Technical Memorandum

To:

From:

Date: July 25, 2007

Subject: ODOT Contract No. 16902 – I-5 Trade Corridor Study Phase II
Technical Memorandum, Option Package 3

OPTION PACKAGE 3: LIGHT RAIL TRANSIT (LRT) WITHOUT CORRIDOR-WIDE CAPACITY INCREASE

Road Network Description

Option Package 3 involves investment in a regional light rail transit (LRT) system without corridor-wide freeway capacity increases. Two variations have been established for this option package to test the performance/benefits of two separate investment levels in light rail, construction of a an arterial parallel to I-5 from Vancouver south to Columbia Blvd., and no investment in I-5 freeway capacity. Key features of each variation follow:

Option Package 3a: Loop LRT system (SR 500)

Key features of this option package include the following:

- Includes an LRT loop system with the following segments:
  - Expo park-and-ride to Clark College
  - Clark College to 83rd park-and-ride lot with service to Vancouver Mall
  - 83rd park-and-ride to Parkrose transit center with service to Vancouver Mall
- LRT crosses the Columbia River on an LRT-only bridge
- Assumes no investment in I-5 freeway or parallel arterial roadways
- Represents a pure LRT only option

Option Package 3b: LRT from Expo P&R to Clark College only with joint use arterial/HOV bridge

Highway and Columbia River crossing improvements under this option package are nearly identical to Option Package 2. The addition of LRT into Clark County is the principal difference from Option Package 2. Key features of this option package are include the following:

- Establishes a new four-lane joint use arterial and HOV/express bus bridge across the Columbia River serving Hayden Island and matching existing/planned HOV lanes in Oregon and in Washington
- Includes LRT segment from Expo/PIR to Clark College only
- Converts the northbound existing/planned third travel lane from Mill Plain Blvd. to 134th Street for HOV use during the p.m. peak period
- Results in a northbound HOV system from Going Street to 134th Street and a southbound HOV system from 134th Street to approximately Lombard Street
- Includes direct express bus ramps to/from Expo/PIR transit center to I-5
- Results in removal of the existing I-5/Hayden Island interchange – access to Hayden Island would be provided via the new bridge
- Includes HOV specific facility treatments

Corridor Schematic

Overall corridor schematics for Option Packagess are shown in **Figures 3-1, and 3-2**, and depict the functional operation of I-5 under each option package variation. Text call-out boxes direct attention to specific projects or operational features within the corridor.

Park-and-Ride Facilities

Table 3-2 lists the planned park-and-ride facilities supporting the Clark County loop LRT system as well as the Airport and Interstate Max systems.

TABLE 3-2
PLANNED LRT PARK-AND-RIDE LOCATIONS AND CAPACITY

LRT System/P&R Facility	Planned Capacity
Airport MAX	
• Parkrose/Sumner TC	193 spaces[1]
Interstate MAX	
• PIR	300 spaces[1]
• Expo Center	300 spaces[1]
Subtotal	***793 spaces***
Clark Co. LRT Loop System	
• I-5 @ VA Hospital	1000 spaces[2]
• SR 500 @ Falk Rd.	550 spaces[1]
• SR 500 @ Andresen Rd.	1000 spaces[2]
• SR 500 @ Vancouver Mall TC	910 spaces[1]
• I-205 @ Crossroads	1200 spaces[1]

• I-205 @ 83rd Avenue		1300 spaces[1]
• I-205 @ NE 18th Street		830 spaces[1]
	Subtotal	***6790 spaces***
	TOTAL	**7583 spaces**

1. Surface parking
2. Parking structure

Sources: C-Tran and Tri-Met

Although planned park-and-ride capacity will be used as input into the travel demand modeling, park-and-ride capacity will be unconstrained by the model. Through an equilibration procedure, park-and-ride capacity will be adjusted to reflect transit ridership demand. This equilibration process allows transit demand under LRT and express bus options to be compared fairly.

