REVIEW DRAFT

I-5 Columbia River Crossing Partnership:
Conceptual Engineering & Environmental Analysis

Boat Survey

Technical Memorandum #B.3.4

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OBJECTIVE

The objective of this memorandum is to describe navigation and vessel traffic on the Columbia River through the I-5 crossing reach. Navigation activity affects the corridor in two ways:

1. Shallow and deep draft navigation on the Columbia/Snake system transports commodities that are frequently from, or destined for, the I-5 corridor truck and rail infrastructure; and

2. Navigation through the I-5 corridor requires intermittent halts to vehicular and rail traffic at corridor intersections. Both rail and highway bridges must be opened to allow passage of most commercial and some recreational vessels.

INTRODUCTION AND BACKGROUND

Navigation Corridor

The Columbia River forms the boundary between Washington and Oregon below approximate river mile 308, downstream of Wallula, Washington. The river is also a navigable corridor for commercial and recreational vessel traffic and the transport of commodities between lower Columbia/Willamette River ports and upriver facilities in Oregon, Washington, and Idaho. The navigation corridor intersects the ground transportation corridor where the I-5 highway and Burlington Northern-Santa Fe (BNSF) railroad bridges transect the Columbia, at miles 106.5 and 105.5 respectively.

The intersection of these corridors is a major factor in the development of deep-water port facilities at Portland and Vancouver. The lower Columbia River ports' advantage is that they are at the terminus of a *water level* route through the Cascade Mountain Range, facilitating barge, rail, and truck access to and from origin and destination ports throughout the Pacific Northwest as well as more distant points in the United States, including the Midwest.

The existence of this water level route led to transportation infrastructure development for barge (locks and dams up to Lewiston, ID); rail infrastructure, including Union Pacific on the Oregon side and BNSF on the Washington side of the river; and the development of I-84, essentially at water level. The Columbia River Between Vancouver and The Dalles Project is the authorized navigation project that intersects the I-5 corridor and is described below.

The Columbia River Between Vancouver and The Dalles Project

The Columbia River Between Vancouver-The Dalles Project provides for a 300' wide x 27' deep channel between the I-5 Bridge and The Dalles. The Corps of Engineers currently maintains the channel to a depth of 17' because the full authorized depth is not required by current vessel traffic. This channel extends to Lewiston, Idaho through a series of other authorized projects. An access channel connects the upstream portions of the Oregon Slough project to the main channel and runs from Slough mile 5.8 upstream, joining the main channel after approximately 5,800'.

