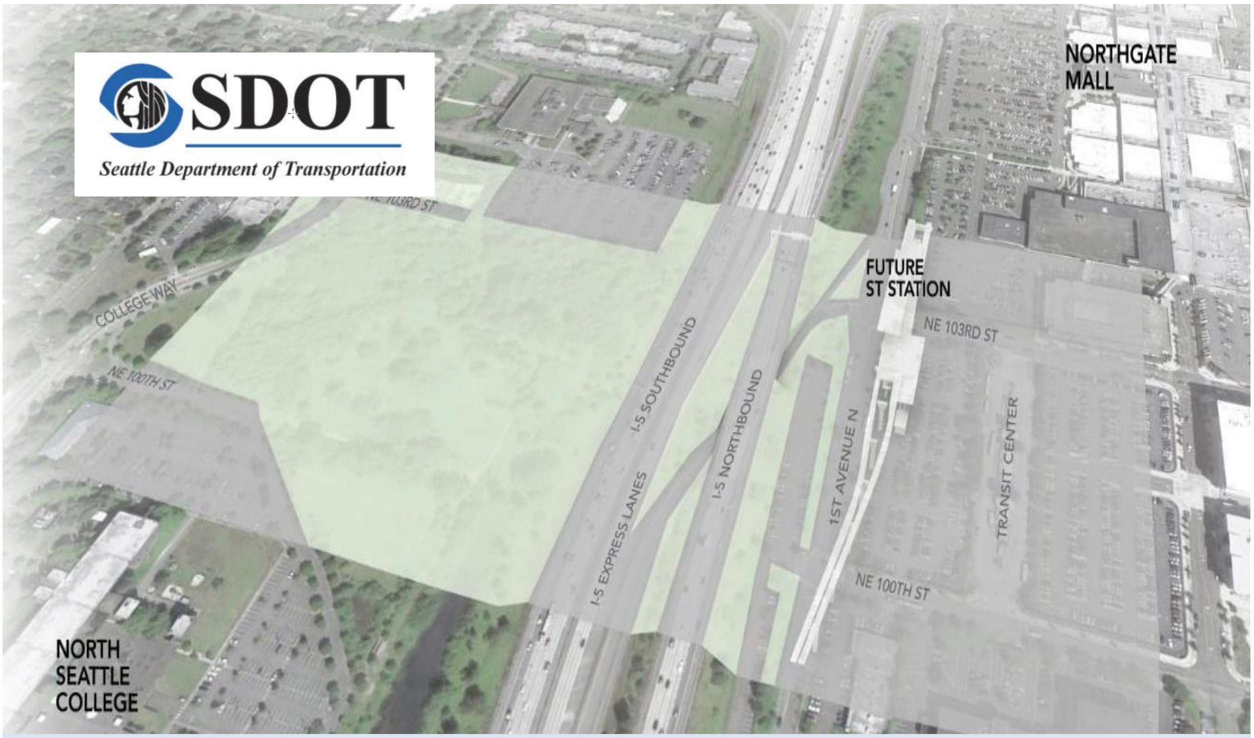

The Seattle Department of Transportation

Northgate Pedestrian and Bicycle Bridge

Alternative Development and Selection

November 21, 2014

kpff

KPFF Consulting Engineers in association with

Alta Planning & Design
Environmental Science Associates (ESA)
Hart Crowser
LMN Architects
Lin & Associates Inc.
Stepherson & Associates Communications
Swift Co.

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1 Executive Summary

INTRODUCTION

Northgate is located north of the City of Seattle and is one of six urban centers established by the Seattle Comprehensive Plan. Northgate comprises the Maple Leaf neighborhood to the east and the Licton Springs neighborhood to the west. Northgate is also the home of the Northgate Transit Center, operating as the largest facility in the King County Metro system. In the near future, the existing transit center will be enhanced by the construction of a Sound Transit light rail facility with planned connections to downtown Seattle and as far south as SeaTac International Airport and as far north as Lynnwood.

Figure 1.1—Project Location Within the Seattle Metro Area

A major obstacle to the sense of community between the Maple Leaf and Licton Springs neighborhoods, as well as to the full utilization of the transit center and future light rail station, is the location of the Interstate 5 (I-5) corridor through the middle of Northgate. The I-5 corridor divides Northgate and makes access to the transit center from the west more difficult.

The City of Seattle's Northgate Pedestrian and Bicycle Bridge project will provide the design and construction of a much-needed pedestrian and bicycle overpass across I-5 to connect communities, neighborhoods, businesses, and schools in the Northgate area. Existing crossings of I-5 occur to the north at North Northgate Way and to the south at Northeast 92nd Street. The objective of this project is to provide a new crossing somewhere between these established crossings.

PURPOSE AND NEED

The need for a pedestrian- and bicycle-friendly connection between the east and west sides of I-5 has been identified in a number of Seattle's plans as a key to improving access to the transit center and other assets of the neighborhoods. These plans include the Northgate Coordinated Transportation Investment Plan and the Puget Sound Regional Council's (PSRC's) Growing Transit Communities effort. The Northgate Pedestrian and Bicycle Bridge also is identified within the PSRC's Regional Bike Network as a key connection.

King County Department of Transportation (KCDOT) completed the *Northgate Pedestrian Bridge Feasibility Study Report* in December 2012. The report identifies possible alignments, bridge types, and estimated costs for a pedestrian- and bicycle-friendly bridge as well as key parameters required by WSDOT for the crossing of I-5. The study reported that a bridge would reduce the walking distance from the transit center to North Seattle College from 1.2 miles to approximately .25 miles.

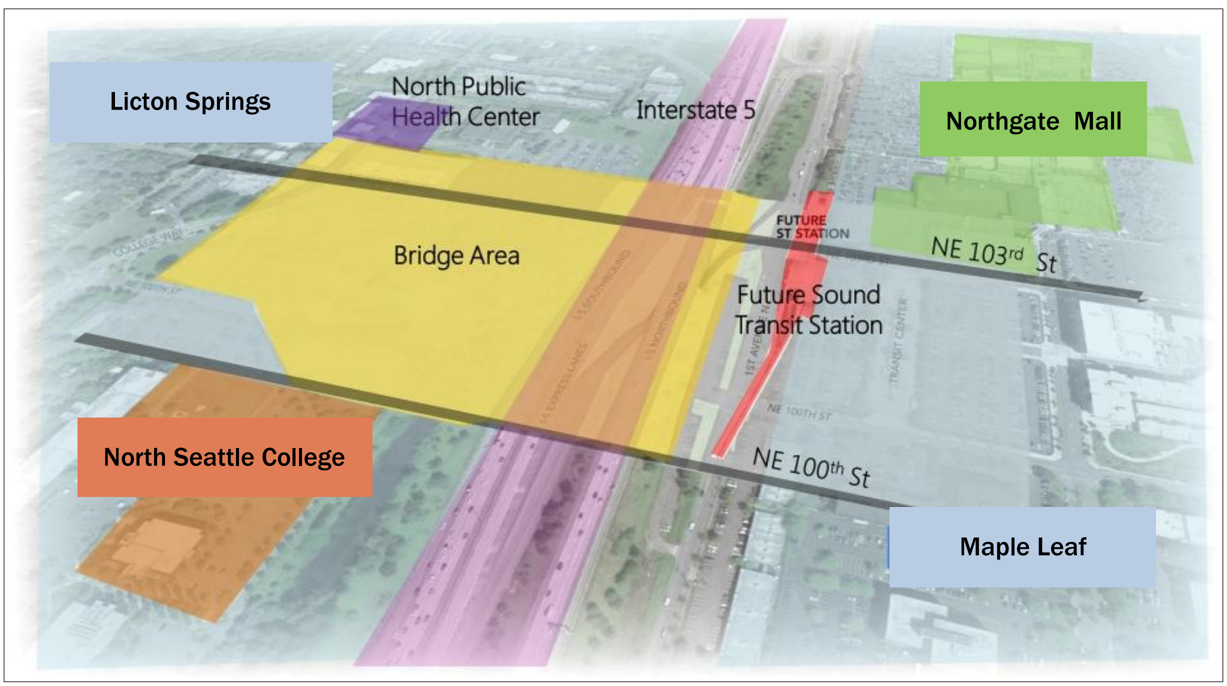
The report cites a previous study indicating that a bridge would result in a 30% reduction in average walking time to the Northgate Transit Center and Light Rail Station and would effectively expand the area walk shed to more than 150 buildings and the bike shed to more than 3,000 additional buildings.

In early 2013, the City of Seattle awarded a consultant contract to complete an analysis of potential pedestrian/bicycle bridge types and alignments. The purpose of this report is to describe the alternatives evaluated throughout the process and the criteria through which each alternative was selected or eliminated.

PROJECT LOCATION AND LIMITS

Northgate Mall fills the area on the east side of I-5 from North Northgate Way to NE 103rd. North Seattle College fills the area west of I-5 from Northeast 92nd Street to Northeast 103rd Street. This leaves a zone bounded by Northeast 103rd Street to the north and Northeast 100th Street to the south for a location of the pedestrian facility.

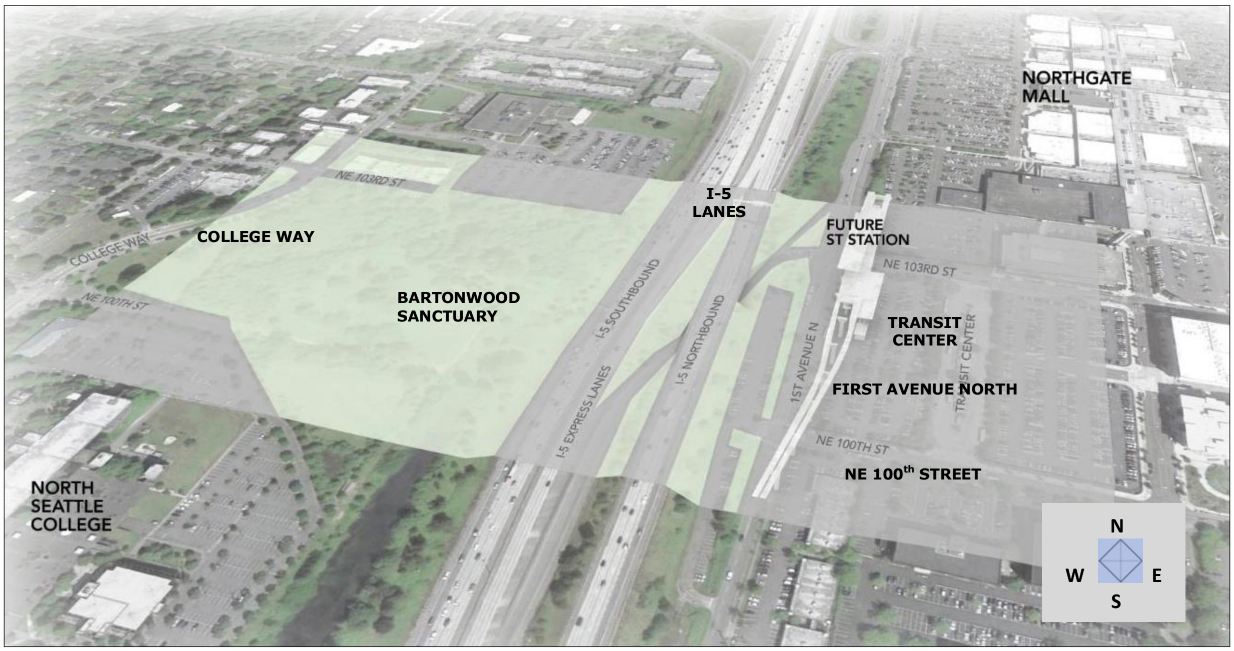
Figure 1.2—Location of Project Area



The City of Seattle plans to build a protected bicycle lane between Northeast 100th Street and Northeast 92nd Street along the west side of First Avenue NE, as well as a multi-use trail between Northeast 103rd Street and Northeast Northgate Way along the east side of First Avenue NE. Therefore, First Avenue NE makes a logical boundary to the east.

College Way North travels along the western border of the North Seattle College and connects with existing mass transit stops and neighborhood greenways. Therefore, College Way North defines the western boundary of the project. In total, the proposed boundaries of the project are Northeast 100th Street to the south, Northeast 103rd Street to the north and College Way North and First Avenue NE to the west and east respectively.

Figure 1.3—Location Connections



PROJECT SCOPE OF WORK

The Northgate Pedestrian and Bicycle Bridge project will take place in three phases, which include the following:

- Phase 1: Alternative Development and Selection and National Environmental Policy Act (NEPA) Compliances
- Phase 2: Plans, Specifications, and Cost Estimate (PS&E)
- Phase 3: Construction Management

This report is the Alternative Development and Selection, which includes data collection and review; basis of design preparation; type, size and location of alignment/approaches, and structures; geotechnical engineering; environmental services; urban design; inclusive outreach and public engagement; and definition of permitting requirements.

PREFERRED ALIGNMENT

All project alignments studied were broken into the following three distinct components: west approach, I-5 crossing, and east approach.

West Approach

The west approach is bounded by College Way North to the west and I-5 to the east. The north and south boundaries are North 103rd Street and North 100th Street respectively. Within these boundaries is the Bartonwood Sanctuary, a greenbelt containing more than 2 acres of mature, forested wetland. West approach alignments that touch down and are aligned with both North 103rd Street and North 100th Street were studied.

The preferred west approach alignment is the North 100th Street alignment because it aligns with a neighborhood greenway, has less environmental impact, is safer and provides the best connection to the I-5 overcrossing and east approach.

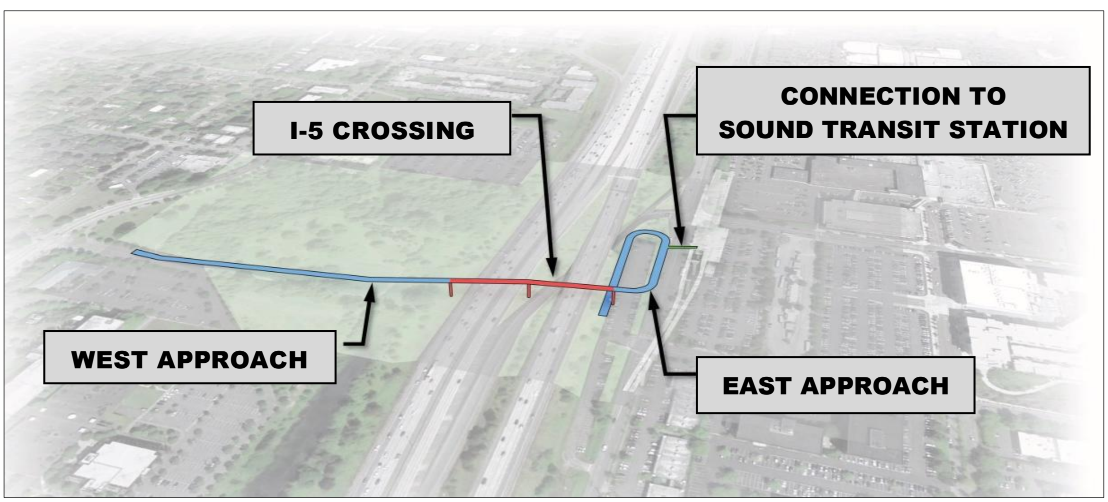
I-5 Overcrossing

For the main bridge spanning I-5, the possible foundation locations are defined by the alignment intersection with the WSDOT ROW along the western side, the foundation zones defined by WSDOT in the center of I-5, and the connection with the east approach. These parameters create the ability to construct a two-span bridge, with spans in the range of 200 feet for a total bridge length in the range of 400 feet.

East Approach

The east approach is more constricted than the west approach in terms of available space, and careful ramp placement is required to meet the ADA compliance geometrics for this approach. The boundaries for the east approach are I-5 to the west, the I-5 express lane ramp and 103rd Street to the north, the light rail station to the east, and North 100th Street to the south.

Figure 1.4—Approaches, I-5 Crossing, and Sound Transit Connection



Within these boundaries are a WSDOT embankment alongside the I-5 northbound lanes, a WSDOT parking lot, First Avenue NE, and the King County Transit Center. Studied were east approach alignments touching down at 103rd Street, 100th Street, and at midblock between them. The recommended east approach alignment is the 100th Street alignment because it creates an efficient connection to the proposed light rail station, provides a ramp that is completely contained within the northern half of the WSDOT parking lot, and aligns with 100th Street, providing clear visibility.

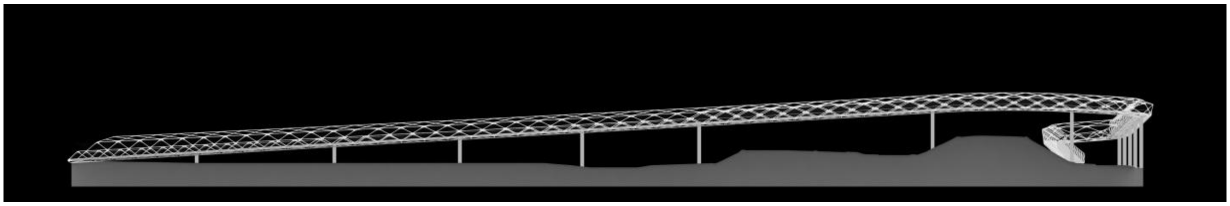
PREFERRED BRIDGE TYPE

Structural types that are commonly used for conventional site conditions, with spans in the 200-foot range like the Northgate Bridge Pedestrian and Bicycle Bridge, include steel and concrete box girders, steel plate girders, and steel trusses. For sites with special conditions and aesthetic considerations, structural types also include cable-stayed, suspension, and arch bridges.

The length of the approaches is a key consideration for this project—important because of the time required for users to transverse the facility and the limited space on the east approach. Minimizing the depth of the superstructure results in reducing the length of the approaches and so is a strategic consideration in the selection of a bridge type. For every foot of depth, there is a required 50-foot length of ramp when the slope is defined by a 2% grade. Consequently, truss, arch, and cable-stayed bridges have shorter ramp length because of their shallower depths when compared to girder-type bridges.

Figure 1.5—Truss/Tube Rendering with Pedestrians

Figure 1.6—Truss/Tube Rendering



The recommended bridge type is a truss/tube structure. A truss/tube is preferred because of the potential for prefabrication to facilitate minimal site disruption; potential to accommodate acoustic barrier for users; potential to integrate overhead weather protection, railings and throw barriers; accommodation and containment of lighting; safety perception of being protected from highway below; and overall cost.

ESTIMATED CONSTRUCTION COSTS

The preferred combination of alignment, landings, and bridge type was advanced to a level that provided enough design to establish a preliminary project cost estimate. The estimated cost range of the bridge per the findings of the Alternative Development and Selection is between $23 and $26 million. (See Figure 1.7 on the next page.)

The project costs will be affected by a number of variables. A few key variables include:

- timing for project construction;
- final geometry of the structure specifically the bridge width; and
- actual ROW acquisitions costs.

Figure 1.7—Tube Truss and Tied Arch Cost Estimations

NORTHGATE PEDESTRIAN BICYCLE BRIDGE				
Base Construction Costs	Tube Truss		Tied Arch	
	20-foot path	15-foot path	20-foot path	15-foot path
West Approach				
Civil	$312,494	$295,106	$331,563	$314,176
Landscaping	$1,115,016	$1,115,016	$1,416,407	$1,416,407
Structural/Architectural	$1,779,208	$1,507,356	$1,779,208	$1,507,356
West Approach Subtotal	**$3,206,717**	**$2,917,478**	**$3,527,178**	**$3,237,939**
East Approach				
Civil	$340,487	$329,412	$340,487	$329,412
Landscaping	$430,533	$430,533	$430,533	$430,533
Structural/Architectural	$3,571,544	$2,929,983	$3,521,544	$2,929,983
East Approach Subtotal	**$4,342,564**	**$3,689,928**	**$4,292,564**	**$3,689,928**
Main Spans				
Structural/Architectural	$3,205,100	$2,676,325	$3,820,600	$3,140,950
Main Spans Subtotal	**$3,205,100**	**$2,676,325**	**$3,820,600**	**$3,140,950**
Lighting/Electrical/Mechanical				
Lighting/Electrical/Mechanical	$1,260,000	$1,260,000	$1,260,000	$1,260,000
Lighting/Electrical/Mechanical Subtotal	**$1,260,000**	**$1,260,000**	**$1,260,000**	**$1,260,000**
Environmental Mitigation				
Environmental Mitigation	$130,000	$130,000	$130,000	$130,000
Environmental Mitigation Subtotal	**$130,000**	**$130,000**	**$130,000**	**$130,000**
Subtotal	**$12,144,381**	**$10,673,731**	**$13,030,342**	**$11,458,817**
Mobilization (10% of Construction Subtotal)	$1,214,438	$1,067,373	$1,303,034	$1,145,882
Contingency (30%)	$3,643,314	$3,202,119	$3,909,103	$3,437,645
Escalation to 2016 (2% per year)	$490,633	$431,219	$526,426	$462,936
Construction Subtotal (2016)	**$17,492,766**	**$15,374,442**	**$18,768,905**	**$16,505,280**
Miscellaneous Costs				
Construction Administration (40% of Construction Subtotal)	$6,997,107	$6,149,777	$7,507,562	$6,602,112
Construction Contingency (20%)	$1,399,421	$1,229,955	$1,501,512	$1,320,422
Sum	$8,396,528	$7,379,732	$9,009,074	$7,922,534
Total (2016)	**$25,889,294**	**$22,754,174**	**$27,777,979**	**$24,427,814**

2 INTRODUCTION

INTRODUCTION AND BACKGROUND

Figure 2.1—Project Location within the Seattle Metro Area

The Northgate area, located in northeast Seattle, is one of the Puget Sound region's major residential and employment centers with 3,600 households and more than 11,000 jobs. The area comprises the Maple Leaf neighborhood to the east and the Licton Springs neighborhood to the west and is one of six urban centers established by the Seattle Comprehensive Plan. It also is one of Seattle's most affordable communities and has attracted a higher proportion of economically disadvantaged populations than the city as a whole.

The Northgate project area consists of residential, commercial, and educational pockets separated by I-5, high-volume arterial streets, and large parking lots. This creates an environment that is difficult to safely navigate by any means other than by car. However, even by car, traveling between Point A to Point B in the Northgate area often requires long, circuitous trips, which can add at least a mile to any single trip. Bus routes for commuters traveling from one side to the other also are circuitous and often delayed by traffic congestion.

Northgate serves as a major transit hub. In the near future, the existing transit center—which is the largest in the King County Metro system—will be enhanced by the construction of a Sound Transit light rail facility, with planned connections in downtown Seattle and as far south as SeaTac International Airport and as far north as Lynnwood. However, the I-5 corridor divides the Northgate area and makes full utilization of the transit center and future light rail station more difficult.

Ten lanes of I-5 bisect the neighborhoods, creating barriers between homes, jobs, schools, transit stops, and vital community services. Within this urban center are only two I-5 crossings. Each is a distant walk from the light rail station site, and one is complicated by freeway entrances. The lack of convenient and safe pedestrian and bicycle connections at the two crossings makes it difficult or impossible for many people to access the light rail station without a car or bus transfer.

The I-5 barrier has hindered job growth and influenced choices of travel mode. Trip surveys indicated that the choice of whether commuters walk or bike to work within Northgate is strongly influenced by the presence of I-5, with residents 50 percent less likely to walk or bike to work if they live on one side of the freeway and work on the other. While slated for significant growth as part of both Seattle's Comprehensive Plan and the Puget Sound Regional Council's (PSRC's) Vision 2040 Plan, growth in Northgate has lagged behind most other designated growth centers due to this auto-oriented built environment.

PURPOSE AND NEED

Northgate Pedestrian and Bicycle Bridge is part of several non-motorized improvements being developed in the Northgate, North College Park, and Licton Springs neighborhoods in the vicinity of Sound Transit's Northlink Station and the North Seattle College. The purpose of the bridge project is to span I-5 and connect the west and east neighborhoods and businesses that are divided by the freeway, to connect the bridge to separated bicycle facilities along First Avenue North from Northeast Northgate Way south to Northeast 92nd Street, and to integrate with the Sound Transit Northgate Station.

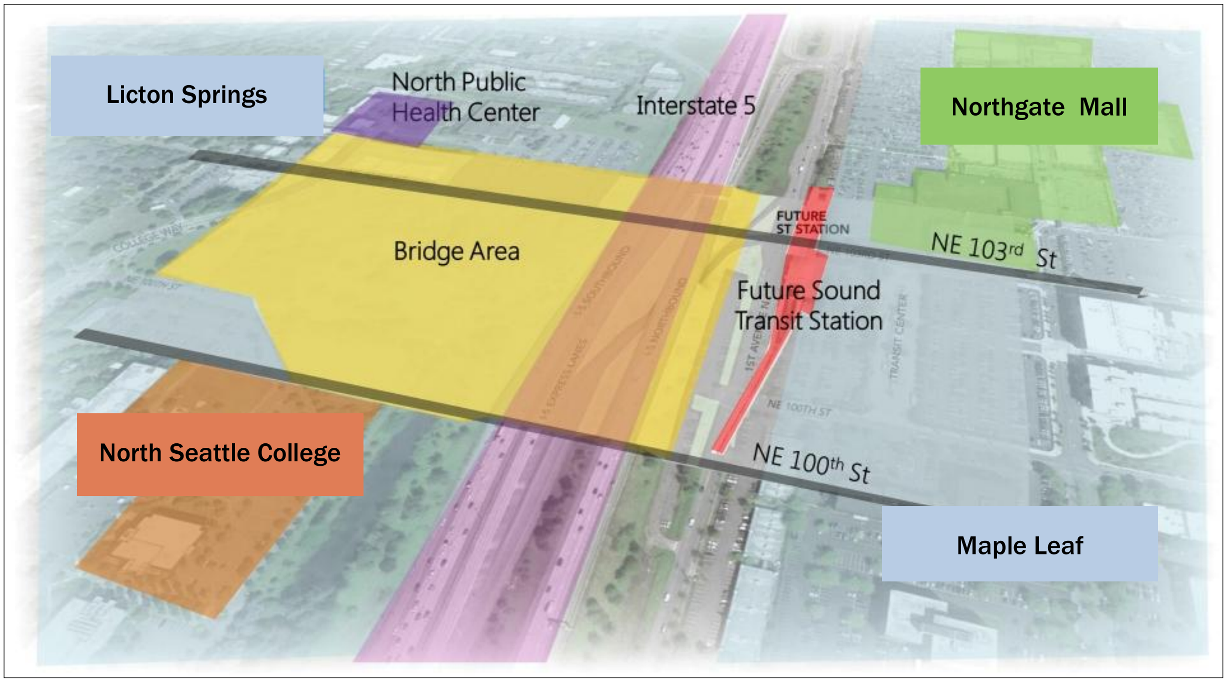
The creation of a pedestrian- and bicycle-friendly connection between the east and west sides of I-5 has been identified in a number of Seattle's plans as a key to improving access to the transit center and other neighborhood assets. These plans include the Northgate Coordinated Transportation Investment Plan and the Puget Sound Regional Council's (PSRC's) Growing Transit Communities effort. The Northgate Pedestrian and Bicycle Bridge also is identified within the PSRC's Regional Bike Network as a key connection.

