridge (Figure 5).

Figure 5. Horizontal Clearance between Bridge Piers and Upriver/Downriver Bridge Width



Note: The width shown does not include any temporary bridge works anticipated during construction.
Source: Google Earth

The elevations of all bridge states meet or exceed the maximum elevation of all river users.

The 165-foot horizontal clearance of the temporary bridge state would impose an operations impact on three known river users, which would be mitigated via tug-assist, as stated below:

- Combined Forestry reported that they could not transit safely, but one or two tug assists could mitigate the impact. However, tug assists would not guarantee safe transit for Combined Forestry.
- AAC reported that they would require a tug assist for safe transit.
- Shaver Transportation reported that they would require a tug assist on a case-by-case basis.

2 Existing Navigation Use and Requirements

2.1 Existing Bridge and Cable Crossing Clearances

Fifteen bridges and four cables cross the Willamette River between mouth and the Willamette Falls (Table 5). Elevations when comparing bridges are given with respect to the Columbia River Datum (CRD), which varies along the length of the Willamette River.

Table 5. Willamette River Bridges and Crossings, Mouth to Mile 25.9

Bridge/Interference	Milepost	Elevation ft. above CRD*	Horizontal (Closed) ft.	Elevation (Raised) ft. above CRD	Horizontal (Raised) ft.
St. Johns Bridge	6.0	205	1068	-	-
St. Johns Railroad Bridge (Burlington Northern RR Bridge 5.1)	7.0	54	499	200	499
Fremont Bridge	11.1	163	928	-	-
Broadway Bridge	11.7	90	251	Infinite	251**
Steel Bridge	12.1	26	205	161	205
Existing Burnside Bridge	**12.4**	**64**	**205**	**Infinite**	**205****
Temporary Burnside Bridge (Proposed)	**12.4**	**TBD**	**165**	**162**	**165**
Permanent Retrofit Burnside Bridge (Proposed)	**12.4**	**64**	**205**	**Infinite**	**205****
Permanent Replacement Burnside Bridge (Proposed)	**12.4**	**64**	**205**	**Infinite**	**205****
Morrison Bridge	12.8	69	209	Infinite	185

Table 5. Willamette River Bridges and Crossings, Mouth to Mile 25.9

Bridge/Interference	Milepost	Elevation ft. above CRD*	Horizontal (Closed) ft.	Elevation (Raised) ft. above CRD	Horizontal (Raised) ft.
Hawthorne Bridge	13.1	49	200	159	200
Marquam Bridge	13.5	102	350	-	-
*Marquam Bridge (*Centermost)*	13.5	120	220***	-	-
Tilikum Crossing Bridge	13.7	63	651	-	-
*Tilikum Crossing (*Centermost)*	13.7	77	150***	-	-
Ross Island Bridge	14.0	90	330	-	-
*Ross Island Bridge (*Centermost)*	14.0	120	100***	-	-
Cable (East Channel)	14.3	83	-	-	-
Cable (West Channel)	14.3	123	-	-	-
Cable	16.3	103	-	-	-
Cable	16.4	91	-	-	-
Sellwood Bridge	16.6	72	270	-	-
Lake Oswego Railroad Bridge	20.0	74	280	-	-
I-205/Abernethy Bridge	25.5	76	325	-	-
Oregon City Bridge	25.9	74	181	-	-

* *CRD is 5 ft above NAVD88 at Burnside Bridge.*

** *Represents horizontal clearance in the shipping channel at waterline. The horizontal clearance between raised bridge spans may be less.*

*** *Represents horizontal clearance of the tallest section of the bridge; the full bridge has a larger horizontal clearance at a lower elevation.*

2.1.1 Governing Navigation Limitations

A key component of the USCG Bridge Permit Application is a comparison of the subject bridge to existing structures on the waterway (USCG 2016). This section provides that comparison. The Application focuses in particular on whether or not the subject bridge will become the most restrictive structure on the waterway, with regard to either horizontal clearance or elevation.

Horizontal Clearance

The proposed Burnside Bridge with a temporary bridge would be the most restrictive horizontal clearance on the waterway for that period (Table 6). Neither the existing bridge, nor the permanent replacement bridge, nor the permanent retrofit bridge would be the most restrictive horizontal clearance on the waterway. Two bridges currently have

more restrictive horizontal clearances than the existing and permanent bridge design states. These are the Oregon City and Hawthorne Bridges, as shown in Table 6.

Table 6. Most Restrictive Horizontal Clearances on Willamette River

Bridge	Milepost	Elevation ft. above CRD*	Horizontal ft.	Elevation (Raised) ft. CRD*	Horizontal (Raised) ft.
Temporary Burnside Bridge (Proposed)	**12.4**	**TBD**	**165**	**162**	**165**
Oregon City Bridge	25.9	74	181	-	-
Hawthorne Bridge	13.1	49	200	159	200
Existing Burnside Bridge	**12.4**	**64**	**205**	**Infinite**	**205****
Permanent Replacement Burnside Bridge (Proposed)	**12.4**	**64**	**205**	**Infinite**	**205****
Permanent Retrofit Burnside Bridge (Proposed)	**12.4**	**64**	**205**	**Infinite**	**205****
Steel Bridge	12.1	26	205	166	205
Morrison Bridge	12.8	69	209	Infinite	185

* *CRD is 5 ft above NAVD88 at Burnside Bridge.*

** *Represents horizontal clearance in the shipping channel at waterline. The horizontal clearance between raised bridge spans may be less.*

Elevation

The permanent replacement and temporary bridge design states exceed the navigational elevation of thirteen existing structures on the waterway (Table 7).

Table 7. Most Restrictive Elevations on Willamette River

Bridge/Interference	Milepost	Elevation ft. above CRD*	Horizontal ft.	Elevation (Raised) ft. above NAVD 88	Horizontal (Raised) ft.
Sellwood Bridge	16.6	72	270	-	-
Lake Oswego Railroad Bridge	20.0	74	280	-	-
Oregon City Bridge	25.9	74	181	-	-
I-205 / Abernethy Bridge	25.5	76	325	-	-
Tilikum Crossing (Centermost)	13.7	77	150	-	-
Cable (East Channel)	14.3	83	-	-	-
Cable	16.4	91	-	-	-
Cable	16.3	103	-	-	-

Table 7. Most Restrictive Elevations on Willamette River

Bridge/Interference	Milepost	Elevation ft. above CRD*	Horizontal ft.	Elevation (Raised) ft. above NAVD 88	Horizontal (Raised) ft.
Ross Island Bridge (Centermost)	14.0	120	100	-	-
Marquam Bridge (Centermost)	13.5	120	220	-	-
Cable (West Channel)	14.3	123	-	-	-
Hawthorne Bridge	13.1	49	200	159	200
Steel Bridge	12.1	26	205	161	205
Permanent Replacement Burnside Bridge (Proposed)	**12.4**	**64**	**205**	**Infinite**	**205****
Temporary Burnside Bridge (Proposed)	**12.4**	**TBD**	**165**	**162**	**165**

* *CRD is 5 ft above NAVD88 at Burnside Bridge.*

** *Represents horizontal clearance in the shipping channel at waterline. The horizontal clearance between raised bridge spans may be less.*

The other two bridge states, existing and permanent retrofit, significantly exceed the above elevations and are not shown in Table 7.

Governing Clearances

Table 8 summarizes the most restrictive clearances on the Willamette River between the mouth and Willamette Falls listed in Table 6 and Table 7. The Burnside Bridge temporary bridge would be the most restrictive horizontal clearance on the waterway.

Table 8. Most Restrictive Clearances on Willamette River

Bridge	Milepost	Elevation ft. above CRD*	Horizontal ft.	Minimum Clearance on Waterway?
Temporary Burnside Bridge	12.4	162	**165**	**Yes, for Horizontal Clearance**
Sellwood Bridge	16.6	**72**	270	**Yes. for Vertical Clearance**

* *CRD is 5 ft above NAVD88 at Burnside Bridge.*

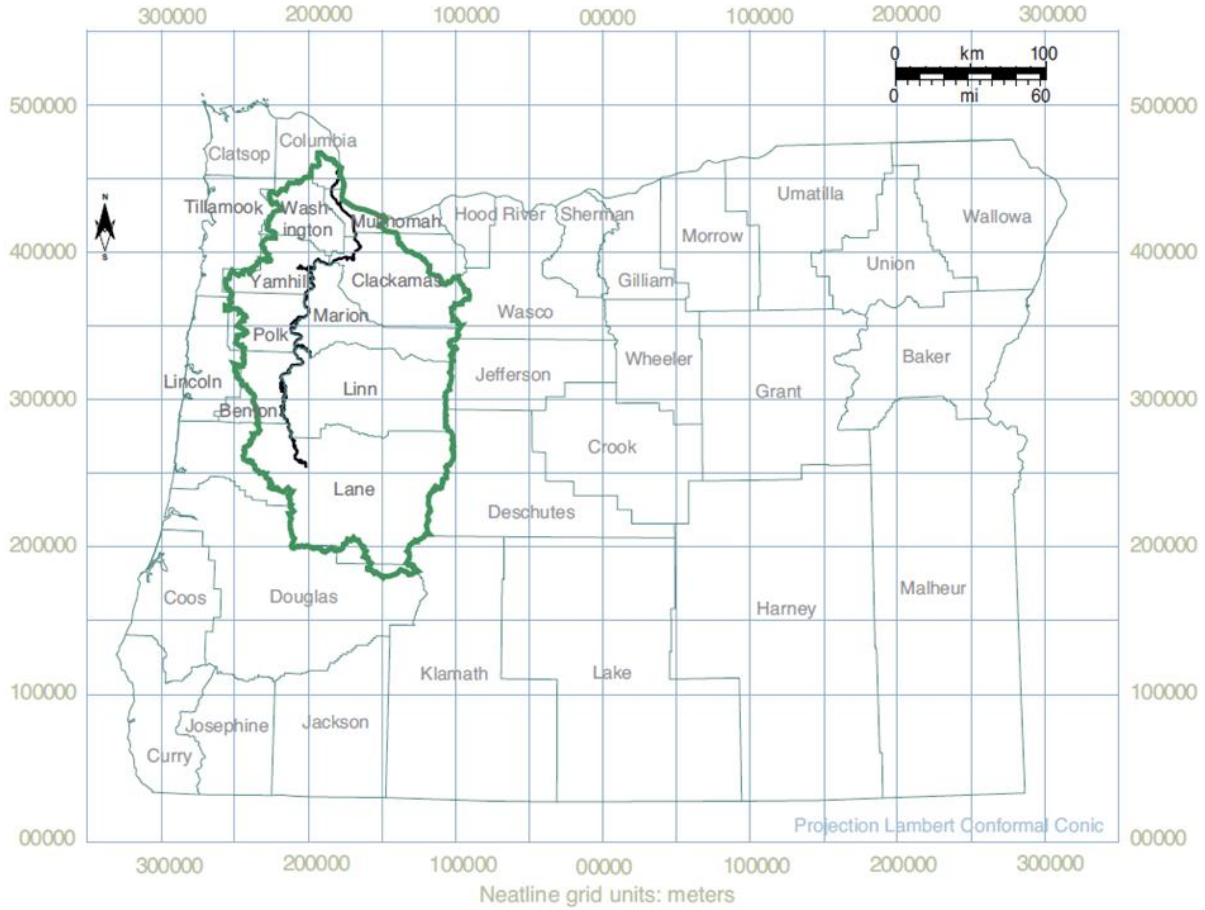
2.2 Navigation Channel

2.2.1 Waterway Layout and Geometry

The 187-mile Willamette River initiates near Eugene, Oregon, runs through Portland, Oregon, and terminates at the Columbia River estuary, the largest fluvially dominated estuary in the Pacific Northwest. Lying in the Willamette Valley, the river drains an area of 11,200 mi^2 in the Willamette River Basin (Figure 6). With an average width of 75 miles,

the Willamette River Basin accounts for 12 percent of Oregon state area, 13 of 36 Oregon state counties, and 70 percent of Oregon state population (FEMA 2010, PNERC 2002, USACE 2017, Wherry 2018).

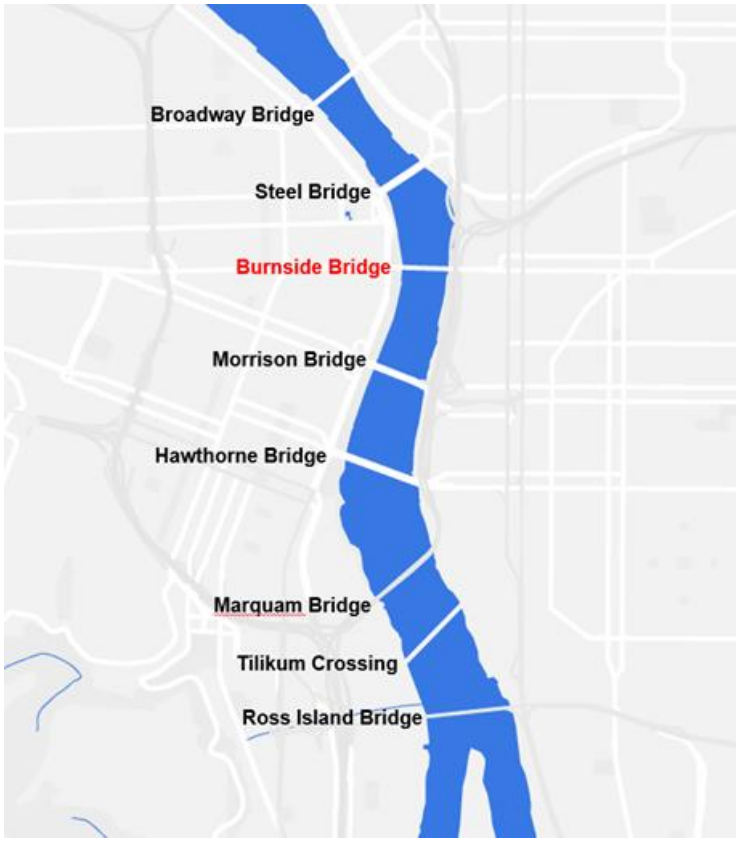
Figure 6. Willamette River Basin (green), Willamette River (black), and Oregon Counties



Source: Pacific Northwest Ecosystem Research Consortium (PNERC) 2002

The waterway layout in the vicinity of the Burnside Bridge impacts navigation. The Burnside Bridge is situated just south of a bend in the Willamette River adjacent to Downtown Portland (Figure 7). River users must navigate four bridges in close proximity near this river bend.

Figure 7. Willamette River Waterway Layout in Vicinity of Burnside Bridge



The combination of waterway layout and bridge proximity increases the challenge of river navigation when transiting the Burnside Bridge. As described by Advanced American Construction, Inc., passability is "in relation to other bridges. Ultimately that's what you have to align with." Additionally, the Columbia River Pilots noted that "narrowing the approach on Burnside would make the approach to Steel Bridge even more difficult" (Appendix C).

2.2.2 Hydrology and Waterway Natural Flow

In the downstream portion of the Willamette River, floodplains are narrow, the river gradient is low, and the backwatering effect of the Columbia River is dominant (PNERC 2002). Flooding near Portland is linked in the spring to the Columbia River Basin snowmelt freshet, and in the winter to rainstorms and high flows in the Columbia and Willamette Rivers (FEMA 2010).

At Willamette Falls (WRM 26), the 1 percent annual exceedance probability (AEP) regulated flow is 11,000 m^3/s (Wherry 2018).

This study focuses on the downstream, or northern, portion of the Willamette River between Willamette Falls (WRM 26) and the Columbia River (WRM 0). This portion of the river flows through a basalt trench formed by a series of lava flows that pre-date the uplift of the northern Cascade Mountain Range. It has undergone little geomorphic change over the last 150 years; river channels and islands have remained relatively consistent (PNERC 2002).

Discharge at the proposed bridge is derived from USGS Station 14211720 Willamette River at Portland, OR (Table 9, USGS, n.d.).

Table 9. Willamette River Discharge

Annual Mean Discharge, Average	33,312 ft.3/sec	1973 to 2017
Annual Mean Discharge, Minimum	21,170 ft.3/sec	1992
Annual Mean Discharge, Maximum	57,490 ft.3/sec	1996

2.2.3 Waterway Depth and Elevation Fluctuations

Willamette River Basin Datums

Three datums are commonly referenced throughout the Willamette River Basin (NOAA, CREOFS, n.d., and Datums, n.d.):

- **National Geodetic Vertical Datum of 1929 (NGVD 29)**. This vertical control datum was originally established in 1929 as the Sea Level Datum of 1929, and re-established with its current name in 1973. It was developed from the observed heights of mean sea level at 26 tide gauges throughout the U.S. and Canada. In 1992, this datum was superseded by the North American Vertical Datum of 1988.
- **North American Vertical Datum of 1988 (NAVD 88)**. This vertical control datum was established in 1991, and developed from the height of the primary tidal bench mark at a single station: Father Point/Rimouski, Quebec, Canada.
- **Columbia River Datum (CRD)**. This non-tidal, defined-gradient datum along the Columbia River (between miles 23 ad 145) and the Willamette River (from WRM 0 to WRM 27). USACE first established this low-water reference plan during a 1912 observational study. The zero reference for CRD lies below average low water, but not at the lowest record. CRD was historically redefined with respect to first NGVD 29, and then NAVD 88.

The City of Portland Datum and Portland River Datum also appear on some survey documents, but they are not used in this study.

Tidal and Flood Elevations

The United States Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA) historically maintained three tidal stations in the downstream portion of the Willamette River (Table 10).