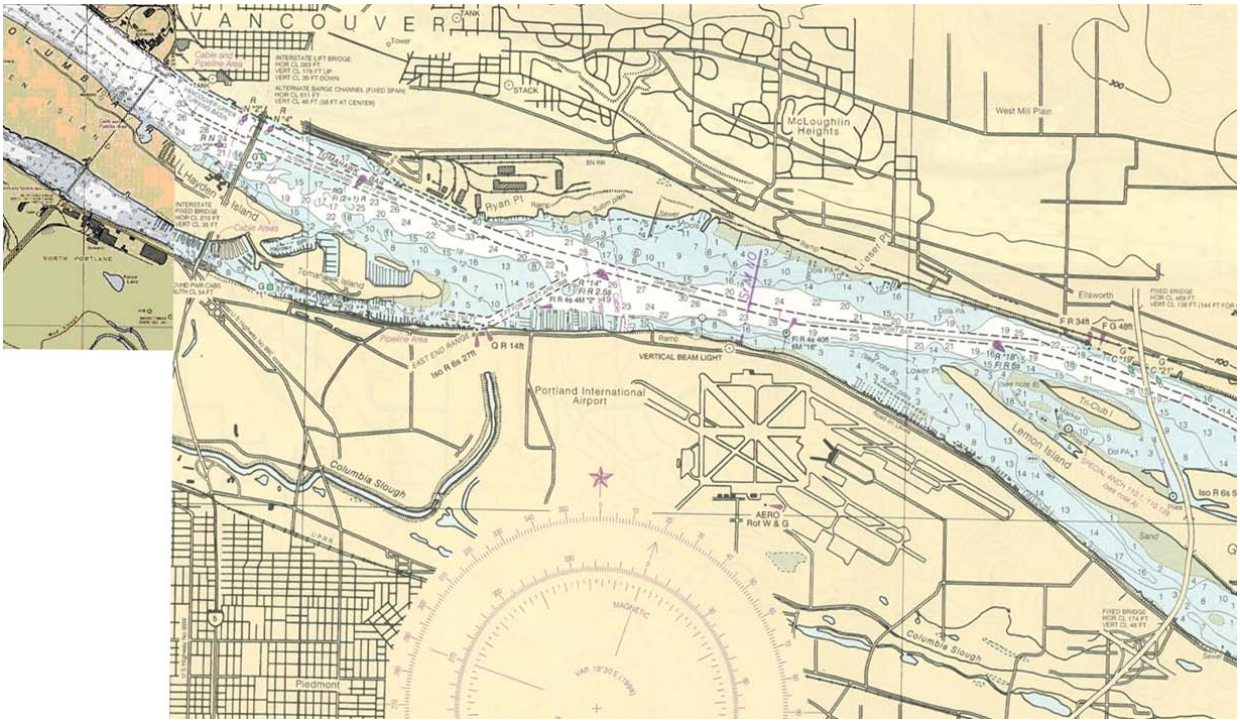
The Vancouver-The Dalles Project has two authorized channel routes that pass under I-5:

1. The original channel passes through bridge piers 2 and 3 near the northerly river bank which also contain the existing I-5 vertical lift span, and

The alternate barge channel passes between piers 4 and 6 (Piers are numbered consecutively starting with 1, first pier, Washington side, and ending with 13, last pier, Oregon side. Pier 5 was removed from the old bridge when the new bridge and its southbound lanes were constructed in 1958.). I-5's alternate barge channel provides up to 29 additional feet of vertical clearance over the main channel when the vertical span is down, or 69' compared to 40' of clearance measured from the Columbia River Datum (CRD).

Figure 1 shows the navigation channels and bridges of the I-5 crossing river reach.

Figure 1 I-5 Navigation Channels and Bridges within the I-5 River Crossing Reach



I-5 Highway Bridge

The I-5 highway bridge intersects the Columbia River near river mile 106.5. The original I-5 Bridge, today's northbound lanes, was constructed in 1917 in a joint effort by Clark and Multnomah counties. The bridge was constructed to allow 40' (39.86') vertical clearance Columbia River Datum (CRD)[1] at the location of its lift span between piers 2 and 3. When raised, the lift span increases vertical clearance to 178.9'.

[1] River datums are established to provide a reference for river stage, or height, measurements. A river's stage is stated against some vertical datum. Columbia River Datum [CRD] is a low water datum that is required so that soundings on the river can be referenced to something that will indicate to the mariner how much water he has below his ship. CRD is a sloping (rather than level) vertical datum, reflecting a point below the average low water but not so deep as the lowest record for a long period, which is caused by a combination of circumstances that seldom occur.

A second bridge was added in 1958 to expand capacity. Its design basically replicated the dimensions and characteristics of the original bridge. The second bridge forms the southbound lanes of the current I-5 Bridge. Pier 5 of the original bridge has been to allow a horizontal clearance of 531' between piers 4 and 6, which matches that of the newer bridge. This 531' clearance is called the "wide span" and accommodates the alternate barge channel described above. Vertical clearances through the wide span vary. At the span's center, clearance at zero CRD is 58'. Clearance increases to 69' near the span's southern pier.