King County Department of Transportation (KCDOT) completed the *Northgate Pedestrian Bridge Feasibility Study Report* in December 2012. The report identifies possible alignments, bridge types, and estimated costs for a pedestrian- and bicycle-friendly bridges as well as key parameters required by WSDOT for the crossing of I-5. The study reported that a bridge would reduce the walking distance from the transit center to North Seattle College from 1.2 miles to approximately .25 miles.

The report cites a previous study indicating that a bridge would result in a 30-percent reduction in average walking time to the Northgate Transit Center and Light Rail Station and would effectively expand the area walk shed (.5 miles long) to more than 150 buildings and the bike shed (3 miles long) to more than 3,000 additional buildings.

PROJECT LOCATION

Figure 2.2—Location of Project Area



The Northgate Pedestrian and Bicycle Bridge project is located north of the City of Seattle's downtown district, along the I-5 corridor between Northeast 100th and Northeast 103rd streets. To the west of the proposed crossing of I-5 is North Seattle College, and to the east lies Northgate Transit Center and the future Northlink light rail station.

The City of Seattle also plans to build a protected bicycle lane between Northeast 103rd and Northeast 92nd streets along the east side of First Avenue NE, as well as a multi-use trail between Northeast 103rd Street and Northeast Northgate Way along the east side of First Avenue NE. Therefore, First Avenue NE was chosen as a logical boundary to the east.

College Way North travels along the western border of the North Seattle College and connects with existing mass transit stops and neighborhood greenways. Therefore, College Way North defines the western boundary of the project.

In total, the proposed boundaries of the project are:

- Northeast 100th Street to the south
- Northeast 103rd Street to the north
- College Way North to the west; and
- First Avenue NE to the east.

(See Figures 2.3 and 2.4 on the following pages.)

Figure 2.3—Connections to Existing Transportation Modes and Infrastructure

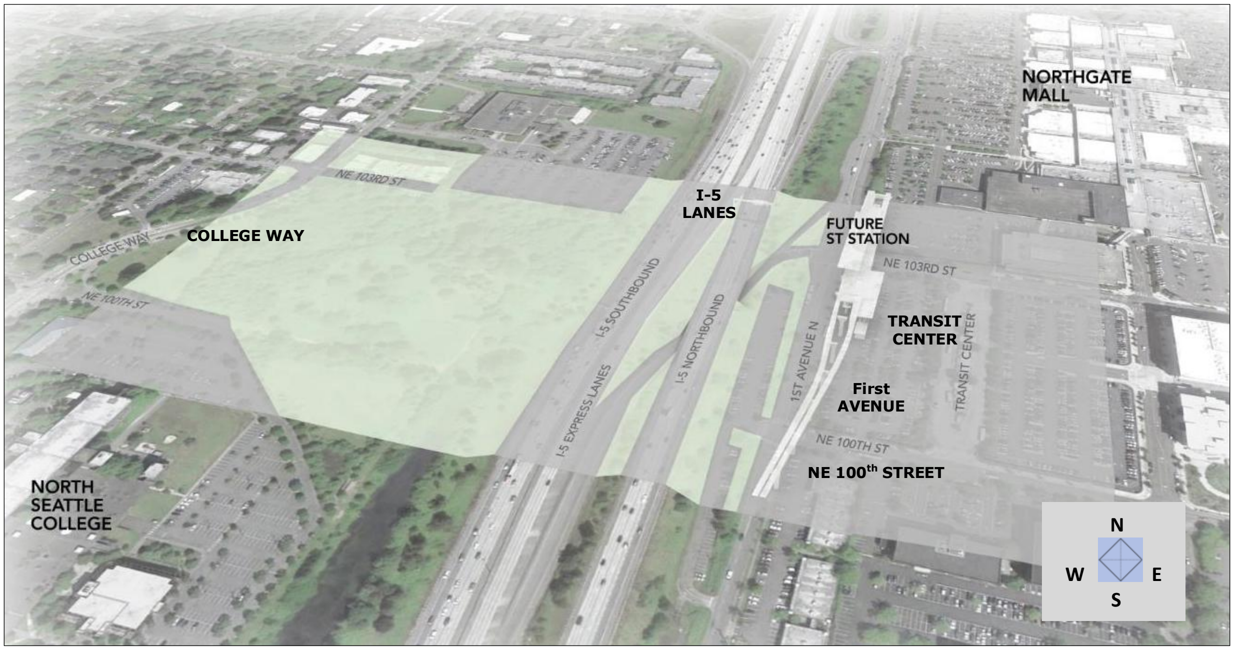
EXISTING CONDITIONS

The project location is dominated by the presence of I-5, which towers nearly 20 feet above the adjacent surface streets. The interstate itself comprises four southbound lanes, four northbound lanes, two express lanes, and an express lane ramp. In total, the WSDOT right-of-way extends more than 500 feet wide.

The area east of the interstate is dominated by automobile infrastructure comprising surface streets and expansive parking lots, including one lot within the WSDOT right-of-way adjacent to the northbound lanes of I-5.

Between the parking lot and First Avenue NE is the Thornton Creek water course. Further east are the Northgate Transit Center and the future location of the Northgate light rail station. The area west of the interstate is a part of the North Seattle College campus referred to as the Bartonwood Sanctuary. The area includes significant tree stands, native understory, and an open water pond—all of which contribute to a character unique to the Puget Sound basin. The topography is relatively level, with the exception of a small hill emerging from the surrounding landscape. The property is an amenity to the school and surrounding neighborhood in providing a natural open space, educational opportunities, and the visual complexity associated with a mature wetland.

Figure 2.4—Project Location



Soil Conditions

Field explorations were not conducted for this preliminary study. Accordingly, the recommendations are based on available site information and best judgment of likely soil conditions.

Many explorations were done in the vicinity of the proposed bridge by the Washington State Highway Commission during the 1960s; however, information was not used from these explorations because the horizontal and vertical locations are uncertain, and the explorations are too shallow and lacking quantitative soil density facts.

For this report, the project site has been divided into three areas: the area east of I-5 (East Area), the area between the north and southbound lanes of I-5 (Middle Area), and the area west of I-5 (West Area). According to available information, the subsurface conditions were interpreted in the three general areas as follows:

- **East Area.** Subsurface conditions in the East Area generally consists of 3 to 7 feet of fill, overlying loose to medium-dense coarse-grain soils, and very soft to medium-stiff fine-grained soils, overlying very dense, glacially over-consolidated coarse- and fine-grained soils. Glacially consolidated, hard peat layers were observed in two borings at depths of 48- to 99-feet below ground surface (bgs); typical reported peat layer thicknesses were 3 to 5 feet with a maximum 10-foot-thick layer. Bridge foundations should bear within very dense/hard glacially over-consolidated soils (bearing soils). We expect depth of bearing soils in the East Area to vary from approximately 10- to 28-feet bgs.

- **Middle Area.** There is insufficient subsurface information in the Middle Area to provide adequate information for bridge foundation design. For planning purposes, we expect depth of bearing soils in the Middle Area to be similar to that of the East Area.
- **West Area.** Subsurface conditions in the West Area generally consist of 2 to 10 feet of fill, overlying glacial deposits. Fill generally consists of loose to dense silty sand. Glacial deposits generally consist of medium-dense to very dense coarse-grained soils. We expect depth of bearing soils in the West Area to vary from approximately 3- to 15-feet bgs.

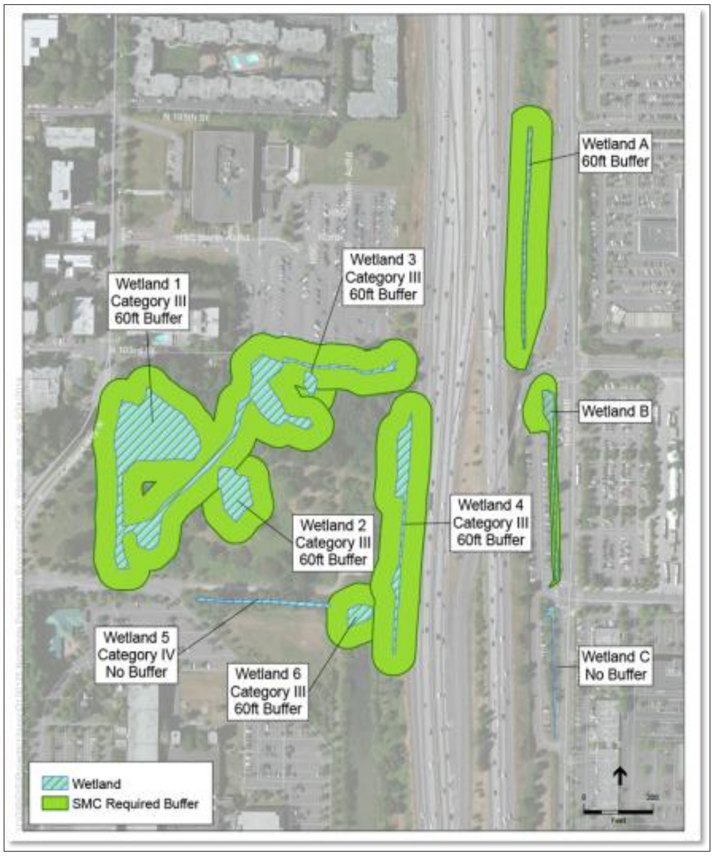
Cultural Resources Assessment

A cultural resource assessment is underway in compliance with the National Historic Preservation Act. A field assessment resulted in the identification and documentation of the Kumasaka Farmhouse and Green Lake Gardens Company archaeological site, which is recommended eligible for listing in the National Register of Historic Places under Criteria A and B. No prehistoric or ethnographic cultural materials were observed.

Wetland Delineation

Wetland delineation was completed as part of an early phase of the project. Figure 2.5 shows the wetlands and buffers identified during wetland delineation.

Figure 2.5—Wetland Locations and Buffers within Project Area Delineation



SUMMARY OF PRIOR STUDIES AND REPORTS

Improvements to non-motorized infrastructure in Northgate have been a subject of study for several years. The following reports and studies were reviewed during the initial phase of this study.

- *Northgate Pedestrian Bridge Feasibility Study Report*—King County Department of Transportation, 2012
- *Northgate Non-Motorized Access Study*—Sound Transit, 2013
- *Northgate Outreach, Report on Focus Group Findings*—Seattle DPD, 2013
- *Northgate Urban Design Framework*—City of Seattle DPD, 2013

PROJECT DESCRIPTION

Scope of this Study

KCDOT's 2012 *Northgate Pedestrian Bridge Feasibility Study Report* identified possible alignments, bridge types, and estimated costs for a pedestrian- and bicycle-friendly bridge as well as key parameters required by WSDOT for crossing I-5. Project alignments were broken into three distinct components: west approach, I-5 crossing, and east approach.

In early 2013, the City of Seattle Department of Transportation (SDOT) awarded a consultant contract to complete an analysis of potential pedestrian/bicycle bridge types and alignments. The purpose of this report is to describe the alternatives evaluated throughout the process and the criteria by which each alternative was selected or eliminated.

PREFERRED ALIGNMENT

West Approach

The west approach is bounded by College Way North to the west and I-5 to the east. The north and south boundaries are North 103rd Street and North 100th Street respectively. Within these boundaries is the Bartonwood Sanctuary, a greenbelt containing more than 2 acres of mature, forested wetland. West approach alignments that align with and touch down at North 103rd Street and North 100th Street were studied.

The preferred west approach alignment is North 100th Street because it aligns with a neighborhood greenway, has less environmental impact, is safer, and provides the best connection to the I-5 overcrossing and east approach.

I-5 Crossing

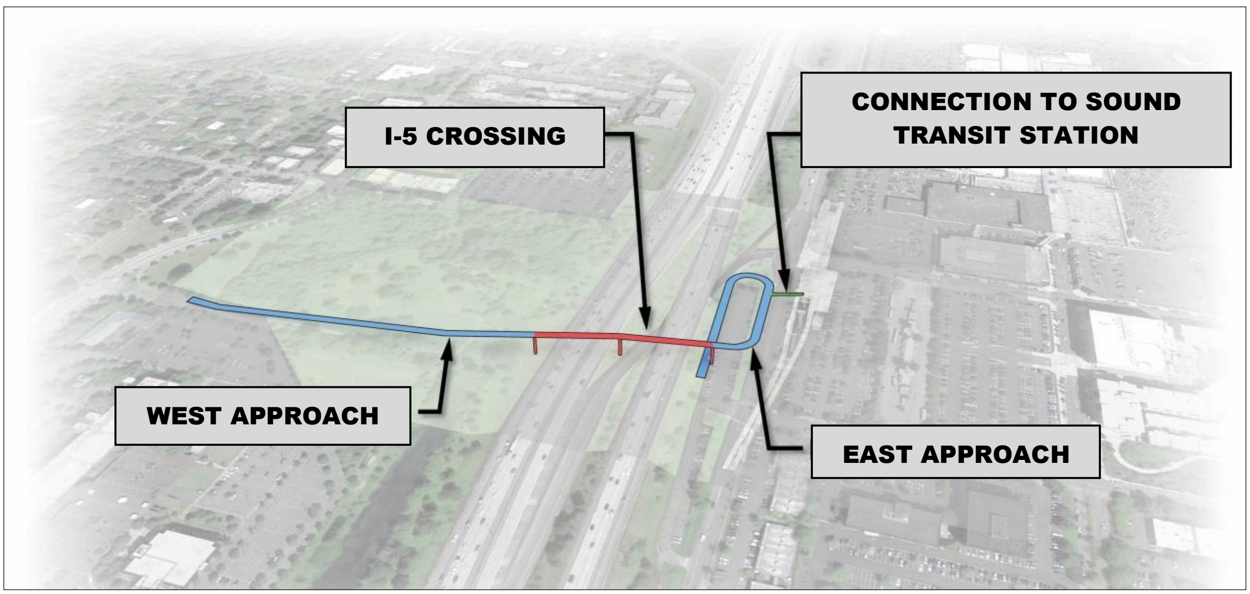
For the main bridge spanning I-5, the possible foundation locations are defined by the alignment intersection with the WSDOT ROW along the western side, the foundation zones defined by WSDOT in the center of I-5, and the connection with the east approach. These parameters create the ability to construct a two-span bridge, with spans in the range of 200 feet, for a total bridge length in the range of 400 feet.

East Approach

The east approach is more constricted than the west approach in terms of available space, and careful ramp placement is required to meet the ADA compliance geometrics for this approach. The boundaries for the east approach are I-5 to the west, the I-5 express lane ramp and 103rd Street to the north, the light rail station to the east, and North 100th Street to the south. Within these boundaries are a WSDOT embankment alongside the I-5 northbound lanes, a WSDOT parking lot, First Avenue NE, and the King County Transit Center. Studied were east approach alignments touching down at 103rd Street, 100th Street, and midblock between them.

Preferred is the 100th Street alignment because it creates an efficient connection to the proposed light rail station, provides a ramp that is completely contained within the northern half of the WSDOT parking lot, and aligns with 100th Street, providing clear visibility.

Figure 2.6—Approaches, I-5 Crossing, and Sound Transit Connection



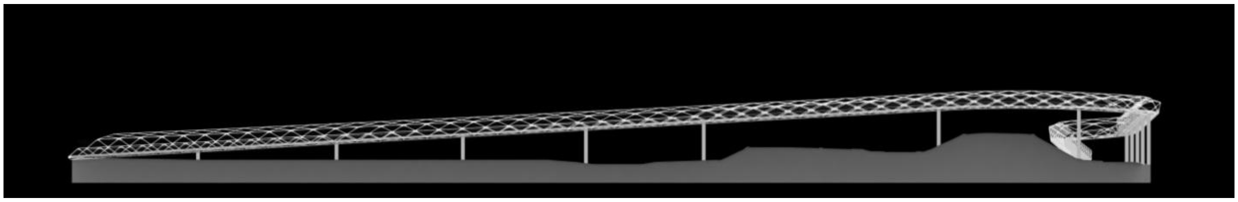
PREFERRED BRIDGE TYPE

Structural types that are commonly used for conventional site conditions, with spans in the 200-foot range like the Northgate Pedestrian and Bicycle Bridge, include steel and concrete box girders, steel plate girders, and steel trusses. For sites with special conditions and aesthetic considerations, structural types also include cable-stay, suspension, and arch bridges.

The length of the approaches is a key consideration for this project—important because of the time required for users to traverse the facility and the limited space on the east approach.

Minimizing the depth of the superstructure results in reducing the length of the approaches and thus is a strategic consideration in the selection of a bridge type. For every foot of depth, there is a required 50-foot length of ramp when the slope is defined by a 2% grade. Consequently, truss, arch, and cable-stay bridges have shorter ramp length because of their shallower depths when compared to girder-type bridges.

Figures 2.7 and 2.8—Truss/Tube Bridge Renderings



The preferred bridge type is a tube/truss structure. A tube/truss is preferred because of the potential for prefabrication to facilitate minimal site disruption; potential to accommodate acoustic barrier for users; potential to integrate overhead weather protection, railings, and throw barriers; accommodation and containment of lighting; safety perception of being protected from the highway below; and overall cost.

ESTIMATED CONSTRUCTION COSTS

The preferred combination of alignment, landings, and bridge type was advanced to a level that provided enough design to establish a preliminary project cost estimate. The estimated cost range of the bridge per the findings of the TSL study is between $23 and $26 million. The project costs will be affected by a number of variables. A few key variables include timing for project construction, final geometry of the structure—specifically the bridge width, and actual ROW acquisitions costs.

3 Project Design Criteria

INTRODUCTION

During the design process, a basis of design document was created to outline foundation for design of the Northgate Pedestrian and Bicycle Bridge. The purpose of this chapter is to provide an overview of the design criteria contained within the basis of design. (The basis of design memo can be found in Appendix D.)

The design criteria are intended to provide the framework for design development of the project. There are three different types of criteria discussed in this chapter, each serving a different purpose within the hierarchical decision-making process. Each type of criteria provides a different layer of guidance to the design process and varies in nature from highly regulatory to agency preference.

- Design Standards and References
- Performance Parameters
- Design Considerations

DESIGN STANDARDS AND REFERENCES

The backbone of engineering design is derived from design codes and references. These codes provide engineering guidance and direction regarding best practices that promote safety and durability during design.

Figures 3.1 and 3.2 provide a list of publications to be used for all design and construction. The publications are listed in hierarchical order within the specific subheading, with the most important appearing at the top of the list. This is not a comprehensive list; other applicable publications may be required to complete the design and construction.

Figure 3.1—Pedestrian Facilities Codes and References

1. ***Washington State Department of Transportation (WSDOT)—Pedestrian Facilities Guidebook, Incorporating Pedestrians into Washington's Transportation System, July 2013***
2. ***American Association of State Highway and Transportation Officials (AASHTO)—Guide for the Development of Bicycle Facilities, 4th Edition, 2012***
3. ***WSDOT—Design Manual, July 2013***
4. ***AASHTO—A Policy on Geometric Design of Highways and Streets, 2011***
5. ***Institute of Transportation Engineers—Design and Safety of Pedestrian Facilities, March 1998***
6. ***American with Disabilities Act Accessibility Guidelines (ADAAG)***
7. ***Draft Public Rights of Way Accessibility Guidelines (PROWAG)***

Figure 3.2—Bridge and Structures Codes and References

1. ***AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, 2nd Edition, December 2009***
2. ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition, 2012, with Interim Revisions***
3. ***AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 2012 with Interim Revisions***
4. ***AASHTO LRFD Bridge Construction Specifications, 3rd Edition, with 2010, 2011, and 2012 Interim Revisions***
5. ***AASHTO—Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, 6th Edition, 2013***
6. ***WSDOT—Bridge Design Manual, August 2012***
7. ***IBC—International Building Code, 2012 Edition, International Code Committee***
8. ***ACI 318—Building Code Requirements for Structural Concrete, Reported by the American Concrete Institute Committee 318, 2011 Edition***
9. ***AISC 360—Specification for Structural Steel Buildings, March 9, 2005, by the American Institute of Steel Construction, Inc.***
10. ***Bridge Welding Code: AASHTO/AWS D1.5M/D1.5: 2008, An American National Standard, 5th Edition, with 2009 Interims***
11. ***Structural Welding Code—Steel: AASHTO/AWS D.1M/D1.1M, 2006***
12. ***ASCE 7: Minimum Design Loads for Buildings and Structures***

PERFORMANCE PARAMETERS

Performance parameters provide regulatory guidance to specific criteria on the project. In some cases, the performance parameters are found within the design codes mentioned above, and in other cases, they are parameters that are mutually agreed upon by stakeholders involved in the project.

Vibration

Vibrations shall be investigated in accordance with the LRFD Guide specification for the Design of Pedestrian Bridges. Vertical modes shall meet either of the following criteria:

- Fundamental frequency shall exceed 3.0 hertz, or
- Weight of Supported Structure (kips) $\geq 180e^{-0.35\text{frequency}(\text{Hz})}$

Lateral modes shall meet either of the following criteria:

- Fundamental frequency shall exceed 1.3 hertz, or
- Mitigation of lateral structural accelerations (side sway)—An evaluation will be completed to evaluate dynamic performance and explore possible methods to mitigate side sway from footfall patterns that cause pedestrian discomfort.

Deflection

- Live Load Vertical Deflection < L/360
- Wind Load Lateral Deflection < L/360

Span Length-to-Depth Ratio

The effective span length-to-depth ratio of the bridge deck should be limited to 100.

Span Length-to-Width Ratio

The bridge deck's effective span length-to-width ratio should not be greater than 30. The definition of the effective span of the bridge is the longest length between any two consecutive nodes of its fundamental vibration mode shape.

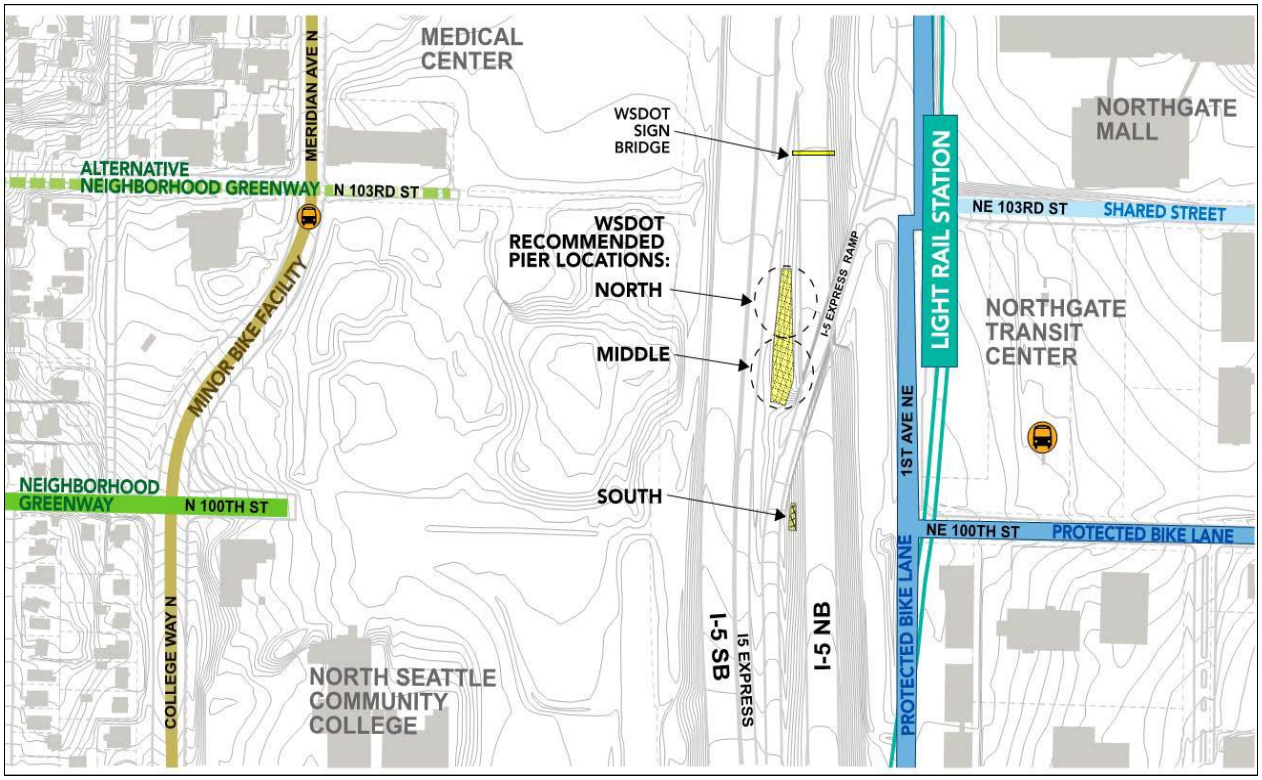
Vertical Clearances

- Vertical Clearance to I-5—A clearance of 17'-6" is the target for vertical clearance over I-5. This clearance is inclusive of all paved driving surfaces, such as existing shoulders and future lanes.
- Vertical Clearance to City Streets—Minimum vertical clearance shall be no less than 16'-6" over city streets.

Horizontal Clearances

- Horizontal Clearance to I-5—Horizontal clearance must accommodate 40 feet on the west side of I-5 for construction of a future lane. All new bridge piers or abutments shall be located at least 15 feet away from existing traffic lanes, shall consider a future additional lane and full shoulder in the southbound I-5 direction, and allow for some widening of northbound off ramps.
- On the east side of I-5, the Northlink light rail project has an established offset, which is 20 feet east of the Northbound I-5 fog line, essentially allowing for one additional 12-foot lane and one 8-foot shoulder. This includes a 5-foot buffer beyond the 20-foot offset for the design to accommodate various wall types or drainage features.
- Foundation Location Zones within I-5 Medians—See Figure 3.3.
- Horizontal Clearance to City Streets—All new bridge piers or abutments located adjacent to city streets shall comply with clearances as required by the City of Seattle DOT. This includes a minimum clearance of 3 feet from face of curb to face of column and a minimum clear sidewall width of 5 feet.

Figure 3.3—Zones



Construction Constraints

- No construction staging will be allowed on the freeways. Nighttime closure of lanes on the freeway between 10 p.m. and 5 a.m. may be considered as long as two lanes of traffic each way remain open at all times. For express lanes, short-term two- to three-hour closures or closure of one lane may be possible.
- Any planned construction methods, approaches, schedules, and traffic closure and control plans should be reviewed and approved by WSDOT. Consideration should be given to ease of bridge inspection and inspection frequency.