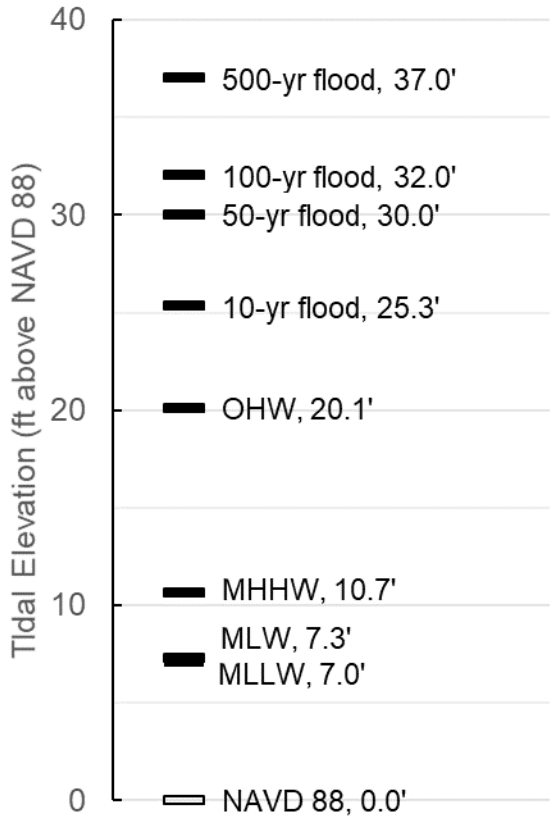
Table 10. Willamette River Tidal Stations

Agency	Station ID	Location	Date Established	Date Removed	Datum
NOAA	9439221	Morrison Bridge	16 Oct 1940	28 Jan 2009	7.03 ft. abv NAVD 88
USGS	14211720	Morrison Bridge	1 Oct 1988	-	5.01 ft. abv NAVD 88
USGS	14207770	Willamette Falls	1 Oct 2007	-	3.51 ft. abv NAVD 88

Source: NOAA, Station ID 9439221; USCG 1420770, 14211720, n.d.

Figure 8 displays tidal and flood elevations in the Willamette River at Morrison Bridge with respect to NAVD 88. Tidal data from NOAA Station 9439221 Morrison Bridge provides the assumed tidal characteristics for Mean Higher High Water (MHHW), Mean Low Water (MLW), and Mean Lower Low Water (MLLW). Ordinary High Water (OHW) stage is derived from the USACE at the proposed bridge (USACE 2017). Flood characteristics are provided by a 2010 Federal Emergency Management Agency (FEMA) flood insurance study (FEMA 2010).

Figure 8. Expected Tidal and Flood Elevations at Morrison Bridge (WRM 12.8)



Source: NOAA Station ID 9439221, n.d.; FEMA 2010

OHW is the water level that Portland USACE uses for planning purposes, based on the high water mark naturally demarcated by vegetation along the river bank. OHW was justified as a basis for the worst-case river level stage for the purposes of required navigational clearance in the most recent navigation study in the area that was accepted by the USCG (Tilikum Crossing).

Up to 13 feet of tidal fluctuation between OHW and MLLW is expected. Flood fluctuations far exceed tidal fluctuations. A flood with a 10 percent chance of occurring in any year (10-year flood) exceeds MLLW elevation by 18 feet. A flood with a 1 percent chance of occurring in any year (100-year flood) exceeds MLLW elevation by 25 feet. (FEMA 2010).

Flood Control

Four flood control types are identified in the Willamette River Basin (FEMA 2010, PNERC 2002, USACE 2017):

- **Willamette Valley Project**. Between 1941 and 1969, the U.S. Congress authorizing the Willamette Valley Project through a series of Flood Control Acts. Under these Acts, USACE constructed thirteen dams, reservoirs, and affiliated infrastructure in the Willamette River Basin with 1.6 million acre-feet flood storage capacity. This system has not only reduced flood elevation on the Columbia and Willamette Rivers, but also aided navigation, irrigation, hydropower, water supply, pollution abatement, fish and wildlife, and recreation.
- **Revetments**. For more than a century, the Willamette River has been redirected and its erosion slowed by placing large stones in riprap, wing deflectors, and levees. USACE constructed and manages approximately half of the 96 miles of revetments. While revetments may mitigate floods and erosion at the installation site, they can simultaneously expedite floods and erosion in other areas.
- **Seawall**. The Portland Seawall is a concrete wall extending from the Steel Bridge (WRM 12.1) to Hawthorne Bridge (WRM 13.1). Built in 1928, the railing of the wall extends above 500-year flood levels. However, floods may still circumvent the seawall downstream of the Steel Bridge.
- **Nonstructural measures**. In April 1972, Ordinance No. 134486 National Flood authorized the participation of the City of Portland in the FEMA National Flood Insurance Program. Under this resolution, building permit applications and subdivision proposals are reviewed for flood safety.

2.2.4 Maintenance Dredging

Maintenance dredging last occurred in 2011, when the channel at WRM 1+50 to WRM 2+52 was dredged to -40 ft CRD plus overdredge. There are currently maintenance dredging operations being planned at WRM 1+50 to 2+52 and WRM 9+40 to 10+17. Responsibility for maintaining the channel from the Broadway Bridge (WRM 11.6) to the Ross Island Bridge (WRM 14.0) is delegated to the Port of Portland[2]. There has been no

[2] Source: Yballe, D. (comments on 1/31/20 draft version of this report) [US Army Corps of Engineers, Portland District], February 28, 2020

recent channel maintenance in this stretch and none is currently planned[3]. See Section 2.2.6 for a description of the federal navigation channel.

2.2.5 Guide Clearances

The USCG has established Guide Clearances for many navigable waterways in the United States (USCG, n.d.). Bridges and causeways that satisfy these navigational clearances are viewed favorably during the bridge permitting process. Table 11 provides the USCG Guide Clearances for the Willamette River.

Table 11. Willamette River Guide Clearances

River Segment	Description	Bridge Type	Clearance	
			Horizontal	Vertical
WRM 0 – 11.6	Mouth to Broadway Bridge	Fixed	1,000 ft.	211 ft. abv NAVD 88
WRM 11.6 – 14.0	Broadway Bridge to Ross Island Bridge	Fixed	500 ft.	171 ft. abv NAVD 88
		Movable	250 ft.	71 ft. abv NAVD 88 (closed)
WRM 14.0 – 25.5	Ross Island Bridge to Abernethy Bridge	-	None	None

Source: USCG, n.d.

Existing bridges are not necessarily required to satisfy USCG Guide Clearances. Two of four bridges in the first segment (WRM 0 – 11.6) do not satisfy vertical Guide Clearances (St John's Railroad Bridge, and the Fremont Bridge). Three of six bridges in the second segment (WRM 11.6 – 14.0) do not satisfy vertical Guide Clearances (Marquam Bridge, Tilikum Crossing Bridge, and Ross Island Bridge). Future bridges, however, are encouraged to achieve these guide clearances, if practicable.

2.2.6 Channel and Waterway Alignment

The **Willamette River Navigation Channel** from WRM 0.0 to the Broadway Bridge (WRM 11.6) is authorized to -43 feet CRD plus overdredge. The channel has a depth of 40 feet, and widths ranging from 600 feet to 1,900 feet. (USACE Portland District, 2003).

From the Broadway Bridge (WRM 11.6) to the Ross Island Bridge (WRM 14.0), the authorized federal navigation channel is 30 feet CRD. The authorized channel width is 300 feet, however it is not currently delineated; thus, this study assumes no restrictions on vessel access between riverbanks[2].

Table 12 summarizes the navigation channels on the Willamette River.

[3] Source: Super, G. (phone call) [Port of Portland], April 20, 2020.

Table 12. Navigation Channels on Willamette River

River Segment	Description	Active Federal Navigation Channel?	Authorized Depth (CRD)
WRM 0.0 – 11.6	Mouth to Broadway Bridge	Yes; active	43 ft.
WRM 11.6 – 14.0	Broadway Bridge to Ross Island Bridge	Yes; active; maintenance delegated to Port of Portland	30 ft.
WRM 14.0 – 25.5	Ross Island Bridge to Abernethy Bridge	Yes; active	Varies

Source: Yballe, D. (comments on 1/31/20 draft version of this report) [US Army Corps of Engineers, Portland District], February 28, 2020

The **Willamette River above Portland and Yamhill River Channel** runs upstream of the Willamette River Navigation Channel from Portland to the Yamhill River. This USACE Federal Navigation Channel is active but not maintained. The last recorded dredging activity is 1990.

3 Future Development and Adopted Plans

3.1 Portland Urban Plan History

For more than thirty years, Portland has developed and re-developed urban plans focused on the role of the Willamette River. Historic documents presenting these plans include:

- Willamette Greenway Plan Goal and Objectives (1987).
- Central City 2035 Plan (1988, 2012, 2017).
- Oregon's Statewide Planning Goals & Guidelines, Goal 15 (1973; 2010).
- River Renaissance (2001).
- River Plan (2010, 2020).

These plans are summarized in this section.

3.2 Willamette Greenway Plan Goal and Objectives

The Willamette Greenway Plan was developed in 1987 with a goal to protect and enhance land qualities along the Willamette River (BPS 1987). It established boundaries for the Willamette Greenway, and allocated areas within the Greenway by land use. This plan introduced four types of overlay zones for Greenway land:

1. River Industrial
2. River Development
3. River Recreational

4. River Natural

The plan also included design guidelines and landscaping guidelines.

3.3 Central City Plan

The Central City 2035 Plan provides a development framework for portions of Portland's Central City regions (BPS 2017). Developments focused on the Willamette River include increasing river setback to implement a River Environmental overlay zone, allowing small shops to activate the waterfront, and encouraging riverfront use.

3.4 Oregon's Statewide Planning Goals & Guidelines

In 1973, the State of Oregon established a set of goals and guidelines focused on land use and related topics (Department of Land Conservation and Development 2010). Although Oregon's Land Conservation and Development Commission (LCDC) directs the statewide planning program, city and county governments have responsibility for the implementation and execution of the land use goals and guidelines.

Goal 15 establishes the Willamette River Greenway Program, whose main objectives are the protection, conservation, enhancement, and maintenance of land along the Willamette River. This land is zoned according to eleven potential uses:

1. Agricultural lands.
2. Recreation.
3. Public access.
4. Fish and wildlife habitat.
5. Scenic qualities and view.
6. Protection and safety.
7. Vegetative fringe.
8. Timber resource.
9. Aggregate extraction.
10. Development away from river.
11. Greenway setback.

The Oregon Department of Transportation (ODOT) prepares and maintains "inventories" that record the boundaries of the above zones within the Willamette River Greenway. Cities and counties that include the Willamette River Greenway must incorporate boundaries into zoning maps. A draft inventory was developed in February 2019 as part of the River Plan (Section 3.6).

3.5 River Renaissance

River Renaissance Vision (2001)

Developed in 2001 on the 150th anniversary of Portland's founding, this report summarizes a future vision for the city of Portland.

The Vision is comprised of five central themes:

1. Assure a clean and healthy river for fish, wildlife, and people.
2. Maintain and enhance our prosperous working harbor [sic].
3. Embrace the river as Portland's front yard.
4. Create vibrant waterfront districts and neighborhoods.
5. Promote partnerships, leadership, and education.

Public input is an important aspect of the Vision. In developing the Vision, the Portland Bureau of Planning drew on feedback from planning events attended by over a thousand Portlanders.

River Renaissance Strategy (2004)

This document refines the River Renaissance Vision by expanding each theme with policy guidance, success indicators, and recommended actions.

3.6 River Plan

The current manifestation of the River Renaissance is the River Plan, a focused urban planning project for the downstream Willamette River. Also derived from the 1987 Willamette Greenway Plan, Greenway zoning code, and Greenway design guidelines, the River Plan was initially adopted by the Portland City Council in April 2006. Key stakeholders guiding the River Plan include a voluntary citizen's committee, ad-hoc task groups, and technical advisers.

The River Plan divides the downstream Willamette River from the mouth (WRM 0) through Elk Rock Island (WRM 19) into three reaches for future development (Figure 9, Table 13).

Figure 9. River Plan Reaches

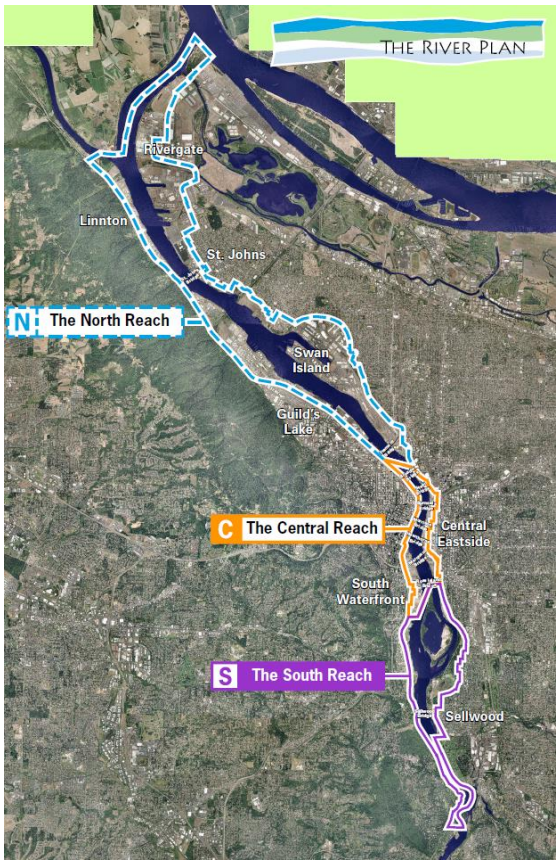


Table 13. River Plan Reaches and Themes

Reach	Title	Extent
The North Reach	Portland's Working Waterfront	Mouth to Broadway Bridge (WRM 0 to WRM 11.6)
The Central Reach	The Region's Gathering Place	Broadway Bridge to Ross Island Bridge (WRM 11.6 to WRM 14)
The South Reach	Neighborhoods and Natural Areas	Ross Island Bridge to Dunthorpe Neighborhood (WRM 14 to WRM 19)

As of the writing of this Navigation Study, the River Plan current status includes:

- **River Plan / North Reach court rulings**. After its adoption by the Portland City Council in 2010, the River Plan / North Reach faced two years of legal proceedings regarding the regulation of land for urban use in Oregon's statewide land use planning goals. Following this process, focus shifted to the River Plan / Central Reach.
- **River Plan / Central Reach in Central City 2035**. In June 2018 the Portland City Council adopted the Central City 2035 plan, which includes focused goals for the Central Reach.

- **Draft inventory**. In February 2019, the River Plan team completed an updated draft inventory of natural resources in support of Oregon's Statewide Planning Goals and Guidelines (Section 3.4). The inventory contains maps that geographically present regulatory, land use, ownership, environmental, recreation, historic, and cultural information across all three reaches.
- **Draft River Plan / South Reach**. In January 2020, The River Plan / South Reach draft was released, which includes establishing a renewed vision for the area, updating existing policies and regulations, identifying implementation actions, and identifying future South Reach investments (City of Portland, 2020).

3.7 Development Impacts on River

Within the five River Renaissance themes, proposed River Plan projects address a broad range of topics including industry, neighborhoods, recreation, and natural resources. The development projects planned for each reach address the five central themes of the River Renaissance Initiative. As shown in Table 14, select proposed projects would specifically affect Willamette River traffic, flow, or footprint.

Table 14. River Plans Projects Potentially Impacting River Traffic, Flow, or Footprint

Project Description	Planned Reach(es)
Contaminated site cleanup	North Reach (Portland Harbor Superfund)
Recycling of brownfield and unoccupied sites	North Reach; Central Reach (Zidell Marine Yard); South Reach (Ross Island restoration)
Riverbank treatment and planting	North Reach
River channel maintenance and dredging	North Reach; South Reach
Waterfront refurbishment	North Reach (St. Johns, Linnton); Central Reach (Centennial Mill)
New bridge (or bridge modification)	North Reach (new bridge, or modifications to St. Johns or Railroad Bridges; Hayden Island; Sauvie Island)
New river ferry or river taxi system	Central Reach
New cruise ship terminal	Central Reach (Central City)

Projects identified in Table 14 are not guaranteed to occur, but should be monitored during their development, potential construction, and execution. These projects may affect the vessels that call on the Burnside Bridge. Potential impacts of these projects on navigation elevation and horizontal clearance requirements include:

- *Increased horizontal clearance requirement*. All projects identified in Table 14 could undergo a construction phase. This phase could increase tug and barge traffic similar to that described in Section 4.2. Thus, all projects could increase traffic with a large horizontal clearance.

- *Increased elevation requirement*. A new cruise ship terminal could encourage larger, taller passenger vessels to call on downtown Portland.

Additionally, River Plan projects must work in concert with the land use zones delineated in the Goal 15 Inventory.

4 Burnside Bridge Clearances

4.1 Overview

In this study, a river user is a public or private entity expected to transit the Burnside Bridge in a vessel during and/or after Burnside Bridge modification. A river user may be an individual (such as a private vessel owner) or a group (such as a company, marina, or organization).