BNSF Railroad Bridge

The railroad bridge is approximately one mile downstream of the I-5 highway bridge and has a design vertical clearance of 35' at zero CRD. The railroad bridge has swing spans at both its north and south ends: the northern span swings open to accommodate commercial and recreational vessel traffic in the Vancouver-The Dalles authorized project to the north, and the southern span accommodates vessel traffic in and out of west North Portland Harbor. Vertical clearance at the railroad bridge is 35' with the swing span *closed*.

Downbound commercial tows transiting the I-5 and BNSF bridges often avert I-5 Bridge lifts by using I-5's "wide span," then swinging right to align for the transit through the BNSF open swing span. Large tows and high river velocities complicate maneuvering this particular river stretch. These factors can encumber tug operations and impede their flexibility to realign after the wide span to pass through the opened swing span. Tow operators maintain that moving the railroad swing span one bridge span to the south will allow them greater flexibility in using I-5's "wide span" and the vertical clearances available between piers 6 and 7, thereby reducing I-5 Bridge lifts.

I-205 Bridge

The I-205 Bridge is located at approximately river mile 111 and was constructed in 1982. The vertical clearance over the main stem channel is 136 ft with a horizontal clearance of 469 ft. The center 300 ft of the 469 ft horizontal span has 144 ft vertical clearance. The south span, from Government Island to Oregon, has a horizontal clearance of 174 ft and a vertical clearance of 48 ft.

NAVIGATION OPERATIONS IN I-5 CROSSING RIVER REACH

Cargo and Vessel Trips

The U.S. government records vessel trips and cargo movements on the country's waterways. Data are available for movements within The Vancouver-The Dalles reach and provide an indication of commercial and pleasure craft activities over the past years. The data indicate that cargo tonnage has remained fairly constant since 1990, while the overall number of vessel trips has declined. This can be explained in part by the new lock at Bonneville Dam that has allowed larger tows to move through the system more efficiently. Also, technological advances in towboat design have contributed to an increased barge:tug ratio. Table 1 summarizes the number of vessel trips through the Vancouver-The Dalles reach by vessel type. Figures 2 and 3 demonstrate these data graphically.

Table 1 Vessel Trips and Cargo Movements; Vancouver-The Dalles Reach

	1990	1995	2000	2001	2002
Downbound Trips					
Cargo	4,595	1,910	1,495	1,356	1,083
Passenger	579	646	412	536	28
Total Trips	5,174	2,556	1,907	1,892	1,111
Upbound Trips					
Cargo	4,579	1,909	1,562	1,285	1,173
Passenger	655	646	418	531	26
Total Trips	5,234	2,555	1,980	1,816	1,199
Volume (1000 short tons):	9,735	11,626	10,672	9,793	7,990

Source: Waterborne Commerce of the U.S., Part 4.