Bridge Features

Figure 3.4 on the next page provides a description of the bridge features, including:

- Railing
- Throw barrier
- Deck joints
- Canopy/windscreen

Figure 3.4—Bridge Features

Bridge Features	Description
Bridge Railing	■ The handrail shall be continuous and provide a barrier that prevents the passage of a 4-inch-diameter sphere from the finished grade to the top of handrail. ■ The bridge railing shall meet the height requirements for bicycles.
Throw Barrier	■ The minimum combined height of a barrier rail with curved fence shall be 8 feet or with a straight fence shall be 10 feet. ■ Throw barrier infill shall not allow an opening of more than 2 inches and shall be designed to prevent climbing.
Deck Joints	■ Bicycle-safe expansion joints
Canopy/Windscreen	■ It is assumed that the bridge will not have an overhead cover. ■ Wind protection should be included in the design of the throw barrier.

DESIGN CONSIDERATIONS

Design considerations are non-technical parameters that influence the design but are not regulatory in nature. The purpose of these parameters is to clearly identify bridge features that will improve the project's fulfillment of the project goals. Early identification of these parameters allows them to be integrated into the design without additional design effort later in the process.

Safety

The Northgate Pedestrian and Bicycle Bridge will utilize the four principles of Crime Prevention through Environmental Design (CPTED) to enhance user safety. The four CPTED principles are:

- Natural Surveillance
- Natural Access Control
- Territorial Reinforcement
- Maintenance and Management

NATURAL SURVEILLANCE

The basic premise of the concept of natural surveillance is to create an environment that places formal and informal "eyes on the street." Criminals do not want to be observed, and natural surveillance acts as a deterrent to their activity.

Natural surveillance can be achieved on the Northgate project by a number of informal methods. Given the length of the pathway, it will be important to avoid sharp turns in order to create clear sight lines. Landscaping should be carefully selected to minimize locations to hide, and lighting should avoid casting shadows on the pathway.

NATURAL ASSESS CONTROL

Natural access control is a design concept that physically guides users through the project space. Design elements are used to indicate the appropriate path and discourage movement away from the designated path. Access control can take the form of physical or psychological barriers. Physical elements can be barriers, such as fences or shrubs. Psychological barriers can be created with paving treatments, lighting, or variations in construction materials. Pathways should be direct and entrances clearly identifiable.

TERRITORIAL REINFORCEMENT

Territorial reinforcement, like natural access control, is based on identifying clear boundaries between the project uses and the functions of areas around the project. This can be achieved through clearly visible and simple-to-understand signage. Boundaries of the pathway should be clearly marked, possibly utilizing a transition area between the paths and surrounding activities.

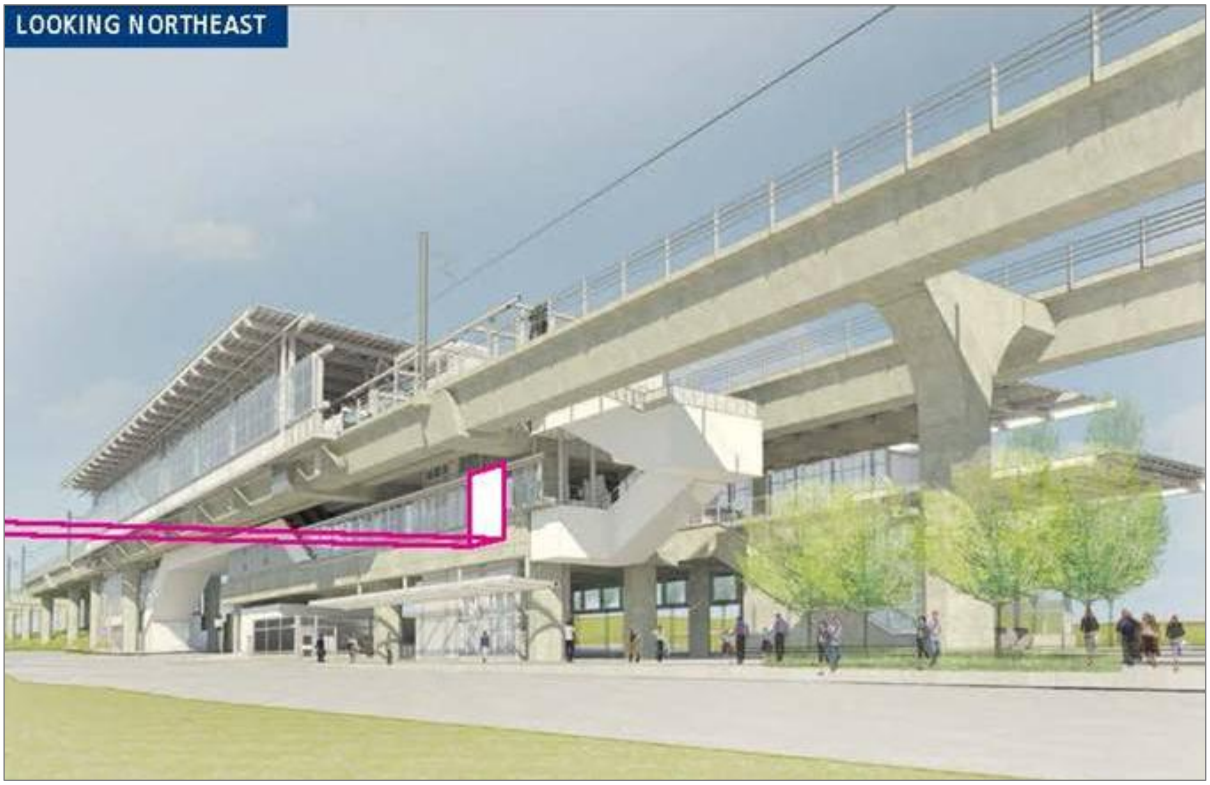
Wayfinding is the process of finding your way to a destination and is an essential piece to any active transportation facility. To function properly, wayfinding information must be provided in a logical, consistent, and reliable manner. Comprehensive signage and pavement markings guide active travel users to their destinations along preferred routes.

MAINTENANCE AND MANAGEMENT

The appearance and condition of an area can influence the activities in an area. The more unkempt and rundown a facility appears, the more likely it will attract undesirable activity. The materials chosen for the project will greatly influence the level and type of maintenance required throughout the life of the facility.

Materials should be chosen that reduce the ability to vandalize the facility. For example, graffiti should be considered when designing flat surfaces. The mature size of plants should be considered when selecting landscaping. The final sizes of plants should not require extensive maintenance to clear sight lines or areas to hide.

Figure 3.5—Northlink Station Connection



Connection to Northlink Station

The Northgate Pedestrian and Bicycle Bridge will be designed with the capability to connect into the future existing Northlink light rail station. Sound Transit has the following compatibility requirements to facilitate a successful connection:

- Station Connection Locations—The link from the pedestrian bridge to the station shall occur at the mezzanine level of the station in the location as identified in Figure 3.5. No physical connection for support of the bridge by the station will be allowed.
- Foundation Locations—A foundation independent of the station will be required to support the pedestrian bridge link at the station.
- Station Access and Operating Hours—The station will not be accessible 24 hours per day; therefore, the link to the pedestrian bridge must be closed to pedestrians when the station is closed.

Geometric Considerations

PATH WIDTH

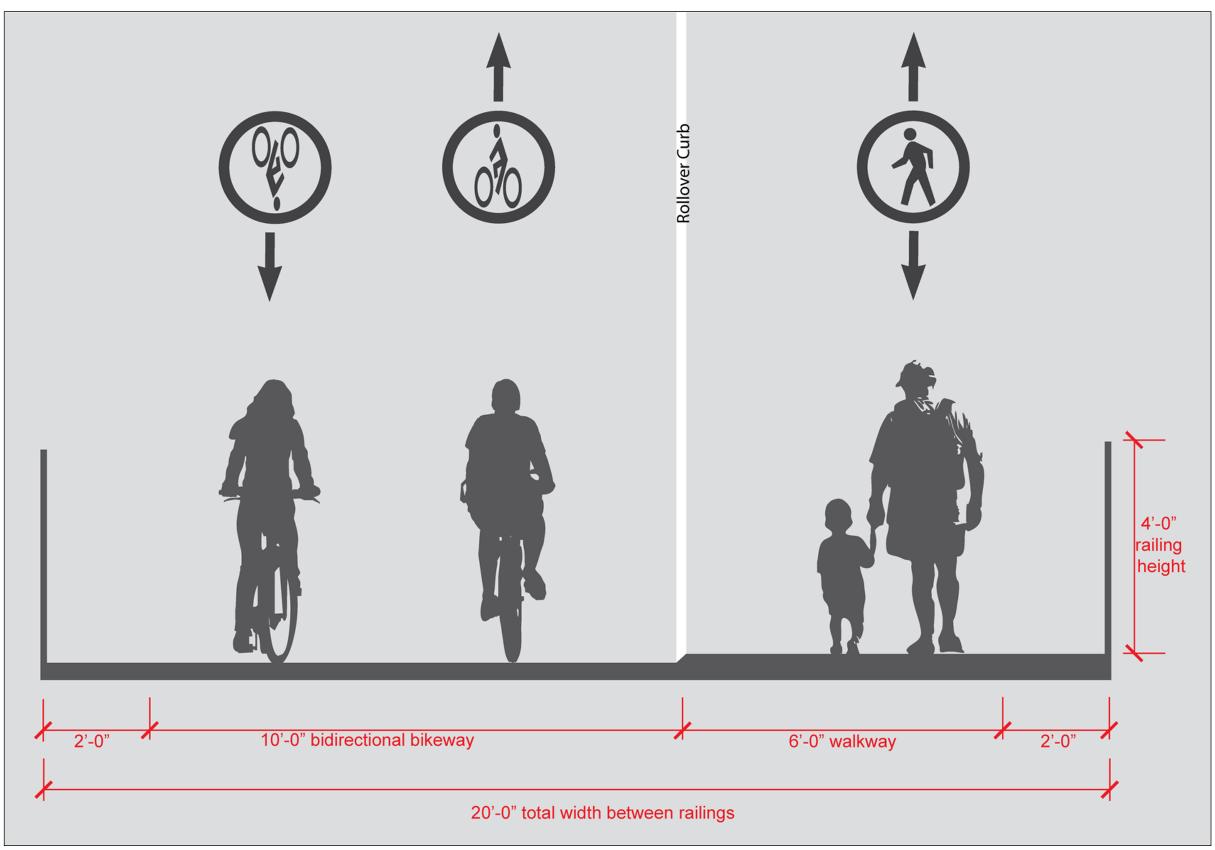
The recommended minimum width for a two-way path is 20 feet (5 feet in each direction for bicyclists, a 6-foot walkway for pedestrians, and 2-foot clearance on either side of the path). This bridge should allow bi-directional travel of all users and permit passing by faster-moving runners, cyclists, or skaters.

Determining appropriate path widths involves consideration of several factors:

- Anticipated pedestrian and bicycle use (e.g., volumes)
- Sufficient maneuvering space to avoid fixed objects (e.g., railings and barriers)
- Potential conflicts between differing users (e.g., users traveling at differing speeds, users traveling in opposite directions, users stopped on the bridge)
- Real or perceived safety issues (e.g., the "tunnel effect" created by some enclosed structures)
- Anticipated use by in-line skaters, children, or bicycles towing trailers
- Curves, intersections, and areas with sightline constraints
- Steep grades where the speed differential between users in each direction is greatest
- Anticipated use by maintenance and emergency vehicles

In general, overcrossings wider than the recommended minimum best address these issues. The width of the path on the bridge should be at least as wide, or wider than, connecting active travel facilities plus an additional 2-foot clear width from vertical barriers. Carrying the clear width across the structure provides minimum, horizontal shy distance from the railing or barrier and offers space to allow faster-moving cyclists and in-line skaters to avoid conflicts with other users.

Figure 3.6—Recommended Widths for Bicycle/Pedestrian Lanes on Active Transportation Bridges



In circumstances where flows are concentrated in a particular direction during peak hours (i.e. minimal bi-directional traffic exists), a centerline unnecessarily reduces space for passing and maneuvering. Ideally, no centerline should be included, allowing users to organize themselves according to the circumstances.

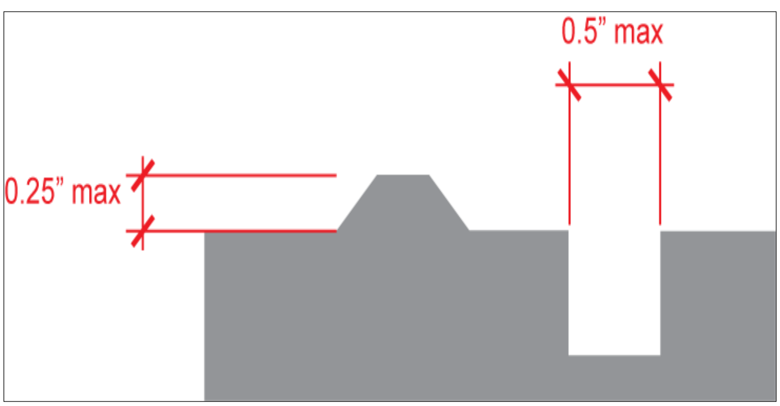
By contrast, edge lines can be included from the outset since they are helpful as a means to highlight the path edges and obstacles during low light conditions. In circumstances where pathways experience high bi-directional volumes or operational challenges, such as sight distance constraints, the use of centerline stripes on a path can help to clarify the operating space allocated to users traveling in opposite directions. A solid centerline is used to separate opposing traffic where passing is not permitted, and a broken line where passing is permitted.

Given the expense and expected lifecycle of the overcrossing, it is recommended that the path width be designed to provide an acceptable level of service (LOS) for expected active transportation use for the duration of the bridge's expected lifecycle. The FHWA Shared-use Path Level of Service calculator can provide guidance on acceptable path width for various user volumes; however, at high bicycle and pedestrian volumes, the accuracy of the calculator is compromised.

SURFACE AND SURFACE TRANSITIONS

The quality of the path surface and transitions should be considered to accommodate a high level of comfort for wheeled users. Transitions between paths and bridge decks should be smooth with no lips or bumps protruding more than one-quarter inch. Gutter seams, drainage inlets, and utility covers should be flush with the surrounding surface and oriented to prevent conflicts with the tires of wheelchairs, strollers, skates, and bicycles. All surfaces should be textured in a way to be skid-resistant.

Figure 3.7—Maximum Dimensions for Joints



Inspection

Consideration should be given to the bridge inspection and inspection frequency. Items to consider include but are not limited to: access to the bridge elements, types of materials chosen, elements requiring special inspection methods (e.g., fracture critical members), safety of inspectors over the roadway, areas that could collect debris and/or bird nests, and so on.

4 Evaluation Framework

This chapter covers the evaluation framework used by the design team to develop and evaluate a broad range of alternatives.

EVALUATION CRITERIA

Utilizing the defined project goals as a framework, specific criteria/metrics were developed to compare each alternative. The table below shows the evaluation criteria used. Public and stakeholder comments were considered during each phase of the evaluation.

Figure 4.1–Evaluation Criteria

Criteria	Performance Parameter	Metric
Connectivity	Access to transit	Qualitative comparison of access to nearby bus stops and light rail station
	Access to bicycle infrastructure	Proximity to protected/shared bike lane from bridge entry point
	Access to pedestrian infrastructure	Proximity to existing sidewalk from bridge entry point
Visual Presence	Wayfinding	Qualitative assessment of path clarity
	Visibility from adjacent infrastructure	Visibility of access points from streets, station, and adjacent uses
	Distraction to traffic on I-5	Yes or No
Environmental Sustainability	Ecological function of Bartonwood Sanctuary	Square foot of construction area within wetland
	Ecological function of Thornton Creek	Square foot of construction area within wetland
	Minimize impact to adjacent cultural resources	Square foot of construction area within identified cultural site
Safety	Natural surveillance	Qualitative evaluation
	Natural access control	Qualitative evaluation
	Multimodal congestion	Qualitative evaluation

Criteria	Performance Parameter	Metric
Constructability	Traffic disruption	Qualitative assessment of traffic disruption
	Feasibility	Yes or No
Cost	Construction cost	Total estimated construction dollars
	Maintenance	Estimated inspection/ maintenance cost throughout the design life
	Qualitative benefits	Travel time savings/health benefits

Clarification of Specific Performance Parameters

WAYFINDING (VISUAL PRESENCE)

Wayfinding is the process of finding your way to a destination and is an essential piece to any active transportation facility. To function properly, wayfinding information must be provided in a logical, consistent, and reliable manner. Given its size and length, there is an opportunity for the structure to serve as a wayfinding guide for users trying to access the path from adjacent infrastructure. Consequently, various wayfinding opportunities were compared.

DISTRACTION TO TRAFFIC ON I-5 (VISUAL PRESENCE)

The perception of motorist traveling along I-5 must be a consideration for each alternative. The design should not draw excessive interest from motorists because this could result in a potentially hazardous situation on the interstate. Heavy weight was given to WSDOT input regarding this criterion.

NATURAL SURVEILLANCE (SAFETY)

An environment that facilitates natural surveillance provides a safer user experience from practical and perceived safety perspectives. Positioning the pathway alignment with visibility from surrounding areas, such as the college parking lot, the future transit station, and other public areas, will increase the number of "eyes" on the pathway.

Given the length of the pathway, it will be important to avoid sharp turns to create clear sight lines along the path. Landscaping should be carefully selected to minimize locations to hide, and lighting should avoid casting shadows on the pathway. While these factors are difficult to measure explicitly, direct comparisons of each alternative provided sufficient data for an evaluation.

NATURAL ACCESS CONTROL (SAFETY)

Natural access control is a design concept that physically guides users through the project space. Design elements are used to indicate the appropriate path and discourage movement away from the designated path. Access control can take the form of physical or psychological barriers. Examples of physical barriers include fences or shrubs. Psychological barriers can be created with paving treatments, lighting, or variations in construction materials. Pathways should be direct and entrances clearly identifiable from adjacent infrastructure. Opportunities for natural access control were compared between alternatives.

MULTIMODAL CONGESTION (SAFETY)

Highly congested areas are defined as areas where a large number of users are expected to collect in a relatively small space. The most common example of congestion is a busy intersection. Areas that contain many users with a variety of transportation modes can make navigation difficult and result in potential safety issues. The variety of traffic movements at path access points for each alternative was compared.

TRAFFIC DISRUPTIONS (CONSTRUCTABILITY)

The impact of construction on traffic is an important metric to consider when evaluating an alternative. Accordingly, construction methods of each alternative were compared to determine which alternatives will likely have the greatest impact. Lane closure on I-5 mainlines, I-5 express lanes, and adjacent surface streets were used for this comparison.

5 Alignment Alternative Analysis

The alignments alternatives for this project were evaluated using a four-step process. The steps included:

- Step 1 – Optimize Connectivity
- Step 2 – Define the Alignment
- Step 3 – Refine the Approaches
- Step 4 – Select Bridge Type

STEP I—OPTIMIZE CONNECTIVITY

At the core of this project is the goal to provide non-motorized access across I-5 that facilitates connections between employers and employees, students and college, consumers and retail stores, and communities and neighborhoods. These connections lead to opportunities for growth that current infrastructure is unable to provide. The objective of the Step I alignment analysis is to identify all access points within the project limits that connect to existing or future infrastructure and determine which points best meet the goals expressed in the purpose and need statement.

Developing Project Nodes

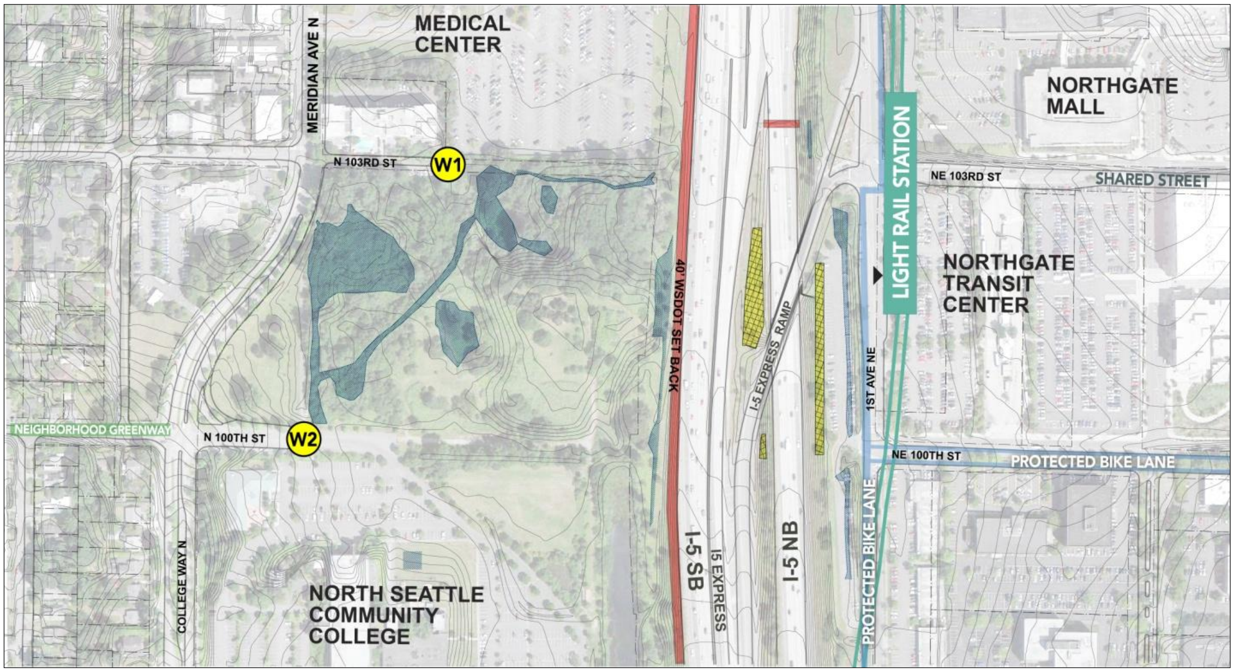
Existing and future pedestrian and bicycle infrastructure was examined to help identify locations where access to the bridge would naturally integrate into the larger transportation plan. Using documents such as the Seattle Bicycle Master Plan and the Northgate station design drawings helped to indicate locations where concentrations of non-motorized users would naturally seek access to the bridge. Locations within the project boundaries that were identified are called nodes. Nodes are connection points where a pedestrian or cyclist accesses the pathway of the bridge from grade. The nodes identified are the street level connections that link into existing predominant uses, pedestrian, bicycle, and transit facilities.

Several nodes were identified on each side of the project. Two were identified on the west side (W1 and W2) and three on the east side (E1, E2, and E3). These are illustrated in Figures 5.1 and 5.2 on the following pages.

WESTERN NODES

The dominant features on the western boundary of the project are the North Seattle College and its adjacent open space, known as the Bartonwood Sanctuary. Anchoring the northern most boundary of the west approach area is the University of Washington Medical Center.

Figure 5.1—West Approach Nodes



Node W1 is located in the vicinity of the intersection of North 103rd Street and College Way North. This location has an existing mass transit stop and is the termination point of a proposed neighborhood greenway. In addition, King County Public Health has a facility just north of the project area on North 105th Street.

The main North Seattle College campus core is located on the southern edge of the sanctuary and anchors Node W2. Node W2 is also the termination point of North 100th Street, an established public street designated by the 2014 Seattle Bicycle Master Plan as the preferred neighborhood greenway in the Licton Springs neighborhood. Additionally, Node W2 has the benefit of lying near two mass transit stops; connecting to North 100th Street, which leads to a signalized crossing at Aurora Avenue North; and proximity to the college and its childcare center.

Both Nodes W1 and W2 border the Bartonwood Sanctuary, a greenbelt containing remnants of both historic and restored wetlands that feed the south branch of Thornton Creek and provide an important stormwater management function. A system of trails wanders through the sanctuary and extends south along the east side of campus, traveling along the edge of I-5 to the south end of campus. The sanctuary is used by the college as an educational facility for multiple disciplines and courses.

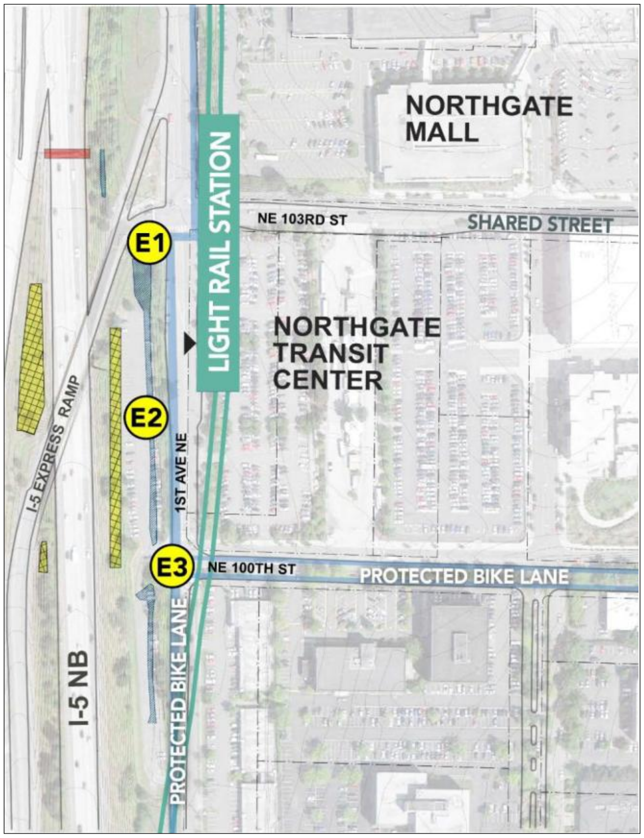
EASTERN NODES

There are many features on the east boundary of the project, which is defined by a rapidly maturing urban neighborhood. The neighborhood is building upon existing regional commerce activities, a multi-modal transportation hub, and the development of higher-density residential areas.

The Northgate Transit Center, the Thornton Creek Cinema, and other nearby developments currently occupy the area along First Avenue NE between Northeast 103rd Street, Fifth Avenue NE, and Northeast 100th Street.

To the west of First Avenue NE is a WSDOT-owned at-grade parking facility that is surrounded by I-5 to the west, a freeway express ramp to the North, and the Thornton Creek watercourse and a proposed protected bike lane to the East. The parking lot is currently occupied by Sound Transit as a staging area for construction of the adjacent light rail station. To the north of Northeast 103rd Street are the Northgate Mall and the Northgate Library and Community Center.