3.1. River Crossing Options

Each of the Option Package 3 variations includes a different Columbia River Bridge concept consisting of a new bridge to supplement the existing I-5 Bridge structures:

Option Package 3a: Loop LRT system on LRT only bridge
Option Package 3b: LRT from Expo/PIR to Clark College with joint use arterial/HOV bridge

Option Description

LIGHT RAIL

Option Package 3a: Loop LRT system (SR 500)

Conceptual Engineering for Light Rail has been performed for a loop system. The total length of the loop system is approximately 17 miles, there would be 17 or 18 LRT stations depending upon the final alignment, and there would be approximately 6200 park and ride spaces. The LRT option description is describes in three segments:

1. Expo to Clark College (3.0 miles)
2. Clark College to Vancouver Mall Transit Center via SR 500 or Fourth Plain Blvd (4.7 miles)
3. Airport Junction to Padden Expressway Terminus via I-205 (9.3 miles**)**

LRT Segment 1: Expo to Clark College

Overview

- Length: 3.0 miles
- Alignment:
  - Parallels I-5 on new LRT bridge

  - Through Downtown Vancouver via Washington St. and McLoughlin Blvd. to VA Hospital
- Possible station locations:
  - Jantzen Beach
  - 7th St Transit Center
  - 12th St
  - 17th St
  - E St
  - VA Hospital
- Park and Ride Spaces: 1000 spaces at VA Hospital Station

Description of Conceptual Alignment: Expo to Clark College

- From Expo Station LRT continues north under Columbia Blvd to a new bridge over
- North Portland Harbor and Jantzen Drive to an elevated Hayden Island Station.
- LRT bridge over Jantzen Beach/Tomahawk Island Drive Interchange that continues past Red Lion and over the Columbia River.
- On the Washington side of the river LRT crosses over Columbia Way and under the BNSF Railroad.
- In Downtown Vancouver LRT follows Washington St with possible stations at the 7th St Transit Center, at 12th St, and at 17th St.
- The alignment turns east via McLoughlin Blvd with a station at E St serving the Arnada neighborhood/
- Continuing in the center of McLoughlin Blvd. under I-5, the alignment briefly turns north between I-5 and the Clark College athletic fields with station serving the VA Hospital and a 1000 space park and ride garage.

STRUCTURE - LRT I-5 BRIDGE

The Bridge option currently under study would be a low-level lift span bridge constructed at a height similar to the existing I-5 Bridge spans. The lift segment could be either a vertical lift, similar to the I-5 bridges, or a bascule type, which is similar to the Morrison and Burnside Bridges in downtown Portland. The main river crossing would consist of multiple spans with pier spacing similar to the existing I-5 Bridges. The vertical alignment must maintain the current dual I-5 Bridges horizontal and vertical clearances. Currently the dual bridges provide a horizontal clearance of 263 feet between the lift spans piers over the main navigation channel. The lift span provides a 39-foot vertical clearance above the Columbia River Datum (also refereed to as zero gage or low water) when closed, and a maximum of 178 feet when fully raised. An increase vertical clearance of 58 feet is provided at the alternate barge channel beneath the bridge's fixed 531-foot truss span. South of the 531-foot span, a vertical clearance of 72 feet is provided between prier 6 and 7 and piers 7 and 8; these spans are outside of the maintained channel limits. Touchdowns at the south end are at Hayden Island and the North end over Columbia Way(with reconstruction and or re-routing of Columbia Way), under the BNSF RR, and at grade with downtown Vancouver, and not impacting Person Airpark Flight paths. Regardless if the LRT only bridge parallels

the existing bridge to the west or east, column/pier locations will have to be coordinated with river users and US Coast Guard, given the existing bridge is known to impact river navigation and any additional obstruction would compound the issues.

Major Considerations

- *Superstructure Type* - The superstructure section could be a Bow String Arch type with a vertical lift span at the main river navigation channel. The cross section would have a constant deck thickness with the arch ribs follow the truss lines of the existing bridge. This structure type would fit with the existing I-5 Bridge of have the main structural element above deck allowing the LRT profile to be as tight as possible to the control river vertical clearance requirements. In addition, 1'6" is required from the top of the deck to the top of rail for ballast or direct fixation rail details, for clearance calculations. The Bow String Arch will hold a thin deck line with sweeping arches overhead blending with the above deck truss of the existing I-5 Columbia river Crossings. Alternatively, a concrete segmental bridge type could follow the same pier spacing, but utilizing a bascule lift span over the main channel. This bridge type would require a slight higher profile because the main structural elements are below the deck surface.