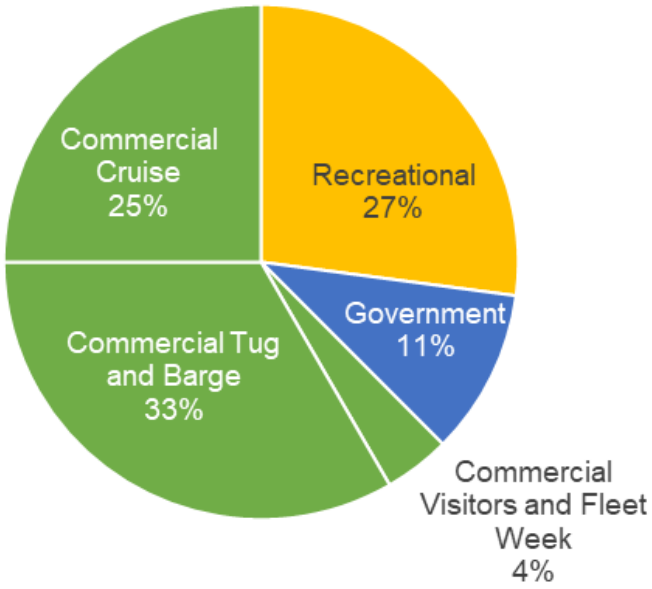
As part of this study, 84 river users potentially affected by a change in clearance of the Burnside Bridge were initially contacted or researched. Users without significant marine assets in the project area or who declined response were omitted from further study (Appendix B). Elevations and horizontal clearance requirements were ultimately obtained for 47 river users (Appendix A, Appendix C). These 47 users are a representative subset of the thousands of actual river users who may transit under the Burnside Bridge.

Each river user is classified as one of the following:

- *Commercial*: includes tug/barge river users, shipyards, cruise operators, or other.
- *Recreational*: includes yacht clubs, sailing clubs, private vessels, or private marinas.
- *Government*: includes infrastructure, regulatory, or emergency response.

As described in Figure 10, a majority of river users are commercial.

Figure 10. Distribution of River Users



Elevation and Horizontal Clearance Requirements

Elevation and horizontal clearance requirements reported in this section are provided by the river users themselves. These requirements represent the minimum space needed for the river user to safely transit the bridge. **Unless otherwise stated, these requirements imply safe transit without tug assist.**

The basis for these requirements varies from river user to river user. Typically, the elevation requirement derives from the river user's highest vessel air draft (distance from waterline to highest point on vessel) expected to transit the Burnside Bridge.

Typically, the horizontal clearance requirement derives from the river user's largest vessel beam (vessel transverse dimension) expected to transit the Burnside Bridge. The horizontal clearance requirement includes an additional margin for safe navigation around river obstacles like bridge supports. Many river users specified either a complete horizontal clearance, or a beam and safety margin. For those who did not, Glosten estimated a horizontal clearance based on vessel length, beam, and typical navigational practices.

For some users, such as operators who tow multiple barges side-by-side, the horizontal clearance requirement may derive from the beam and safety margin of multiple vessels transiting the bridge simultaneously. An individual barge may have a small beam, but if the operator expects to tow two or three barges simultaneously, their horizontal clearance requirement will significantly exceed an individual beam.

River user elevation and horizontal clearance requirements communicate river user needs for safe transit with no operational impact. Minimization of navigational impact is a key evaluation factor of the USCG for Bridge Permit Applications (Section 1.1).

4.2 Commercial Users

About two-thirds of all river users are classified as "Commercial." These river users are compensated for vessel operations on the Willamette River between the mouth and Willamette Falls. They fall into three subcategories (Figure 10):

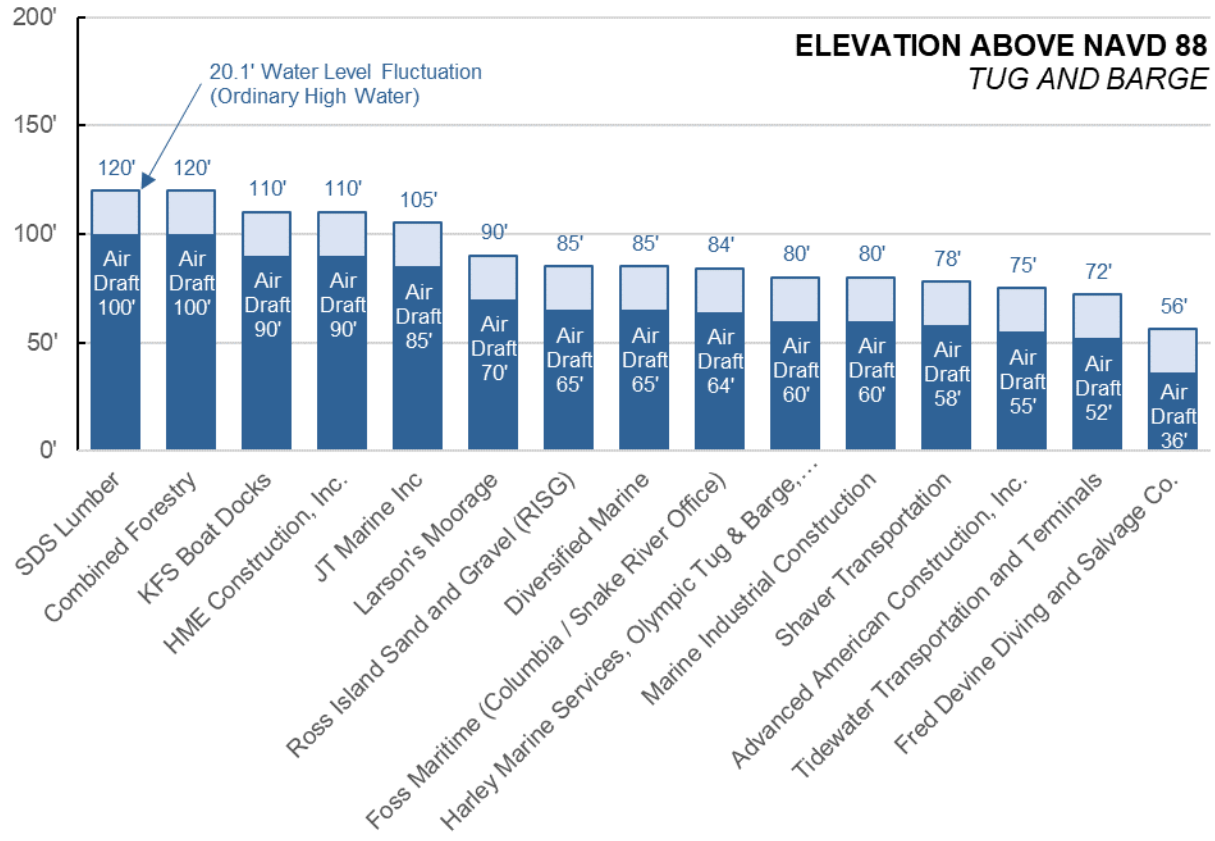
- *Tug and barge*: These river users operate tugboats, barges, and other large marine assets to support towing, shipyard, and construction projects. About one-third of all Willamette River users are tug and barge river users.
- *Cruise*: These river users transport paying passengers for day or overnight cruises, or as part of launch services. About one-quarter of all Willamette River users operate cruises.
- *Visitors and Fleet Week*: "Visitors" refers to large vessels that transit the Burnside Bridge and require permitting through the Harbor Master. "Fleet Week" refers to the set of Navy, sea, and other vessels that visit Portland during the annual Fleet Week celebration in June.

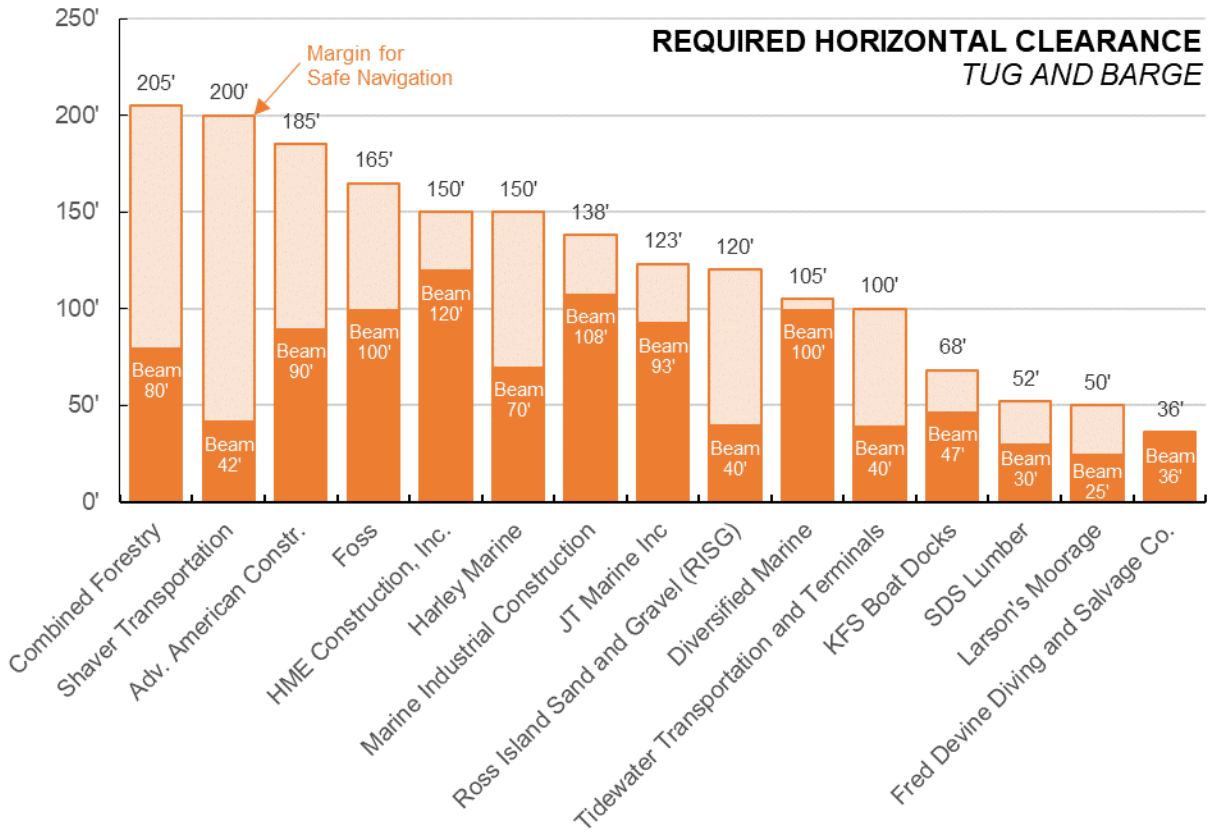
Tug and Barge

Sixteen tug and barge river users were identified. Figure 11 depicts their air drafts, expected elevation requirements, beams, and horizontal clearance requirements.

(Brusco Tug & Barge declined to provide breadth or draft information and is not included in Figure 11).

Figure 11. Tug and Barge Users - Required Vertical Clearance Elevations (top) and Required Horizontal Clearance Widths (bottom)





At OHW, all tug and barge river users can safely transit beneath the infinite and 167-foot elevations of all bridge design states.

All tug and barge river users can safely transit the 205-foot horizontal clearance of the existing, permanent retrofit, and permanent replacement bridge design states. This precedent was established with the existing Burnside Bridge and the downstream Steel Bridge, both of which have a 205-foot horizontal clearance and verified by the river user survey.

The horizontal clearance requirements of three tug and barge users exceed the 165-foot horizontal clearance of the temporary bridge state:

- *Combined Forestry & Marine Services, Inc.*: This river user prefers the existing clearance of 205 feet. The reasons for this preference include:
    - Horsepower limitations within the Combined Forestry fleet.
    - River conditions near the Burnside Bridge. Eddies and boils prevail, and cause vessels to track at an angle.

The 165-foot horizontal clearance of the temporary bridge in conjunction with a possible 390-foot bridge width is “a non-starter” for this river user. Although assist tugs may mitigate the loss of work with such a bridge, Combined Forestry may still lose some work. In contrast, a bridge width closer to 200 feet would impact 50 percent or more of Combined Forestry operations.

- *AAC*: This general contractor would require a tug assist to safely transit the 165-foot horizontal clearance and 390-foot width of the temporary bridge.
- *Shaver Transportation*: Shaver Transportation has stated that the 165-foot clearance of the temporary bridge would require an assist tug on a case-by-case basis.

Table 15 summarizes the horizontal clearance requirements of these impacted tug and barge river users.

Table 15. Horizontal Clearance Requirements of Impacted Tug and Barge River Users

User	Horizontal Clearance Requirement	Temporary Bridge (considering a 165 ft. to 390 ft. width range)
Combined Forestry & Marine Services. Inc.	205 ft.	**No safe transit**, but tug assist may mitigate the impact
Shaver Transportation	200 ft.	Safe transit with 1 tug assist (on case-by-case basis)
AAC	185 ft.	Safe transit with 1 tug assist

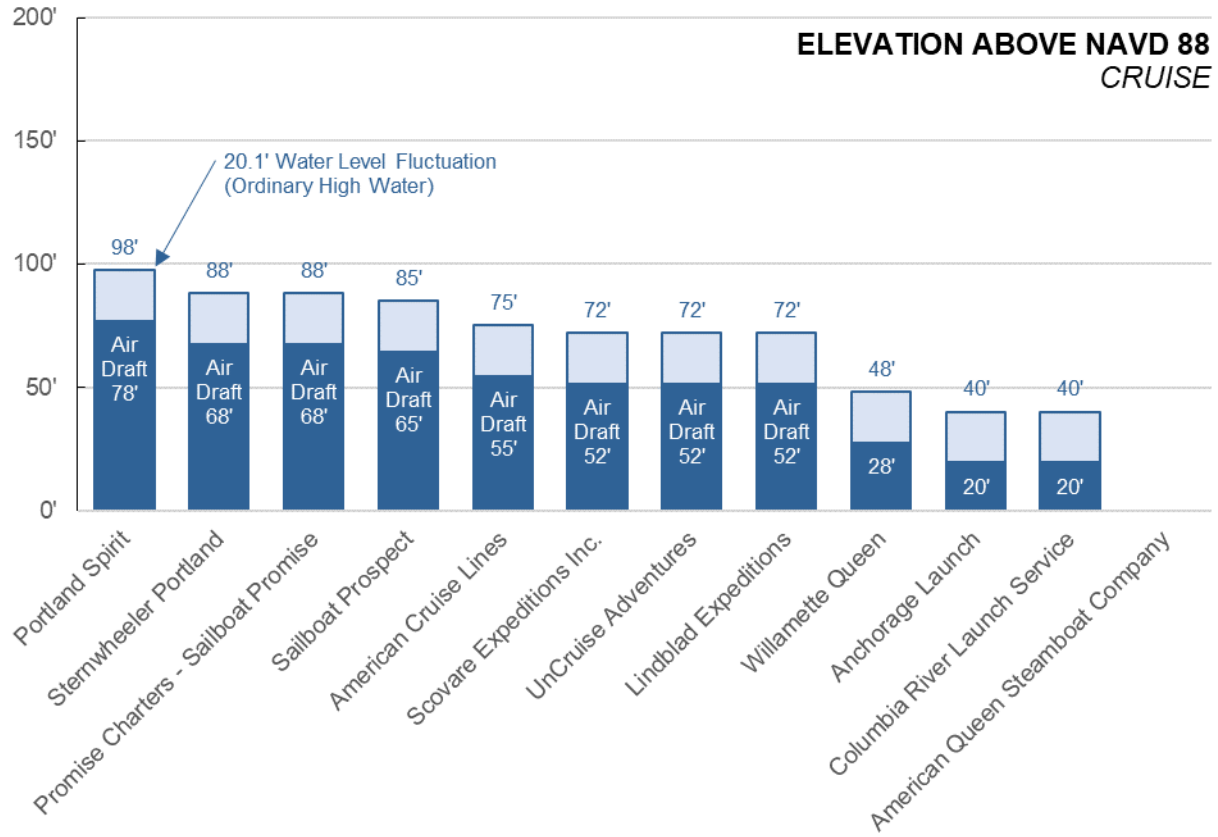
Figure 12. Foss (left) and AAC (right) Facilities on the Willamette River

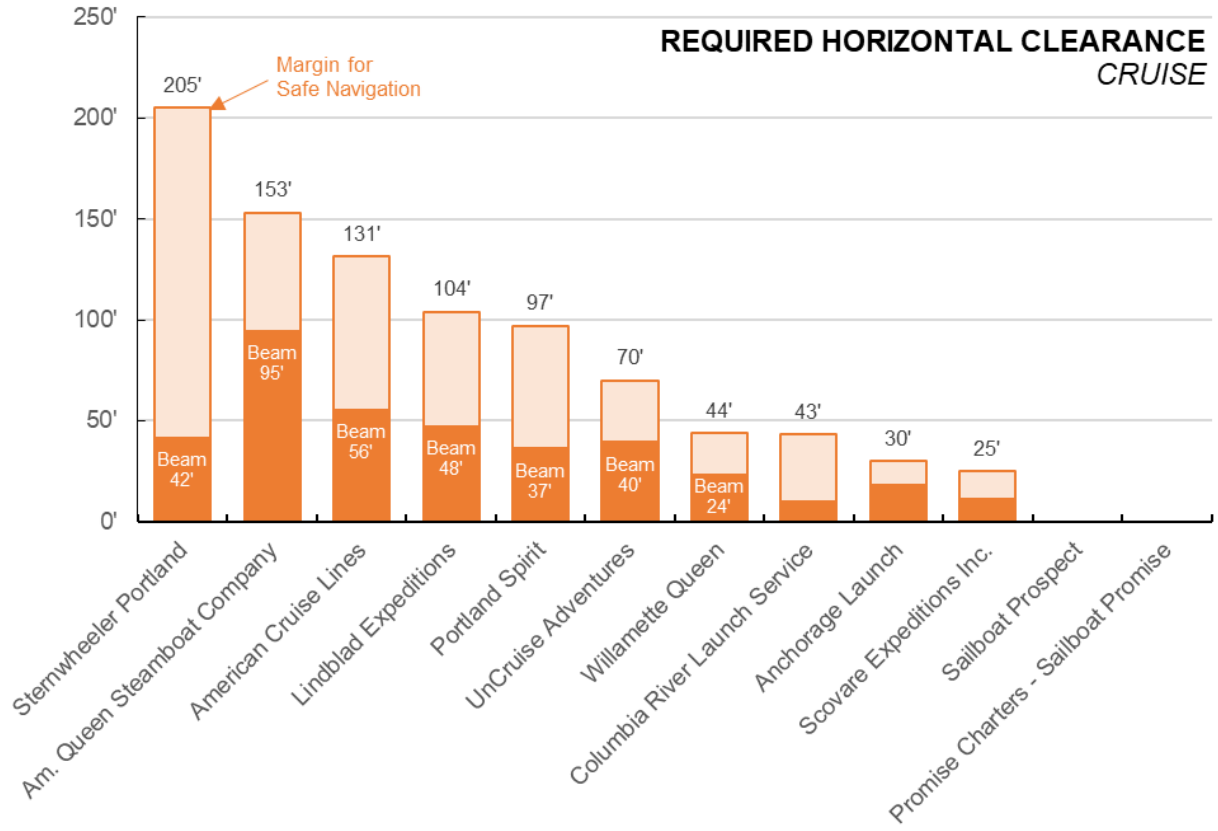
One other tug and barge river user merits special note. The Foss Maritime Columbia / Snake River office assists barges on the Willamette River (Figure 12). Following the shutdown of Zidell Marine in 2016, Foss rarely transits upriver. The maximum beam of Foss Maritime vessels is 100 feet. Foss can safely transit within a 165-foot horizontal clearance but has declined comment on the 165-foot horizontal clearance combined with the 390-foot upriver width of the temporary bridge.

