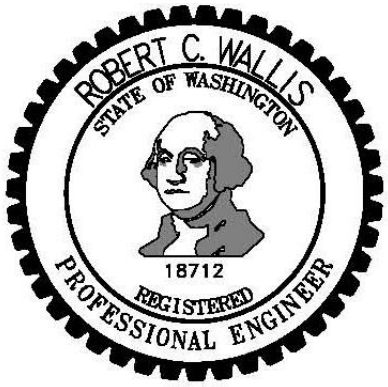
Conceptual Design Report

IBRP Tunnel Option North Bank Connections

April 20, 2023 Working Draft For City of Vancouver and Port of Vancouver Staff Review



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Introduction

Background

In 2018 the second attempt was started to implement a freeway expansion project that included the replacement of the I-5 bridge. This project, called the Interstate Bridge Replacement Project (IBRP), was a joint effort between WSDOT and ODOT. This was a continuation of a previous effort called the Columbian River Crossing (CRC) which proceeded through preliminary design and completion of an EIS prior to being put on hold because of lack of funding.

An initial effort in the IBRP was a screening of alternatives, one of which was the Immersed Tube Tunnel (ITT) tunnel. That alternative was rejected for a variety of reasons, one of the more significant being that it was concluded that connections could not be made to Historic Downtown Vancouver and SR-14. Following that rejection, the IBRP obtained approval of a "bridge only" conceptual design option referred to as the Modified Locally Preferred Alternative (MLPA), which became the basis for a preliminary design effort currently being completed in conjunction with the preparation of an environmental impact statement (EIS).

The IBRP engineering effort that led to the conclusion was summarized in a report entitled Tunnel Concept Assessment (TCA). The TCA established a vertical alignment for the tunnel, which greatly exaggerated its depth. For more on that error, see the engineering report "Tunnel Too Deep Error" at SeriouslyCivil.Com.

Seriously Civil completed a more detailed conceptual engineering evaluation to determine what the implications of a realistic tunnel depth would be upon the connections from I-5 to Historic Downtown Vancouver and SR-14. That effort is summarized in the following paragraphs.

Scope

This engineering effort addressed only the geometric design issues related to connectivity to SR-14, Historic Downtown Vancouver, and the Waterfront Development with the tunnel option. With the exception of the tunnel depth, which was found to be significantly exaggerated, the tunnel design information in the TCA was assumed to be valid.

Conclusion And Recommendation

The conceptual engineering evaluation summarized in this report concludes that, contrary to the conclusions from the TCA, the Tunnel Option would provide better connections than would the High Bridge Option being evaluated in the MLPA. Most notable:

- The Tunnel Option offers less out of direction travel for several key connections as compared to the High Bridge Option

- The Tunnel Option improves the ability to connect the Waterfront Developments to I-5 north and south.
- As compared to the High-Bridge Option, the Tunnel Option improves freight movement. Vertical grade separation between I-5 and connecting streets and highway is considerably less.

Based upon that conclusion, it is recommended that the tunnel option be assessed in detail in the IBRP EIS.

Conceptual Design Summary

A conceptual design was completed in accordance with the design criteria listed below.

Horizontal Alignments

Given the limited scope, a graphic prepared by others was utilized as the assumed plan for the tunnel and connecting ramps plan. That plan, shown as Figure 1, is essentially a schematic, as opposed to an actual plan. It is sufficient for purposes of illuminating the feasibility of making connections with a tunnel. There is sufficient flexibility in grades to accommodate a survey-based engineering layout of the Tunnel Option.

The tunnel was assumed to be located upstream of the existing bridge, with light rail on the west side and the multi-purpose path on the east side.

Vertical Alignments

Elevations above and below the river were based upon USGS topographic maps using NGVD 1929 datum. Elevations at key points along I-5 and ramps are summarized in Table 2.

The TCA engineering effort developed vertical alignment without considering the fact that the Primary Navigation Channel would be relocated from near the north bank of the Columbia to near the centerline of the river. That led to an exaggerated tunnel depth. The engineering effort summarized in this report assumed that the Navigation Channel would be relocated near the center of the river.

Geometric Design Criteria

Geometric design criteria are summarized as follows:

1. Tunnel cross section configuration and dimensions were assumed to be those identified in the TCA. One exception was that the TCA assumed that the multi-use path would be located between the two light rail lines and vehicle lanes. This report assumed that the multi-use path would be located on the east side (upstream) of the tunnel.