Figure 2 Upbound Vessel Trips Between Vancouver and The Dalles

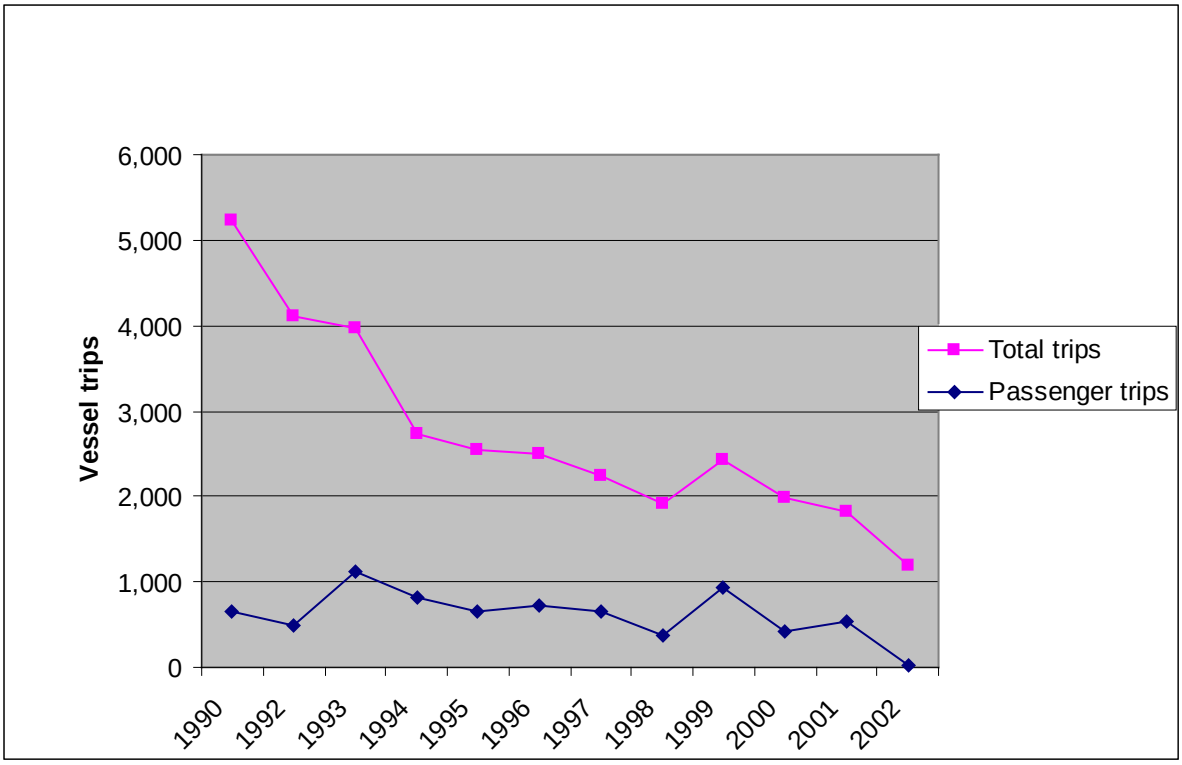
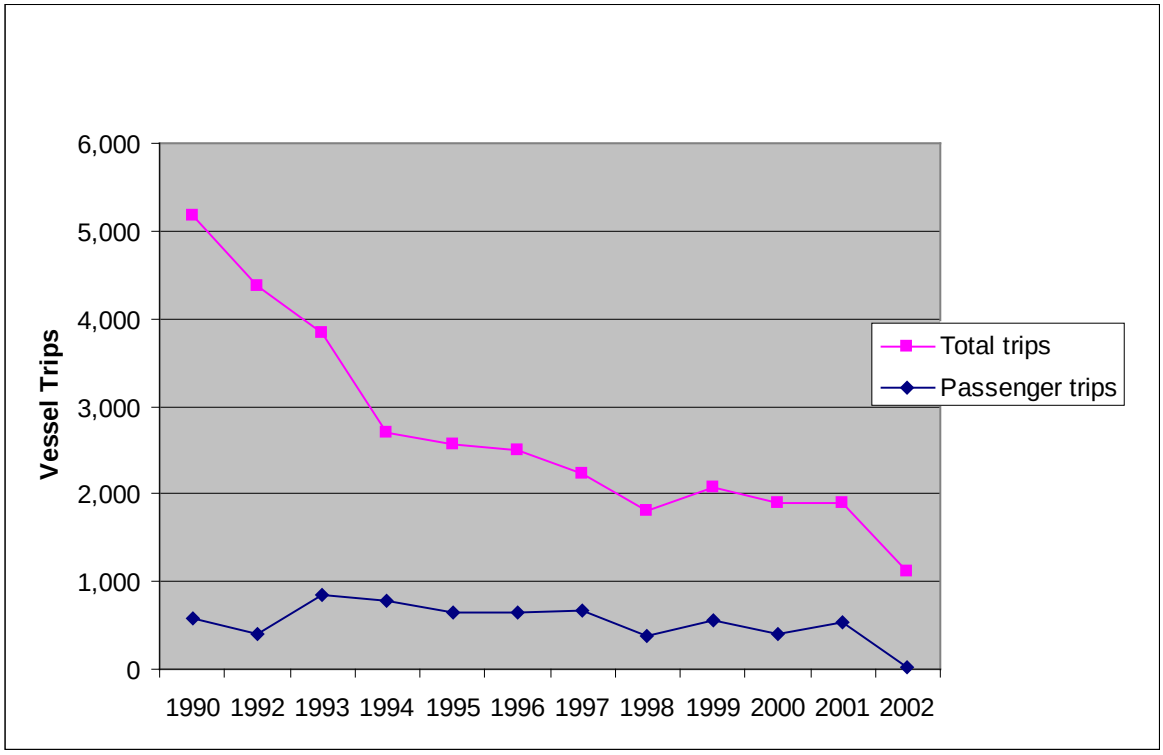