Cruise

Twelve major cruise river users were identified. They comprise about a quarter of all Willamette River users (Figure 10). Figure 13 depicts their air drafts, expected elevation requirements, beams, and horizontal clearance requirements. Air draft information was unavailable for American Queen Steamboat Company. Horizontal clearance information was unavailable for the Sailboat Prospect and Promise Charters.

Figure 13. Cruise Ship Users - Required Vertical Clearance Elevations (top) and Required Horizontal Clearance Widths (bottom)





At OHW, all cruise river users can safely transit beneath the infinite and 167-foot elevations of all bridge design states.

All cruise river users can safely transit the 205-foot horizontal clearance of the existing, permanent retrofit, and permanent replacement bridge design states.

The horizontal clearance requirement of one river user exceeds the 165-foot horizontal clearance of the temporary bridge state: the Sternwheeler *Portland* (Figure 14).

Figure 14. The Oregon Maritime Museum Sternwheeler *Portland*

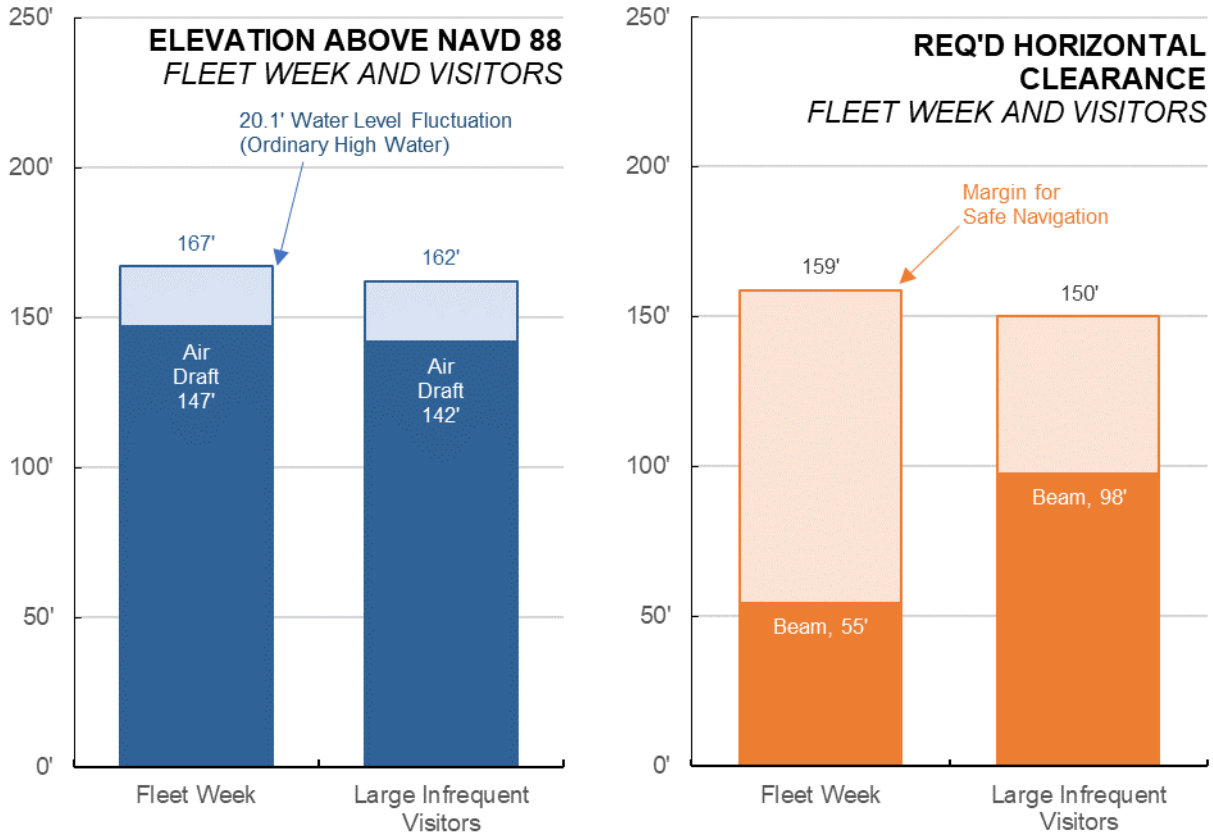
This historic paddlewheeler houses the Oregon Maritime Museum and takes passengers on multi-hour river cruises. Due to limited propulsion and control, the vessel requires more horizontal clearance for transit under the proposed bridge than a modern vessel of similar size.

Clark Vincent Caffall, President of Combined Forestry and Marine Services, provided clearance requirements for the Sternwheeler *Portland*. Mr. Caffall frequently captains the *Portland*. He estimates the vessel would require one to two tug assists to transit the temporary bridge.

Large Visitors and Fleet Week

The remaining two commercial river users include visitors to Portland, and Fleet Week. Figure 15 depicts their air drafts, expected elevation requirements, beams, and horizontal clearance requirements.

Figure 15. Visitors and Fleet Week Vessels - Required Vertical Clearance Elevations (left) and Required Horizontal Clearance Widths (right)



At OHW, these two users can safely transit beneath the infinite and 167-foot elevations of all bridge design states. Additionally, both users can safely transit the horizontal clearances of all bridge design states.

Importantly, the clearance requirements of these two river users represent the possible needs of a range of vessels that may transit the Burnside Bridge in the future. These requirements derive from the needs of specific vessels that have transited in the past, as described below. It is uncertain whether these specific vessels from the past will transit Burnside again. However, this analysis assumes that similar vessels with similar clearance needs will transit in the future.

- *Large Infrequent Visitors*: This river user represents a diverse set of visiting vessels that moor in Portland and require a lift of the Burnside Bridge. The data in Figure 15 reflects the largest vessel in this set: the luxury condo yacht *The World*, with an air draft of 142 feet and beam of 98 feet (Figure 16).

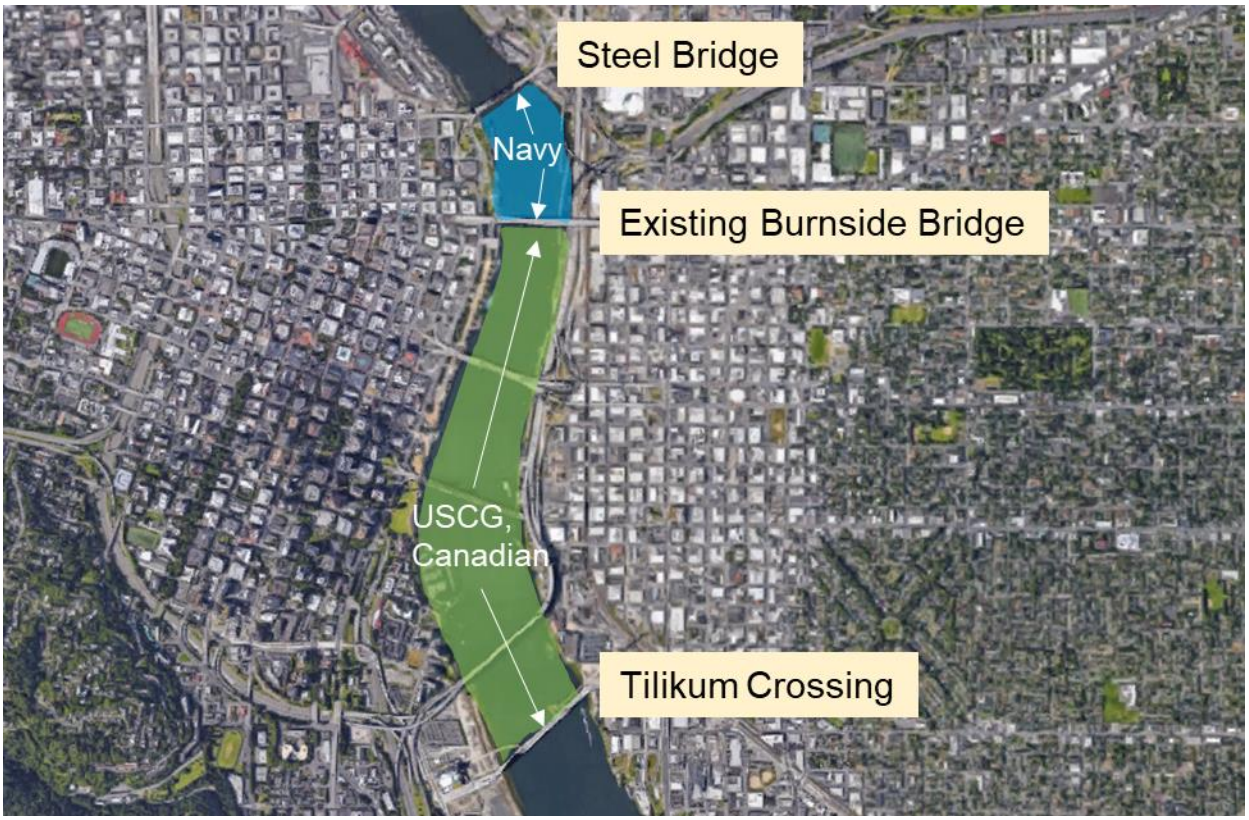
Figure 16. MS *The World*

Source: CruiseMapper, n.d.

- *Fleet Week*: This river user represents the set of Navy, sea, and other vessels that visit Portland during the annual Fleet Week celebration in June. The data in Figure 15 reflects the largest vessels in this set: the USCGC *Waesche*, with an air draft of 147 feet and beam of 54 feet, and the HMCS *Regina*, with an air draft of 114 feet and beam of 55 feet.

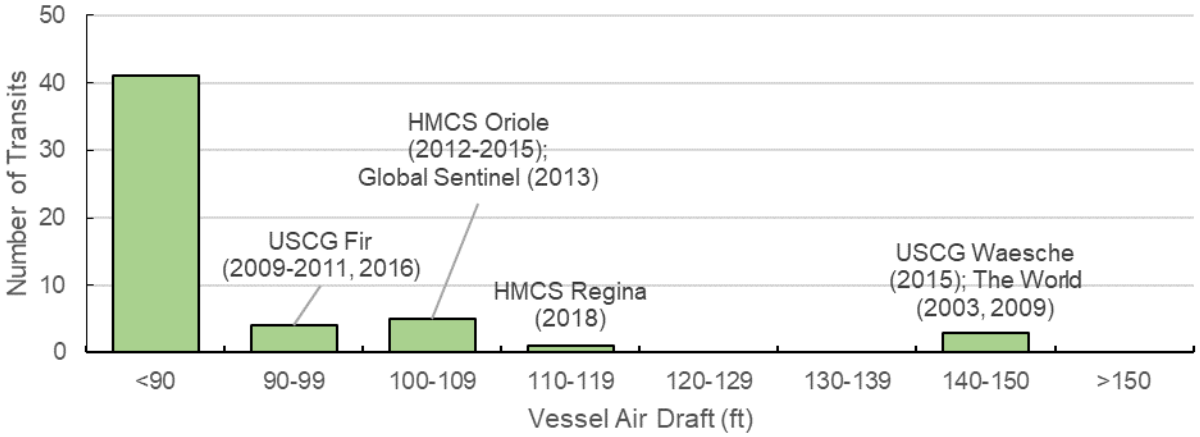
During Fleet Week, U.S. Navy vessels moor between the Steel Bridge and Burnside Bridge (Figure 17). The U.S. Navy creates a secure zone between these bridges and monitors the vessels. USCG and Canadian vessels moor between the Burnside Bridge and Tilikum Crossing. Tilikum Crossing is the upstream boundary for the Fleet Week vessels.

Figure 17. Diagram of Fleet Week Vessel Mooring Plan



Over the last decade, seven different vessels with air drafts over 90 feet have transited the Burnside Bridge at various times, either as a visitor, or as part of Fleet Week[4]. Figure 18 shows when these transits occurred.

Figure 18. Fleet Week Vessels with Air Drafts Greater Than 100 Feet That Transited Through the Burnside Bridge, 2008 – 2018



The transit frequency of the cable-laying vessel Global Sentinel (elevation requirement 127 feet; air draft 107 feet) is not known, but this vessel has transited at least once since

[4] Pratt, R. (email) [Portland Fire & Rescue], "RE: Burnside Bridge vessel traffic," 12 February 2019

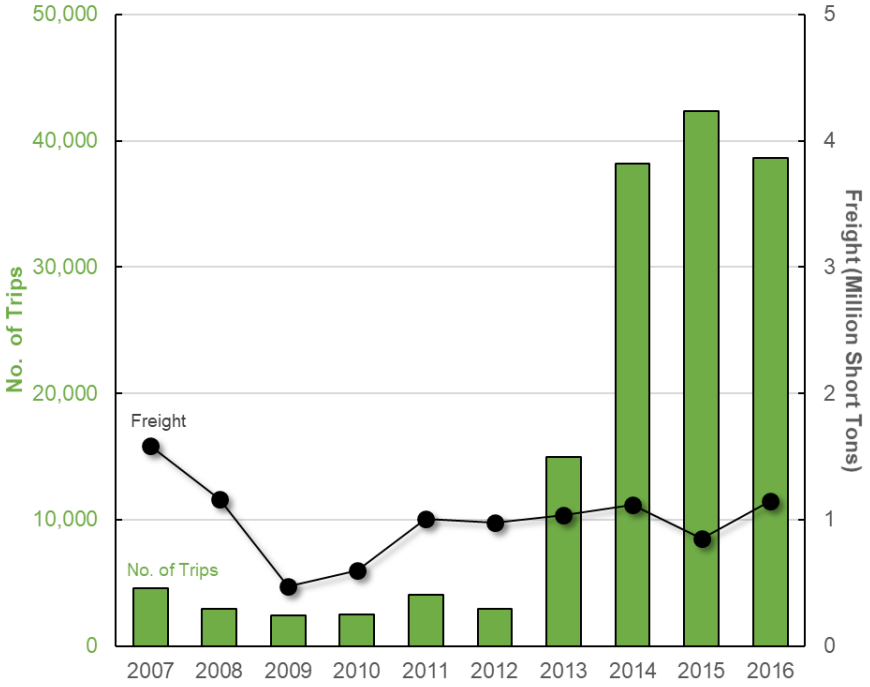
2008. Based on historical precedent, it is reasonable to assume that visitors and Fleet Week vessels will continue to transit Burnside Bridge. These vessels take advantage of large vessel moorage immediately upstream of the Burnside Bridge, including the Seawall and Riverplace Marina.

4.2.1 Waterborne Commerce Statistics

Since 1955, the USACE has evaluated domestic and foreign waterborne commerce in the United States. Compiled in the annual USACE publication *Waterborne Commerce of the United States*, the data includes the movements of commodities and vessels around the ports, harbors, waterways, and canals of the U.S. and its territories.

This study focuses on waterborne commerce data available for the upper Willamette and Yamhill Rivers (USACE IWR, 2007-2016). This region includes 159 miles of the Willamette River between Portland and Harrisburg, OR, and 4 miles of the Yamhill River from its mouth to Yamhill River Mile 4.0. Figure 19 summarizes Upper Willamette-Yamhill waterborne commerce between 2007 and 2016.

Figure 19. Upper Willamette and Yamhill River commerce between 2007 and 2016



Source: USACE IWR, 2007-2016

More than 99 percent of cargo annually was classified as “sand & gravel.” In 2013 and 2014, less than 1 percent of the annual cargo was classified as “wood in the rough” or “fabricated metal products.”