Simulated Bow Sting Arch LRT Bridge, Down Stream of the Existing I-5 Bridges
(This rendering is an example. Selection of an alignment, and bridge type has not taken place.)

Existing I-5 Columbia River Bridges from Jantzen beach looking North

- *Column Type* - The river pier columns could match the type and spacing of the existing I-5 Bridges for the Bow String Arch Bridge Type. For a concrete segmental the pier could be made up by a twin wall pier arrangement, which gives sufficient flexibility for final service conditions and provides the required stability for balanced cantilever construction. These walls will be 20 feet long and 2 feet 6 inches thick and set apart 26 feet, or 13 feet from the centerline of the pier to each wall.

- *Foundations* - The two end transition piers are on land at the riverbanks, and the interior piers are all in the river. For the river piers, a footing plan size of approximately 32 X 52 for the Bow String Arch option and 54 X 56 feet for the Concrete Segmental could be required. Deep foundation elements may be either driven piles or drilled shafts. Larger diameter drilled shafts may be preferable to limit the construction impacts of noise and vibration normally associated with driven piles.

- *Construction Procedures* - The river piers may be constructed by conventional methods using cofferdams. This features braced sheet piling walls, driven piles, underwater tremie concrete pours, and extensive pumping of the water inside the cofferdam to allow construction of the remainder of the pier footing and columns in the dry. This foundation type features footings that are founded below the river bottom. Because contractors assume a high risk with this type of foundation construction, costs are generally high for the cofferdams.

  The river piers may also be constructed as water level foundations. This foundation makes use of a precast concrete lost footing form. The form has a bottom and four sides approximately 15' high. The bottom has holes for piling or in this case, large diameter drilled shafts. The drilled shafts are installed with permanent casings from the water level down below the bottom of the river. The precast footing form is lifted and placed over the top of the shaft casings and supported by hangers from the casings. Underwater tremie concrete is placed in the bottom of the form to allow pumping out the water to construct the remainder of the footing in the dry. However, in this configuration, the bottom of footing is at a much higher elevation, requiring a smaller tremie pour due to the reduced hydrostatic head. This type of foundation is generally less costly, because the contractor risk is lowered.

  The Bow String Arch superstructure construction would be fabricated off site, and finished spans barged to the site and lifted into position. A concrete deck would then be poured in place after the finished Bow Sting Arches are all in place.

  The Concrete Segmental would be constructed of either precast concrete units or cast-in-place concrete units. Both methods could be constructed from conventional overhead travelers and employ balance cantilever construction methods. These methods would eliminate the need for formwork to be place across the river (refer to *Major River Crossing Finding Report, May 1995, Section 6.2 " Bridge Superstructure"*). These methods were employed for the Glenn Jackson

LRT Segment 2: Clark College to Vancouver Mall Transit Center via SR 500 or Fourth Plain Blvd

Overview

- Length: 4.7 miles
- Alignment:
  - Via Ft. Vancouver Way and St. John's Blvd. OR Via I-5 and SR 500 to Burnt Bridge Trail
  - Via SR 500 OR 4th Plain Blvd to Vancouver Mall
- Possible station locations:
  - Clark College and St John's Blvd via Ft.Vancouver Way OR
  - 33rd St, P St, and Y St via I-5/SR 500
  - Falk Rd, Stapleton Rd, Andresen Rd, 77th Ave, and Van Mall Transit Center via SR 500 OR
  - Brand Rd, Caples Ave, 62nd Ave, Burton Rd, 86th Ave, and Van Mall Transit Center via Fourth Plain Blvd.
- Park and Ride Spaces: 1500 spaces via SR 500 or 1000 spaces via Fourth Plain Blvd.
- The SR 500 LRT conceptual alignment assumes implementation of the frontage road and interchange improvement at St John's Blvd, Falk Rd, Stapleton Rd, and Thurston Way.