Figure 5.2—East Approach Nodes



Three key connection options exist on the east side. Node E1 is the northernmost point and aligns with Northeast 103rd Street, which has been designated by the Seattle Bicycle Master Plan as a shared street and connects with a local neighborhood greenway and tertiary bicycle facilities. There is a restricted signalized intersection at First Avenue NE.

Node E2 is a mid-block location between Northeast 103rd and Northeast 100th streets and is in closest physical proximity to the light rail station. There are no existing sidewalks on the west side of First Avenue NE nor signalized crossing at this location.

Node E3 is the southernmost point and aligns with Northeast 100th Street, which will have a protected bike lane and will be a primary bicycle facility leading to a designated neighborhood greenway. Node E3 also is near a signalized crossing at First Avenue NE.

West Node Evaluation

Evaluation Criteria

The west node anchors the west approach, defined as the pathway from either Node W1 or Node W2 to the I-5 overcrossing.

Criteria for evaluating the west node considered all of the points below.

CONNECTIVITY

How well does the approach connect to the following?

- Licton Springs neighborhood
- North Seattle College
- Bicycle networks
- Mass transit stops
- Pedestrian facilities

VISUAL PRESENCE

What is the visibility from the following vantage points, as well as their wayfinding options?

- Major transit locations
- Pedestrian routes
- Bicycle routes

ENVIRONMENTAL SUSTAINABILITY

How would the approach be rated on the environmental criterion below?

- Minimizing wetland impacts to the Bartonwood Sanctuary
- Enhancing cultural resources within the Bartonwood Sanctuary

SAFETY

Is safety maintained in the following areas?

- North Seattle College
- Major public areas

CONSTRUCTABILITY

How will the approach location affect constructability in these areas?

- Construction access
- Interruptions to traffic
- Duration

COST

How will the approach affect the bottom line in each area below?

- Right-of-way acquisition
- Maintenance and lifecycle costs
- Construction costs

Screening Results

For screening purposes, the following scale was used for each major component and category of the project:

Screening Scale

Very Unfavorable | Unfavorable | Neutral | Favorable | Very Favorable

Node W1—North 103rd Street

CONNECTIVITY

This alternative does not rate highly with regard to connectivity or geometry. There are no existing bicycle facilities nor any recommended facilities for North 103rd Street on the west side of I-5. Access currently occurs via the existing road system. Pedestrian access also is limited. North 103rd Street terminates along the side of a multi-unit residential building with pedestrian-level garage parking. There are no sidewalks on 103rd east of Meridian Avenue North. Cars use the forested south edge of North 103rd as an informal angle-in parking lot, thereby increasing the perception of a private drive area and lack of pedestrian/cyclist visibility.

Connectivity to the college and Bartonwood Sanctuary likewise is limited and is also in poor condition and not easily identifiable. The trails enter the forested wetland portion of the sanctuary.

VISUAL PRESENCE

The character and feel of the intersection of North 103rd Street and Meridian Avenue North are dominated by car and bus transit along Meridian and multi-story residential buildings flanking the north-side roadway. The multi-lane vehicular nature of Meridian Avenue North to the north and College Way North to the south represents a potential immediate obstacle to approach access for the bridge user.

ENVIRONMENTAL SUSTAINABILITY

Significant tree removal and habitat impact would be required to construct the approach from North 103rd Street. A large percentage of the forested wetland condition exists in the northern two-thirds of the Bartonwood Sanctuary and would be adversely impacted.

SAFETY

The lack of pedestrian amenities and the absence of an "active public frontage" to the residential building combine to increase the feeling of vulnerability along this route. The heavily forested southern edge of North 103rd provides little natural surveillance and limits alternate entry/exit routes available to bridge users. The trails and approach would be through the wooded portion of the sanctuary, raising issues of defensible space and resulting in an impact on the ecological function of the sanctuary.

CONSTRUCTABILITY

The west approach alignment, associated with Node W1, is located through a series of wetlands. Additionally, alignments crossing the highway from the north would create an obstruction to motorists' view of an existing I-5 exit sign.

COST

Additional costs would be incurred from substantial trail improvements, wetland mitigation, and any requirement to move the existing I-5 sign.

Node W2—North 100th Street

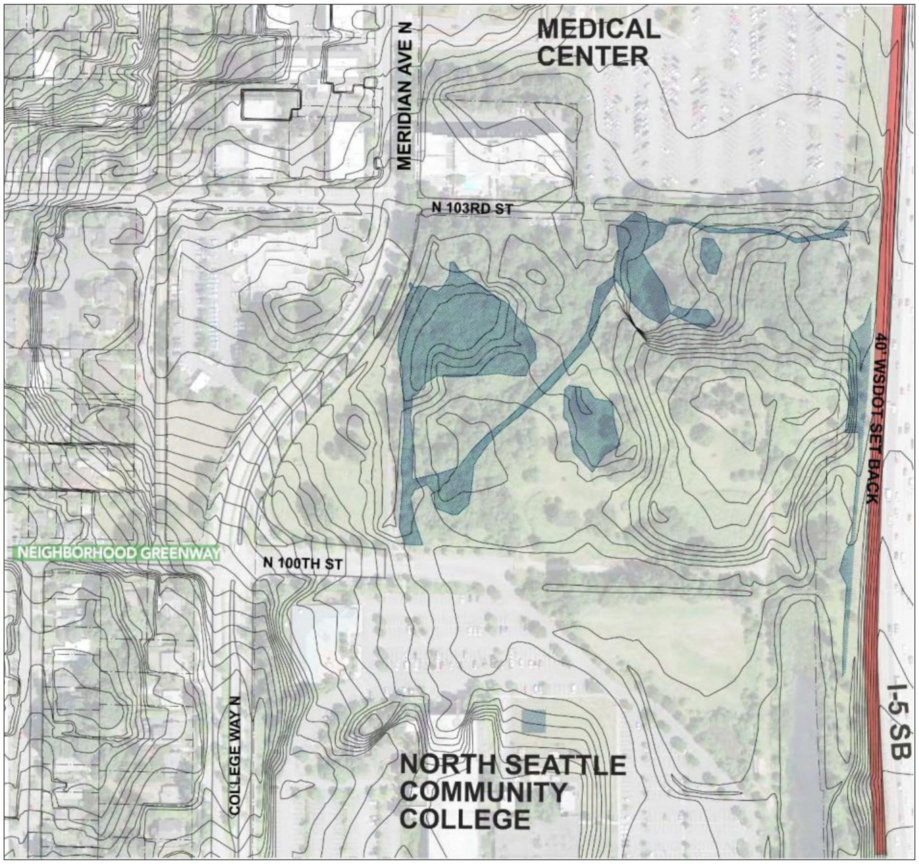
CONNECTIVITY

This alternative allows co-location of the western approach with the North Seattle College campus, which will provide a broader array of pedestrian-oriented route options than the other alternatives. The intersection at College Way North and North 100th Street is already designed to accommodate the pedestrian population of the college. Access to public transit already servicing the college and the future planned Neighborhood Greenway along North 100th Street aids in the integration of multi-modal active transit. In addition, the 2014 Seattle Bicycle Master Plan recommends a Neighborhood Greenway along North 100th Street, which provides easy access to the Licton Springs Neighborhood and a direct link to the existing Fremont Avenue North greenway.

VISUAL PRESENCE

The property is an amenity to the school and surrounding neighborhoods in that it provides natural open space, wildlife corridors, ecological connectivity, educational opportunities, and visual complexity all associated with a mature, forested wetland. As the Northgate Neighborhood continues to densify to become a true urban village, the importance of the open space that Bartonwood Sanctuary represents will undoubtedly increase.

Figure 5.3—West Approach



ENVIRONMENTAL SUSTAINABILITY

The Bartonwood Sanctuary is a unique opportunity for users to experience a diverse Northwest ecosystem. The area includes significant tree stands, native understory, stormwater wetlands, and an open-water vernal pond—all contributing to a character unique to the Puget Sound basin. This path could be located outside wetland areas and in areas of less vegetation plus is located near existing cultural resources in the sanctuary and provides an ability to enhance awareness of these features.

SAFETY

The spatial organization of Bartonwood Sanctuary—with two large clearings wrapped by forest with an ascending topography—results in a clarity of wayfinding. Limited removal of blackberry bushes to increase generous mown connections will increase the sense of identity and the safety of use. The close proximity of North Seattle College will increase the number of people observing and using the bridge and will contribute to an increased perception of safety and actual safety. Providing for the maximum integration of all mobility options ensures that the bridge acts as a direct, safe, and comfortable active transportation facility.

CONSTRUCTABILITY ▲

This area offers the benefit of construction occurring outside existing wetland areas. Additionally, the area is adjacent to an existing maintenance access road, which would facilitate movement of construction equipment and material.

COST ▲

This approach minimizes wetland mitigation costs and easily integrates the existing trail system.

Summary of West Node Evaluation

The west approach screening results are summarized in the chart below. Node W2—North 100th Street is the recommended alignment for the west approach.

Figure 5.4—Summary of West Node Evaluation

Screening Criteria	W1 N 103rd St	W2 N 100th St
Connectivity	▼	▲▲
Visual Presence	▼▼	▲
Environmental Sustainability	▼	▲
Safety	▼▼	▲▲
Constructability	▼	▲
Cost	▼	▲

East Node Evaluation

Evaluation Criteria

The east node anchors the east approach, defined as the pathway from either Node E2 or Node E3 to the I-5 overcrossing. Criteria for screening the east approach will consider all of the points below.

CONNECTIVITY

How well does the approach connect to the following?

- Maple Leaf neighborhood
- Sound Transit Northlink Station
- Bicycle networks/cycle track
- King County transit center
- Pedestrian facilities

VISUAL PRESENCE

What is the visibility from the following vantage points, as well as their wayfinding options?

- Major transit locations
- Pedestrian routes
- Bicycle routes

ENVIRONMENTAL SUSTAINABILITY

How well would the approach minimize wetland impacts to the Thornton Creek?

SAFETY

Does the approach provide safety in the following areas?

- Visibility from transit hub
- Visibility to surrounding motorized and non-motorized routes
- Safety of interaction between motorized and non-motorized users

CONSTRUCTABILITY

How will the approach location affect constructability in these areas?

- Construction access
- Interruptions to traffic
- Duration

COST

How will the approach affect the bottom line in each area below?

- Right-of-way acquisition
- Maintenance and lifecycle costs
- Construction costs

Node E1—NE 103rd Street

CONNECTIVITY

Node E1 provides access to the future City of Seattle cycle track and the multi-use trail; however, the access point is at a complex intersection that involves surface traffic, a high number of bus movements through the intersection due to proximity to the Northgate Station, and the I-5 off-ramp. The complexity and type of movements suggests that this is not the optimal location to introduce a significant new population of bicyclists.

Pedestrian sidewalks will be provided on the south, east, and north side of the intersection of Northeast 103rd. All are sized to meet the pedestrian requirements of the Sound Transit light rail station. (See the notes in Appendix A regarding bicycle movement, many of which apply to pedestrian movements.) The complexity and type of movements suggests that this is not the optimal location to introduce a significant new population of pedestrians.

VISUAL PRESENCE

The larger neighborhood context is defined by the rapidly maturing urban village with its combination of retail, commercial, increased housing, and the transit station, which is immediately adjacent to the node and integrated with the large bus station. The sloped grassland defining the edge of the freeway, the WDOT parking lot, and the proposal for improved wetland/creek conditions define the immediate node context.

In comparison with the western approach area, this is a busy, noisy, complex urban condition with additional pedestrian amenities proposed for the near future. The northern node immediately adjacent to the freeway off-ramp is the most experientially complex of the three. The alignments associated with this node would require the relocation of an existing interstate exit sign.

ENVIRONMENTAL SUSTAINABILITY

E-1 is located in a wetland area associated with Thornton Creek.

SAFETY

The quality of user experience and safety is largely defined by the convergence of modes and complexity of the intersection. While safety can be largely addressed, the quality of the experience will be impacted by the volume of traffic and location of the node immediately adjacent to the I-5 off-ramp.

Issues of defensible space and user safety will require attention to accommodate what is a relatively anonymous intersection condition in which people typically do not assume the need to provide "eyes on the street." Good lighting and signage will help, but the location will never support natural public safety surveillance.

CONSTRUCTABILITY

The wetland area poses a problem in constructability of this approach.

COST

This approach would incur costs from wetland mitigation and any requirement to move the existing I-5 sign.

Node E2—Mid Parking Lot

CONNECTIVITY

Node E2 is located midpoint between Northeast 103rd Street and Northeast 100th Street in the center of the WSDOT parking lot site. This location offers users the potential to go north or south, where connections to existing and proposed bicycle infrastructure are possible.

Direct access to the cycle track proposed for First Avenue NE is not possible due to the proposed Thornton Creek drainage improvements. A proposed sidewalk on the west side of First Avenue NE would provide for pedestrian movement after pedestrians have left the parking lot.

VISUAL PRESENCE

The visual presence for Node E2 is the same as for E1. It's worth noting that the bridge is not immediately visible from Northeast 100th Street or Northeast 103rd Street.

ENVIRONMENTAL SUSTAINABILITY

This area avoids wetlands and has eutral impact.

SAFETY

This approach would deposit users in the middle of a parking lot without being able to cross First Avenue.

CONSTRUCTABILITY

Constructability is neutral to all of the other alternatives on the east side.

COST

This approach creates the longest connection from the ramp to the Northlink Transit Station, which would be more costly.

Node E3—NE 100th Street

CONNECTIVITY

Node E3 provides access to the future City of Seattle cycle track and the multi-use trail to the north via the intersection of First Avenue NE and Northeast 100th Street as well as the protected bike lane on Northeast 100th Street. The intersection of First Avenue NE and Northeast 100th Street is less complex without the freeway off-ramp and the reduced traffic volume moving through the intersection from the WDOT parking lots. The potential for conflicts with buses also is reduced, due to the location of the cycle track.

Some limited reconfiguration of the connection between the node and the intersection will be required to provide for a safe transition at the southern end of the WDOT parking lot and may result in a limited loss of parking. A proposed sidewalk on the west side of First Avenue NE would provide for pedestrian movement after pedestrians have left the parking lot.

VISUAL PRESENCE

Similar to E-1, the larger neighborhood here is defined by the rapidly maturing urban village. In comparison with the western approach area, this is a busy, noisy, complex urban area with additional pedestrian amenities proposed for the near future. However, of the three options, E3 is the least impacted by the traffic and freeway and therefore will be perceived as the most desirable of the three locations.

ENVIRONMENTAL SUSTAINABILITY

The east approach is confined within the WSDOT parking lot; therefore, impacts to the First Avenue watercourses and Thornton Creek headwaters are avoided.

SAFETY

The quality of the user experience and safety at the node will be defined by the improvements integrated into the southern end of the WSDOT parking lot that support safe pedestrian and bicycle movement and access to the street grid.

The intersection of First Avenue NE and Northeast 100th Street is less complex without the freeway off-ramp and the reduced traffic volume moving through the intersection from the WSDOT parking lots. The potential for conflicts with buses is also reduced, due to the location of the cycle track.

Issues of defensible space and user safety will require attention to accommodate the nature of a relatively anonymous condition where people typically do not assume the need to provide “eyes on the street.” This can be accommodated with good lighting and signage. Of the three options, this has the best potential to be a safe node throughout the day.

CONSTRUCTABILITY ■

Constructability is neutral in relation to all of the other alternatives on the east side.

COST ▲

This approach creates the shortest connection from the ramp to the Northlink Station, which would save costs.

Summary of East Node Evaluation

The east approach screening results are summarized in the chart below. Node E3—Northeast 100th Street is the recommended alignment for the east approach.

Figure 5.5—Summary of East Node Evaluation

Screening Criteria	E1 NE 103rd St	E2 Mid Parking Lot	E3 NE 100th St
Connectivity	▼	▼▼	▲▲
Visual Presence	▼	▼▼	▲▲
Environmental Sustainability	▼	■	■
Safety	▼▼	▼▼	▲
Constructability	▼	■	■
Cost	▼▼	■	▲

STEP II—DEFINING THE ALIGNMENT

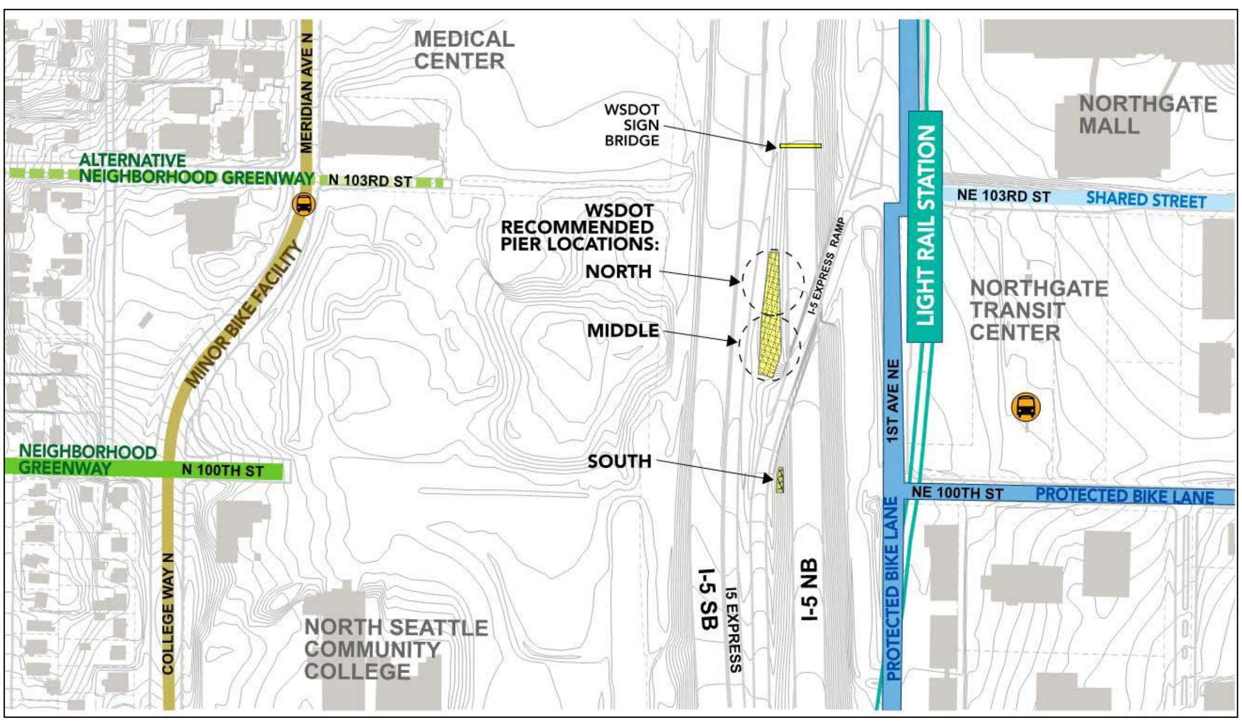
The purpose of the Step II analysis is to define general alignment alternatives supported by the Step I analysis. The measures for the Step II evaluation are to develop the alternatives in more detail and then evaluate how each alternative fulfilled the criteria identified in the evaluation framework. The goal is to narrow the broad list of alternatives to a selection of no more than three to be considered for further refinement. The alternatives most satisfying the criteria move on for further analysis.

Interstate I-5 Zones

A key parameter for alignment was the location of a foundation proposed for the pedestrian/bicycle bridge that would land within I-5 freeway property owned by WSDOT and regulated by both WSDOT and the Federal Highway Administration (FHWA). WSDOT has defined three possible zones located between the south- and northbound traffic lanes of I-5 where bridge columns could be located. (See Figure 5.6.)

The north zone is just south of the Northgate Way and First Avenue NE exit (Exit 173) and is in close proximity to Northeast 103rd Street. The middle zone is bounded by the north zone and the ramp for the I-5 express lanes. As its name suggests, this zone is located midway between Northeast 103rd and Northeast 100th streets. The south zone is much smaller than either the north or middle zones. It is located just south of the ramp for the express lanes of I-5 in proximity to the alignment of Northeast 100th Street.

Figure 5.6—Zones for Middle Pier



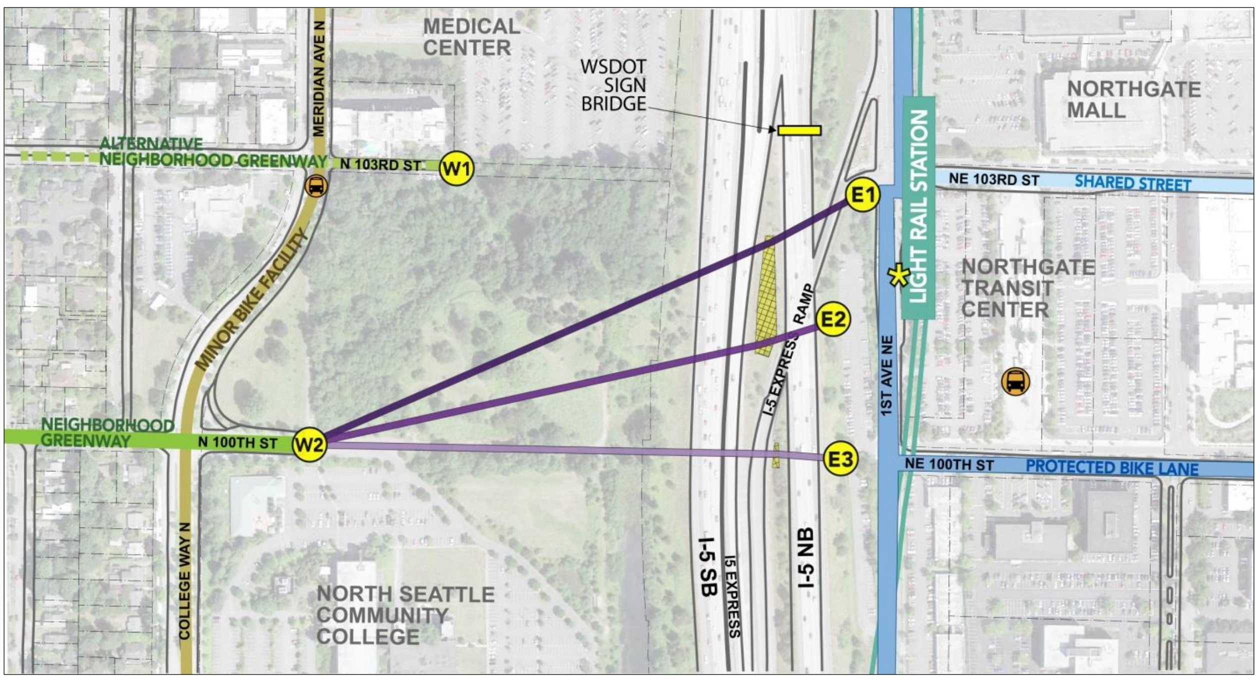
Alignment Alternative Development

Based on the Step I analysis, we know the alignment will begin at node W2 and terminate at E3. The path will ramp the user up to the western abutment of the I-5 pedestrian/bicycle bridge crossing. The bridge will span from the edge of the WSDOT ROW on the west and meet with the east approach.

The east approach is defined as the ramp from the eastern end of the bridge to the access node located at E2 or E3. Alignment alternatives generating from Nodes W2 are shown in Figure 5.7. Further refinement will be required during the next phase to determine the east approach during the Step III analysis.

The alignment for the I-5 overcrossing must travel through one of the three designated zones. The alignment will connect the west and east approaches.

Figure 5.7—W2 Alignment Alternatives



Alignment Alternative Evaluation

North Zone

CONNECTIVITY

The topographic grade differences between northbound I-5 and the surrounding area are less than those in the vicinity of the middle zone, so the height of possible bridge piers would be shorter than the middle zone. Any structures crossing I-5 anchored in the northern zone will travel in front of the I-5 exit sign for Exit 173 and Exit 174. Hindering the view of this existing sign does not allow drivers the required time to see it while traveling north on I-5, which violates sight distance requirements established by FHWA.

Figure 5.8–Ramp Signage on I-5 Northbound.

VISUAL PRESENCE

Legibility of the connection between the access points of the path and the most visible portions of the elevated structure is important for intuitively communicating the route to potential users. A path that is accessed from 100th Street but crosses I-5 near 103rd Street does not translate intuitively for users some distance away trying to access the structure. Users will see the bridge at 103rd and look for access points too far north.

ENVIRONMENTAL SUSTAINABILTIY

An alignment that travels from the North I-5 zone to W2 would diagonally bisect the Bartonwood Sanctuary, resulting in significant tree removal and habitat impact. A large percentage of the forested wetland condition exists in the northern two-thirds of the Bartonwood Sanctuary and would be adversely impacted.

SAFETY

The portion of the alignment through the wooded sanctuary raises issues of defensible space. The heavily forested route provides few opportunities for natural surveillance along the path and limits alternate entry/exit routes available to bridge users.

CONSTRUCTABILITY

The resulting western portion of this alignment is located within the Bartonwood Sanctuary, resulting in difficult construction conditions. Accessibility to this location would be limited without significant clearing of tress in the vicinity. Additionally, there are no convenient construction lay-down areas within the Bartonwood Sanctuary.

COST

Additional costs would be incurred from substantial trail improvements, wetland mitigation, and any requirement to relocate the existing I-5 sign.

Middle Zone

CONNECTIVITY

The topographic grade differences between northbound I-5 and the surrounding area are greater than those in the vicinity of the north and south zones, so the height of possible bridge piers would be taller than those in the other zones. The pier location within I-5 would result in two spans of roughly equal length, providing symmetry to the appearance of the main spans. This alignment provides a clean and effective connection without any conflicts with the WSDOT sign mentioned above.

VISUAL PRESENCE

Legibility of the connection between the access points of the path and the most visible portions of the elevated structure is important for intuitively communicating the route to potential users. A path that is accessed from 100th but crosses I-5 further north does not translate intuitively for users some distance away trying to access the structure.

ENVIRONMENTAL SUSTAINABILITY

This alignment could be located outside wetland areas and in areas of less vegetation reducing its impact to nearby wetlands in the Bartonwood Sanctuary while still providing the user the experience of traveling through a natural environment.

SAFETY

The spatial organization of Bartonwood Sanctuary—with two large clearings wrapped by forest with an ascending topography—results in a clarity of wayfinding. Limited removal of blackberry bushes to increase generous mown connections will increase the sense of identity and the safety of use. Although this alignment is close to North Seattle College, sightlines to and from the campus would be obstructed by trees.

CONSTRUCTABILITY

This area offers the benefit of construction occurring outside existing wetland areas in the Bartonwood Sanctuary, but access to the site would still require maneuvering around existing trees. The nearby maintenance access road could function as a lay-down area. Construction of a pier within the I-5 limits on this alignment could be staged entirely within the grassy median with minimal impact to traffic.

COST

This approach minimizes wetland mitigation costs and easily integrates the existing trail system, which eases cost by simplifying construction.