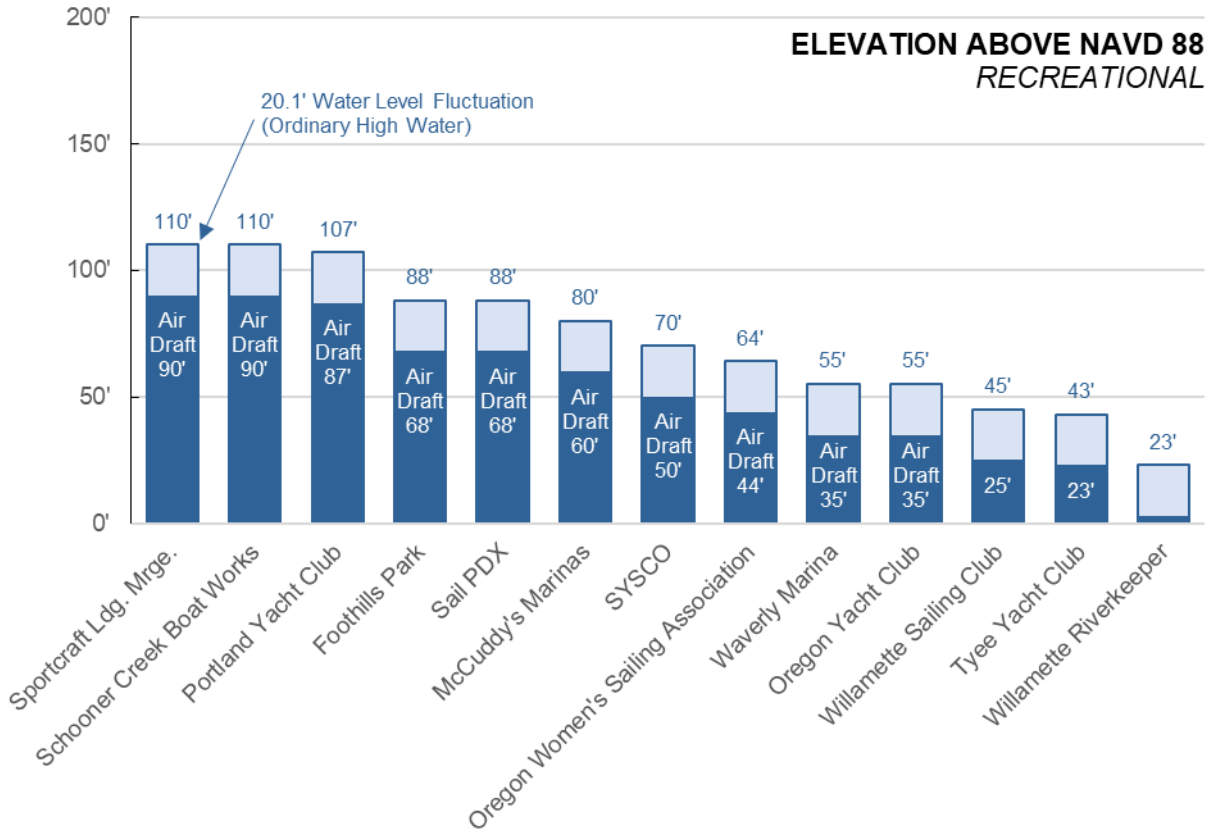
Freight traffic on the upper Willamette and Yamhill Rivers (black dots on Figure 19) has been relatively constant over the study period, with an average of 1 million short tons annually. However, the number of commercial trips (green bars on Figure 19) has increased by a factor of eight over the study period, from 3,305 trips on average annually between 2007 and 2011, to 27,412 trips on average annually between 2012 and 2016.

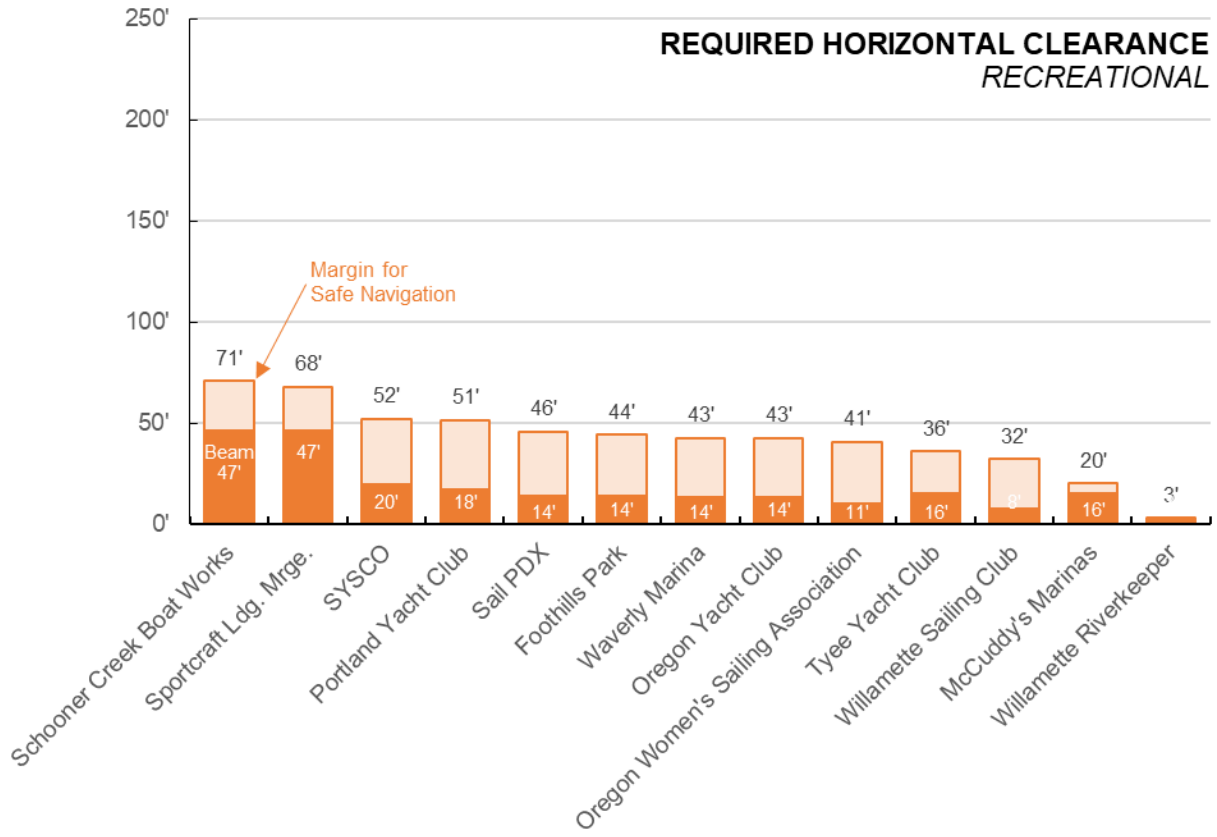
The upward trend in trips suggests that although more commercial vessels are transiting the upper Willamette and Yamhill Rivers in recent years, those vessels are carrying less cargo. The increase in number of trips coincides with the departure of Hanjin Shipping from Portland in early 2015 (Conley 2017).

4.3 Recreational Users

Approximately one-third of all river users are classified as recreational. These users represent entities that transit the river for non-commercial and non-government purposes, and includes sailing clubs, public moorages, private moorages, and a river advocacy organization. Figure 20 depicts their air drafts, expected elevation requirements, beams, and horizontal clearance requirements.

Figure 20. Recreational users - Required Vertical Clearance Elevations (top) and Required Horizontal Clearance Widths (bottom)



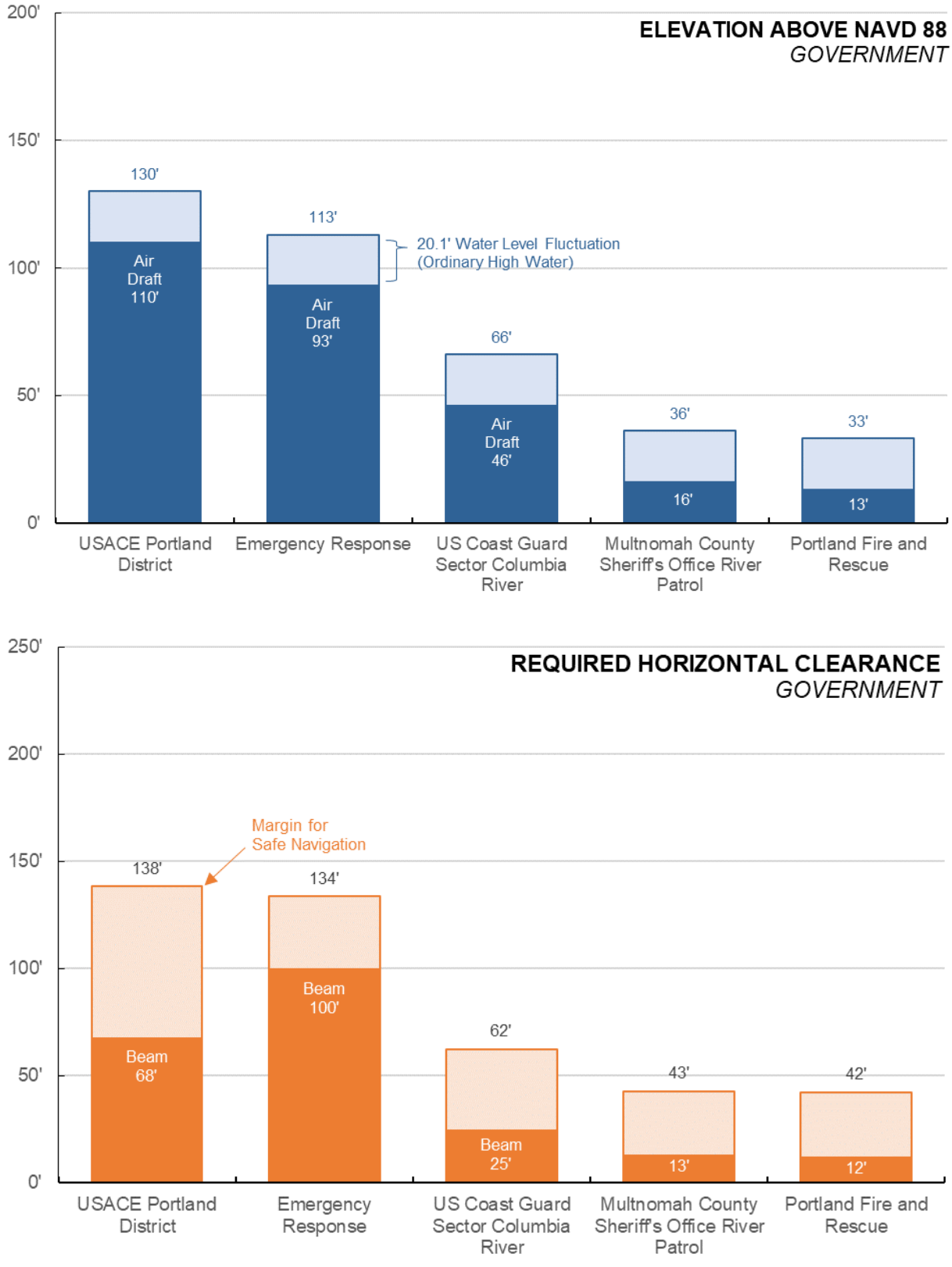


At OHW, all recreational river users can safely transit beneath the infinite and 167-foot elevations of all bridge design states. Additionally, these users can safely transit the horizontal clearances of all bridge design states.

4.4 Government Users

Less than one-tenth of all river users are classified as government. These users represent state and federal agencies that transit the Willamette River for emergency operations, defense activities, or channel maintenance. Figure 21 depicts their names, air drafts, and expected elevation requirements and horizontal clearance requirements.

Figure 21. Government Users - Required Vertical Clearance Elevations (top) and Required Horizontal Clearance Widths (bottom)



At OHW, all government river users can safely transit beneath the infinite and 167-foot elevations of all bridge design states. Additionally, these users can safely transit the horizontal clearances of all bridge design states.

Neither the temporary nor proposed bridge will impact USCG and other government vessels' ability to transit the bridge to conduct mission essential functions.

- *U.S. Coast Guard Sector Columbia River* monitors the river for search and rescue purposes and patrols the river for major events such as dragon boat races. Additionally, the 100-foot USCG *Bluebell* transits monthly to support Aids to Navigation.
- *Multnomah County Sheriff's Office River Patrol* patrols both the Columbia and Willamette River as far as the county line near Oswego with vessels up to 36 feet in length.
- *Emergency Response Vessel* represents the largest government river user. This user is represented by a large derrick barge potentially called upon for the requisite work. This particular derrick has an overall length of 333.5 feet with the boom stowed, a beam of 100 feet, and an assumed maximum air draft of 93 feet with the spuds in the stowed position. More details are provided in Section 5.2.

In addition to the government river users above, the *Columbia River Pilots* are indirect users of the Burnside Bridge. This state agency is comprised of expert vessel navigation personnel ("pilots") who board vessels upon request and navigate them safely in and out of port.

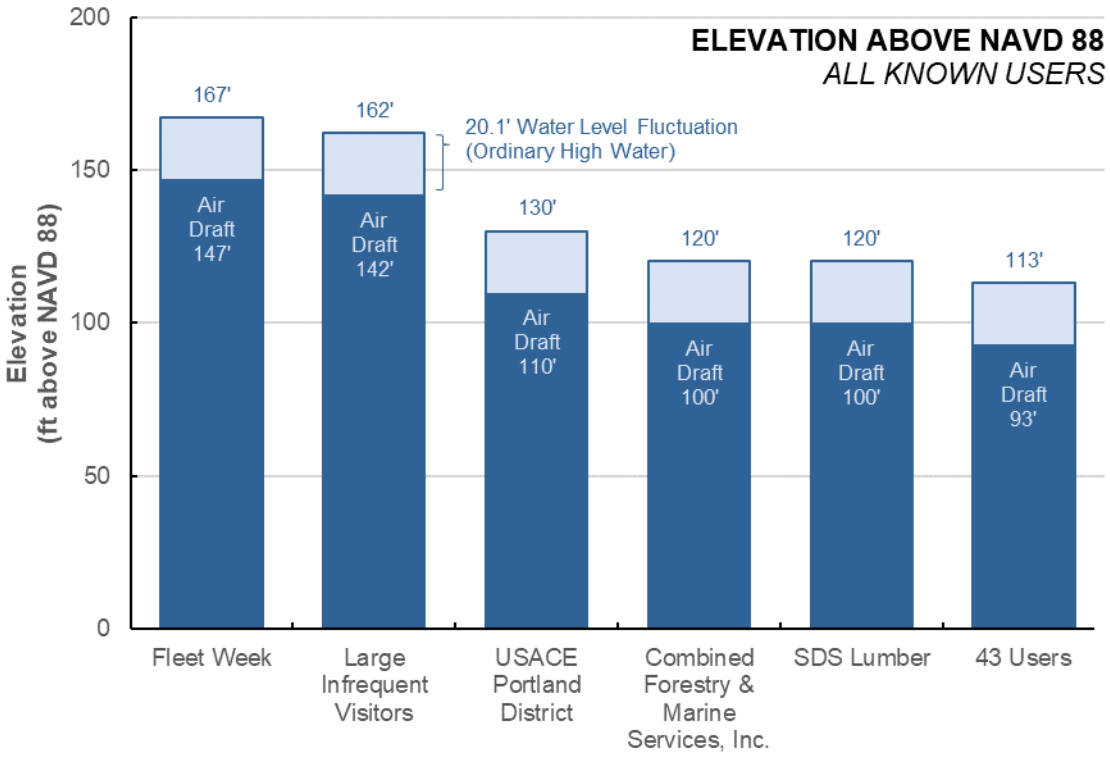
Jeremy Nielsen, Vice President of the Columbia River Pilots, offered expertise regarding clearances for this study. Compulsory pilotage jobs through the Burnside Bridge are extremely rare, but voluntary pilot requests are typically made for Fleet Week vessels. Captain Nielsen acknowledged that tug and barge traffic transits through the Burnside Bridge are fairly light, but he cautioned against reducing the bridge's horizontal clearance. He reasoned that narrowing the approach to the Burnside Bridge would make the approach to the Steel Bridge even more difficult.

4.5 Bridge Clearance Recommendations

4.5.1 Recommended Vertical Clearance Elevation

Figure 22 displays the elevation requirements of all known river users.

Figure 22. Elevation Requirements of All Known River Users

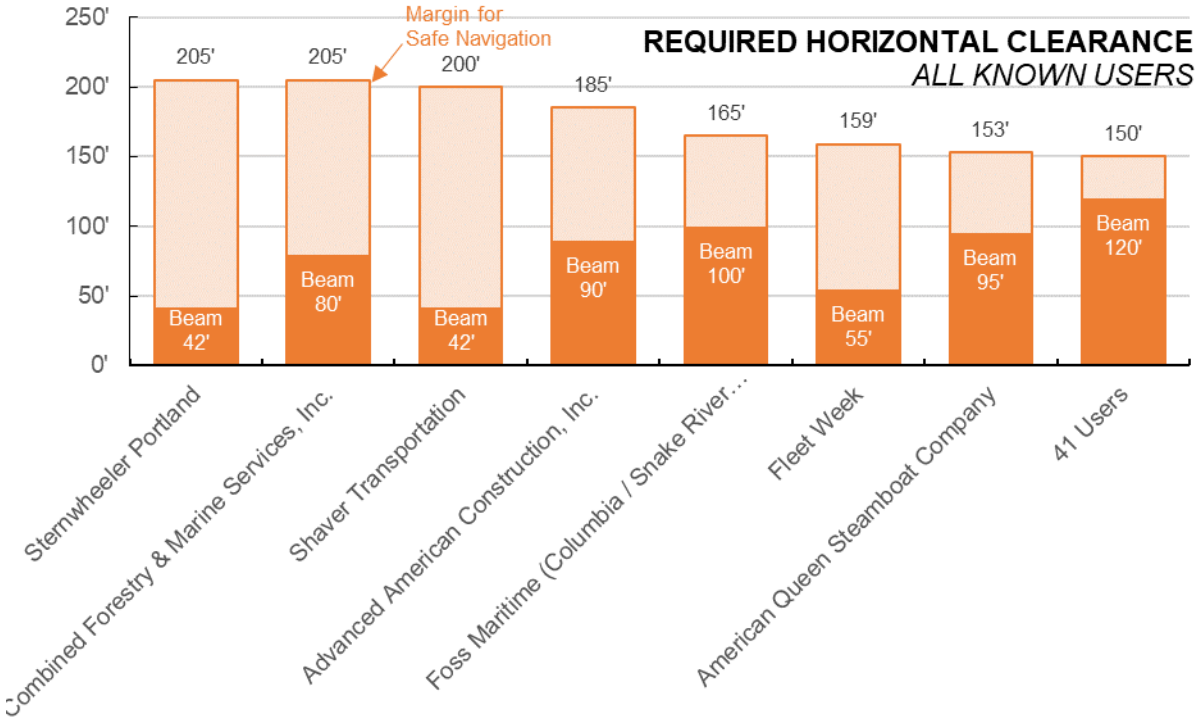


The recommended elevation for all bridge design states is 167 feet above NAVD 88. With this clearance, all river users would safely transit beneath the Burnside Bridge at OHW. For short-term reductions to these clearances during construction, it is reasonable to assume that the USCG will grant temporary deviations to these clearance dimensions, as evidenced by the many recent rehabilitation projects. These temporary deviations, however, are on a case-by-case basis only and should be limited to days and a few weeks rather than months. Temporary deviations may require agreements from affected river users.