2. Horizontal geometric design criteria were assumed to be:
   - Multi-use path – 16'
   - Rail corridor – 30'
   - Lane number and widths assumed be the save as High-bridge Option
   - Vehicle ramp radius – 200'
   - Multi-use path radius – 50'

3. Vertical geometric design criteria
   - I-5 and ramp tunnel height, pavement to tunnel exterior – 34'
   - Light rail tunnel height, rail to tunnel exterior – 20'
   - Multi-purpose path tunnel height, pavement to tunnel exterior – 20'

4. Grades
   a. Max I-5 roadway – 5%
   b. Max ramp down – 8%
   c. Max ramp up – 5%
   d. Max LR – 8%
   e. Max bike/ped path – 5%

Connections

I-5 connections to and from SR-14, Historic Downtown Vancouver, and the Waterfront Development are summarized in Table 1 for both the Tunnel Option and the High-bridge Option (that approved with the MLPA).

It is important to note that all dimensions and elevations are approximate. The conceptual design that is summarized herein makes it apparent that a more refined design, with better base mapping, would not result in any changes in the conclusions regarding connections.

Table 1 – Summary of Connections

Connection	Tunnel Option	Tunnel Segments	High-bridge Option
1–I5 North and South	Roadway 55' below the North Bank of the Columbia	A	Roadway 100- above the north bank of the Columbia River
2–I5 North to SR-14 East	Direct by tunnel ramp up 40'	B	Direct by elevated ramp down 80'
3–I5 North to Waterfront Development	Direct by E Loop Ramp up to East 3rd and Columbia Way via RA	C, D, F, I	Indirect elevated ramp down to C Street, then 6th, then Columbia Street

Connection	Tunnel Option	Tunnel Segments	High-bridge Option
5 - I5 South to SR-14 East	Surface road with overpass over SR-14	L	Surface road with overpass over SR-14
6–I5 South to Waterfront Development	Very indirect from Mill Plain		Very indirect from Mill Plain
7–I5 South to Historic Downtown	Very indirect from Mill Plain		Very indirect from Mill Plain
8 – SR-14 West to I5 North	Direct surface ramp		Direct surface ramp
9 – SR-14 West to I5 South	Elevated overpass 20’ rise	E	Elevated loop ramp – 60’ rise
10– SR-14 West to Waterfront Development	Direct via 3rd East to Round About to Columbia Way	I	Indirect to Columbia Street via W 3rd Street
11– SR-14 West to Historic Downtown	Direct via 3rd Street East via Round About to Washington	D, I	Direct to Washington
12 – Waterfront Development to I5 North	Indirect from Columbia Street to Mill Plain, or Via Columbia Way Washington Street to Mill Plain, or With Design Option 1 – more direct from Columbia Way to C Street	F, I N	Indirect via Columbia Street north to Mill Plain, or Via West 3rd and Washington north to Mil Plain
13 –Waterfront to I5 South	Direct by Columbia Way to W Loop Ramp via RA	I, F,	Very indirect by Columbia to 6th to C Street
15 - Waterfront Development to SR-14 East	Direct by Columbia Way via RA to E 3rd	I, D	Indirect by Columbia Street via West 3rd Street
15 –Historic Downtown to I5 North	Indirect to Mill Plain		Indirect to Mill Plain
16 –Historic Downtown to I5 South	Direct by 6th Street tunnel south to I5, or Indirect by Washington to West Tunnel via RA	L G, H	Direct by 6th Street to I5 South by elevated ramp 60’ high
17–Historic Downtown to SR-14 East	Direct Washington south via RA to E 3rd	G, F, D	Direct by C street via overpass

Connection	Tunnel Option	Tunnel Segments	High-bridge Option
18 – Light Rail	Along west side of I5 with 35-foot deep transit stop	M	Along west side of I5 with 70-foot high Waterfront Development transit stop
19 – Multi-use path	West via tunnel and ramp direct to transit stop with vertical transition of 60 feet	N	Spiral on east side of I-5 with vertical rise of 90 feet

Highway Segments

A design summary of Tunnel Option highway segments is summarized in Table 2. Table 2 includes references to the schematic graphics showing the location of these highway segments. These graphics are included in Appendix A.