Figure 3 Downbound Vessel Trips Between Vancouver and The Dalles



Vessel Traffic

Vessel traffic on the Columbia River through the I-5 corridor is characterized by commercial barge tows, passenger cruises, and recreational craft. A summary of vessel activities and maximum clearance requirements is provided in this section.

Tugs, Tows: Bridge openings for tugs are usually to accommodate barge tows of grain cargos between upriver points and lower Columbia River ports. The largest 'tower tugs' that characterize these tows require about 58' of vertical clearance from the vessel waterline. During extreme high water periods, the tugs may lay down their masts and reduce their clearance requirements to 49'.

Sailboats-Recreational: There are eighteen recreational and small boat moorages in the river reach between the I-5 and I-205 bridges. These moorages include at least two boat launch facilities. Most of these marinas are along the shores of north Portland and Hayden Island.

The recreational vessel mix is predominated by powerboats, but several ocean-going sailboats are also moored in the reach. Sailboat mast heights average between 45 and 65 feet. The two tallest masted sailboats both appear to regularly moor at the Portland Yacht Club. They have masts of 88 feet and 76 feet, and currently traverse the I-5 corridor about 20 times each, annually.

Marine Industries: A few marine industrial businesses are located between I-5 and I-205 on the Columbia. They are primarily located on the Washington side at Columbia Business Center [CBC], at approximate river mile 108. Current tenants at CBC include Thompson Metal Fabrication, Oregon Iron Works, Christianson Yachts, Kiewet Construction Company, and USI. These industrial facilities

require waterfront access to ship construction equipment and large metal manufactured products for heavy construction and maintenance, such as bridge and offshore facilities:

- Christianson Yachts builds and sails out three to six luxury motor vessels a year.

- Oregon Iron Works and Kiewet Construction use the site to fully or partially construct elements of construction projects, build prototypes, and produce other heavy load products. Both firms are staging areas the San Francisco Bay Bridge modifications from this site.

Marine Contractors: Construction contractors occasionally need to access the hydroelectric dams, navigation locks, and other major infrastructure on the Columbia-Snake River system above I-5. Most of the work is for maintenance of U.S. Army Corps of Engineers dams, although mobilization plans for security planning since 9/11 have included requirements for large construction equipment.

Large contractors Manson and Kiewet-General's highest clearance requirements are for heavy cranes. The largest such crane is 110 feet high (Manson). Other marine contractor equipment common to the reach includes barges with spuds that require 80' clearance from the waterline. The requirement to move such equipment is infrequent and depends largely on maintenance requirements at upriver dams.

Passenger Cruise: Two passenger cruise lines currently provide cruise service that often requires transit through the I-5 reach. Cruise West and American West Steamship Company run vessels out of the Portland area to upriver points. The highest clearance requirement is by American West and equals 60 feet.

A summary of the largest vessel clearance requirements for the I-5 reach is provided in Table 2.