4.5.2 Recommended Horizontal Clearance

Figure 23 displays the horizontal clearance requirements of all known river users.

Figure 23. Horizontal Clearance Requirements of All Known River Users



The recommended horizontal clearance needed to eliminate user impacts for all bridge design states is 205 feet. Three bridge states satisfy this recommendation: existing, permanent retrofit, and permanent replacement. The 165-foot horizontal clearance of the temporary bridge state would impose an operations impact on three known river users:

- Combined Forestry could not transit safely, but one or two tug assists could mitigate the impact. However, tug assists would not guarantee safe transit for Combined Forestry.
- AAC would require a tug assist for safe transit.
- Shaver Transportation would require a tug assist on a case-by-case basis.

Moreover, the Columbia River Pilots advised against narrowing the permanent Burnside Bridge from its existing 205-foot horizontal clearance.

River User Consent for Single-Leaf Closure

Closure of a single leaf of the Burnside Bridge may occur during any bridge state for bascule bridge designs. In this analysis, a single-leaf closure is assumed to cut available horizontal clearance in half. Table 16 details assume single-leaf horizontal clearances across all bridge states:

Table 16. Assumed Horizontal Clearance if a Single Leaf Must Be Closed

Design State (if Bascule)	Horizontal Clearance	Single-Leaf Horizontal Clearance
Existing	205 ft.	102 ft.
Temporary	165 ft.	82 ft.
Permanent Retrofit	205 ft.	102 ft.
Permanent Replacement	205 ft.	102 ft.

USCG grants permission for single-leaf closures through Temporary Rules or Temporary Deviations (Section 1.1). During a single-leaf closure, affected river users include those whose horizontal clearance requirements exceed the single-leaf horizontal clearance. Applications for Temporary Rules and Temporary Deviations must indicate consent from these affected river users to forego transit during the closure period.

In the event of a single-leaf closure during any of the four Burnside Bridge states, the following river users are recommended to be contacted and provide consent. All of the following users have horizontal clearance requirements exceeding 82 feet:

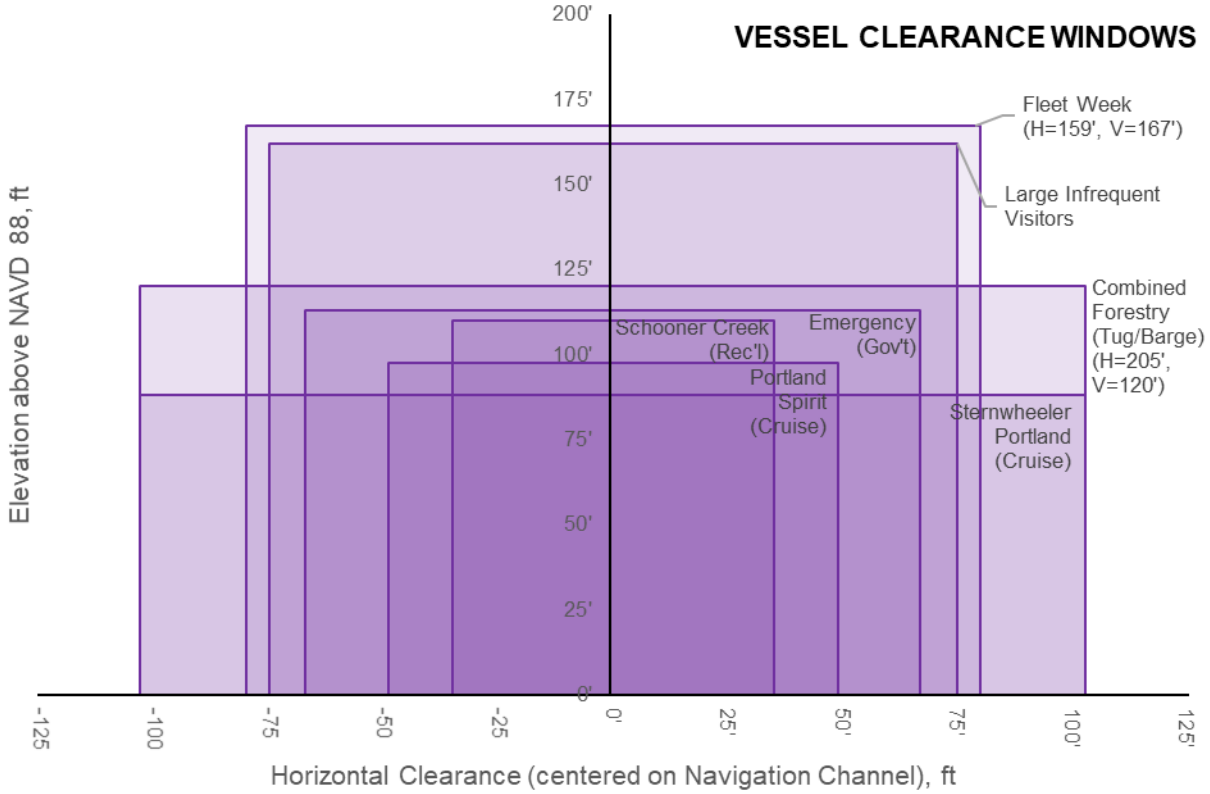
- Combined Forestry & Marine Services, Inc.
- Shaver Transportation
- Advanced American Construction, Inc.
- Foss Maritime
- Portland Rose Festival Association (Fleet Week)
- Oregon Maritime Museum
- American Queen Steamboat Company
- HME Construction, Inc.
- Harley Marine Services; Olympic Tug & Barge; Pacific Terminals
- Marine Industrial Construction
- American Cruise Lines
- JT Marine, Inc.
- Ross Island Sand and Gravel
- Diversified Marine
- Lindblad Expeditions
- Tidewater Transportation and Terminals
- Portland Spirit

Horizontal clearance requirements and contact information for the above seventeen river users are provided in Appendix A.

4.5.3 Clearance Window

Clearance windows illustrate the origin of the above recommended elevation and horizontal clearance. Figure 24 displays the clearance windows for the vessels with the largest clearances in each user type. The height and width of each box in Figure 24 correspond to the required elevation and horizontal clearance (centered on the navigation channel) for each vessel.

Figure 24. Elevation Requirement and Corresponding Horizontal Clearance Requirement for Each River User Type



The 167-foot recommended elevation derives from the Fleet Week Vessels. The 205-foot recommended horizontal clearance derives from both Combined Forestry tug and barge vessels, as well as the Sternwheeler Portland for the Oregon Maritime Museum.

4.5.4 Navigation Impacts and Recommendations

River users provided feedback regarding navigating the existing Burnside Bridge. Their concerns fell into several categories:

- *Bridge proximity*. The proximity of Burnside Bridge to neighboring bridges (Steel Bridge, 0.4 miles downriver, and Morrison Bridge, 0.3 miles upriver) requires large vessel operators to set their trajectory for a bridge two or three bridges away. Horizontal clearance reductions complicate trajectory planning.
- *River conditions*. Eddies and boils near the bridge push vessels off course. River users with less power, such as recreational vessels and small vessel operators, have

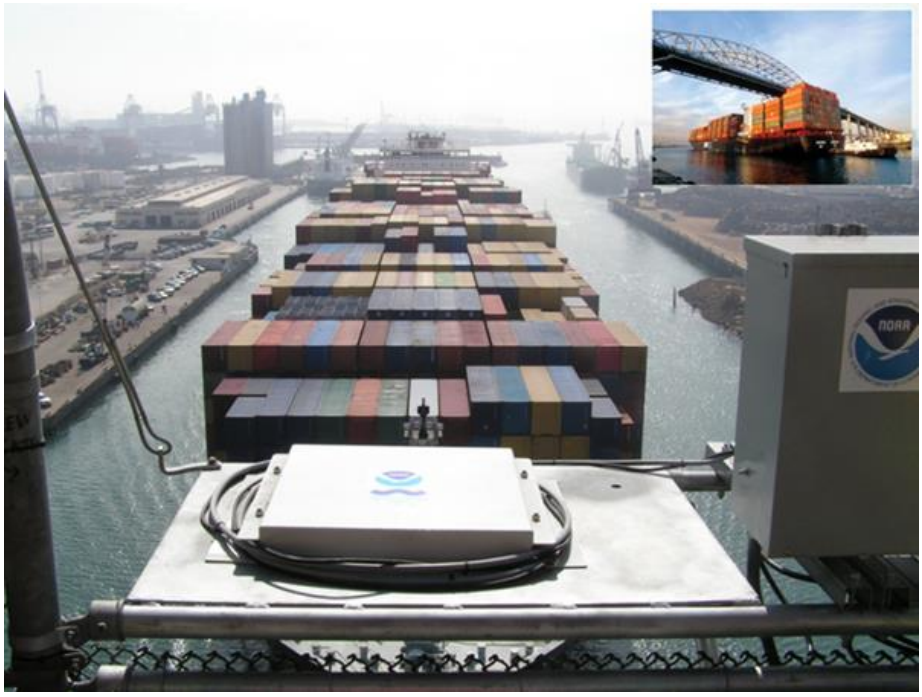
less ability to overcome these conditions, and have more difficulty remaining within restricted horizontal clearances.

- *Congestion*. Both commercial and recreational operators commented on the difficulties of sharing the river with other traffic.

This feedback motivates recommendations for the design and construction of the temporary and permanent bridges:

- Clear navigation signage for both commercial and recreational vessel operators.
- Dedicated transit lane for small recreational craft such as kayaks and stand-up paddleboards. The lane should be wide enough to allow the 35' long Portland Fire & Rescue boat (33' elevation above NAVD 88) to turn around within the lane.
- Real-time clearance gauge. Bridge clearance signs often indicate clearance above a fixed datum. However, as river conditions change throughout the day, the river level above the datum changes, and the vertical clearance from the water line to the bridge changes as well. A real-time clearance gauge, such as the Microwave Air Gap Bridge Clearance Sensor by NOAA, would make it easier for vessel operators to know whether they clear the bridge at any given moment (Figure 25; NOAA 2005).

Figure 25. Air Gap Sensor on Gerald Desmond Bridge in Long Beach, California



NOAA Celebrates 200 Years of Science, Service, and Stewardship, n.d.

5 Earthquake Response Vessels

5.1 Overview

The following federal, state, and municipal agencies provided input regarding earthquake response vessels that may have critical functions in the lower Willamette River following a major earthquake:

- USCG Marine Transportation System Recovery Unit (MTSRU)
- Oregon Office of Emergency Management
- Multnomah County Office of Emergency Management
- Portland Bureau of Emergency Management
- Port of Portland

FEMA Region 10 office was also contacted but declined to comment.

Depending on a variety of factors, the above agencies would likely coordinate waterborne earthquake response in the Lower Willamette River. These agencies may have overlapping jurisdictional claims and responsibilities. Because the Willamette River constitutes "navigable waters of the United States" and part of the area marine transportation system, USCG Incident Command (MTSRU) would likely be in a lead role, at least initially.

5.2 Summary of Findings

There is no common definition of emergency response vessels adopted by emergency response agencies across varying levels of government locally or nationally, nor are there identified standard vessel types for the requisite work functions of waterborne earthquake response. However, there is largely consensus among the above agencies on a four-phased approach to waterborne response and recovery of the affected marine transportation system, as described explicitly by key individuals of MTSRU. These phases describe the necessary work functions of marine vessels following a significant earthquake, from which suitable vessel types can be determined based on Glosten's experience and familiarity with the commercial marine industry.

5.2.1 Initial Response

Initial Response is focused on the immediate rescue and/or movement of people to safety. This can take the form of search and rescue (SAR) operations, mass evacuations, or both, depending on the nature and severity of circumstances or hazards. While this phase of response is focused on lifesaving, it also includes preliminary, non-technical assessments of damage and/or impacts that can be viewed from a waterway vantage, which may confirm or deny coinciding emerging land/air assessments. These non-technical assessments are largely directed at critical components of the marine transportation system and assist in identifying and mobilizing appropriate technical assessment resources.

Suitable vessel types for this work would likely include:

- Smaller shallow-draft SAR vessels or other fast craft - perhaps with firefighting and EMS capabilities. Landing craft may prove necessary for nearshore rescues where conventional docking of vessels may not be possible.
- "Vessels of opportunity" for mass evacuation, such as: existing passenger vessels (perhaps modified to expedite berthing and/or loading and offloading processes); scows and/or flat-deck barges handled by a tug or tug(s); landing craft, or; other vessel types suitable for carriage of passengers on an emergency basis.
- Purpose-built vessels for mass evacuation – i.e. shallow-draft passenger-only vessels with the ability to berth at multiple locations and make rapid ship-to-shore transfers. Landing craft designs could prove particularly effective for this purpose.

Such vessel types are similar in size to those currently transiting the Lower Willamette River on a regular basis, and therefore would not drive special consideration with respect to elevation or horizontal clearances of the replacement Burnside Bridge.

Phase I: Stabilization

The stabilization phase bridges the response between the Initial Response and Sustainment phases. Importantly, stabilization occurs even as the immediate response continues. In this phase, non-technical assessments begin supporting partial waterway restoration. These solutions may provide a limited use of some part of the waterway infrastructure via a waiver or prescribed limitations. This may support ongoing lifesaving operations as well as emerging community life sustainment priorities and decision making. The Stabilization phase maintains the forward progress of response, matching a need for cohesive and logical decisions to be made concerning most critical actions necessary to complete quick fixes even as more long-term recovery resources can be brought to bear to address critical regional sustainment needs.

Suitable vessel types for this work are the same as those listed for the Initial Response phase and would not drive special consideration with respect to elevation or horizontal clearances of the replacement Burnside Bridge.

Phase II: Sustainment

This stage of the response effort involves the evaluation and technical/engineering assessment of critical infrastructure associated with affected waterways, including, but not limited to: marine terminals and other port infrastructure, public waterfronts, pedestrian and vehicular bridges, power line crossings, and cable and utility crossings. Onsite vessel support is necessary to provide access to affected sites and to assess the condition and/or integrity of supporting structures. For this reason, vessels associated with this stage of the response effort may need the capability to support commercial dive operations or ROV operations for conducting underwater surveys.

Suitable vessel types for this work would likely include small (approximately 100 feet or less) nearshore survey vessels of shallow draft. These vessels may have the ability to support commercial dive operations and/or deploy and recover underwater survey equipment. The vessels may also require specialized sonar equipment for the location and evaluation of sub-sea structures, and to conduct or otherwise support bathymetric surveys.

Such vessel types are similar in size to those currently transiting the Lower Willamette River on a regular basis, and therefore would not drive special consideration with respect to elevation or horizontal clearances of the replacement Burnside Bridge.

Following the technical assessments described above, USCG and other agencies (local, state, or federal) may, depending on the nature of the affected infrastructure and jurisdictional issues, support evaluation of community impacts caused by earthquake-damaged infrastructure or the condition of the waterway. Following this evaluation, strategic decisions will be made as to the nature and sequencing of removal and remediation work. The scope of this work will strongly influence vessel requirements for the final phase of the response, Long-term Recovery/Restoration.

Phase III: Long-term Recovery/Restoration

The Long-term Recovery/Restoration phase encompasses the remedial actions necessary to restore full function of the waterway and associated infrastructure. This is the time priorities must be established and work commenced to begin to remove the previously established Stabilization and Sustainment "workarounds" in such a way as to keep the community functioning as critical infrastructure is restored to a state that meets all existing and/or new regulations or requirements. More specifically, the Long-term Recovery/Restoration phase includes the requisite construction and/or marine construction work for the removal of hazards and rebuilding of key infrastructure, as identified during the Sustainment phase.