Table 2 – Tunnel Option Highway Segments

Highway Segment	Connection	Tunnel Design Summary	Figure
A - I5	1	Centerline location approximately 200 feet east (upstream) of existing bridge. Lanes assumed to be per MLPA.	1
B - I5 North exit ramp to SR-14 East	2	Tunnel off ramp single lane at 4% to 5%. Concept design assumed 5 %. Could easily be two lanes.	
C/ East Loop Ramp Up to Historic Downtown and Waterfront Development	6, 7	I5 North exit single lane tunnel loop ramp up at 4% to 5%. Concept design assumed 5%. Could easily be two lanes. This ramp feeds Historic Downtown and Waterfront Development.	
D East 3rd Street	8, 9, 10, 11	One surface lane each way connecting SR-14 to Historic Downtown and Waterfront Development Segment 5 parallels East 3rd on the north side.	
E. SR-14 West to I5 South	9	Surface road with 20’ rise for overpass above West tunnel loop ramp to I-5 south ramp	
F – Round About	6	Two lane round about with three legs – Washington, East 3rd, and Columbia Way With Design Option	

Highway Segment	Connection	Tunnel Design Summary	Figure
G -Washington between 5th and Round About	16, 17	Two surface lanes, one each way The northbound lane just northwest of the Round About would merge with Segment 5	
H. West Loop Ramp Tunnel To I5 South	13, 14	Two tunnel lanes merging to one (or three merging to two if needed) from outer Round About Lane (Segment 6) and SR-14 to I-5 South lane Segment 5) down at 6% to I5 south.	
I – Columbia Way	13, 14	Two surface lanes from Columbia Way intersection south of the BNSF RR, under existing I-5 overpass, to Round About Segment I would be unnecessary if Design Option E was selected (West 3rd Street extension from Columbia Street)	
J - SR-14 West to I5 North	8	Surface lane same as LPA	
K. I5 South to SR-14 East	5	Single surface lane assumed but two lanes possible from current I5 South exit on west side of I5 across north end of I5 tunnel to overpass over SR-14 then along south side of SR-14 merging with SR-14 to the east	
L. C Street South Tunnel Extension	16	One tunnel lane south down from C Street to I5 South Tunnel. Light rail will cross above this tunnel at on an overpass. This segment would provide a second connection to I-5 south from Historic Downtown	
M. Light rail	18	Two light rail lines would be on the west (downstream) side of the I5 tunnel. The light rail grade would pivot at the approximate "bottom of north bank" location to extend north at 8 percent grade to provide a potential stair/escalator accessible Waterfront Transit Stop (depth of 35'). If an elevator were to be used (as with the High Bridge Option), the grade of the transit stop could be reduced. From the transit stop the light rail would extend north at 3% under the northwest side of the Round About (under upper West Tunnel Loop and Washington, then increase to 8% to rise above the lower end of the West Loop Ramp, then continue north to parallel I5 just west of the I5 South off ramp. That 8% grade could be reduced by raising the roundabout elevation, which would have limited impact to traffic but could detract from the Apple Tree Park West. The overpass above the C Street extension south to I-5 south (Segment L) could be deleted	

Highway Segment	Connection	Tunnel Design Summary	Figure
N. Multi-use path	19	A multi-use path would be located on the east side (upstream of the I5 tunnel). At the top of the north bank of the tunnel the Path Tunnel would exit the Main Tunnel north and extend east along the south side of the BNSF RR tracks approximately 600 feet where it would reverse loop back to the west, paralleling the RR track and exiting just east of the Columbia Way extension where it would follow the Columbia Way extension north a short distance to the Waterfront Transit Stop	
Design Option 1		An option to provide uninterrupted movement from Columbia Way to C Street would be to provide a single lane from the Round About north on around the W Loop to C Street north.	

Vertical Alignment Design Summary

Vertical alignment design summary for all highway segments is presented in Table 3.