Table 2 Summary of Large Vessel Clearances at or Upstream of the I-5 Crossing

Vessel Type	Clearance Requirement at 0 ft CRD	Approximate Annual Frequency
Tugs, Tows		
Tower tugs - mast up	58'4"	>500
- mast down	49'	
Sailboats-Recreation		
Portland Yacht Club	88'	24
Portland Yacht Club	76'	24
Marine Contractors		
Manson	110'	NA
Kiewet/General	100'	NA
Marine Industrial		
Christianson Yacht	65'	6
Cruise/Passenger Vessels		
Cruise West	50'	25
American West	60'	25

River Characteristics

Tides, upriver reservoir levels, and Willamette River discharge in addition to hydrologic contributions such as rainfall and runoff influence water levels on the lower Columbia River. River levels are measured and recorded along the river at gauge stations; the Vancouver gauge measures river levels at mile 106.5, the existing I-5 Bridge crossing location.

A river's stage and other vertical measurements of fixed structures, such as bridges, are stated against a vertical datum. The datum referenced in this report is Columbia River Datum. When the existing bridge's current vertical clearance is stated at 40 feet, it is 40 feet at 0 feet CRD. If the river rises five feet, the stage is +5' CRD and available clearance is reduced to 35 feet CRD [40' minus 5'].

It is important when considering vessel and bridge requirements to ensure a consistent datum for planning and design activities.

Bridge Openings

Bridge lifts, or openings, occur when commercial or recreational vessels require more clearance than is afforded, given vessel height and existing water levels.

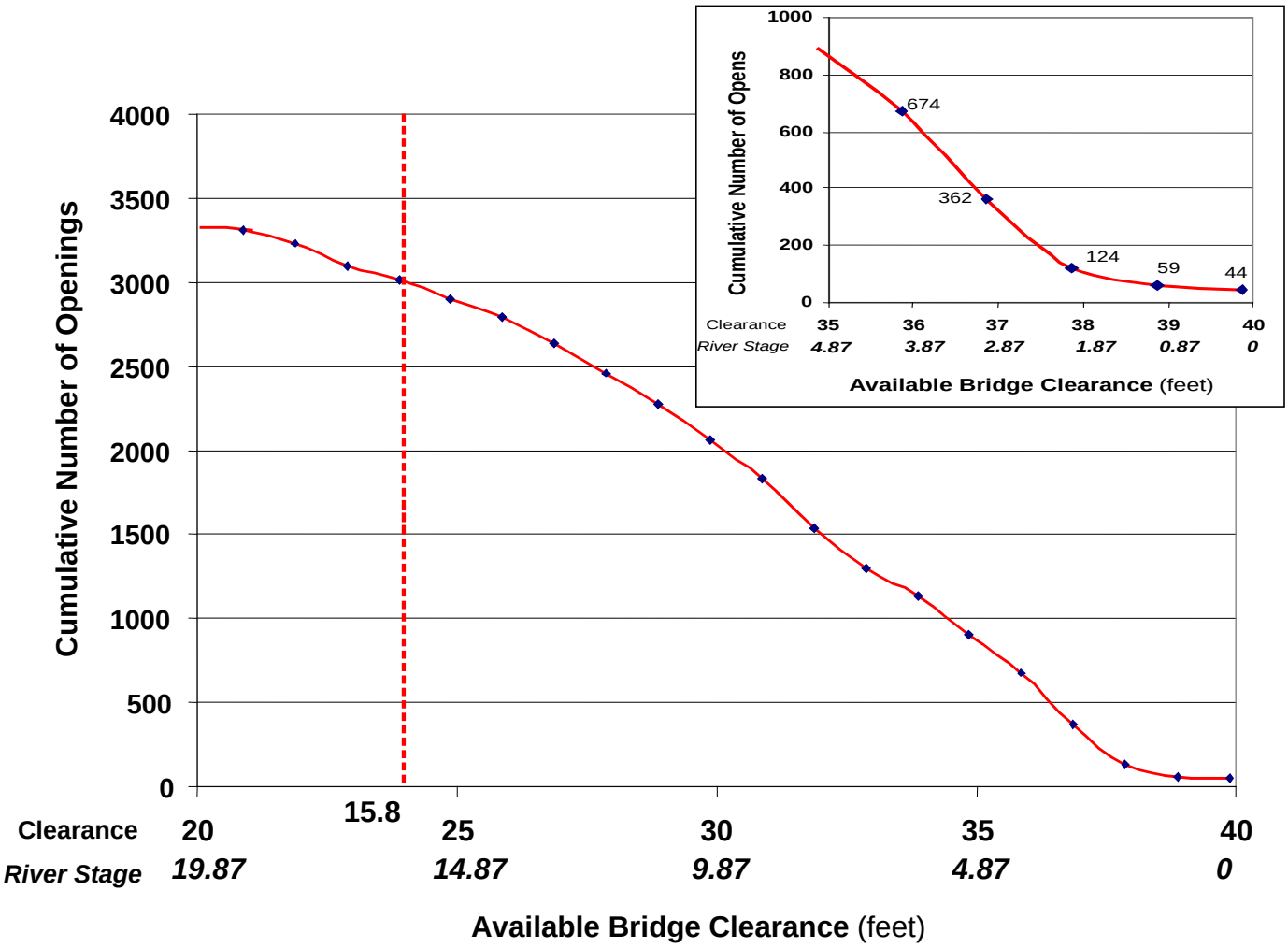
Data are shown in Table 3 for I-5 Bridge openings for 1998 through 2001. Data are from the bridge tender logs and were provided by ODOT.