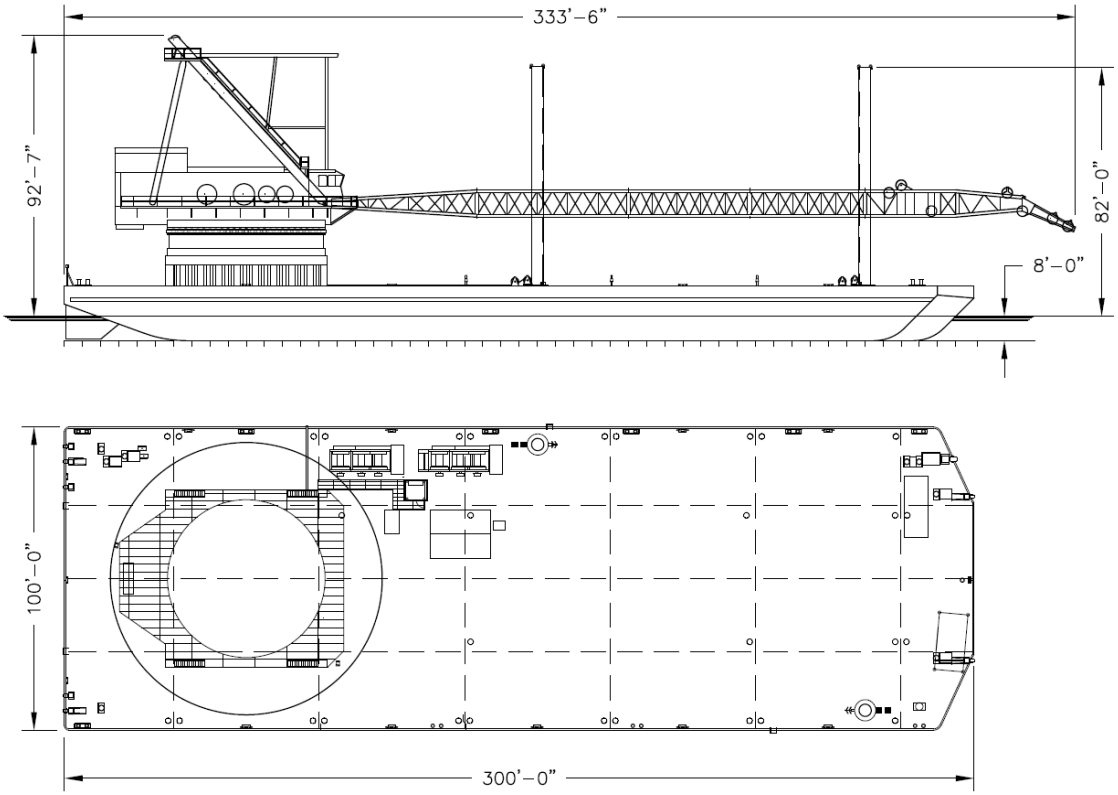
Depending on the scope of the construction work, suitable vessel types for this purpose would likely include:

- A variety of barges commonly used to support marine construction projects, including but not limited to:
    - Derrick barges, equipped to support pile-driving and removal operations (i.e. floating cranes)
    - Flat-deck barges (with or without spuds) with a variety of materials and heavy equipment on deck, including cranes and/or dredging equipment
    - Purpose-built marine dredging vessels
    - Scows and/or dump barges
- Harbor tugs of relatively shallow draft, capable of handling the above barge types in confined waterways
- Work skiffs

Some of these vessel types may be considerably larger than those currently transiting or operating in the Lower Willamette River (derrick and spud barges in particular) and therefore should drive special consideration of elevation and horizontal clearances of the replacement Burnside Bridge.

Figure 26 shows a representative large derrick barge which could be called upon for the requisite work. This particular derrick has an overall length of 333.5 feet with the boom stowed, a beam of 100 feet, and an assumed maximum air draft of 93 feet with the spuds stowed.

Figure 26. Representative Derrick Barge



Though larger derricks do exist on the U.S. West Coast, we estimate this vessel represents a "largest vessel type" mobilized for removal and remediation work in the Lower Willamette River and, therefore, is conservative for determining reasonable elevation and horizontal clearances for the replacement Burnside Bridge. This vessel is incorporated into the analysis of government river users (Section 4.4).

Additionally, the spud height of this derrick, which is the most plausible limiting dimension for bridge transits, is equal to or greater than the majority of derrick barges in service on the U.S. West Coast. Taller spuds would not be necessary for construction work in the Lower Willamette River, given that maximum water depths are less than 80 feet.

5.2.2 Considerations of Deep Draft Vessels

Following a worst-case Cascadia Subduction Zone earthquake, it is conceivable that one or more local area hospitals may be severely damaged or otherwise unusable for treatment of patients. In such circumstances, an emergency 'hospital ship' may have to be mobilized to serve the medical needs of the community temporarily, until local area hospitals can be brought back online. This need would most likely be met by a U.S. naval vessel, which have deep operating drafts and high superstructures, as compared to the current marine traffic.

Assuming such vessels *would* enter the Lower Willamette River following an earthquake, they would obviously drive special consideration of elevations for the replacement Burnside Bridge. However, limited water depth and the presence (or uncertainty) of navigational hazards would likely preclude such vessels from entering the waterway.

No Federal Navigation Channel is currently maintained on the Willamette River. The river gradually shallows upriver, which restricts the movement of deep draft vessels. Additionally, it is possible that one or more of the bridges downstream of the Burnside Bridge could collapse during a major earthquake – in whole or in part - leaving fallen bridge structure in the water, possibly obstructing the navigable channel. For these reasons, and, based on input from current and former USCG officers at the above agencies, it is assumed that any U.S. naval vessel acting as a temporary hospital ship would serve the local community by anchoring in the Columbia River, just outside the mouth of the Willamette River, to minimize navigational risk.

It is therefore our recommendation that U.S. naval vessels or other deep draft vessels not be considered in determining minimum elevation and horizontal clearances for the new Burnside Bridge.

6 Conclusions and Recommendations

6.1 Minimum Recommended Elevation

The minimum recommended elevation for all bridge design states is 167 feet above NAVD 88. At OHW, all river users can safely transit beneath the 167-foot elevation of the temporary and proposed bridge design states.

6.2 Minimum Recommended Horizontal Clearance

The minimum recommended horizontal clearance for all bridge design states is 205 feet. Three bridge design states satisfy this recommendation: existing, permanent retrofit, and permanent replacement. The 165-foot horizontal clearance of the temporary bridge design state would impose an operations impact on three known river users:

- Combined Forestry could not transit safely, but one or two tug assists could mitigate the impact. However, tug assists would not guarantee safe transit for Combined Forestry.
- AAC would require a tug assist for safe transit.
- Shaver Transportation would require a tug assist on a case-by-case basis.

Moreover, the Columbia River Pilots advised against narrowing the Burnside Bridge. The Burnside Bridge is the narrowest bridge in the Sellwood Reach.

The temporary bridge would become the most restrictive horizontal clearance on the waterway. Any reduction to its horizontal clearance at either the temporary or permanent phases will require negotiation with these impacted river users.

6.3 Bridge Width

Bridge upriver/downriver width (Figure 1) also has navigation impacts. The width of the temporary bridge system could range from 220 feet to 390 feet. Some river users will require a tug assist due to this extensive bridge width. The width of the permanent replacement bridge could range from 150 feet to 195 feet. River users do not anticipate requiring regular tug assists to navigate this bridge width. Depending on future project

work and river conditions, occasional tug assist may be needed. One river user recommended widening the horizontal clearance to aid navigation through the longer bridge corridor.

6.4 Impact of Clearance Requirements on Bridge Design States

No changes to any design states would be needed to satisfy the minimum recommended elevation. All bridge design states meet or exceed the minimum recommended elevation of 167 feet.

No changes to the existing, permanent retrofit, or permanent replacement bridge design states would be needed to satisfy the minimum recommended horizontal clearance. All bridge design states meet or exceed the minimum horizontal clearance of 205 feet.

The temporary bridge design state does not meet the minimum recommended horizontal clearance of 205 feet. Providing a tug assist for the temporary bridge mitigates, but may not fully eliminate, the impact on river user operations; one user anticipates an operational impact even if assist tugs were provided.

Design and Construction Recommendations

Based on feedback from participating river users and elevation and horizontal clearance requirements, several recommendations are presented for the design and construction of all bridge states:

- Clear navigation signage for both commercial and recreational vessel operators.
- Dedicated transit lane for small recreational craft such as kayaks and stand-up paddleboards.
- Real-time vertical clearance gauge to inform operators whether they clear the bridge at any given moment or river level.

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Appendix A. River User Master List

River Users Sorted by Air Draft

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Fleet Week	Commercial - Other	Steven Bledsoe (Waterfront Activities Manager)	503.227.2681	stevenb@ rosefestival.org	443.0	147.0	158.9
Large Infrequent Visitors	Commercial - Other	Sean Whalen (cc on correspondence)	503.209.8109 (Whalen cell)	sean.whalen@ portlandoregon.gov	644.0	142.0	150.0
USACE Portland District	Govt. - Infrastructure	Karla Ellis	503.808.4377	karla.g.ellis@ usace.army.mil	350.0	110.0	138.2
Combined Forestry & Marine Services, Inc.	Commercial - Tug/Barge	Clark Vincent Caffall (President)	360.921.4304 (cell) 360.225.8359 (house)	-	-	100.0	205.0
SDS Lumber	Commercial - Tug/Barge	Captain Gary Collins (Marine Supervisor)	509.493.2155 (office) 541.490.1370 (cell)	-	55.0	100.0	52.0
Emergency Response	Govt. - Infrastructure	Mr. Scott Bates (Seattle); Mr. Bynum (San Francisco)	206.220.7231 (Bates, Seattle) 415.399.7364 (Bynum, SF)	-	300.0	93.0	133.5
HME Construction, Inc.	Commercial - Tug/Barge	Greg Speyer (Vice President of Administration)	360.695.4553	greg.speyer@ hmeconst.com	-	90.0	150.0
KFS Boat Docks	Commercial - Tug/Barge	Eric Dye	503.449.6667	kfsdocks@ comcast.net	100.0	90.0	68.0
Schooner Creek Boat Works	Recreational	Pascal (General Manager)	503.735.0569	generalmanager @ schoonercreek.com	110.0	90.0	70.6
Sportcraft Landing Moorage	Recreational	Kimberly Dye	503.655.0981 (office) 503.780.6667 (cell?)	kimberlydyerealtor@ comcast.net	100.0	90.0	68.0
Portland Yacht Club	Recreational	Kathleen Inman (Member Service Coordinator)	503.285.1922	admin@ portlandyc.com	65.0	87.0	51.5
JT Marine Inc	Commercial - Tug/Barge	Irene Toristoja (Controller)	360.750.1300	irene@ jtmarineinc.com	-	85.0	123.0

River Users Sorted by Air Draft

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Portland Spirit	Commercial - Cruise	Daniel Yates (President) Captain Cameron Hunt	503.224.3900 (Yates) 360.305.2379 (Hunt)	dan@ portlandspirit.com	-	77.5	97.0
Larson's Moorage	Commercial - Tug/Barge	Ken Larson (Owner)	503.286.1233	-	-	70.0	50.0
Foothills Park	Recreational	Ben Labounty (Park Ranger)	503.675.2548	blabounty@ ci.oswego.us	40.0	68.1	44.1
Sail PDX (Oregon Corinthian Sailing Association, OCSA)	Recreational	Bruce Newton (Commodore)	503.806.6625	commodore@ SailOCSA.org	46.8	68.1	45.8
Sternwheeler Portland	Commercial - Cruise	Brad (President)	503.224.7724	president@ oregonmaritime museum.org	219.0	68.0	205.0
Promise Charters - Sailboat Promise	Commercial - Cruise	Captain Warren Brown	503.621.2561	captain@ sailpromise.com	-	68.0	-
Diversified Marine	Commercial - Tug/Barge	Kurt Redd (CEO)	503.289.2669	kredd@ teleport.com	-	65.0	105.0
Ross Island Sand and Gravel (RISG)	Commercial - Tug/Barge	Craig Jacobs (General Manager, Sand, Gravel, and Crushed Stone Operations)	503.239.5504	-	-	65.0	120.0
Sailboat Prospect	Commercial - Cruise	Lavine A. Linker	-	-	-	65.0	-
Foss Maritime (Columbia / Snake River Office)	Commercial - Tug/Barge	Captain Peter Roney (Project Cargo Transp, West Coast) Captain Toby Jacobsen (Port Captain)	360.391.4486 (Roney) 503.286.0631 (Jacobsen; Press 4 for Operations Dept., then 1 for Port Captain)	proney@ foss.com	-	64.0	165.0
Harley Marine Services, Olympic Tug & Barge, Pacific Terminals	Commercial - Tug/Barge	Kirk	503.737.0124	-	-	60.0	150.0

River Users Sorted by Air Draft

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Marine Industrial Construction	Commercial - Tug/Barge	Tom McCauley	503.682.9925	tom@ marineindust.com	250.0	60.0	138.0
McCuddy's Marina, McCuddy's Landing, Big Oak Marina, Hayden Island Moorage, Marine Drive Moorage	Recreational	Mark McCuddy	503.289.7879	Mark@ McCuddysMarina .com	-	60.0	20.0
Shaver Transportation	Commercial - Tug/Barge	Fred Harding or Brad Korpela (Port Captains)	503.228.8850	pc@ shaver transportation.com	110.0	58.0	200.0
Advanced American Construction, Inc.	Commercial - Tug/Barge	Evan Clemson	503.445.9000	evanc@ callaac.com	-	55.0	185.0
American Cruise Lines	Commercial - Cruise	Media and Public Relations	203.453.6800	media@ americancruiselines.com	335.0	55.0	131.2
Lindblad Expeditions	Commercial - Cruise	Captain Mike Jones (Vice President of Fleet Support)	206.403.1512	mikej@ expeditions.com	238.0	52.0	104.0
Scovare Expeditions Inc.	Commercial - Cruise	Captain Shane St. Clair	503.893.2283 (office) 971.219.5797 (cell)	info@ sailscovare.com	-	52.0	25.0
Tidewater Transportation and Terminals	Commercial - Tug/Barge	Neil Maunu (Business Development)	360.759.0321 (direct) 503.536.3760 (mobile)	neil@ tidewater.com	-	52.0	100.0
UnCruise Adventures	Commercial - Cruise	JD Ross Leahy (Director of Nautical Operations)	206.284.0300	-	-	52.0	70.0
Small Yacht Sailing Club of Oregon (SYSCO)	Recreational	Anna Campagna (Commodore)	503.789.0586	commodore@ syscosailing.org	65.0	50.0	52.0
US Coast Guard Sector Columbia River	Govt - Regulatory	Russell Nichols (Waterways Management)	503.240.2575	-	100.0	46.0	62.2

River Users Sorted by Air Draft

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Oregon Women's Sailing Association	Recreational	Tressa Yellig (Rear Commodore)	503.451.0061	rearcommodore@owsa.net	29.9	44.0	40.5
Fred Devine Diving and Salvage Co.	Commercial - Tug/Barge	Marvin Smith (Operations Manager)	503.283.5285	devinesalv@msn.com	-	36.0	36.0
Oregon Yacht Club	Recreational	Cathryn Cushing (Secretary)	503.804.9171	cath5155@hotmail.com	35.0	35.0	42.7
Waverly Marina	Recreational	Andrew (Harbormaster)	(503) 231-3985	Harbormasterandrew@comcast.net	35.0	35.0	42.7
Willamette Queen	Commercial - Cruise	Barbara Chesbrough	503.371.1103	WQSternwheeler@aol.com	-	28.0	44.0
Willamette Sailing Club	Recreational	Brandon Roberts (Club Manager)	503.246.5345	manager@willamettesailingclub.com	-	25.0	32.1
Tyee Yacht Club	Recreational	Rick Bryant (2019 Commodore)	503.284.4772 (club) 503.329.4125 (cell)	pdxh20man@gmail.com	55.0	23.0	36.0
Anchorage Launch	Commercial - Cruise	Alex	503.246.0535	-	-	20.0	30.0
Columbia River Launch Service	Commercial - Cruise	Klancy Shriver	360.703.7721 (office); 360.430.7253 (direct)	klancy@crlsllc.net	40.0	20.0	43.1
Portland Fire & Rescue	Govt	Sean Whalen	503.209.8109 (Whalen cell)	sean.whalen@portlandoregon.gov	35.0	13.0	42.2
Multnomah County Sheriff's Office River Patrol	Govt - Traffic	Deputy Rod Nuzum	503.988.6788	Rod.nuzum@mcso.us	36.0	16.0	42.7
Willamette Riverkeeper	Recreational	Kate Kuthe	503.223.6418	kate@willametteriverkeeper.org	-	3.0	3.0
American Queen Steamboat Company	Commercial - Cruise	-	-	-	380.0	-	153.0

River Users Sorted by Air Draft

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Brusco Tug & Barge	Commercial - Tug/Barge	Dan Zandell	360.636.3341 (office) 360.562.6876 (cell)	dan.zandell@ bruscotug.com	-	-	-

River Users Sorted by Horizontal Clearance

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Combined Forestry & Marine Services, Inc.	Commercial - Tug/Barge	Clark Vincent Caffall (President)	360.921.4304 (cell) 360.225.8359 (house)	-	-	100.0	205.0
Sternwheeler Portland	Commercial - Cruise	Brad (President)	503.224.7724	president@ oregonmaritime museum.org	219.0	68.0	205
Shaver Transportation	Commercial - Tug/Barge	Fred Harding or Brad Korpela (Port Captains)	503.228.8850	pc@ shaver transportation.com	110.0	58.0	200.0
Advanced American Construction, Inc.	Commercial - Tug/Barge	Evan Clemson	503.445.9000	evanc@ callaac.com	-	55.0	185.0
Foss Maritime (Columbia / Snake River Office)	Commercial - Tug/Barge	Captain Peter Roney (Project Cargo Transp, West Coast) Captain Toby Jacobsen (Port Captain)	360.391.4486 (Roney) 503.286.0631 (Jacobsen; Press 4 for Operations Dept, then 1 for Port Captain)	proney@ foss.com	-	64.0	165.0
Fleet Week	Commercial - Other	Steven Bledsoe (Waterfront Activities Manager)	503.227.2681	stevenb@ rosefestival.org	443.0	147.0	158.9
American Queen Steamboat Company	Commercial - Cruise	-	-	-	380.0	-	153.0
Harley Marine Services, Olympic Tug & Barge, Pacific Terminals	Commercial - Tug/Barge	Kirk	503.737.0124	-	-	60.0	150.0