Table 3 – Tunnel Option Vertical Design Summary

Segment	Length (ft)	Slope	Elev. Diff.	Elevations at start point			Elevations at end point			Notes
				Pvmt. Top	Outer tunnel top	Ground Surface	Roadway surface	Outer tunnel top	Ground Surface	
Segment A - I5 (A1 channel) (A2 – ped ramp) (A3-SR-14)(A4-E 3rd) (A5 west loop ramp) (A6 east loop ramp)(A7-C Street ramp)(A8-portal)(A9-grade)										
A1 to A2	400	5%	20’	- 53	-23	-13	- 33	-3	20	
A2 to A3	100	5%	5’	-33	-3	20	-28	2	25	
A3 to A4	500	2.5%	12	-28	2	25	-16	14	35	
A4 to A5	100	1%	1	-16	14	35	-15	15	33	
A5 to A6	100	5%	5	-15	15	33	-10	20	35	
A6 to A7	200	5%	10	-10	20	35	0	30	38	
A7 to A8	300	5%	15	0	30	38	15	45	45	
A8 to A9	700	5%	35	15	45	45	50	-	50	
Segment B - I5 N Ramp to SR-14 (B1 same as A3 = start off ramp at I5 N)(B2 – portal) (B3 – SR-14)										
B1 to B2	560	5%	28’	- 28	2	20	0	30	30	
B2 to B3	640	5%	32’	0	30	30	32	-	32	
Segment C – E Loop Ramp (C1 exit I5 N)(C2 portal) (C3 ramp under overpass)(C4 - merge with E 3rd)										
C1 to C2	200	5%	10’	-10	20	35	0	30	30	C1 = A6
C2 to C3	340	5%	17’	0	30	30	17	-	30	
C3 to C4	250	5%	12	17	-	30	29	-	32	
Segment D – East 3rd at surface with grade no critical grades										
Segment E – SR-14 E to I5 S (E1 -SR-14 exit) (E2 – overpass C/L above East Rampa t East Ramp point C5) (E3 -merge with West Tunnel entrance)										
E1 to E2	300	5%	15	30	-	-	45	-	-	
E2 to E3	400	3%	12	45			33			
F – Round About at surface, must have pavement at elevation 35’ to allow Light Rail to pass beneath										
G – Washington Street at surface with considerable vertical and horizontal alignment flexibility										
Segment H – W Loop Ramp to I5 South (H1 – Round About cross above LR) (H2- merge with SR-14 offramp) (H3 - portal) (H4 cross above LR) (H5– I5 S)										
H1 to H2	100	6%	6	35	-	29	29	-	33	
H2 to H3	470	6%	28	29	-	33	1		31	
H3 to H4	230	6%	14	1	-	31	-13	23	32	H4 = S5

Segment	Length (ft)	Slope	Elev. Diff.	Elevations at start point			Elevations at end point			Notes
				Pvmt. Top	Outer tunnel top	Ground Surface	Roadway surface	Outer tunnel top	Ground Surface	
H4 to H5	200	1%	2’	-13	23	30	-15	15	32	
Segment I – Columbia Way passes under existing RR overpass above existing I5 to connect to Round About. Considerable alignment flexibility										
Segment J – Single surface lane connecting SR-14 to I5 north										
Segment K – Single surface lane connecting I5 south on west side of I5, crossing I5 tunnel, and crossing SR-14 with overpass to connect on S side of SR-14										
Segment L – C Street South Tunnel (L1 – C street at grade) (L2 Cross under LR Overpass) (Portal) (L3 – I5) (L4 – I5)										
L1 to L2	250	8%	20’	40		40	20	-	35	L2 = M6
L2 to L3	190	8%	15’	20		35	5	35	35	
L3 to L4	60	5%	5’	5	35	35	0	30	35	L4 = A7
Segment M- Light Rail I5 (M1 -north side of existing main channel) (M2 – transit stop) (M3 – Under E 3RD) (M4 – portal) (M5 -over W Loop Ramp to I5) (M6 –over C St. tunnel) (M7 -grade at 6th St)										
M1 to M2	700	7%	49’	-53	-23	-13	-4	16	30	
M2 to M3	300	4%	12’	-4	16	30	8	28	35	
M3 to M4	110	8%	9’	8	28	35	17	37	37	
M4 to M5	165	8%	13’’	17	37	37	30	*5	35	
M5 to M6	300	5%	15	30			45	-	-	
M6 to M7	200	2.5%	5	45	-	-	40	-	-	
Segment N– Ped/bike path (N1 - I5 exit) (N2 – turn) (N3 – portal) (N4 – at grade)										
N1 – N2	650	4%	26	-33	-13	2-	-7	13	20	N1 = A2
N2 – N3	825	4%	33	-7	13	23	23	-	30	
Segment O – Design Option 1 connecting the Round About north to C Street has considerable design flexibility										

FIG. 1


Tunnel Option
Downtown Vancouver
Fort Vancouver
Tunnel limits
A
B
C
D
E
F
G
H
I
J
K
L
M
N
A