South Zone

CONNECTIVITY

The topographic grade differences between northbound I-5 and the surrounding area are less than those in the vicinity of the middle zone, so the height of possible bridge piers would be shorter than the middle zone piers. The pier location would result in a longer west span than the other alternatives. This alignment provides a clean and effective connection without any conflicts with the WSDOT sign previously mentioned.

VISUAL PRESENCE

Legibility of the connection between the access points of the path and the most visible portions of the elevated structure is important for intuitively communicating the route to potential users. An alignment that both functionally and visually serves as a non-motorized continuation of 100th Street intuitively translates as a clear wayfinding landmark.

ENVIRONMENTAL SUSTAINABILITY

This alignment could be located outside wetland areas and in areas of less vegetation, reducing its impact to nearby wetlands in the Bartonwood Sanctuary while still providing the user the experience of traveling through a natural environment. This alternative provides the least impact to the Bartonwood Sanctuary.

SAFETY

The spatial organization of Bartonwood Sanctuary—with two large clearings wrapped by forest with an ascending topography—results in a clarity of wayfinding. Limited removal of blackberry bushes to increase generous mown connections will increase the sense of identity and the safety of use. The close proximity of North Seattle College will increase the number of people observing and using the bridge and will contribute to an increased perception of safety and actual safety. Providing for the maximum integration of all mobility options ensures that the bridge acts as a direct, safe, and comfortable active transportation facility.

CONSTRUCTABILITY ■

This area offers the benefit of construction occurring outside existing wetland areas. Additionally, the area is adjacent to an existing maintenance access road, which would facilitate movement of construction equipment and material.

COST ■

This approach minimizes wetland mitigation costs and easily integrates the existing trail system, which eases cost by simplifying construction.

Summary of Alignment Alternative Evaluation

The alignment evaluation results are summarized in the chart below. The south alignment is recommended to move into Screening Step III.

Figure 5.9—Summary of Alignments Evaluation

Screening Criteria	North	Middle	South
Connectivity	▼	▲▲	▲▲
Visual Presence	▼	■	▲▲
Environmental Sustainability	▼▼	■	■
Safety	▼▼	■	▲
Constructability	▼	■	■
Cost	▼	■	■

STEP III–REFINING THE APPROACHES

With the preferred nodes identified and the I-5 alignment selected, the purpose of Step III is to develop and evaluate the west and east approaches that connect them. The measures for the Step III analysis further develop the alternatives with additional detail and then evaluate how each refined alternative meets the evaluation criteria. The evaluation, along with input from the design team and stakeholders, is used to determine the preferred alternative for the project.

Since most of the key parameters for the project were already incorporated into the alternatives during Step I and Step II development phases, the primary focus of this analysis is to increase the detail of each alternative. The portions of the project with the least development in earlier phases were the east and west approaches. An approach refers to the part of the path that connects the access point to the main bridge span.

Several key parameters that influence the approaches are the starting and ending elevations and the maximum path slope of 5% to facilitate ADA requirements. As mentioned during the Step I bridge feasibility evaluation, this combination results in long elevated approaches, which has implications to connectivity, environmental sustainability, and safety.

West Approach Alternatives

The west approach is bounded by College Way North to the west and I-5 to the east. The north and south boundaries are North 103rd Street and North 100th Street respectively. Within these boundaries is the Bartonwood Sanctuary, a greenbelt containing more than 2 acres of mature, forested wetland.

The sanctuary provides educational and stormwater benefits and is a source of ecological connectivity to the South Fork of Thornton Creek. The sanctuary has a trail system that meanders through the property, providing an educational resource as well as a unique opportunity for users to experience a diverse Northwest ecosystem. The combination of land form, forest, trees, and mowed clearings create distinct site characteristics as well as distinct areas within the sanctuary. (Figure 5.10, next page.)

The quality of the experience creates a sense of being in a natural environment, separate from the city. The lack of city and freeway views, coupled with bird sounds, contributes to these characteristics.

Figure 5.10—Site Conditions

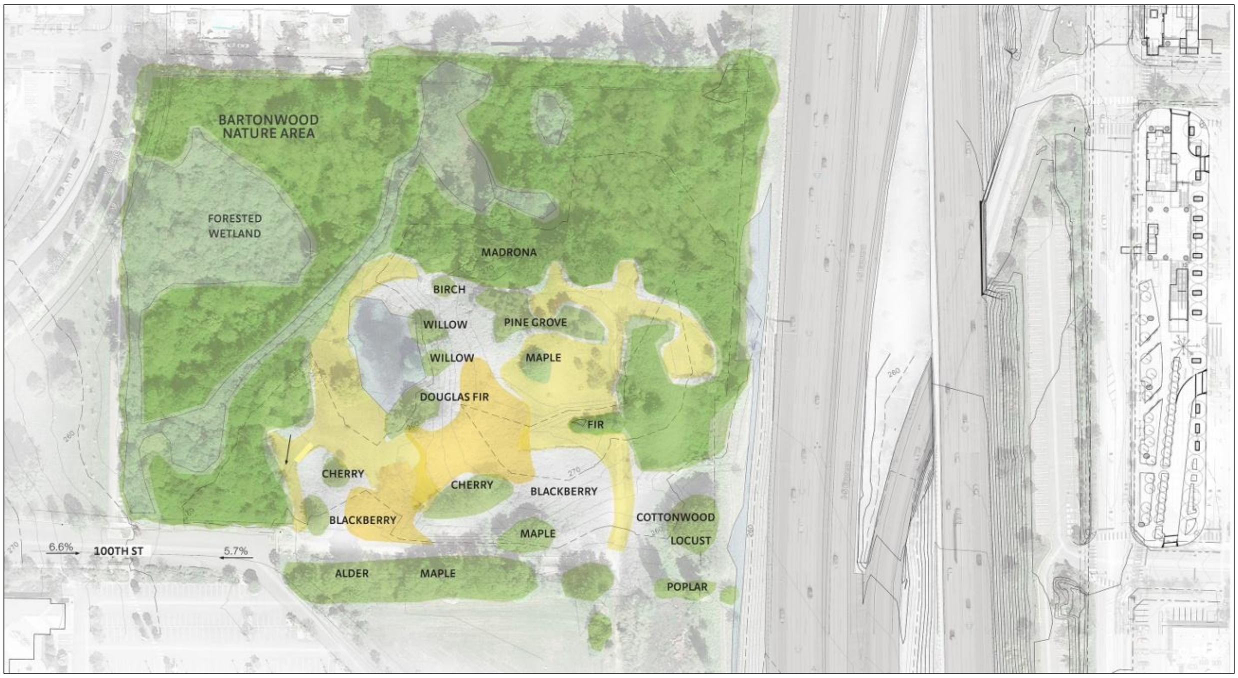
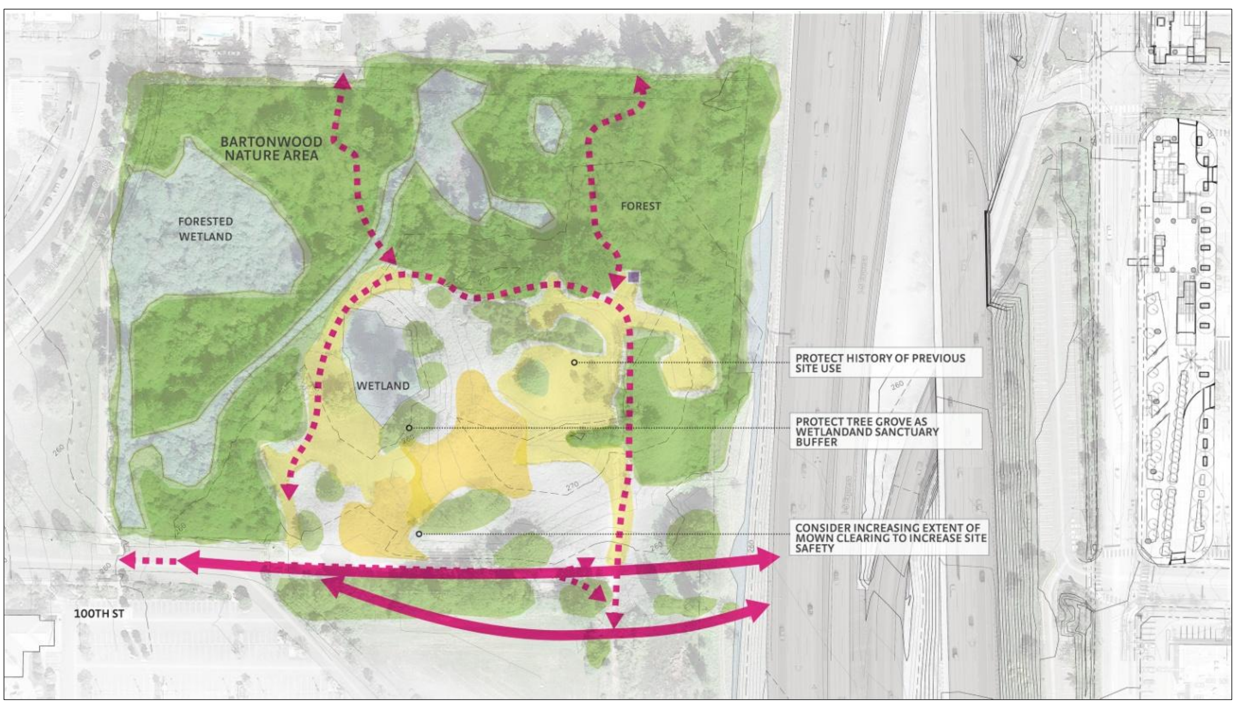


Figure 5.11—Site Recommendations and Observations



Discreet open clearings in the forested landscape create a memorable and distinct sense of place. The structural diversity and mix of species provide a variety of habitat opportunities. Site topography defines edges and clearings, further supporting the sense of place. The topography can provide for ease of pedestrian access. Paths are being pushed to the south to protect these areas.

The western approach is the most southern alignment of the alternatives on the North Seattle College campus and is aligned with 100th Street. Evaluation focused on two alternatives:

- North approach alternative—along the service drive (Figure 5.12)
- South approach alternative —along the inside of the trees bordering the service drive (Figure 5.13)

Figure 5.12—West Approach North Alternative View

Figure 5.13—West Approach South Alternative View

East Approach Alternatives

The east approach is more constricted than the west approach, in terms of available space. Careful ramp placement is required to meet the ADA compliance geometrics for this approach. The boundaries for the east approach are I-5 to the west, the I-5 express lane ramp to the north, the light rail station to the east, and North 100th Street to the south. Within these boundaries are a WSDOT embankment alongside the I-5 northbound lanes, a WSDOT parking lot, First Avenue NE, and the King County Transit Center.

The topographic conditions and site constraints for the eastern approach present a challenge for street level connections with the bridge. At each eastern node alignment option, the bridge span terminates at approximately 40 feet above grade, requiring either a long ramp or elevator system to accommodate ADA access.

The ability to connect directly with the future light rail station at the mezzanine level strengthens the connectivity of the path, which will allow users access to the transit facility or the public plaza below via the station's stairs and elevators. The project would be designed as a stand-alone facility but would provide the opportunity to connect directly with the station.

Figure 5.14—East Approach Alternatives

To meet ADA requirements, the ramp with a 2% slope, connecting the middle I-5 zone to E3, must have a length of approximately 730 feet. To connect into the station and clear First Avenue NE, the ramp at 3% will require a length of 100 feet. The general configuration of the ramp exits the user on the west side of the WSDOT parking lot.

The ramp that connects to the southern I-5 crossing with a slope of 2% has a length of approximately 800 feet. To connect into the station and clear First Avenue NE, a ramp at 3% will require a length of 75 feet. The general configuration of the ramp exits the user on the west side of the WSDOT parking lot; however, a connection can be made to a protected bike lane on Northeast 100th Street.

An elevator is another alternative for bringing bridge users to the existing grade and can be combined with a stairway. Issues to be resolved for the elevator option are its location within the WSDOT property, the life-cycle costs associate with long-term maintenance, and safely getting users to existing pedestrian facilities.

An elevator—as noted above in the Node E2 location—is another alternative for bringing bridge users to the existing grade and, again, can be combined with a stairway. Issues to be resolved for the elevator option are its location within the WSDOT property, the life-cycle costs associate with long-term maintenance, and safely getting users to existing pedestrian facilities.

West Approach Alternative Evaluation

Step III screening will focus on the following criteria:

- Environmental Sustainability
- Safety
- Cost

For the screening process, the major components of the screening process were defined as the west approach, east approach, and I-5 overcrossing. Screening criteria considered the points below for both the W2 North and W2 South approach options, individually weighing:

ENVIRONMENTAL SUSTAINABILITY

How does this option affect the following?

- Surrounding wetlands
- Bartonwood Sanctuary
- Impact on nearby vegetation

SAFETY

How do the following safety factors weigh into each option?

- Visibility
- Inclusion of lighting, signage, and emergency phones

COST

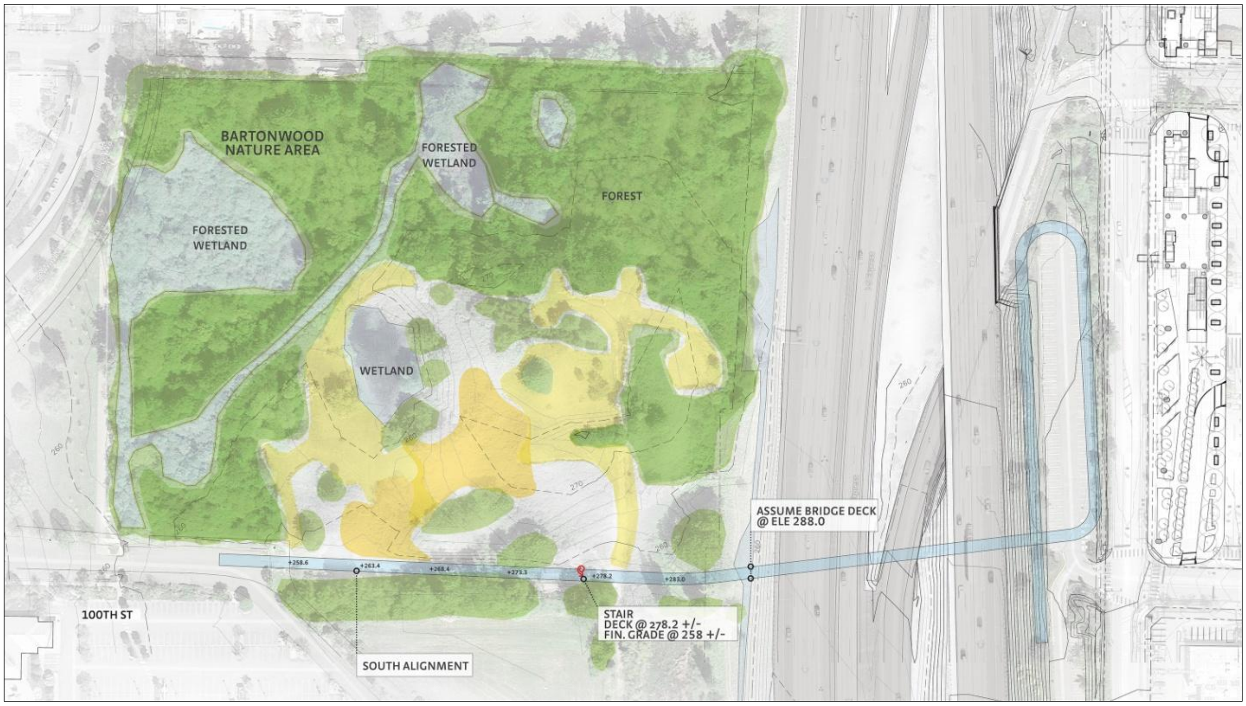
Is one option more expensive than the other?

West Approach Northern Ramp

Figure 5.15—W2 North Option Aerial #1

Figure 5.16—W2 North Option Aerial #2

Figure 5.17—W2 North Option With Features Identified



ENVIRONMENTAL SUSTAINABILITY

This option impacts the south end of central wetland #1, due to walk development, pedestrian lighting, signage, and so on. There also is potential impact on the east wetlands of #4 and #6, due to construction and column placement. This option offers the potential of increasing public use of Bartonwood Sanctuary with potential implications for habitat function. There also is a potential impact on the drainage ditch and wetland #5, directly to the south of the approach alignment.

SAFETY

Safety here is defined using CPTED criteria. In this option, the approach has limited visibility: half of the western side of the approach can be seen from the north parking lot; the eastern side is behind the tree line and is blocked from the parking lot view. However, the entire length of the approach is aligned with 100th Street, allowing for visibility down its length. The level of safety can be increased with the inclusion of lighting, signage, and emergency phones.

COST

There is no appreciable difference between options.

West Approach Southern Ramp

Figure 5.18—W2 South Option Aerial #1

Figure 5.19—W2 South Option Aerial #2

ENVIRONMENTAL SUSTAINABILITY

This option likewise impacts the south end of central wetland#1, due to walk development, pedestrian lighting, signage, and so on. Impacts are reduced to the Bartonwood Sanctuary and to wetland #5, due to the location of the trail south of the tree line.

SAFETY

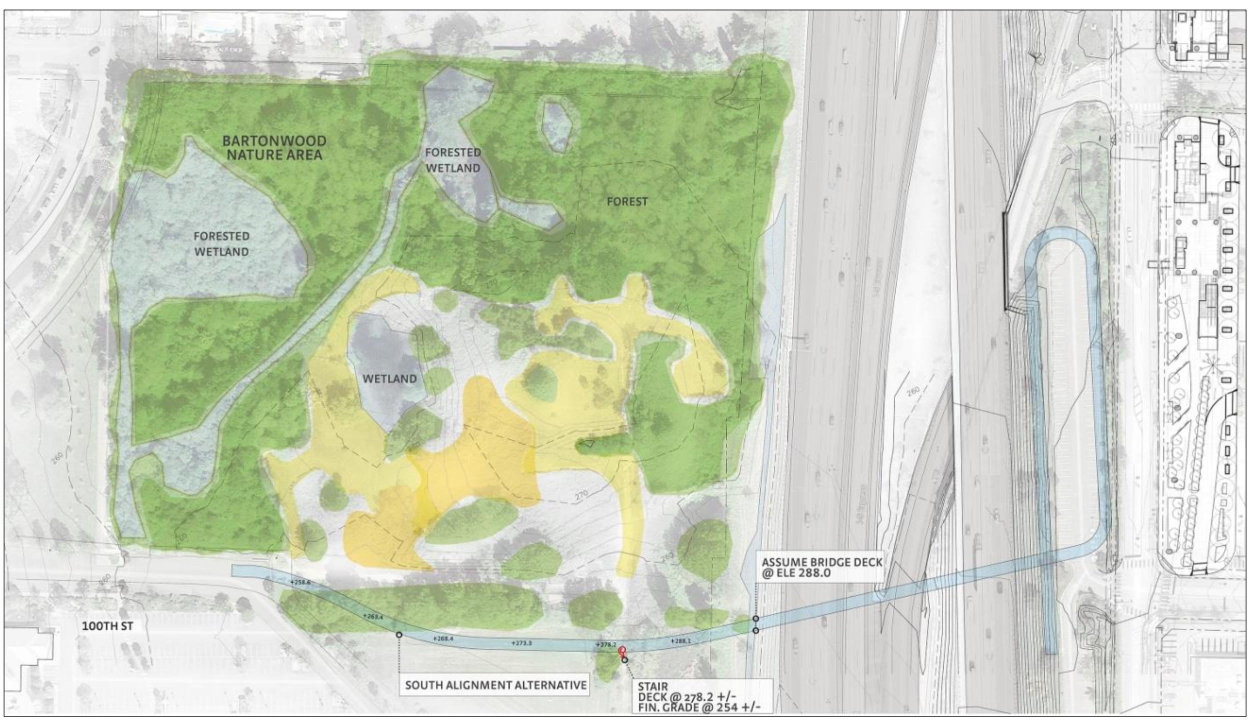
The entire length of the approach can be seen from both the north and northeast parking lots, allowing for increased visibility. The nearby Arts and Sciences Building, part of the North Seattle College campus, also has a view of this approach. The location of the approach to the south of the treed ditch increases eyes on the approach and places the structure within the college context.

There is an opportunity for a stair connection midway along the approach to increase departure routes. The western half of this approach is aligned with 100th Street, allowing for visibility of this section. The level of safety can be increased with the inclusion of lighting, signage, and emergency phones.

COST

There is no appreciable difference between options.

Figure 5.20—W2 South Option with Features Identified



Summary of West Approach Evaluation

The west approach screening results are summarized in the chart below. The west approach southern ramp is the preferred alternative.

Figure 5.21—Summary of West Approach Evaluation

Screening Criteria	West Approach Northern Ramp	West Approach Southern Ramp
Environmental Sustainability		
Safety		
Cost		

East Approach Alternative Evaluation Criteria

The eastern approach was defined in the Step II screening process. It is assumed to be contained within the area of the north half of the WSDOT parking lot. In this alternative, the pedestrian ramp would touch down and users would exit aligned with 100th Street or the mezzanine level of the proposed light rail station.

Screening criteria (as defined in the Step II screening) considered the points below:

ENVIRONMENTAL SUSTAINABILITY

How does this option affect the surrounding area?

- First Avenue watercourses
- Thornton Creek headwaters

SAFETY

How safe is this approach when it comes to the following?

- Visibility
- Inclusion of lighting, signage, and emergency phones

COST

How expensive is this approach?

East Approach Alternative—Ramp on Southern Alignment

ENVIRONMENTAL SUSTAINABILITY

The east approach ramp is confined within the WSDOT parking lot; therefore, impacts to the First Avenue watercourses and Thornton Creek headwaters are avoided.

SAFETY

Safety here is defined using Crime Prevention through Environmental Design (CPTED) criteria. In this option, the approach has visibility from a wide variety of angles, including the parking lot, the 100th Street corridor, and the light rail station.

The alternative also allows for a path that meets ADA requirements to land at the desired node and provides a short station connector spur. The spur into the station allows users to cross First Avenue NE without crossing at-grade through traffic at the 100th Street intersection.

COST

Costs are mitigated by the selection of this alternative in a variety of ways. First, this alignment provides the shortest connection into the mezzanine level of the light rail station. Second, the amount of structure required for the ramp is minimized by utilizing the northbound I-5 embankment.

East Approach Alternative—Using an Elevator

ENVIRONMENTAL SUSTAINABILITY

The impact to wetlands for this alternative is minimal because the elevator would end the path west of the parking lot without reaching the wetland area on the east side of the parking lot.

SAFETY

Users of an elevator are confined to the elevator cab and specific entry and exit points controlled by a mechanical door. This can create situations that may be less safe than an open ramp. Safety can be improved with features such as glass, walled cabs that allow users to see individuals within the elevator or approaching the elevator.

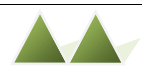
COST

Initial installation would be less than the other alternatives; however, long-term maintenance of a 40-foot tall elevator would likely offset the initial savings in construction cost.

Summary of East Approach Evaluation

The east approach screening results are summarized in the charts below. The east ramp on the southern alignment is the preferred approach.

Figure 5.22—Summary of East Approach Evaluation

Screening Criteria	East Ramp on Southern Alignment	East Approach Using an Elevator
Environmental Sustainability		
Safety		
Cost		

6 Bridge Alternative Analysis

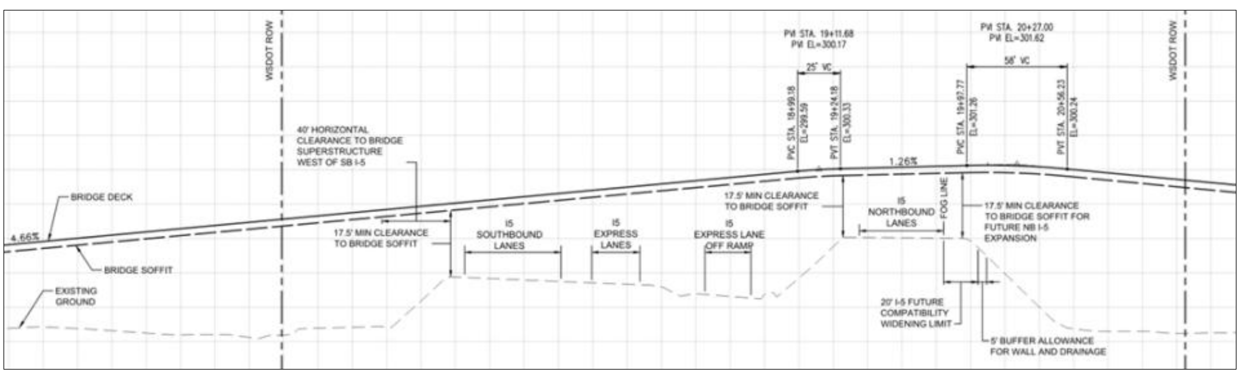
INTRODUCTION

The purpose of the Bridge Alternative Analysis is to develop a broad range of bridge alternatives on the preferred alignment and evaluate them based on the project goals to identify the preferred alternative. The first step in the screening process will be identifying the feasible bridge types based on the geometric constraints of the project. The remaining alternatives will be developed further and evaluated based on the evaluation criteria.

GENERAL BRIDGE TYPES

Key to establishing the bridge type is length of span. With the alignment alternatives as previously described, the next step in selecting the bridge type is to define the span length by determining possible foundation locations along the alternative alignments. (See Figure 6.1.) For the main bridge spanning I-5, the possible foundation locations are defined by the alignment intersection with the WSDOT ROW along the western side, the zones defined by WSDOT in the center of I-5, and the location of Node E3.

Figure 6.1—Alignment Profile Over I-5



This creates the ability to construct a two-span bridge, with spans in the range of 200 feet for a total bridge length in the range of 400 feet. Structural types that are commonly used for conventional site conditions, with spans in the 200-foot range like the Northgate Pedestrian and Bicycle Bridge, include steel and concrete box girders, steel plate girders, and steel trusses.

For sites with special conditions and aesthetic considerations, structural types also include cable-stay, suspension, and arch bridges. Of the possible bridge types, reinforced concrete girder and reinforced concrete box bridges aren't feasible because they have spanning capabilities that don't match the requirements.

Figure 6.2—Structural Type/Span Capability

Structural Type	Span Capability
Reinforced concrete girder	< 60 feet
Reinforced concrete box	< 120 feet
Prestressed girder	< 200 feet
Post-tensioned I-girder	< 250 feet
Steel girder	< 400 feet
Arch	< 500 feet
Post-tensioned concrete box	< 700 feet
Truss	< 1,200 feet
Cable-stayed	< 1,200 feet
Suspension	< 5,000 feet

I-5 OVERCROSSING

The I-5 overcrossing connects the western nodes with the eastern nodes over the interstate. A key consideration for screening bridge types is depth of the bridge superstructure. The allowable superstructure depth for the bridge is set by the distance between the bridge profile for the walking surface and the required vertical clearance below the bridge.