Description of Conceptual Alignment from Clark College to St, Johns interchange with SR 500 (2 alignment options)

- One alignment option follows Ft. Vancouver Way north with a station serving Clark College. The alignment continues along Ft. Vancouver to the intersection with St. Johns Blvd. where a station could be located to serve the Rosemere neighborhood.
- An alternative alignment skirts the neighborhood by following along the east side of I-5 with a station at 33rd Ave. The alignment turns east on the south side of SR 500 with stations at P and Y Streets.

Description of Conceptual Alignment from Clark College to St, Johns interchange with SR 500 (alignment option - St. Johns Interchange with SR 500 to Vancouver Mall via SR 500)

- In this option the alignment continues along the south side of SR 500 with a station at Falk Road, with the possible inclusion of a neighborhood-serving park and ride lot. An additional light rail station could occur at Stapleton Road.
- At Stapleton Road the alignment crosses to the north side of SR 500 and continues eastward to elevated crossing of Andresen Road, where an elevated station and adjacent park and ride structure for about 1000 cars could be sited.

- The alignment continues on the north side of SR 500 with a station near the Heathman Lodge at 79th.
- LRT tracks pass by Vancouver Mall on the narrow strip of land between the south side of the Mall and SR 500 to a new location for the transit center, east of the Mall. The transit center includes transfers to C-Trans buses or to I-205 LRT trains.

Description of Conceptual Alignment from Clark College to St, Johns interchange with SR 500 (alignment option - Ft. Vancouver Way to Vancouver Mall via Fourth Plain Blvd.)

- In this option the alignment turns east from Ft. Vancouver Way along the center of Fourth Plain Blvd.
- Stations could be located at Brand Rd, Caples Ave, 62nd Ave, Burton Rd, and 86th Ave.
- A variation on this alignment option crosses over to the SR 500 alignment just south of the Andresen /Fourth Plain Blvd. intersection.
- Either route winds up at the Vancouver Mall Transit Center located at the east side of the Mall.

LRT Segment 3: Airport Junction to Padden Expressway Terminus via I-205

Overview

- Length: 9.5 miles
- Alignment: Median of I-205 with a possible deviation along Chkalov Blvd
- Possible station locations:
  - Chkalov Blvd or SE 10th
  - NE 18th
  - Burton Road
  - Vancouver Mall Transit Center
  - Padden Expressway
- Park and Ride Spaces: 3600
- The I-205 LRT conceptual alignment assumes the implementation of the frontage road and interchange improvements between SR 14 and SR 500 proposed in the I-205 Corridor Study.

Description of Conceptual Alignment PDX Airport Junction to SR 14

- New track begins at the point where Airport MAX turns west toward the Airport.
- I-205 realigned to allow new tracks to straddle existing Airport MAX structure.
- Options for crossing Columbia River include (See conceptual cross sections):

- Option 1: Locate LRT on Glen Jackson Bridge, strengthened as necessary, and either remove one auto lane (Option 1A) or maintain four lanes with narrow (3.5 feet) shoulders (Option 1B).
- Option 2: Widen Glen Jackson Bridge about 3 feet on the inside and 6 feet on the outside (both bridges) to accommodate 4 lanes with 8 foot shoulders and LRT. Relocate the bike path on the outer edge of one of the bridges.
- Option 3: Construct a new LRT only downstream from the Glen Jackson Bridge. (For cost purposes Option 3 has been assumed since Option 1 is considered unsafe, and Option 2 has too much uncertainty at this stage of the study.)
- A fourth option has been identified that would locate a new LRT bridge further downstream allowing a substantially shorter alignment and bridge structure than Option 3. This alignment would allow the I-205 alignment to go through the Cascade East Station, facilitating transfers to Airport MAX. To proceed with this option it must be first determined that the alignment falls safely outside the landing zone of planes.

- The LRT alignment through the SR 14 interchange varies with river crossing options.