River Users Sorted by Horizontal Clearance

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
HME Construction, Inc.	Commercial - Tug/Barge	Greg Speyer (Vice President of Administration)	360.695.4553	greg.speyer@ hmeconst.com	-	90.0	150.0
Large Infrequent Visitors	Commercial - Other	Sean Whalen (cc on correspondence)	503.209.8109 (Whalen cell)	sean.whalen@ portlandoregon.gov	644.0	142.0	150.0
USACE Portland District	Govt. - Infrastructure	Karla Ellis	503.808.4377	karla.g.ellis@ usace.army.mil	350.0	110.0	138.2
Marine Industrial Construction	Commercial - Tug/Barge	Tom McCauley	503.682.9925	tom@ marineindust.com	250.0	60.0	138.0
Emergency Response	Govt - Infrastructure	Mr Scott Bates (Seattle); Mr. Bynum (San Francisco)	206.220.7231 (Bates, Seattle) 415.399.7364 (Bynum, SF)	-	300.0	93.0	133.5
American Cruise Lines	Commercial - Cruise	Media and Public Relations	203.453.6800	media@ americancruise lines.com	335.0	55.0	131.2
JT Marine Inc	Commercial - Tug/Barge	Irene Toristoja (Controller)	360.750.1300	irene@ jtmarineinc.com	-	85.0	123.0
Ross Island Sand and Gravel (RISG)	Commercial - Tug/Barge	Craig Jacobs (General Manager, Sand, Gravel, and Crushed Stone Operations)	503.239.5504	-	-	65.0	120.0
Diversified Marine	Commercial - Tug/Barge	Kurt Redd (CEO)	503.289.2669	kredd@ teleport.com	-	65.0	105.0
Lindblad Expeditions	Commercial - Cruise	Captain Mike Jones (Vice President of Fleet Support)	206.403.1512	mikej@ expeditions.com	238.0	52.0	104.0
Tidewater Transportation and Terminals	Commercial - Tug/Barge	Neil Maunu (Business Development)	360.759.0321 (direct) 503.536.3760 (mobile)	neil@ tidewater.com	-	52.0	100.0
Portland Spirit	Commercial - Cruise	Daniel Yates (President) Captain Cameron Hunt	503.224.3900 (Yates) 360.305.2379 (Hunt)	dan@ portlandspirit.com	-	77.5	97.0
Schooner Creek Boat Works	Recreational	Pascal (General Manager)	503.735.0569	generalmanager@ schoonercreek.com	110.0	90.0	70.6

River Users Sorted by Horizontal Clearance

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
UnCruise Adventures	Commercial - Cruise	JD Ross Leahy (Director of Nautical Operations)	206.284.0300	-	-	52.0	70.0
KFS Boat Docks	Commercial - Tug/Barge	Eric Dye	503.449.6667	kfsdocks@ comcast.net	100.0	90.0	68.0
Sportcraft Landing Moorage	Recreational	Kimberly Dye	503.655.0981 (office) 503.780.6667 (cell?)	kimberlydyerealtor @ comcast.net	100.0	90.0	68.0
US Coast Guard Sector Columbia River	Govt - Regulatory	Russell Nichols (Waterways Management)	503.240.2575	-	100.0	46.0	62.2
SDS Lumber	Commercial - Tug/Barge	Captain Gary Collins (Marine Supervisor)	509.493.2155 (office) 541.490.1370 (cell)	-	55.0	100.0	52.0
Small Yacht Sailing Club of Oregon (SYSCO)	Recreational	Anna Campagna (Commodore)	503.789.0586	commodore@ syscosailing.org	65.0	50.0	52.0
Portland Yacht Club	Recreational	Kathleen Inman (Member Service Coordinator)	503.285.1922	admin@ portlandyc.com	65.0	87.0	51.5
Larson's Moorage	Commercial - Tug/Barge	Ken Larson (Owner)	503.286.1233	-	-	70.0	50.0
Sail PDX (Oregon Corinthian Sailing Association, OCSA)	Recreational	Bruce Newton (Commodore)	503.806.6625	commodore@ SailOCSA.org	46.8	68.1	45.8
Foothills Park	Recreational	Ben Labounty (Park Ranger)	503.675.2548	blabounty@ ci.oswego.us	40.0	68.1	44.1
Willamette Queen	Commercial - Cruise	Barbara Chesbrough	503.371.1103	WQSternwheeler@ aol.com	-	28.0	44.0
Columbia River Launch Service	Commercial - Cruise	Klancy Shriver	360.703.7721 (office); 360.430.7253 (direct)	klancy@ crlsllc.net	40.0	20.0	43.1
Multnomah County Sheriff's Office River Patrol	Govt. - Traffic	Deputy Rod Nuzum	503.988.6788	Rod.nuzum@ mcso.us	36.0	16.0	42.7
Oregon Yacht Club	Recreational	Cathryn Cushing (Secretary)	503.804.9171	cath5155@ hotmail.com	35.0	35.0	42.7

River Users Sorted by Horizontal Clearance

User	Type	Contact	Phone	Email	LOA	Air Draft	Horizontal Clearance
Waverly Marina	Recreational	Andrew (Harbormaster)	(503) 231-3985	Harbormaster andrew@ comcast.net	35.0	35.0	42.7
Portland Fire & Rescue	Govt	Sean Whalen	503.209.8109 (Whalen cell)	sean.whalen@ portlandoregon.gov	35.0	13.0	42.2
Oregon Women's Sailing Association	Recreational	Tressa Yellig (Rear Commodore)	503.451.0061	rearcommodore@ owsa.net	29.9	44.0	40.5
Fred Devine Diving and Salvage Co.	Commercial - Tug/Barge	Marvin Smith (Operations Manager)	503.283.5285	devinesalv@ msn.com	-	36.0	36.0
Tyee Yacht Club	Recreational	Rick Bryant (2019 Commodore)	503.284.4772 (club) 503.329.4125 (cell)	pdxh20man@ gmail.com	55.0	23.0	36.0
Willamette Sailing Club	Recreational	Brandon Roberts (Club Manager)	503.246.5345	manager@ willamettesailing club.com	-	25.0	32.1
Anchorage Launch	Commercial - Cruise	Alex	503.246.0535	-	-	20.0	30.0
Scovare Expeditions Inc.	Commercial - Cruise	Captain Shane St. Clair	503.893.2283 (office) 971.219.5797 (cell)	info@ sailscovare.com	-	52.0	25.0
McCuddy's Marina, McCuddy's Landing, Big Oak Marina, Hayden Island Moorage, Marine Drive Moorage	Recreational	Mark McCuddy	503.289.7879	Mark@ McCuddysMarina .com	-	60.0	20.0
Willamette Riverkeeper	Recreational	Kate Kuthe	503.223.6418	kate@ willametteriver keeper.org	-	3.0	3.0
Brusco Tug & Barge	Commercial - Tug/Barge	Dan Zandell	360.636.3341 (office) 360.562.6876 (cell)	dan.zandell@ bruscotug.com	-	-	-
Promise Charters - Sailboat Promise	Commercial - Cruise	Captain Warren Brown	503.621.2561	captain@ sailpromise.com	-	68.0	-
Sailboat Prospect	Commercial - Cruise	Lavine A. Linker	-	-	-	65.0	-

Appendix B. River Users Removed from Analysis

River Users Removed from Analysis

User	Type	Status	Comment	Contact	Phone	Email	LOA (ft.)	Air Draft (ft.)	Horizontal Clearance (ft.)
"K" Line America, Inc.	Commercial - Other	Removed	No marine assets in project area.	Kenny Davais (Sales Agent)	503.257.2153		-	-	-
11000 SW Riverwood Rd	Recreational	Removed	No marine assets (assumed floatplane not affected by proposed bridge clearance).	-	-	-	-	-	-
Bernert Barge Lines	Commercial - Tug/Barge	Removed	No response.	-	503.656.8288	-	-	-	-
Columbia River Pilots	Commercial - Other	Removed	Assumed no significant marine assets. Discussion informed research.	Jeremy Nielsen (Vice President; Pilot)	503.289.9924	officers@colrip.com	-	-	-
Columbia River Steamship Operators Association (CRSOA)	Commercial - Other	Removed	Assumed no significant marine assets. Discussion informed research.	Kate Mickelson (Executive Director, also LCRHSC)	503.505.3008	kate@crsoa.net	-	-	-
FEMA Region 10 Office	Govt. - Emgcy Response	Removed	No response.	-	-	-	-	-	-
Gunderson Marine	Commercial - Shipyard	Removed	No response.	Lisa Nelson	503.972.5700	-	-	-	-
Hendren Tow Boat	Commercial - Tug/Barge	Removed	No contact information available.	-	503.285.5679 503.292.4012	-	-	-	-
Kinder Morgan Willbridge Terminal	Commercial - Other	Removed	No marine assets on Willamette.	Andrew Holbrook	503.220.1260	Andrew_Holbrook@kindermorgan.com	-	-	-
Lake Oswego Community Rowing	Recreational	Removed	No response.	-	503.765.6102	info@lorowing.com	-	-	-
Lower Columbia Region Harbor Safety Committee (LCRHSC)	Govt. - Emgcy Response	Removed	Assumed no significant marine assets. Website informed research.	Kate Mickelson (Chair; also CRSOA)	503.228.4361	lcrhsc@pdxmex.com	-	-	-

River Users Removed from Analysis

User	Type	Status	Comment	Contact	Phone	Email	LOA (ft.)	Air Draft (ft.)	Horizontal Clearance (ft.)
Merchants Exchange of Portland, Oregon (PDXMEX)	Commercial - Other	Removed	Assumed no significant marine assets. Website informed research.	Liz Wainwright (Executive Director)	503.220.2091	wainwright@ pdxmex.com	-	-	-
Multnomah County Bridge Services Section	Govt. - Traffic	Removed	Assumed no significant marine assets (contacted relevant stakeholders for bridges).	-	503.988.3757	dcs.bridges@ multco.us	-	-	-
Multnomah County Office of Emergency Management	Govt. - Emgcy Response	Removed	No marine assets on Willamette.	-	-	-	-	-	-
Oregon Department of State Lands	Govt. - Traffic	Removed	Assumed no significant marine assets. Website informed research.	-	-	-	-	-	-
Oregon Office of Emergency Management	Govt. - Emgcy Response	Removed	No response; redirected us to other contacts.	-	-	-	-	-	-
Port of Portland	Govt. - Infrastructure	Removed	No marine assets in project area.	Chet Thomas	503.415.6452 (office) 503.703.6432 (cell)	chet.thomas@ portofportland.com	-	-	-
Portland Bureau of Emergency Management	Govt. - Emgcy Response	Removed	No response; redirected us to other contacts.	-	-	-	-	-	-
Portland Parks & Recreation (Tom McCall Waterfront Park)	Govt - Infrastructure	Removed	No marine assets; discussion informed research.	Cary Coker	503.865.2375	cary.coker@ portlandoregon.gov (phone recommended instead)	-	-	-
Queen of Seattle (Alaska Travel Adventures)	Commercial - Cruise	Removed	No response.	Chris Meier (President	907.789.0052	cmeier@ bestofalaskatravel .com	-	-	-

River Users Removed from Analysis

User	Type	Status	Comment	Contact	Phone	Email	LOA (ft.)	Air Draft (ft.)	Horizontal Clearance (ft.)
Red Lion on the River	Commercial - Cruise	Removed	See "American Cruise Lines."	Veronica (Sales Department)	503.283.4466	-	-	-	-
Riverplace Marina	Commercial - Other	Removed	No response.	0	503.241.8283	info@ riverplacemarina .com	-	-	-
Rose City Yacht Club	Recreational	Removed	No response.	Chuck Pennington (Commodore)	503.282.2049	commodore@ rosecityyachtclub.org	-	-	-
Sause Bros.	Commercial - Tug/Barge	Removed	No marine assets in project area.	Ross McDonald (Director SQES)	503.222.1811	rossm@sause.com	-	-	-
Sellwood Riverfront Park	Recreational	Removed	No significant marine assets in project area.	Portland Parks and Recreation	503-823-7529	-	-	-	-
Ship to Shore Water Taxi	Commercial - Other	Removed	Assumed no significant marine assets.	Mike Kennedy (Owner)	360.690.0800	-	-	-	-
Transversal International Corporation	Commercial - Other	Removed	No marine assets on Willamette.	Scott	503.247.3611	-	-	-	-
United Grain Corporation	Commercial - Other	Removed	No marine assets on Willamette.	Stephanie McClintock (Executive Assistant & Public Relations)	360.816.1901	smcclintock@ ugcpnw.com	-	-	-
US Coast Guard Sector Seattle Bridge Group	Govt. - Regulatory	Removed	No marine assets. Significant qualitative research input.	Steven Fischer	206.220.7282	Steven.M.Fischer3 @ uscg.mil	-	-	-
Westwood Shipping	Commercial - Other	Removed	No marine assets on Willamette.	Geoff LaBelle	503.803.9732	geoff.labelle@ wsl.com	-	-	-
Wiley's Airstrip	Commercial - Other	Removed	No marine assets in project area.	Aron Faegre (Manager)	503.880.1469	faegre@ earthlink.net	-	-	-
Zidell Marine Corporation	Commercial - Tug/Barge	Removed	Assumed no significant marine assets; project scuttled per online notice.	Bill Gobel (VP & COO)	503.228.8691	sales@ zidell.com	-	-	-

Appendix C. Select River User Navigation Feedback

Feedback on Navigation from Commercial River Users

Advanced American Construction, Inc.	Commercial (Tug and Barge)	• *[Passability is] in relation to other bridges. Ultimately that's what you have to align with.* • *[The temporary bridge clearance] will make passage a lot more challenging.*
Columbia River Pilots	Government	• *Tug and barge traffic is pretty light.* • *Although the bridge doesn't need to get wider, it definitely should not get narrower.* • *Narrowing the approach on Burnside would make the approach to Steel Bridge even more difficult.*
Combined Forestry & Marine Services, Inc.	Commercial (Tug and Barge)	• *[Operators have] learned how to work with what's there. They have a system for dealing with what's there. No one wants to see anything pinched down. They've learned how to go through two-wide…I would try to keep the horizontal on the Burnside where it's at.* • *[Tow width] is only half the equation, because when you go through the Burnside you're getting yourself set up for the other bridges. You have a lot of eddies and boils in the harbor. Those eddies and boils cause you to go on an angle. You might only have a footprint of 80', but on an angle, you may be left with 5' on either end. That's where it gets dicey.* • *The other part of the equation is horsepower. My strongest boat is 1300 hp. A lot of outfits are 2500 hp or 3000 hp. They can do the "fancy dance" in a lot of scenarios where it would be extremely difficult for me. With that much power you could do any clearance in any condition…Nobody thinks about the little guy.* • *There are so many events in Portland where bridges have to stay closed – marathons, bikeathons…It's one of the more frustrating things [operators] deal with.*
HME Construction, Inc.	Commercial (Tug and Barge)	• *There was a problem when they were working on the bridge and only half of it was open … for normal navigation, no comments.*
Portland Spirit	Commercial (Cruise)	• *The Tilikum is the lowest height on the river and it was designed to get my boats under it in all weather. I will not support anything shorter than 77.5 feet of the current Tilikum clearance.*
Larson's Moorage	Commercial (Tug and Barge)	• *Recreational boaters. They're supposed to have an Oregon license to operate a boat, but that doesn't mean they obey the law. Down here with the marinas, boaters are supposed to be 200' out with no wake. However, they don't abide by that, don't abide by the buoys.*
Marine Industrial Construction	Commercial (Tug and Barge)	• *Bridge clearance signage for clearances always assists sky height in changing water elevations.*

Multnomah County Sheriff's Office	Government	• *There's always hazards. Lots of recreational boaters, lots of non-motorized paddlers night and day, rowing clubs out there at night rowing that have the bar minimum lighting requirements to make them legal, all the dragon boat practicing and races, lots of kayakers and outrigger canoes, lots of debris in water depending on time of year.*
Ross Island Sand and Gravel	Commercial (Tug and Barge)	• *Recreational boaters in the area, anywhere from recreational boaters to the rowing, stand up paddleboards. There is even a group that swims across the Willamette in that general vicinity, at times they didn't have a safety boat so very hard to see them … I'm not trying to pick on them, just nobody wants to cross that bridge …*
SDS Lumber	Commercial (Tug and Barge)	• *Kayakers, they come flying out in groups, in front of our vessels. Our vessels might be throwing a wake or doing different things, we don't want anyone to get hurt.*
Shaver Transportation	Commercial (Tug and Barge)	• *[The temporary bridge] is making the narrowest choke point for the river users from the mouth to Oregon City Falls*
Uncruise Adventures	Commercial (Cruise)	• *Recreational boaters are a thing. The most challenging days are events like Fleet Week.* • *Additionally, it would be nice to be able get bridge raised/lowered on demand (vs asking in advance).*
Waverly Marina	Recreational	• *A lot of people in August and September talk about the roaming sand bars that are tricky from year to year.*
Willamette Riverkeeper	Recreational	• *Our concern would be when there's construction or scaffolding or a temporary bridge structure in front of [the bridge], when debris is building up on pilings, that can be a real hazard.* • *We are concerned if navigation will be limited due to construction. There are large vessels utilizing the river (like Ross Island Sand and Gravel), but if we are confined to basically going directly under the center, particularly if this project will last a year or more, it might be nice to have another place where paddle craft or much smaller vessels could fit much closer to shore.*