Key vertical clearances below the bridge are the following:

Figure 6.3—Vertical Clearance

Area	Vertical Clearance
Interstate 5	17 feet, 6 inches
First Avenue NE	16 feet, 6 inches
Sidewalks near Transit Station	8 feet

Typical box girder and plate girder bridges have challenges because they require superstructure depths in the range of 8 to 10 feet. The structural depth directly impacts approach length. For every foot of depth, there is a required 50-foot length of ramp when the slope is defined by a 2% grade. Consequently, truss, arch, and cable-stay bridges have shorter ramp lengths because of their shallower depths when compared to girder type bridges. The structural depth required for various types of bridges is shown in Figure 6.5.

Figure 6.4—Structural Depth Per Bridge Type

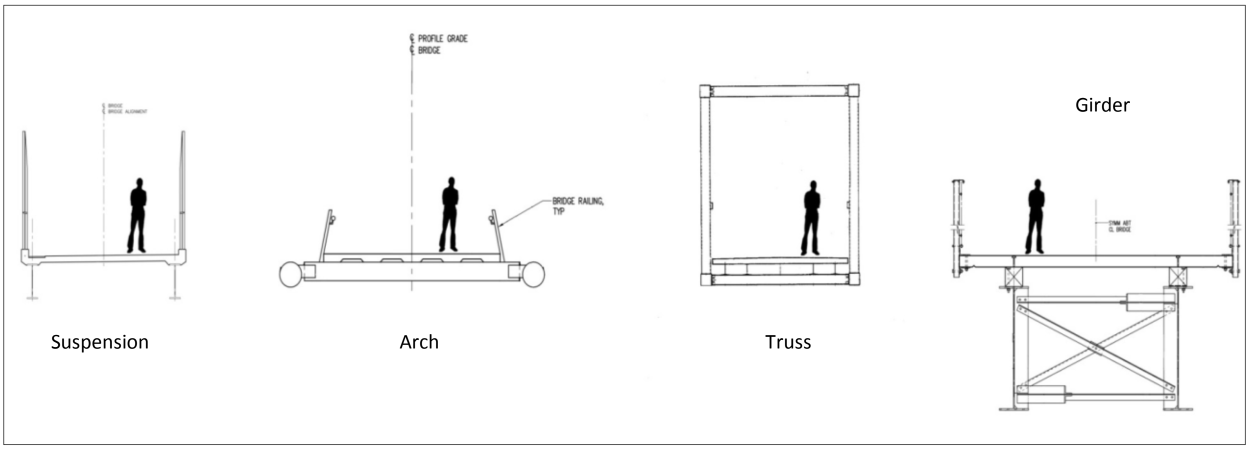


Figure 6.5—ADA Ramp Lengths

	ADA Ramp Length*			
Structural Type	Structural Depth	East	West	Travel Time **
Girder bridge	8-10 feet	1,225 feet	1,175 feet	10.5 minutes
Arch bridge	2.5-3.5 feet	900 feet	850 feet	8 minutes
Tube/Truss bridge	2.5-3.5 feet	900 feet	850 feet	8 minutes
Cable-stay bridge	2.5-3.5 feet	900 feet	850 feet	8 minutes
Suspension bridge	2.5-3.5 feet	900 feet	850 feet	8 minutes

* Approximate length of ramps using 2% slope. Length may vary based on final alignment.

** Travel time based on pedestrian speed of 3 mph; includes 400 feet of main bridge span length

Given these considerations, the bridge types selected for further development will be cable-stay, arch, and tube/truss bridges.

I-5 Overcrossing Evaluation

The criteria used for screening the I-5 overcrossing are listed below.

CONNECTIVITY/GEOMETRY

How well does each bridge type do the following?

- Minimize structural depth
- Minimize approach length

VISUAL PRESENCE

How well does each bridge type minimize distractions for those traveling on I-5?

ENVIRONMENTAL SUSTAINABILITY

How would the bridge type be rated on the environmental criteria below?

- Minimize foundation impacts to wetlands
- Minimize light-shedding into neighborhoods and onto I-5?

SAFETY

Does the bridge maintain safety in the following areas?

- Maximize sight distance along the length of the bridge?
- Provide barriers from noise and wind over I-5

CONSTRUCTABILITY

How will the bridge type affect constructability in these areas?

- Minimize interruptions to traffic
- Minimize construction duration

COST

Is the bridge within the allotted budget?

Cable-Stay Bridge Alternative

CONNECTIVITY

Cable-stay bridges have a thin superstructure depth, minimizing approach lengths.

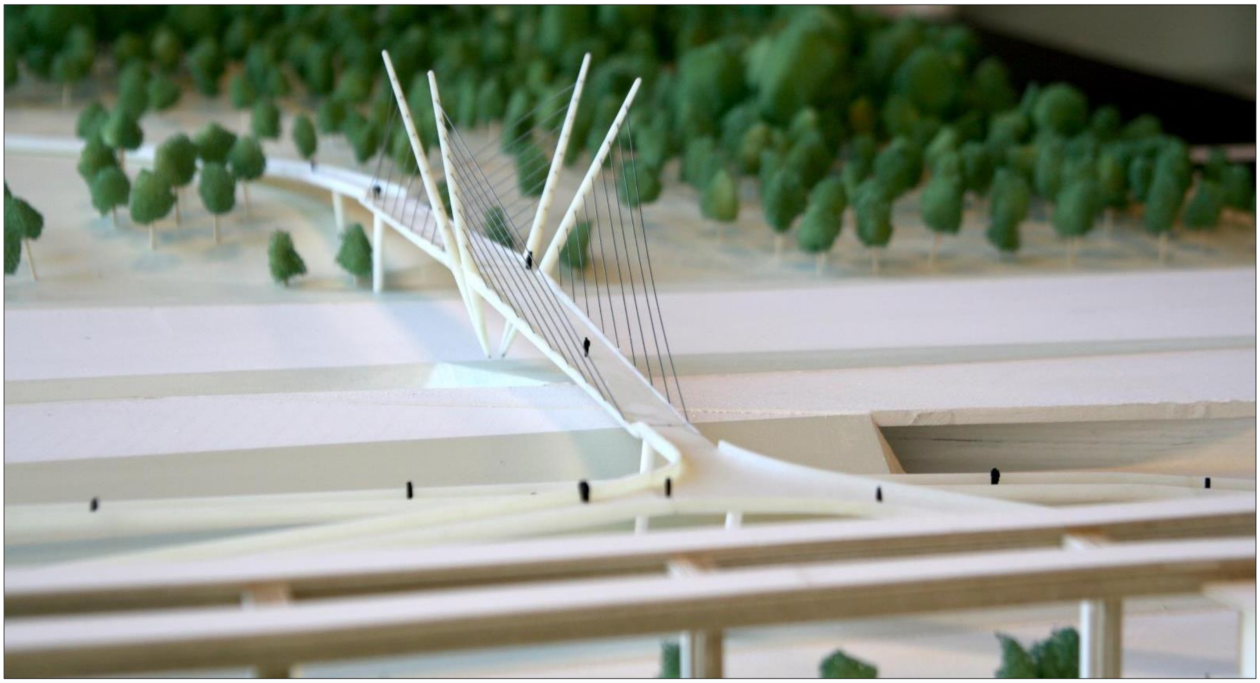
VISUAL PRESENCE

In meetings with WSDOT, officials voiced concerns about visual distractions of a cable-stay bridge to those traveling along I-5.

ENVIRONMENTAL SUSTAINABILITY

Cable-stays have smaller foundation areas at the bridge abutments, minimizing structure that would be in the locations of existing wetlands.

Figure 6.6—Cable-Stay Bridge Example



SAFETY

The cable-stay's open structure provides visibility from multiple angles.

CONSTRUCTABILITY

A large foundation would be located in the median of I-5, which would create challenges in constructability due to interstate access. Additionally, the balanced cantilever construction of cable-stay bridge would require more interruptions to traffic on I-5.

COST

This option is within published budget ranges.

Arch Bridge

CONNECTIVITY

Arch bridges have a thin structural depth, minimizing approach lengths.

VISUAL PRESENCE

From the WSDOT perspective as voiced in coordination meetings, this bridge type offers minimal visual distraction for motorists.

ENVIRONMENTAL SUSTAINABILITY

This bridge type has slightly larger foundations than the cable-stay, which could possibly be near wetlands.

Figure 6.7—Arch Bridge Example

SAFETY

The arch's open structure provides visibility from multiple angles.

CONSTRUCTABILITY

The bridge is capable of being delivered to the site in large pieces.

COST

This option is within published budget ranges.

Tube/Truss Bridges

CONNECTIVITY

The integration of a throw barrier into the structural system could create an integrated barrier to noise and wind over I-5.

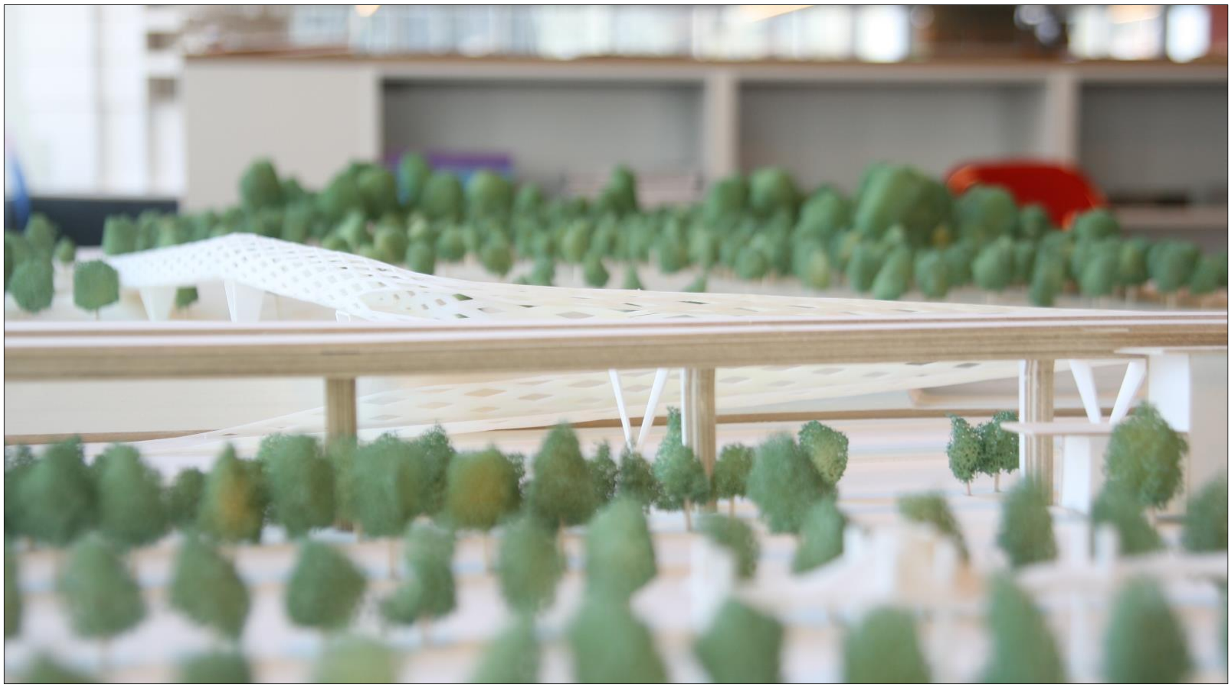
VISUAL PRESENCE

From the WSDOT perspective in coordination meetings, this bridge provides minimal visual distraction for motorists.

ENVIRONMENTAL SUSTAINABILITY

Internal lighting is able to be contained within this particular structure, minimizing light-shedding into nearby neighborhoods and onto I-5.

Figure 6.8—Tube/Truss Bridge Example



SAFETY

With this bridge type, an integrated barrier could be created to minimize noise and wind over I-5.

CONSTRUCTABILITY

This bridge is capable of being delivered to the site in large pieces and then assembled and lifted into place.

COST

This option is within published budget ranges.

Summary of Bridge Type Screening

The bridge type screening results are summarized in the chart below. The arch and tube/truss were recommended to be further developed so a cost estimate could be completed.

Figure 6.9—Summary of Bridge Type Screening

Screening Criteria	Cable-stay	Arch	Tube
Connectivity	▲	▲	▲
Visual Presence	▼	▲	▲
Environmental Sustainability	▲	■	▲
Safety	▲	▲	▲▲
Constructability	▼	▲	▲▲
Cost	■	■	■

Comparing Tube/Truss and Arch Bridge Types

The I-5 overcrossing location was driven by the location of the western and eastern approaches as well as by the acceptable foundation locations provided by WSDOT. The I-5 overcrossing alignment has been set by the Step II screening and will be either a tube/truss or an arch bridge type.

Screening criteria considered the points below for both the tube/truss and arch options, individually weighing:

ENVIRONMENTAL SUSTAINABILITY

What is the bridge's impact to the following?

- Containment of lighting

SAFETY

Does the bridge offer the following?

- Protection from highway below
- Awareness of users on the bridge

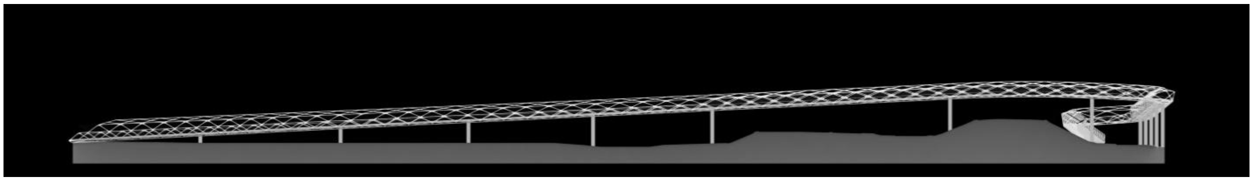
COST

Is one option more expensive than the other?

Figure 6.10—Tube Bridge Interior

Tube/Truss Bridge

Figure 6.11—Tube/Truss Bridge Exterior



ENVIRONMENTAL SUSTAINABILITY

The tube/truss structure has three sides above the walking surface, providing additional structure to accommodate and contain lighting from filtering onto the highway or into surrounding neighborhoods.

SAFETY

The throw barrier and railings can be integrated directly into the structure. With the truss structure surrounding the user, there is a perception of safety and protection from the highway below.

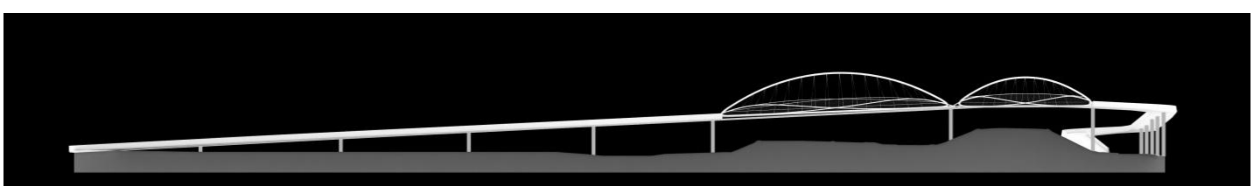
Given the distance a user must travel once committed to crossing the interstate, it is important for the user to feel safe. One way to increase a user's comfort level is to mitigate the noise of the highway below to allow users to hear activity around them on the bridge. The tube/truss structure has the potential to incorporate acoustic barriers around the pathway.

COST

Items providing potential cost savings for the tube/truss style structure are the ability to prefabricate large pieces of the structure and install them with less disruption to I-5 as well as the potential to integrate overhead weather protection, railings, and throw barriers within the structure.

Arch Bridge

Figure 6.12—Arch Bridge Exterior



ENVIRONMENTAL SUSTAINABILITY

The arch structure is more open above the walking surface, providing fewer opportunities to accommodate and contain lighting from filtering onto the highway or into surrounding neighborhoods without adding additional structure.

SAFETY

With the openness of the structure surrounding the user, there is less of a perception of safety and protection from the highway below.

Given the distance a user must travel once committed to crossing the interstate, it is important for the user to feel safe. One way to increase a user's comfort level is to mitigate the noise of the highway below to allow users to hear activity on the bridge. The openness of the arch structure has less potential to incorporate acoustic barriers around the pathway.

COST

Items providing potential cost savings for the arch style structure, compared to the tube/truss, include the reduced surface area of the structure requiring maintenance.

Figure 6.13—Arch Bridge Interior Rendering

Summary of Tube/Truss and Arch Bridge Screening

The tube/truss and arch bridge type screening results are in the chart below. The preferred and selected bridge type is the tube/truss bridge.

Figure 6.14—Summary of Tube/Truss and Arch Bridge Screening

Screening Criteria	Tube	Arch
Environmental Sustainability		
Safety		
Cost		

7 Conclusions

SELECTIONS

The selections for the Northgate Pedestrian and Bicycle Bridge are:

- **West Approach—W2 South**
- **East Approach—100^{th} Street Alignment**
- **Bridge Type—Tube/Truss Bridge**

These selections achieved the purpose and need of connecting communities, neighborhoods, businesses, and schools in the Northgate area; providing a safe crossing across I-5; and offering the least impact to the nearby Bartonwood Sanctuary, trail system, and surrounding environment on the west and Thornton Creek on the east.

Selected West Approach

The west approach alignment is W2 South. It was selected over W2 North because it aligns with a neighborhood greenway, has less environmental impact, and is safer. The slight variation of cost is offset by the improved safety of the location.

Figure 7.1—West Approach Screening

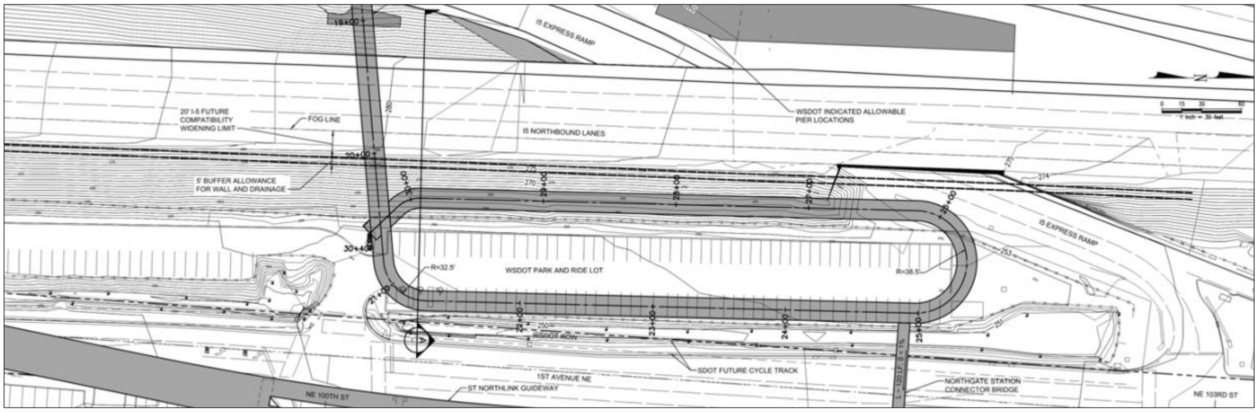
Screening Criteria	W2 North	W2 South
Environment Sustainability		
Safety		
Cost		

Selected East Approach

The boundaries for the east approach are I-5 to the west, the I-5 express lane ramp, and 103^{rd} Street to the north, the light rail station to the east, and North 100^{th} Street to the south. Within these boundaries are a WSDOT embankment alongside the I-5 northbound lanes, a WSDOT parking lot, First Avenue NE, and the King County Transit Center.

Selected is the 100^{th} Street alignment because it creates an efficient connection to the proposed light rail station, provides a ramp that is completely contained within the northern half of the WSDOT parking lot, and aligns with 100^{th} Street, providing clear visibility.

Figures 7.2 and 7.3—East Approach and Cross Section



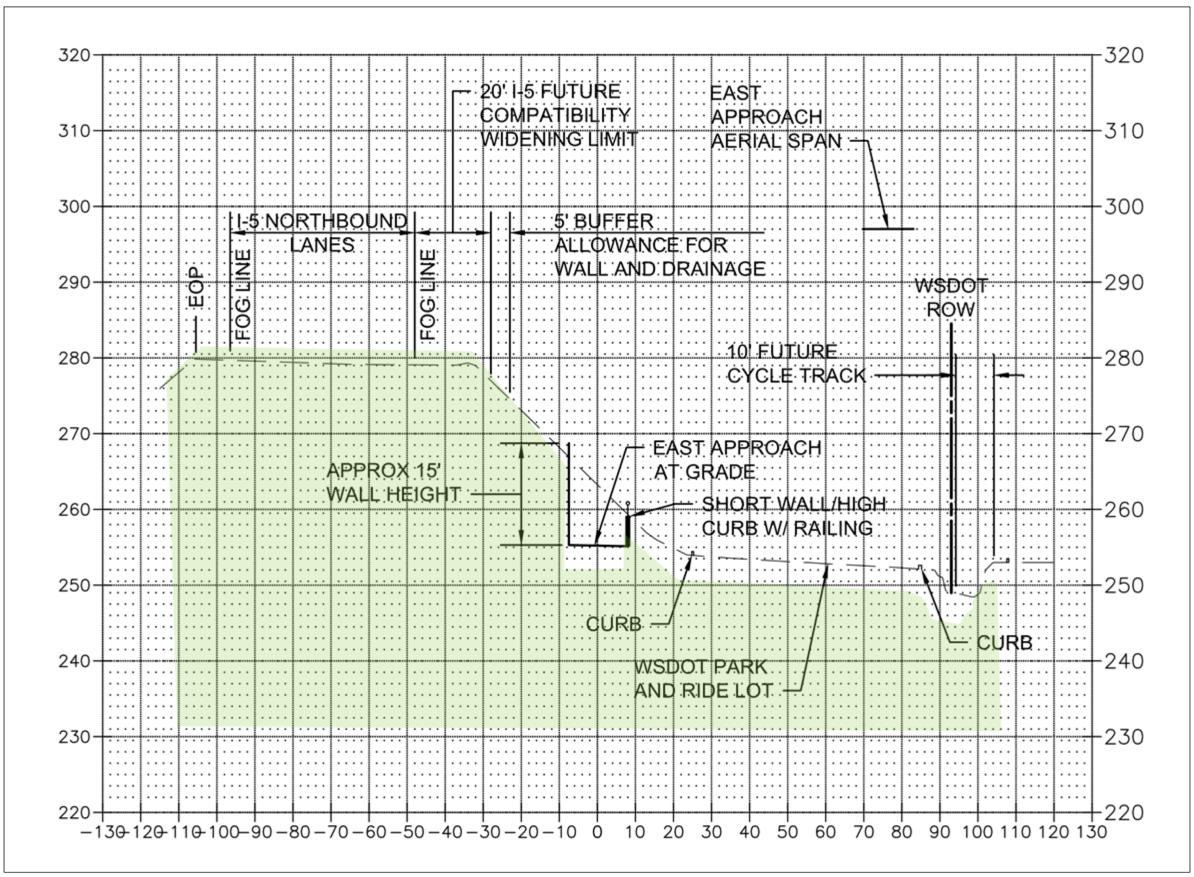


Figure 7.4—East Approach Screening

Screening Criteria	East Ramp on Southern Alignment	East Approach Using an Elevator
Connectivity	▲▲	▼
Visual Presence	■	■
Environmental Sustainability	▲	▲
Safety	■	■
Constructability	▲▲	▲▲
Cost	■	■

Selected Bridge Type

The bridge type selected is a tube/truss bridge. This bridge was preferred because it offers minimal visual distraction for motorists; could contain internal lighting to minimize light shedding into nearby neighborhoods and onto I-5; offers a safety perception of being protected from the highway below; has the potential to integrate overhead weather protection, railings, and throw barriers; could accommodate an acoustic barrier for users; and could be prefabricated to facilitate minimal site disruption.

Figure 7.5—Bridge Type Screening

Screening Criteria	Tube	Arch
Environmental Sustainability	▲	■
Safety	▲	■
Cost	▲	■

APPENDICES

- **Alta Planning & Design**
- **Geotechnical Analysis and Recommendations**
- **Public Outreach**
- **Basis of Design**

Appendix A

Alta Planning & Design: Best Practices

PURPOSE OF THIS APPENDIX

Once the new Northgate light rail station is open, a fast, reliable and high-quality transit option will be available to residents and workers in north Seattle. Providing safe and direct access to the new station is important to maximize the potential ridership of the new transit line. A high-quality bridge across I-5 not only will provide access to the new station but also will improve neighborhood connectivity in north Seattle. The Seattle Bicycle Master Plan Update identifies the Northgate Pedestrian and Bicycle Bridge as an important link in the "all ages and abilities" citywide bicycle network and will increase opportunities for residents to consider active transportation trips as an option in their daily activities: shopping, commuting to work, accessing transit, and kids walking/bicycling to school.

The City has a unique opportunity to enhance the number of bicycling and walking trips in the area by constructing a new bridge that will provide a safe crossing of I-5 and increase access to new transit facilities. This summary of best practices in bicycle and pedestrian bridge design will provide design guidance for providing high-quality user experience.

ACTIVE TRANSPORTATION

Active transportation is commonly defined as non-motorized or human-powered transportation. Under this broad umbrella, active transportation includes active travelers such as walkers and runners, wheelchair users, cyclists, in-line skaters, and users of other wheeled implements. Active travel facilities should consider the needs of a broad range of users, whether fast or slow, young or old.