Description of Conceptual Alignment SR 14 to Vancouver Mall

- From SR 14 two alignments options were identified:
  - Via Chkalov Drive. In this option LRT would leave the median of I-205 on a new structure to land at the signalized intersection of SE 10th and Chkalov Drive, proceeding north in the center of Chkalov Drive. A station could be located on Chkalov Drive, south of Mill Plain Blvd. The alignment crosses Mill Plain Blvd at a traffic signal and follows SE 112th a short way and then returns to I-205 median via a new structure. The intention of this option is to locate the station within the community to facilitate pedestrian access, and to generate opportunities for long-term development related to the station.
  - Via I-205. In this option LRT remains in the median of I-205 with a station located in the median at SE 10th. This option would have fewer impacts compared to the Chkalov option; however, pedestrian accessibility to the station is less attractive and the station is physically separated from the community.
- In the median of I-205 LRT passes under SE 9th and SE 18th. At SE 18th a park and ride station is located to utilize the existing BPA right of way for about 800 surface parking spaces.
- Continuing north the alignment goes over Burton Road on a new structure, providing a station just north of Burton Road.
- Approaching the SR 500 intersection the alignment swings to the west on two successive LRT structures to land at the Vancouver Mall Transit Center and a small surface park and ride parking lot of about 300 spaces (that could be enlarged by constructing structured parking).

Description of Conceptual Alignment Vancouver Mall to Padden Expressway Terminus

- From the Vancouver Mall Transit Center the alignment follows NE 94th about ¼ mile to a new structure that carries LRT back into the median of I-205.
- The alignment continues in the median to a terminus station in the median just south of the Padden Expressway. This station is connected to two park and ride lots on the east side of I-205 (1300 spaces) and on the west side of I-205 (1200 spaces provide by the Crossroads Church). The station connects to the park and ride lots via a new pedestrian bridge over I-205 that also extends westward the existing bike trail along the Padden Expressway.
- The median alignment allows for a future LRT extension to the north.

LIGHT RAIL AND 4-LANE BRIDGE

Option Package 3b: LRT from Expo/PIR to Clark College with joint use arterial/HOV bridge

ROADWAY

Mill Plain to SR500

Between Mill Plain Blvd. and SR500 in Vancouver, the proposed design reconfigures the existing interchanges to eliminate the number of weaving sections on the freeway. The freeway remains a six through lane section with additional lanes added as auxiliary lanes between interchanges where the space between ramps is inadequate to provide for a merge and a diverge from the highway. The interchange improvements are accomplished primarily by braiding the on/off ramps. Construction of the braided ramps will require replacement of the overpasses for 29th St. and 33rd St., and widening of the Mill Plain and McLaughlin overcrossings.

Interchanges were modified based upon the schematic design developed at a workshop held with DOT and consultant team members on June 29, 2001. The design concept included braiding most of the ramps to and from the existing interchanges. Ramps to be braided include:

Northbound

- Fourth Plain on-ramp with SR500 off-ramp: The new diverge point for the SR500 off-ramp would begin on the north side of the Fourth Plain overpass. The Fourth Plain on-ramp would pass over the SR500 off-ramp, merging with the highway near the 29th Street overpass. The Fourth Plain on-ramp would also have an split to allow traffic to decide

between accessing I-5 Northbound or SR500 Eastbound. Braiding of these ramps will require reconstruction of the 29th St. and 33rd St. overpasses.

Southbound

- SR500 on-ramp with Fourth Plain off-ramp: The diverge point for the Fourth Plain off-ramp would be moved to the area between the 39th St. off-ramp and the SR500 overpass. The new ramp would align to the west side of the SR500 on-ramp, cross under the 39th St. on-ramp, and parallel the highway to connect to the existing interchange area. The design currently includes a connection between SR500 and Fourth Plain Blvd via a short weaving area. This weave takes place within the same zone that includes the SR500 to mainline weave and may negate the advantages of braiding the ramps. As a result, further study of the ramp configuration is recommended during the subsequent alternatives analysis to determine the need for this connection and, if warranted, whether the correct design approach is to braid the ramps at this location.
- Fourth Plain on-ramp with Mill Plain off-ramp: The diverge point for the Mill Plain off-ramp would be moved to approximately the same location as the existing Fourth Plain off-ramp diverge. The Mill Plain ramp would rise and crossover both the Fourth Plain on-ramp, which is left mostly unchanged from the existing configuration, and Fourth Plain Blvd. Much of this ramp will be on structure because of the need to clear Fourth Plain.
- Mill Plain on-ramp with SR14 off-ramp: To mitigate an existing short weave distance between the Mill Plain on-ramp and the SR14 off-ramp, the SR14 off-ramp diverge point would be move to the north edge of the Mill Plain underpass, braid over the Mill Plain on-ramp and make a connection to SR14 via the ramp included in the design for each of the river crossing options. The Mill Plain on-ramp would offer the option, via a mid-ramp split, to go to either I-5 southbound or SR14 eastbound.