Table 3 Bridge Openings, I-5 Bridge

I-5 Bridge Openings: 1998-2001				
Year	**Tug**	**Rec/Passenger**	**Maint/Train**	**Total**
1998	184	61	142	388
1999	203	*63*	122	388
2000	121	31	349	501
2001	198	18	78	294

Figure 3 shows the total number of I-5 Bridge lifts for vessel passage plotted against river levels for the period 1992—2001. Openings for maintenance or training are not counted. The figure demonstrates that over nine years, only a handful of bridge lifts were required when the river stage was 0' CRD. Conversely, Figure 3 also demonstrates that the majority of bridge lifts were required when the river stage was +10 feet CRD.

Figure 4 I-5 River Crossing Vessel-Related Bridge Openings (1991-2001)



It is helpful to review historical river elevation averages for a perspective on the Columbia's average and maximum flows at the Vancouver gauge. River stage data available for two historic periods – 1978-1990 *and* 1993-2004 were analyzed. The daily maximum value for each day of the year over the next 25 years of available data was tabulated and plotted. The results are shown in Figure 5.

Figure 5 Maximum Daily Stage, Columbia River At RM 106.5; Water Years 1978-1990 and 1993 to 2004

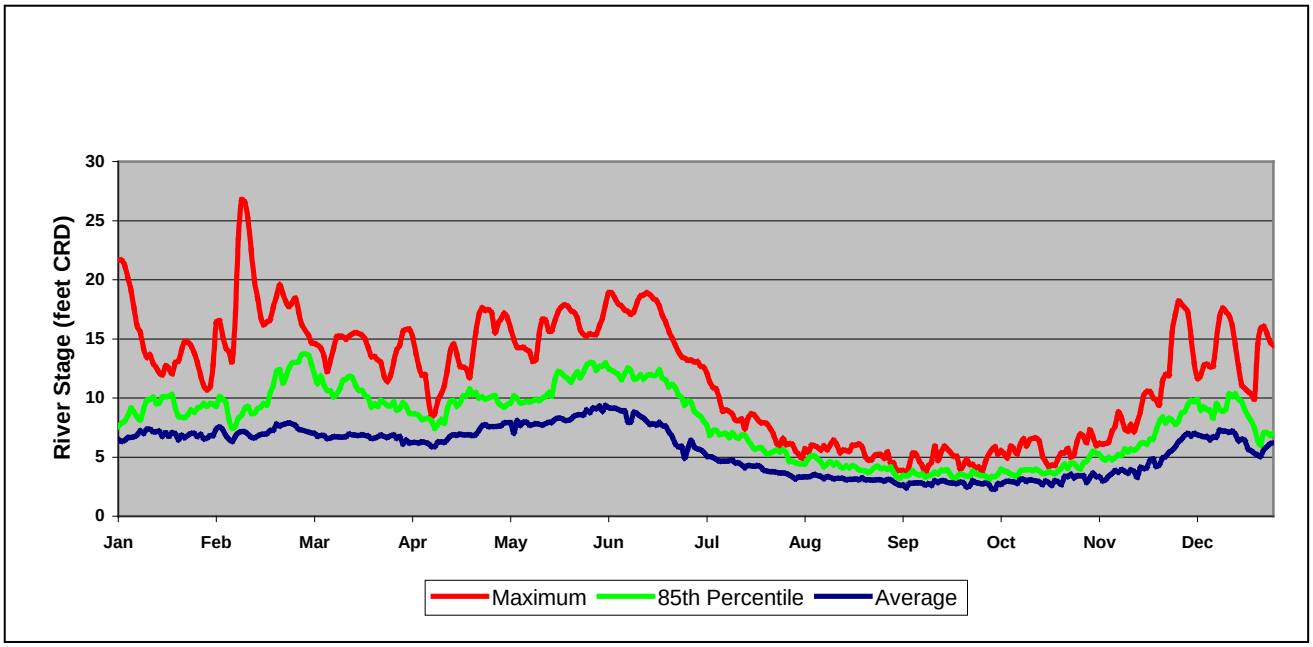


Figure 5 graphically demonstrates daily Vancouver gauge readings for 25 years of data. It demonstrates that for the 85th percentile of daily readings over the 25-year period, the *river never exceeded 15 feet CRD.*

Table 4 Stage Frequency, 1978-1990 and 1993-2004

Stage	Days Exceeding
>=15 CRD	144
>=10 CRD	872
>=5 CRD	4407
Total Days of Readings	8622

CRD: Columbia River Datum

Implications for Vessel Transit