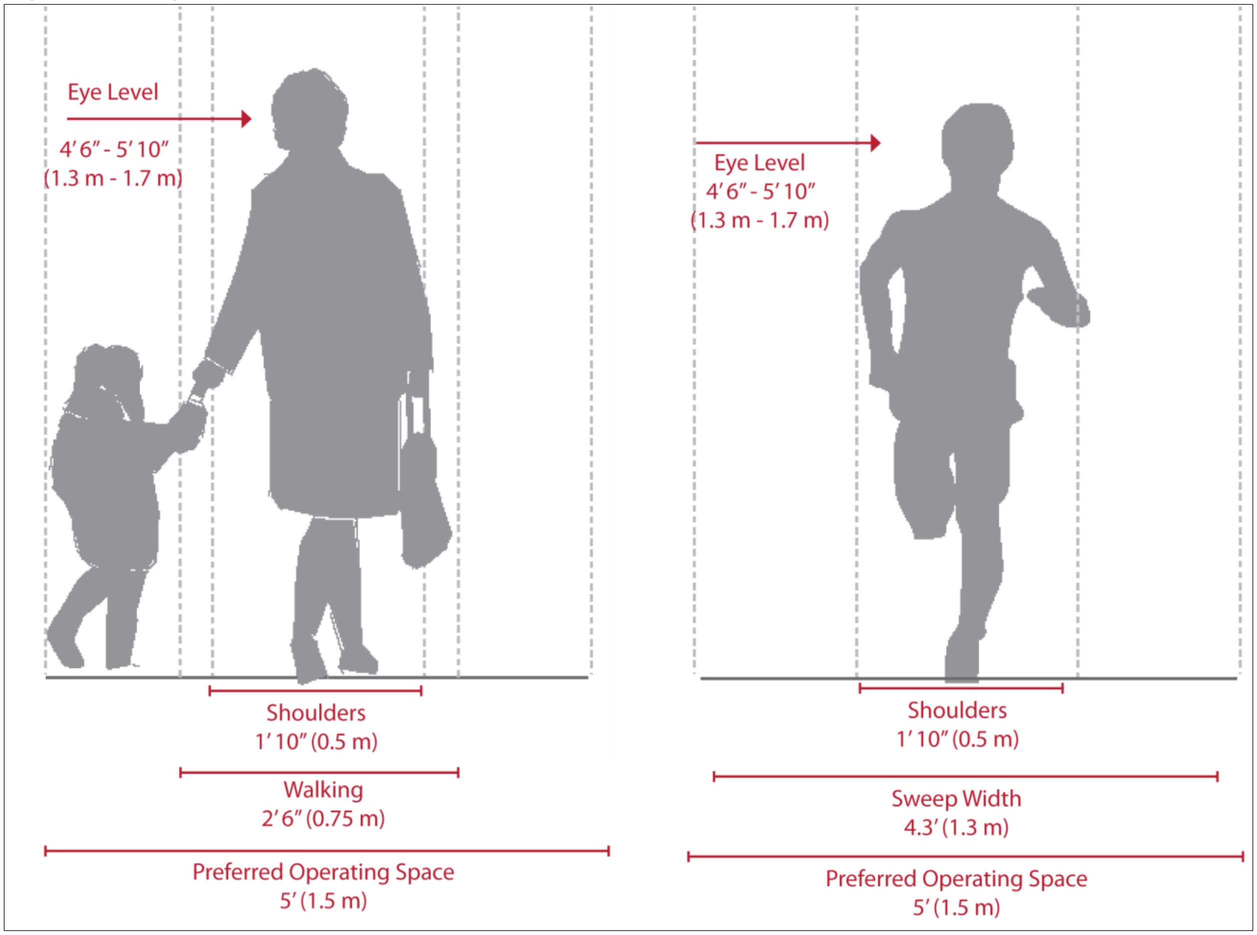
ACTIVE TRAVELERS

"All ages and abilities" is a guiding theme in the Seattle Bicycle Master Plan Update, the Seattle Pedestrian Plan, and the Seattle Transit Master Plan. It emphasizes planning, designing, and building active transportation facilities that are accessible to a broad range of people. Active transportation facilities should be designed to accommodate the full range of users, from ambling pedestrians to inline skaters and commuter cyclists pulling cargo trailers and should be accessible to "all ages and abilities."

A wide variety of active travelers are anticipated to use the Northgate Pedestrian and Bicycle Bridge. The facility must accommodate the largest and fastest vehicle but also must consider the potential interaction of such users with those who are vulnerable or are traveling more slowly.

For this reason, this memorandum considers the needs of a cyclist pulling a trailer as an example of the largest and fastest design vehicle as well as the interaction of such a user with pedestrians and other active travel users.

Figure A.1—Typical Dimensions and Characteristics of Active Transportation Groups

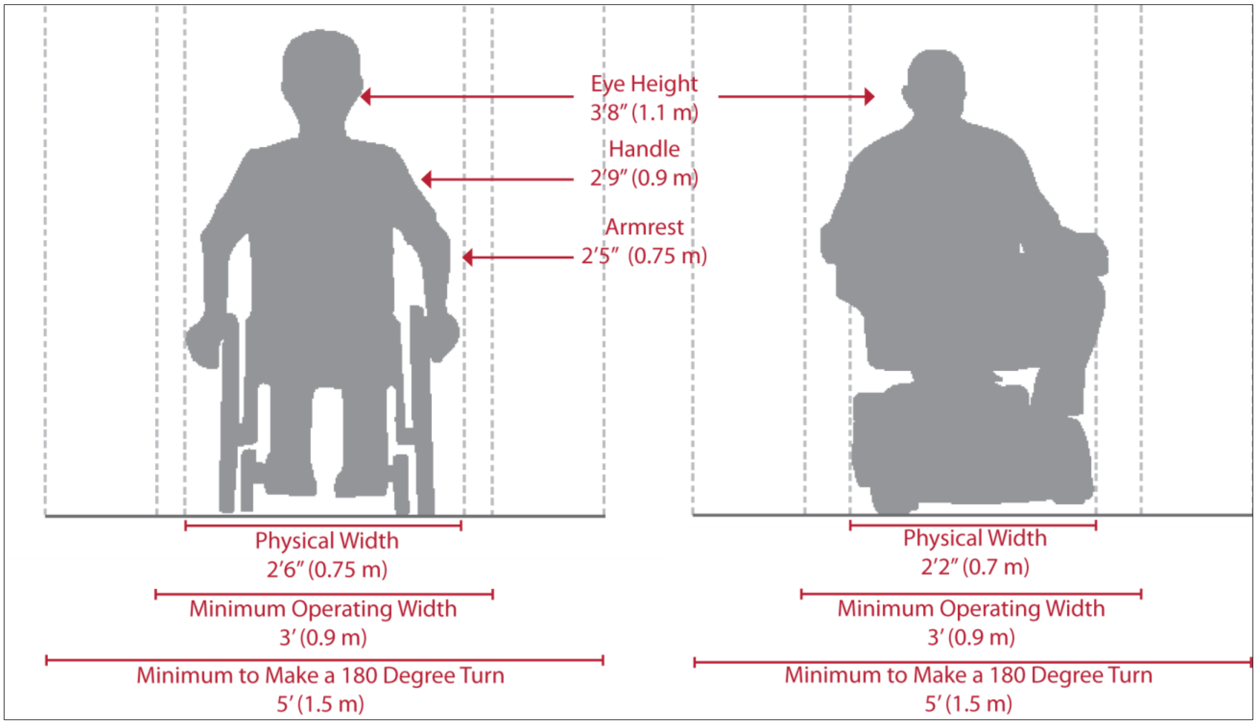


Walkers:

- Speed of travel: 1-3 mph
- Need wide areas for walking in groups
- Are comfortable walking on sidewalks and multi-use paths that are grade-separated from vehicle traffic and faster active travelers

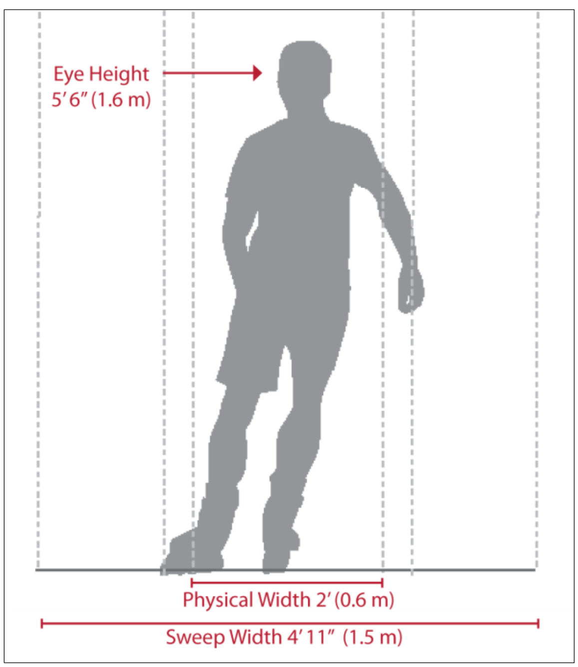
Runners:

- Speed of travel: 3-9 mph
- Are comfortable running on sidewalks but prefer smooth paths with consistent lighting and non-slip surfaces that are grade-separated from vehicle traffic
- Faster, more confident runners may prefer to share space with cyclists during periods of high pedestrian traffic



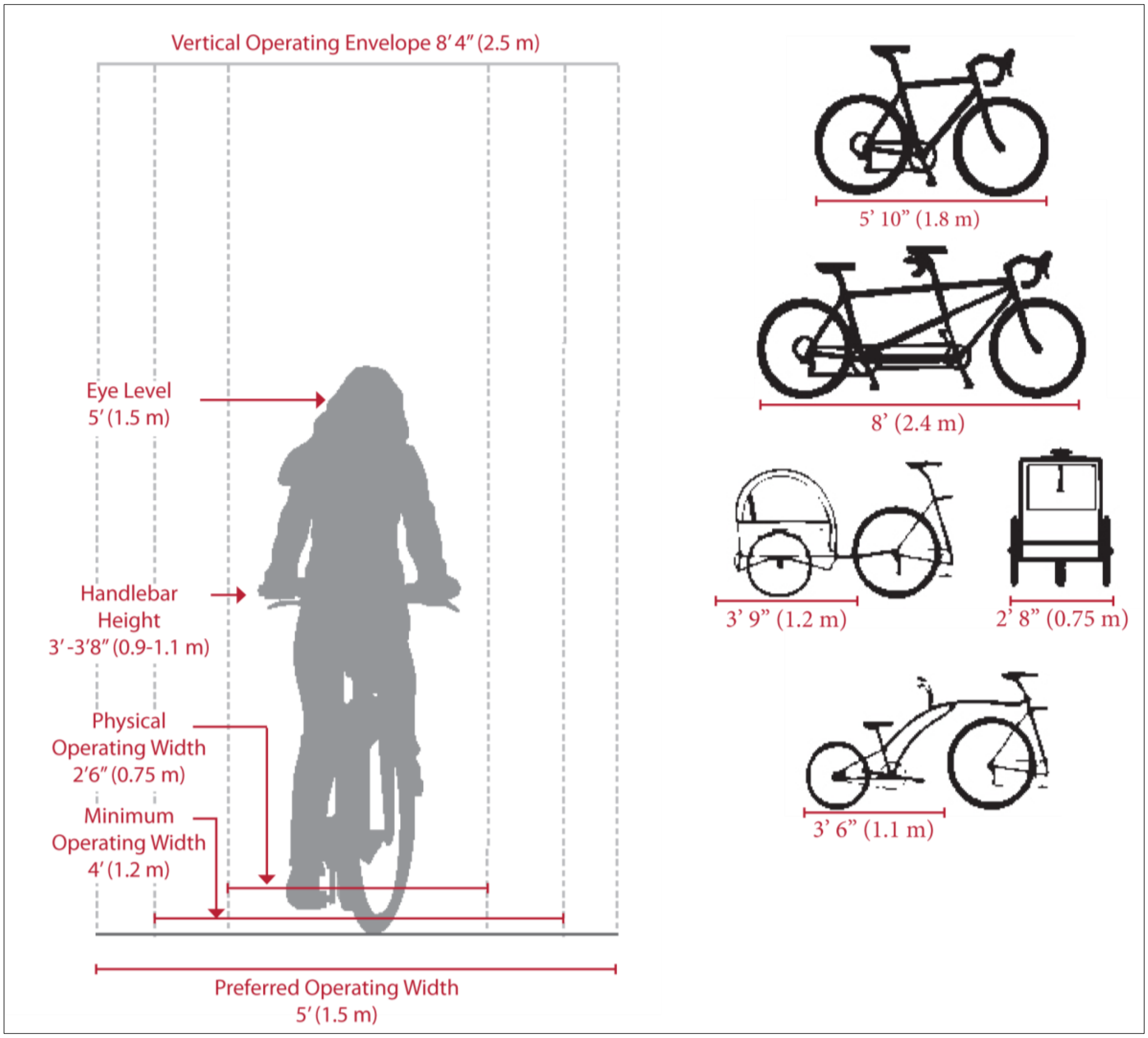
Wheelchair Users:

- Non-motorized speed of travel: up to 6 mph
- Motorized speed of travel: up to 8 mph with average speed of 3-4 mph
- Are comfortable operating on sidewalks and multi-use paths that are grade-separated from vehicular traffic and faster active travels



In-line Skaters:

- Speed of travel: 3–30 mph
- Prefer off-street paths with adequate horizontal maneuvering space
- Require consistent lighting and smooth surfaces, especially at transitions (such as control joints)
- May prefer to use the pedestrian path during slow ascents, transferring to the bikeway on faster descents or during times of high-pedestrian traffic



Bicyclists of All Ages and Abilities (majority of cyclists fall into this category):

- Speed of travel: 8-12 mph
- Prefer bicycle-only paths, shared-use paths, neighborhood greenways, or bicycle facilities on low-volume, low-speed streets
- Tend to avoid cycling on streets with heavy traffic
- May ride on the sidewalk, particularly if there is no on-street facility
- Since it is becoming more common for cyclists to pull trailers, it is recommended that the active travel facility design accommodate these devices; bicycles pulling trailers require additional maneuvering space

Confident and Experienced Bicyclists:

- Speed of travel: up to 25 mph on level grades and 40 mph on steep descents
- Are comfortable riding on most streets but prefer on-street bike lanes, paved shoulders, or bicycle-only paths when available
- Avoid riding on the sidewalk
- Prefer a direct route

Design Speed

A design speed of 20 mph is recommended for the main span of the Northgate Pedestrian and Bicycle Bridge. Assuming the grades of the approaches will not exceed 5 percent, the recommended design speed of the approach ramps is 30 mph. These design speeds, as recommended by the City of Minneapolis Bicycle Facility Design Guidelines, reflect the expected speed of the design vehicle (bicycle pulling trailer) on descending grades longer than 500 feet. Design speeds influence widths, grades, horizontal curves, and stopping distance.

Why Are Best Practices Important?

Bridges represent an important piece of active transportation networks. When confronting physical barriers, active transportation facilities that are direct, safe, and comfortable should be a top priority to meet the needs of active travelers.

Building a great active transportation facility requires an understanding of best practices in facility design combined with insight into local conditions and trends. This memo investigates and recommends best practices related to active transportation facilities on bicycle and pedestrian bridges. We have synthesized information from NACTO, FHWA, AASHTO, and MUTCD, as well as information from the Seattle Pedestrian Lighting Plan, Minneapolis Bicycle Facility Design Guidelines, and the CROW manual. Full citations of these documents appear at the end of the memorandum.

A single inconvenience, such as a difficult intersection or circuitous link, can render an otherwise attractive facility undesirable and unused. The best practices outlined in this memorandum must be comprehensively packaged to provide the best possible user experience for all of the active transportation user groups.

Key Factors and Characteristics for Active Transportation Facilities

This section introduces the design principles and guidelines that inform successful active travel facilities worldwide. Reference guidelines were used to compile a comprehensive suite of design principles related to active travel facilities for the Northgate Pedestrian and Bicycle Bridge. All design recommendations provided are consistent with the minimum AASHTO guidelines.

The design principles and guidelines are broken down into three sub-sections, which reflect different elements of successful active travel facility design that accommodate a range of users, employs sophisticated path design, and is accessible. They include:

- Path design
- Vertical circulation
- User comfort

This bridge in Minneapolis shows separation of bicycle and pedestrian traffic by striping.

PATH DESIGN

The main component and most easily manipulated element of active transportation facilities is the design of the path. Whether on the bridge or other connecting elements, path design that incorporates best practices has a direct impact on the user experience of the facility. Path design affects a user's perception of accessibility, safety, efficiency, and attractiveness of the facility. Good path design also reduces conflicts between the different active transportation groups using the facility.

Active travel facilities need to be accessible to all types of active travel users. Addressing concerns related to ease of access and convenience, grades, cross-slope, surface materials, and transitions are necessary during the design process of the facility.

PATH WIDTH

In instances where grades are such that cyclists (the fastest active travelers) can be expected to travel at more than 20 mph, it is advisable to separate cyclists from other active travel users, particularly if two-way travel is permitted. Separation can be marked by a rollover curb or by a change in materials.

The recommended minimum width for a two-way separated path is 20 feet (5 feet in each direction for bicyclists, a 6-foot walkway for pedestrians, and 2-foot clearance on either side of the path). This bridge should allow bi-directional travel of all users and permit passing by faster moving runners, cyclists, or skaters. Determining appropriate path widths involves consideration of several factors:

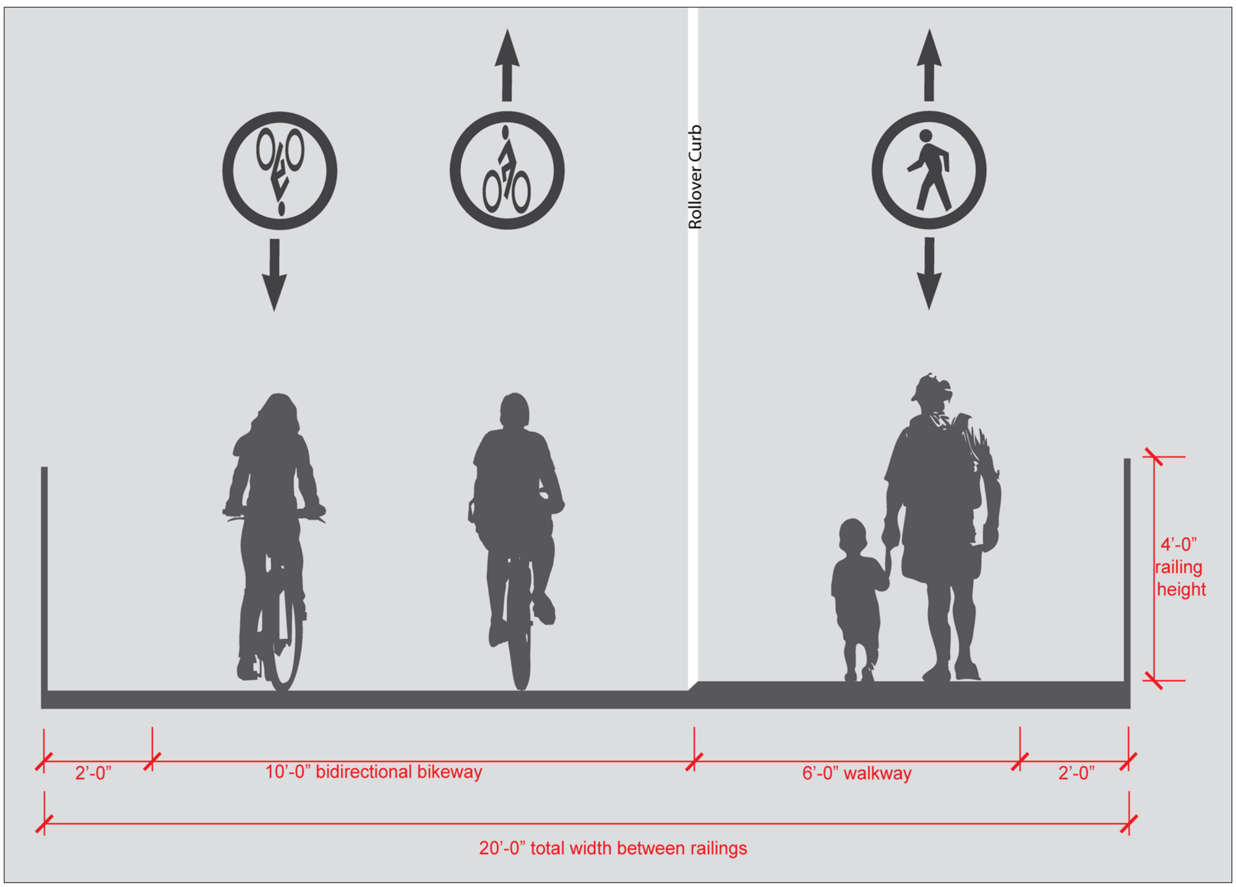
- Anticipated pedestrian and bicycle use (e.g., volumes)
- Sufficient maneuvering space to avoid fixed objects (e.g., railings and barriers)
- Potential conflicts between differing users (e.g., users traveling at differing speeds, users traveling in opposite directions, and users stopped on the bridge)

- Real or perceived safety issues (e.g., the “tunnel effect” created by some enclosed structures)
- Anticipated use by in-line skaters, children, or bicycles towing trailers
- Curves, intersections, and areas with sightline constraints
- Steep grades where the speed differential between users in each direction is greatest
- Anticipated use by maintenance and emergency vehicles

Overcrossings wider than the recommended minimum best address these issues.

The width of the path on the bridge should be at least as wide, or wider than, connecting active travel facilities plus an additional 2-foot clear width from vertical barriers. Carrying the clear width across the structure provides minimum, horizontal shy distance from the railing or barrier and offers space to allow faster-moving cyclists and in-line skaters to avoid conflicts with other users.

Figure A.2—Recommended Widths for Bicycle/Pedestrian Lanes on Active Transportation Bridges



In circumstances where flows are concentrated in a particular direction during peak hours (i.e. minimal bi-directional traffic exists), a centerline unnecessarily reduces space for passing and maneuvering. Ideally, no centerline should be included, allowing users to organize themselves according to the circumstances. By contrast, edge lines can be included from the outset since they are helpful as a means to highlight the path edges and obstacles during low light conditions.

In circumstances where pathways experience high bi-directional volumes or operational challenges, such as sight distance constraints, the use of centerline stripes on a path can help to clarify the operating space allocated to users traveling in opposite directions. A solid centerline is used to separate opposing traffic where passing is not permitted, and a broken line where passing is permitted.

Given the expense and expected life cycle of the overcrossing, it is recommended that the path width be designed to provide an acceptable level of service (LOS) for expected active transportation use for the duration of the bridge's expected life-cycle. The FHWA Shared-use Path Level of Service calculator can provide guidance on acceptable path width for various user volumes; however, at high bicycle and pedestrian volumes, the accuracy of the calculator is compromised.

This bicycle and pedestrian bridge shows clear separation between pedestrians and bicyclists.

GRADES

Ideally, grades should be no greater than 3% on bridges and connecting active travel facilities. Grades greater than 3% become increasingly difficult for bicyclists, especially for longer ascents.

The AASHTO Guide for the Development of Bicycle Facilities recommends that bicycle paths be no steeper than 5%. However, this is a relatively steep incline for a prolonged amount of time, and it would be advisable to provide periodic flatter areas along the bridge for resting platforms. The Americans with Disabilities Act (ADA) stipulates that the lowest grade shall be used wherever possible and that no ramp shall ascend more than 30 inches without an intermediate landing to rest.

Whenever grades exceed 3%, an additional 4 to 6 feet of width should be added to the path to permit ascending bicyclists to overtake slower bicyclists and to provide additional space for maneuvering for descending bicyclists.

Top: Minneapolis—Long, gradual approach ramps lead to the main span of this bicycle and pedestrian bridge. Above: Netherlands—This bridge approach includes curves with large radii and clear sight lines.

HORIZONTAL CURVES

AASHTO provides guidance for determining appropriate curve radius for various design speeds for bicycles. Given the expected limited room for ramps for the bridge, the recommended design speed for the curves at any switchbacks should be a minimum of 12 mph. Curve warning signs in compliance with MUTCD standards should be placed in appropriate locations to alert faster descending bicyclists of upcoming conditions. Additional width is recommended at curves to provide additional maneuvering space for path users.

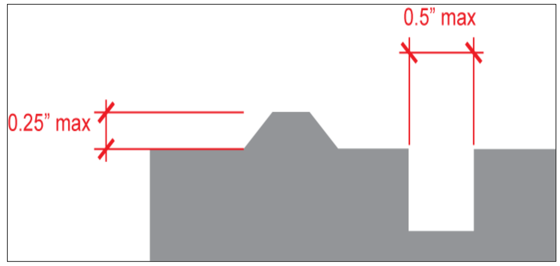
SIGHT AND SHOPPING DISTANCES

Sight distances along the bridge and approaches should accommodate the expected travel speed for bicycles. AASHTO provides guidance for minimum stopping distance. This guidance should also be utilized to consider sightlines for intersections and horizontal and lateral curves.

SURFACE AND SURFACE TRANSITIONS

The quality of the path surface and transitions should be considered to accommodate a high level of comfort for wheeled users. Transitions between paths and bridge decks should be smooth with no lips or bumps protruding more than one-quarter inch. Gutter seams, drainage inlets, and utility covers should be flush with the surrounding surface and oriented to prevent conflicts with the tires of wheelchairs, strollers, skates, and bicycles. All surfaces should be textured in a way to be skid-resistant.

Figure A.3—Maximum Dimensions for Joints



VERTICAL CIRCULATION

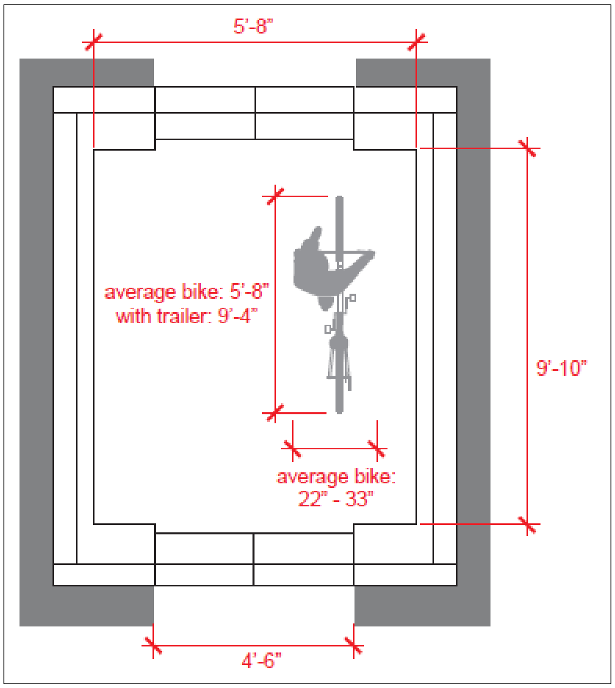
Bridge access designs vary considerably and can include direct ramps, spiral ramps, stairs, and elevators. Depending on the scenario, one element may be more appropriate than another. All of these options have implications on the different user types that should be considered. A bicyclist, wheelchair user, or elderly person can find stairs to be a significant inconvenience. Multiple options for gaining elevation to access the bridge should be provided to accommodate the widest range of active travelers.

RAMPS

Ramps provide a seamless connection for wheeled users between active transportation facilities on the ground and the bridge deck. Ideally, a ramp accommodates active travelers by having a gradual slope and following the general desired direction of travel. When space constraints require switchbacks, extra space should be provided to accommodate increased maneuverability. Additionally, ramps should be wider than the bridge to allow for passing and increased maneuverability.

Netherlands—Long, gradual approach ramps provide a seamless user experience for bicyclists on this bridge.