This design segment also includes a connector between SR500 westbound and the 39th St. northbound on-ramp providing a direct connection between SR500 and northbound I-5.

During the I-5 HOV study, performed by Parsons Brinckerhoff, the observation was made that in Vancouver I-5 functions as both a regional and local connector. To improve performance of I-5, these two traffic types could be separated via a barrier creating, what is in affect, a bypass system through Vancouver for the regional traffic. This option would require additional widening of the freeway to accommodate all the lanes, but would eliminate the need to extensively braid the interchanges. Separation of the freeway would occur north of SR500 and south of SR14, although the river crossing options that include a bypass bridge could connect into the regional route. Lane configurations would likely include 2 lanes in each direction on the bypass (1 HOV and 1 General Purpose) and 2 lanes on the "local" system plus any necessary auxiliary lanes between interchanges. It is recommended that this option be revisited in future studies along with the braided ramp option shown.

ROADWAY

Four-Lane Bridge

The proposed four-lane bridge will provide one High Occupancy Vehicle (HOV) and one General Purpose (GP) lane for each direction. It has 12' shoulder on both sides and 20' center median for a total width of 92 feet. It is located on the west side of the existing I-5 corridor starting from Victory Boulevard and terminating just south of Evergreen Bridge.

The bridge mainline carrying the HOV lanes begins on the north side of Victory Boulevard with its center matching the existing I-5 centerline. It crosses over Interstate-5 (I-5), Highway 99 and Expo Road. The existing I-5 northbound on-ramp at Victory Blvd. will be widened into two lanes to accommodate the proposed northbound GP lane that will cross over I-5 and then merge with the mainline bridge at Expo Center. An exit ramp will be provided for the southbound GP lane that will split into two lanes, one lane goes to Expo road and the other lane merges into the existing I-5. As shown on the plan, the existing I-5 will be widened to accommodate the additional 2 HOV lanes, 2 GP lanes and the existing 6 lanes.

A bus access ramp is proposed at Expo Center Station to serve City of Vancouver southbound and northbound bus service routes. In addition, a ramp is also provided southbound to City of Portland. The existing private road where the bus access is being proposed will be improved and converted into a public road to improve traffic circulation.

The existing I-5 connections at Hayden Island will be eliminated to relieve congestion on this area. Conversely, a split diamond interchange will be built to access Hayden Island through the new four-lane bridge. Tomahawk Island Drive will be extended thru and under I-5 with signalized intersections at both ramps. The entrance and exit ramps at Hayden Island Drive intersections will also be signalized to allow and control all directional traffic movements.

The four-lane bridge will cross the Columbia River with an elevation meeting the existing navigational clearance of the Interstate Bridge. It will go over the existing railroad and SR 14 interchange and touch down south of Evergreen Bridge. A northbound exit ramp is provided for the SR 14 eastbound and Sixth Avenue westbound connections. Furthermore, a southbound on-connection from Washington Street is proposed and a southbound off-connection with an over-crossing is designed to serve Sixth Avenue. All existing SR-14 and I-5 interchange connections will remain.

The affected area of I-5 where the proposed bridge ends will be widened on both sides to accommodate the additional lanes as a result of this improvement. The said widening will not impact the existing hospital on the historic reserve area, however, its road adjacent to the highway will be affected.

These proposed four-lane bridge terminates just south of Evergreen with its new lanes designed to conform to the proposed development of the Mill Plain interchange.