Vessel transit requirements cannot be tied to a particular river stage. Vessels – commercial and recreational vessels – need to transit the I-5 corridor year-round, and river stage varies as this report demonstrates. For the vessels currently requiring the most clearance through the I-5 corridor, Table 5 summarizes air clearance requirements under the river stages summarized in this report.

Table 5 Vessel Clearance Requirements

Vessel Type	Clearance Requirement at 0 ft CRD	At +15 ft CRD	At +10 ft CRD	At +5 ft CRD
Tugs, Tows				
Tower tugs - mast up	58'4"	73'4"	68'4"	63'4"
- mast down	49'	64'	59'	54'
Sailboats-Recreation				
Portland Yacht Club	88'	103'	98'	93'
Portland Yacht Club	76'	91'	86'	81'
Marine Contractors				
Manson	110'	125'	120'	115'
Kiewet/General	100'	115'	110'	105'
Marine Industrial				
Christianson Yacht	65'	80'	75'	70'
Cruise/Passenger Vessels				
Cruise West	50'	65'	60'	55'
American West	60'	75'	70'	65'

SUMMARY

Based on this survey, it was determined that, over the past 25 years, the river has been at a Stage 15' or lower 98 percent of the time. This information combined with the vessel inventory between the I-5 and I-205 bridges indicates that a future bridge with a vertical clearance of 125 feet above the Columbia River Datum could effectively accommodate all existing vessels. It was further determined that a lift span bridge with a closed vertical clearance of 80 feet above the Columbia River Datum could accommodate all river traffic with the exception of 4 construction related barges and two recreational sailboats. This information combined with the constraints of the existing land uses, the Burlington Northern-Santa Fe rail line, and the glide path requirements for Pearson Airpark and Portland International Airport should along a vertical bridge construction window to be developed for guiding the design of the new I-5 river crossing bridge(s).