STRUCTURE - 4-LANE BRIDGE WITH LRT

The 4 Lane Bridge with LRT alternative over the Columbia River is conceptualized as a double deck steel truss type with a vertical moveable span over the navigation channel. The Span layout could be comprised of (south bank to north bank) 260'-540'-270'-540'-540'-280'(Vertical lift Span)-320'. Currently the existing dual bridges provide a horizontal clearance of 263 feet between the lift spans piers over the main navigation channel. The lift span provides a 39-foot vertical clearance above the Columbia River Datum (also refereed to as zero gage or low water) when closed, and a maximum of 178 feet when fully raised. An increase vertical clearance of 58 feet is provided at the alternate barge channel beneath the bridge's fixed 531-foot truss span. South of the 531-foot span, a vertical clearance of 72 feet is provided between prier 6 and 7 and piers 7 and 8; these spans are outside of the maintained channel limits. The assumed profile of the 4-lane bridge with LRT has the upper highway bridge deck elevation over the navigation channel at 145 feet in the closed position with LRT and HOV on the lower deck, approximately 45 feet lower (100' lower deck elevation in closed position). This is compared to the existing twin I-5 bridges which has a deck elevation of 45'feet(+-) in the closed position. The 4 lane bridge will function with the exiting I-5 Bridges in operation. The new bridge is conceptualized to have a vertical lift moveable span, that when open will match existing vertical clearances. The deck elevation of 145 feet was assumed based on the vertical restriction associated with Person Airpark. The airpark airspace restriction is approximately at 175 feet; with the deck at 145 feet this should allow lights, signs and trucks to pass without infringing into the airspace. The two decks would open independently for lift span operations. Near the North Bank (Washington), the double deck bridge would transition to two independent bridges, as LRT facilities head toward downtown Vancouver, and the HOV and general-purpose lanes follow I-5. Both bridges in profile would travel over BNSF tracks.

Major Considerations

- *Superstructure Type* - The superstructure section could be a double deck truss, similar to the Marquam or Fremont bridges. The cross section could vary in depth from maximum depths over the interior piers to $1/10^{th}$ the span length at mid-section (for a truss, arches and other types would have different depth to span rations). A suggested depth to span ration would be 1/8 at the pier, and 1/10 at midspan.

- *Column Type* - The river pier columns could match the type and spacing of the existing I-5 Bridges for the double deck truss Bridge Type.

- *Foundations* - The two end transition piers are on land at the riverbanks, and the interior piers are all in the river. For the river piers, a footing plan size of approximately 32 X 52 for the double deck truss could be required. Deep foundation elements may be either driven piles or drilled shafts. Larger diameter drilled shafts may be preferable to limit the construction impacts of noise and vibration normally associated with driven piles.

- *Construction Procedures* - The river piers may be constructed by conventional methods using cofferdams. This features braced sheet piling walls, driven piles, underwater tremie concrete pours, and extensive pumping of the water inside the cofferdam to allow construction of the remainder of the pier footing and columns in the dry. This foundation type features footings that are founded below the river bottom. Because contractors assume a high risk with this type of foundation construction, costs are generally high for the cofferdams.

  The river piers may also be constructed as water level foundations. This foundation makes use of a precast concrete lost footing form. The form has a bottom and four sides approximately 15' high. The bottom has holes for piling or in this case, large diameter drilled shafts. The drilled shafts are installed with permanent casings from the water level down below the bottom of the river. The precast footing form is lifted and placed over the top of the shaft casings and supported by hangers from the casings. Underwater tremie concrete is placed in the bottom of the form to allow pumping out the water to construct the remainder of the footing in the dry. However, in this configuration, the bottom of footing is at a much higher elevation, requiring a smaller tremie pour due to the reduced hydrostatic head. This type of foundation is generally less costly, because the contractor risk is lowered.

  The double deck truss superstructure construction would be fabricated off site, and finished spans barged to the site and lifted into position. A concrete deck would then be poured in place after the finished trusses are all in place.

Typical Sections

Deviations from Standards

ROW Impacts

Costs

Figure 1 – Option Schematic