Figure A.4—Minimum Recommended Dimensions for Elevator Cabs Intended to Accommodate Bicycles



ELEVATORS

When space constraints or a circuitous journey requires stairs or a long path, an elevator provides a more efficient option for some users. It is vitally important that persons with disabilities and bicyclists with non-standard-sized bikes and/or trailers are provided with facilities that allow an adequate level of access.

Elevator cabs should be sized to accommodate multiple bicycles of varying sizes, including trailers. The cab should also include front and back doors to allow bicyclists to pass through for ease of loading and unloading.

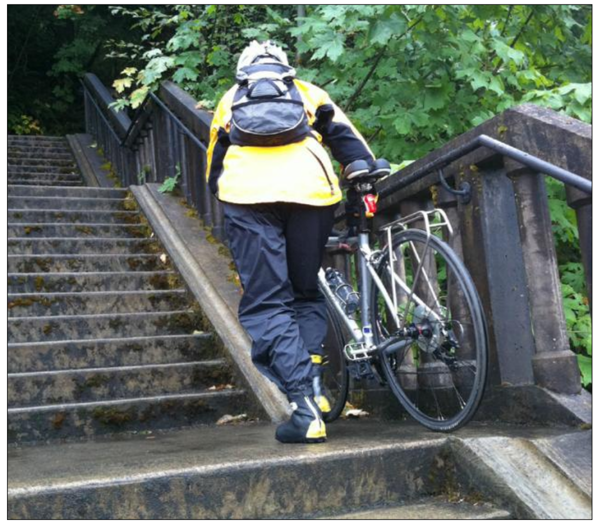
The installation of two elevators could reduce wait times and provide a significant improvement in the level of service experienced by bicyclists and pedestrians. Additionally, multiple elevators provide redundancy in the system to accommodate maintenance issues and repairs. If bicyclists and pedestrians experience a significant level of delay on a regular basis and are not provided with alternate means to access the bridge, the level of service for the bridge is likely to be significantly impacted.

STAIRS

Stairs are useful to pedestrians in constrained circumstances with steep grades but do not accommodate wheelchairs or strollers. When stairs are included in a design, cyclists can also be accommodated through the use of wheel runnels.

Where stairs are used to overcome a significant grade change, runnels (thin ramps placed along staircases with bicycle tire-sized grooves cut into them) should be used so that cyclists can roll their bicycles up or down the staircase with ease. Careful attention should be paid to the design of bicycle runnels. Accessibility requirements for handrails can conflict with the use of bicycle runnels, as handrails may obstruct or decrease the control of the bicycle.

Copenhagen—Easy-to-use shallow stair angle and wide wheel tray.



Clockwise from above: Vancouver Island B.C.—Very steep stair runnel, with the handrail only in the center of the stair. Historic Columbia River Highway State Trail, Oregon—Retrofit stair on very steep stair; railing interferes with handlebars and bags. Portland, Oregon—Stairway retrofit.

USER COMFORT

Convenient and comfortable facilities are important to make them attractive to a wide range of active travelers. Such facilities are safe, well-lit, provide protection from noise and weather, and incorporate effective wayfinding.

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (CPTED)

The American National Crime Prevention Institute suggests that proper design and effective use of the built environment can lead to a reduction in fear and incidence of crime and an improvement in the quality of life.

Active travel facilities on bridges should provide natural surveillance between active travel users to deter crime and enhance the sense of safety. Designs that avoid blank walls, use high-quality materials, and provide consistent lighting and clear sightlines are the most effective at allowing facility users to see and react to one another. Regular maintenance reduces the incidents of vandalism and creates an attractive environment that discourages undesirable activities.

ILLUMINATION

For active transportation facilities, pedestrian-scale lighting is preferred to tall, highway-style lamps. Pedestrian-scale lighting is characterized by shorter standards; closer spacing of standards; lower levels of illumination (except in areas with potential conflict between users); and the use of lamps that provide better color rendition, which facilitates better recognition over long distances. On bridges, light fixtures embedded in handrails that cast a downward light pattern are an option to provide well-lit pavement surfaces with low glare.

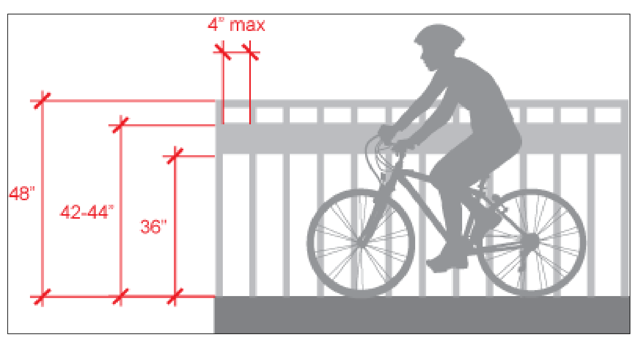
Depending on the location, average maintained horizontal illumination levels between 0.5 and 2 footcandles (5 to 22 lux) should be achieved. For personal safety, higher lighting levels may be necessary in some locations.

Top: Pedestrian-scale light standards on a bridge.
Above: Copenhagen–Handrail lighting.

RAILINGS AND BARRIERS

Railings are necessary for the safety of pedestrians and bicyclists. A railing height of 48 inches is recommended for bridges that include bicycle travel. Where a cyclist's handlebar may come into contact with a railing or barrier, a smooth, wide rubrail should be installed. Bridges over roadways require a barrier to prevent objects from being thrown down onto the roadway.

Figures A.5 and A.6 —The Seattle Pedestrian Lighting Citywide Plan recommends handrail lighting for pedestrian bridges.



Netherlands—Noise barriers on a bicycle and pedestrian bridge over a major highway.

NOISE AND WEATHER BARRIERS

Active transportation facilities that are in close proximity to high volumes of truck traffic (more than 10% of traffic) and exposed to the elements can leave active travel users exposed to uncomfortable levels of noise and wind. It is recommended that steps be taken to mitigate exposure to noise levels higher than 85 dBA. It is recommended to take steps to mitigate exposure to winds greater than 20 mph.

WAYFINDING

Wayfinding is the process of finding your way to a destination and an essential piece to any active transportation facility. In order to function properly, wayfinding information must be provided in a logical, consistent, and reliable manner. Comprehensive signage and pavement markings guide active travel users to their destinations along preferred routes. Maps and/or signs should be placed at decision points along the route. Pavement markings, meanwhile, tend to support and reinforce information on signs, provided information concerning lateral positioning, turning movements, and direction of travel.

For faster active travelers, including bicyclists, a three-tiered system should be implemented:

- Decision signs—marking an upcoming junction and informing travelers of the route to take in order to reach key destinations
- Turn signs—indicating where a multi-use path turns from one street or path to another
- Confirmation signs—indicating to users that they are on the correct route toward their destination

For pedestrians and slower-moving active travelers, a decision sign is not required. A two-sign system should be implemented, consisting of turn signs and confirmation signs.

CONCLUSIONS AND RECOMMENDATIONS

This memorandum identifies four principles that are important to consider when designing a direct, safe, and comfortable active transportation facility. The facility should:

- accommodate active travelers of all ages and abilities;
- have a path design that considers width, grades, curves, sight distance, and surfaces;
- have vertical circulation that meets the specific needs of active travelers; and
- be a convenient and comfortable facility that is safe, well lit, provides protection from noise and weather, and incorporates effective wayfinding.

Together, these principles define the physical characteristics that encourage active travel use. Implementing elements from these principles will help guide the design of the Northgate Pedestrian and Bicycle Bridge.

Access Recommendation Summary

PATH DESIGN

- *Design Speed*
  Main Span: 20 mph
  Approaches: 30 mph
- *Grades*
  Maximum of 5%
- *Horizontal Curves*
  Switchbacks designed for ≥ 12 mph
- *Sight and Stopping Distances*
  – Per AASHTO
- *Surface Transitions*
  Maximum Bump ≤ 1/4 inch
- Maximum Gap ≤ 1/2 inch

VERTICAL CIRCULATION

- *Ramps*
  Maximum Grade of 5%
- *Elevators*
  Sized to accommodate bicycles with trailers
- *Stairs*
  Provide Runnels

USER COMFORT

- *Railings*
  Height = 48 inches
  Opening ≤ 4 inches
- *Noise and Weather Barriers*
  Height: Straight = 8 feet; curved = 10 feet

SOURCES FOR ADDITIONAL INFORMATION

American Association of State Highway and Transportation Officials. *Guide for the Development of Bicycle Facilities*. United States of America. American Association of State Highway and Transportation Officials Publication, 2012

American Association of State Highway and Transportation Officials. *Guide for the Planning, Design and Operation of Pedestrian Facilities*. United States of America. American Association of State Highway and Transportation Officials Publication, 2004

City of Minneapolis, Department of Public Works. *Minneapolis Bicycle Facility Design Guidelines*. Minneapolis, MN, May 2010

CROW. *Design Manual for Bicycle Traffic*. Ede, The Netherlands, 2007

National Association of City Transportation Officials. *Urban Bikeway Design Guide*. http://nacto.org/cities-for-cycling/design-guide/

Seattle Department of Transportation. *Pedestrian Lighting Citywide Plan*. Seattle, WA, 2012

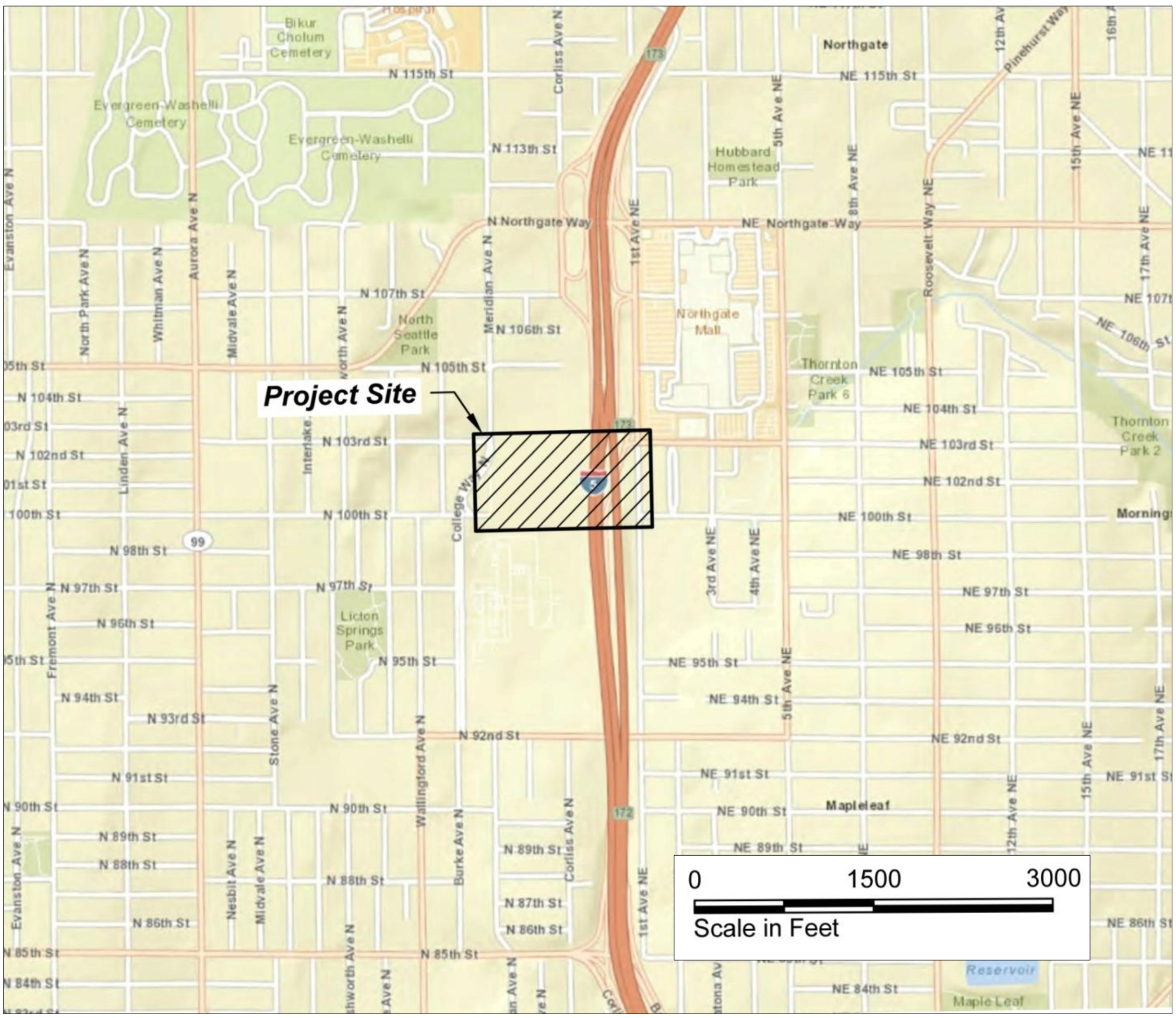
U.S. Department of Transportation. *Manual on Uniform Traffic Control Devices*. Washington, D.C.: U.S. Government Printing Office, 2003 and 2009

Appendix B
Geotechnical Analysis and Recommendations

PROJECT OVERVIEW

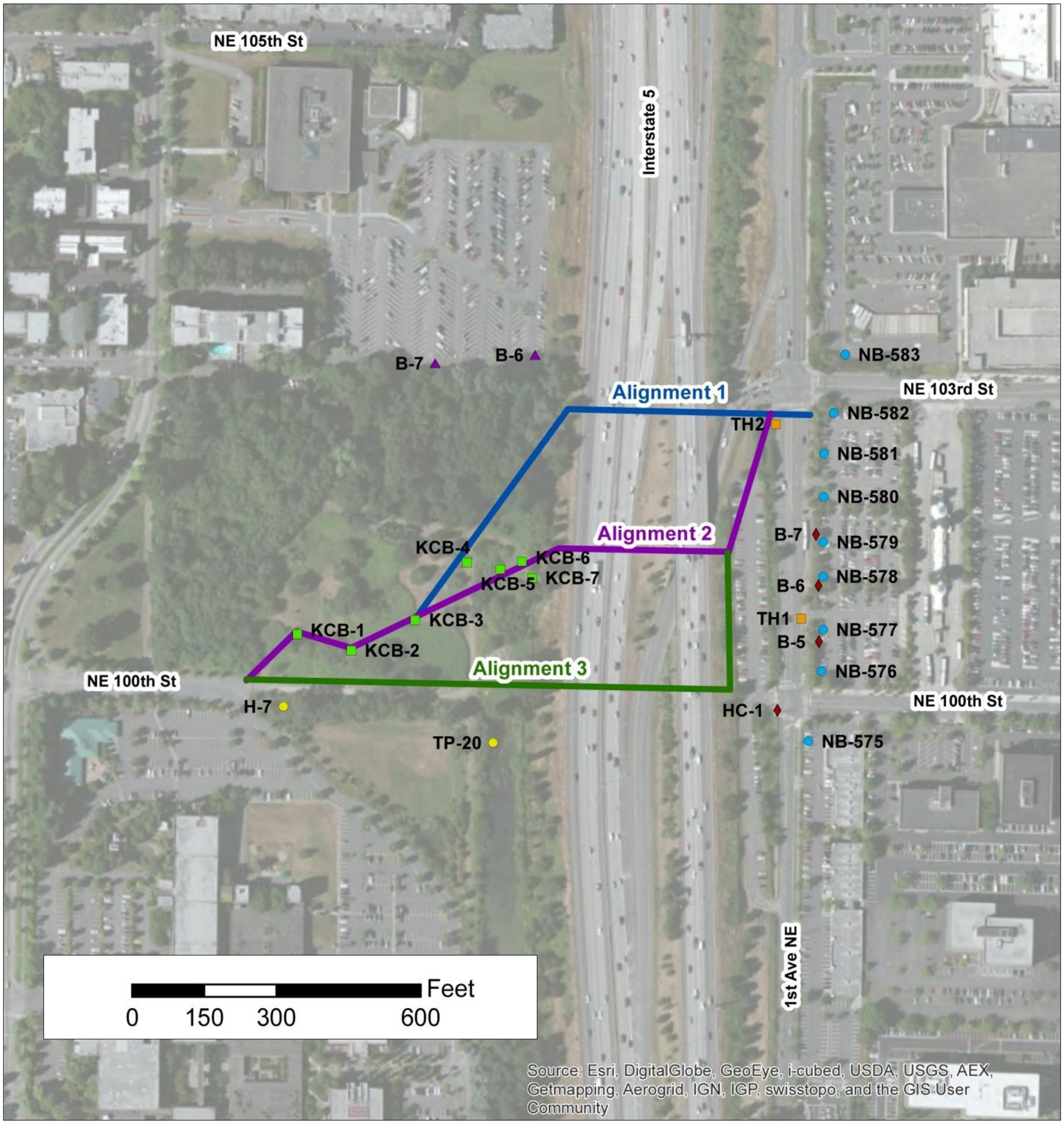
The Northgate Pedestrian and Bicycle Bridge location is shown in Figure B.1. The alternatives analysis includes three east-west alignments. The alignments shown in Figure B.2 come from previous work by King County and include King County's Alignment 1 (north), Alignment 2 (middle), and Alignment 3 (south).

Figure B.1—Project Location



Source: *Base map prepared from ArcGIS Online 2014*

Figure B.2—Alignments



Exploration Location and Number

- King County DOT (2012)
- Shannon & Wilson (2012)
- GeoEngineers, Inc. (1988)
- Hart Crowser (1988)
- Seattle Engineering Department (1974)
- Shannon & Wilson (1968)

Subsurface Conditions

Existing Subsurface Information

Our geotechnical recommendations are based on soil boring logs from the following documents. Note that the elevations provided on boring logs may not accurately reflect the current site conditions because of over-excavation and filling at the site, since the elevations were measured. The elevation datum used throughout this appendix is the North American Vertical Datum of 1988 (NAVD88).

GeoEngineers 1998. Health Resources Northwest Site. August 12, 1998
Hart Crowser 1988. METRO Northgate Transit Center/Park and Ride. December 10, 1988
King County Department of Transportation 2012. Northgate Pedestrian Bridge Preliminary Geotechnical Investigation
Seattle Engineering Department 1974. 1st NE S.S. March 6, 1974
Shannon & Wilson 1967. North Campus Seattle Community College. June 1, 1967
Shannon & Wilson 1968. Report on Foundation Investigation Seattle Community College North Campus. January 26, 1968
Shannon & Wilson 2012. Draft N160 Geotechnical Data, Sound Transit, Northgate Link Extension Final Design, Seattle, Washington. November 16, 2012
Washington State Highway Commission Department of Highways. Seattle Freeway, Multiple Projects, 1960s

Additional Notes

Many explorations were done in the vicinity of the proposed bridge by the Washington State Highway Commission during the 1960s; however, we have not used the information from these explorations because the horizontal and vertical locations are uncertain, the explorations are too shallow, and the explorations lack quantitative soil density information. Because the explorations are of too poor quality to be used for bridge design, we have not included these explorations here.

Field explorations were not conducted for this preliminary study. Accordingly, our recommendations are based on the available site information and our judgment of the likely soil conditions.

We recommend additional field investigation during the design phase to more accurately define the soil conditions and to develop final recommendations.

Soil Conditions

The locations of historical subsurface explorations are shown on Figure B.2. For this preliminary memorandum, we divided the span into three areas: the area east of I-5 (East Area), the area between the north and southbound lanes of I-5 (Middle Area), and the area west of I-5 (West Area).

Once the bridge alignment is finalized, we will complete a boring at each pier and provide subsurface conditions at each pier location. According to the available information, we interpret the subsurface conditions in the three general areas are as follows:

- **East Area.** Subsurface conditions in the East Area generally consists of 3 to 7 feet of fill, overlying loose to medium dense coarse-grain soils, and very soft to medium stiff fine-grained soils, overlying very dense, glacially over-consolidated coarse- and fine-grained soils. Glacially consolidated, hard peat layers were observed in borings NB-577 through NB-582 at depths of 48- to 99-feet bgs; typical reported peat layer thicknesses were 3 to 5 feet with a maximum 10-foot thick layer in NB-580.

  Bridge foundations should bear within very dense/hard glacially over-consolidated soils (bearing soils). We expect that the depth to bearing soils in the East Area varies from about 10 to 28 feet below ground surface (bgs).

- **Middle Area.** There is insufficient subsurface information in the Middle Area to provide adequate information for bridge foundation design. We recommend additional subsurface exploration once the bridge alignment has been finalized. For planning purposes, we expect the depth of the bearing soils in the Middle Area to be similar to that of the East Area.

- **West Area.** Subsurface conditions in the West Area generally consist of 2 to 10 feet of fill overlying glacial deposits. Fill generally consists of loose to dense silty sand. Glacial deposits generally consist of medium dense to very dense coarse-grained soils. KCB-4 encountered hard, fine-grained soils from 35- to 40-feet bgs and from 65- to 75-feet bgs. KCB-6 encountered hard, fine-grained soils from 30- to 70-feet bgs. We expect the depth to bearing soils in the West Area varies from about 3- to 15-feet bgs.

Groundwater Conditions

In the West Area, groundwater was encountered (at the time of drilling) at about 15-feet bgs in borings KCB-1, -2, -5, and -7. These water levels likely represent water perched on underlying low permeability soils. Monitoring wells were not installed in the West Area borings.

In the East Area, the draft Sound Transit Northlink (Shannon & Wilson 2012) borings include vibrating wire piezometers (VWPs) and observation wells (OWs).

The available report includes data from roughly summer 2011 to summer 2012 and is reproduced in Figure B-3. Different water levels were measured in the same boring at different depths indicating that there is probably perched and confined groundwater throughout the subsurface. The water level depths in these borings over the measurement time period varied from about 7 to 25 feet below ground surface.

Figure B.3—East Area Water Level Readings

Well ID	Instrument Depth (ft)	Instrument Elevation (ft)	Water Level Elevation (ft)	
			Low	High
NB-575 VWP1	55.6	196.3	243.5	244.8
NB-575 VWP2	90.6	161.3	234.9	240.1
NB-576 VWP1	98.2	155.3	228.9	230.9
NB-578 VWP1	34	220.4	244.7	246.4
NB-580 VWP1	18.2	237.2	245.7	248.5
NB-582 VWP1	95.1	162.2	238.0	239.9
NB-583 OWP1	27	247.2	256.7	257.7
NB-583 VWP1	105	169.2	253.1	253.7

Seismic Geologic Hazards

Potential seismically induced geotechnical hazards include surface rupture, liquefaction and subsidence, lateral spreading, and landslides.

Surface Rupture

Because there are not any known faults underlying the site, the risk of surface rupture is very low.

Liquefaction and Subsidence

We have performed a screening level assessment of liquefaction potential from available borings. Based on the borings done by King County (King County DOT 2012), there is a low risk of liquefaction in the West Area.

Based on the borings completed for the Sound Transit Northlink (Shannon & Wilson 2012), there is a risk of liquefaction and subsidence in the East Area. The depths of potentially liquefiable soils in the East Area could range from about 15 to 45 feet below ground surface.

Lateral Spreading or Flow Failure

Lateral spreading or flow failure is caused by liquefaction or reduced shear strength of soil within or under a slope. Based on our review of the topography, the risk of lateral spreading or flow failure impacting the proposed bridge is low.

Seismic Design Parameters

Seismic design parameters were determined using the U.S. Seismic Design Maps tool *(http://geohazards.usgs.gov/designmaps/us/application.php)*. The tool uses the 2002 U.S.G.S. hazard data, which is consistent with the 2012 AASHTO LRFD Bridge Design Specifications. Spectral response values for Site Class B (soft rock) are provided in Figure B.4.

Figure B.4—Seismic Design Parameters

Parameter	Value
Latitude	47.7021°
Longitude	−122.3302°
Probability of Exceedance	7% in 75 years
Spectral Response Acceleration at Short Periods, S_S	0.909 g
Spectral Response Acceleration at 1-Second Periods, S_1	0.308 g
Peak Ground Acceleration, PGA	0.408 g

Soil Site Class and Site Factors

We determined the site soil class in accordance with the 2012 AASHTO LRFD Bridge Design Specifications (AASHTO 2012). Based on the available information, the soil site class varies from C to E across the site (encompassing all three potential alignments).

The entire West Area is most likely site class C, based on the King County borings. The site class in the East Area varies from E at the south end of Alignment 3 to C at the north end of Alignment 1. Suitable borings for soil site class evaluation are not available in the Middle Area.

Table 3 summarizes the expected soil site class by general area. For final design, soil site class should be evaluated at each pier location.

According to Table 3.10.3.1-1 of the 2012 AASHTO LRFD Bridge Design Specifications (AASHTO 2012), soils with greater than 10 feet of peat are Site Class F and require a site-specific evaluation (ground response analysis).

Glacially consolidated, hard peat layers were observed in borings NB-577 through NB-582 at depths of 48- to 99-feet bgs. Boring log NB-580 reports a 10-foot-thick layer of peat from 68.5- to 78.5-feet bgs. In our opinion, these glacially over-consolidated, hard peat layers (typical SPT N>50) are not representative of those soils classified by Site Class F and should not automatically trigger the requirement for a site-specific evaluation.

We do not expect that a ground response analysis is necessary for this site; however, we can provide this service if required by the bridge authority or desired by the structural engineer.

Figure B.5—Soil Site Class and Site Factors

Area	Boring	Soil Site Class	F_a	F_v	F_{pga}
West	KCB-4,-6	C	1.036	1.492	1.000
East-North	NB-575	E	1.136	1.783	1.092
East-Middle	NB-579	D	1.009	2.766	0.900
East-South	NB-582	C	1.036	1.492	1.000

Foundation Recommendations

At this report preparation, final alignment, bridge type, and foundation loads have not yet been determined. Based on our experience, we expect that drilled shafts will be the preferred foundation type for the Middle and East Areas and that either spread footings or drilled shafts are feasible in the West Area.

Foundations should bear within very dense/hard glacially over-consolidated soils (bearing soils). The expected depth-to-bearing soils in the West Area is about 3- to 15-feet bgs. The expected depth-to-bearing soils in the East Area is about 10- to 30-feet bgs.

The bottom of the shafts should be designed and constructed to not bear in the peat layers found within the glacially over-consolidated soil deposits. (See Figure B.6.)

Liquefaction is not expected in the West Area but may occur in the East Area. Assessment of liquefaction potential in the Middle Area will require additional borings. Liquefaction and potential down-drag loads will need to be determined as part of shaft design.

Figure B.6—Foundation Recommendations

Area	Foundation Recommendation
Middle Area	Liquefaction potential will require additional borings; drilled shafts preferred
East Area	Depth-to-bearing soils is 10- to 30-feet bgs; drilled shafts preferred
West Area	Depth-to-bearing soils is 3- to 15-feet bgs; spread footings or drilled shafts are feasible

Appendix C
Public Outreach

PUBLIC OUTREACH SUMMARY

Outreach was identified early on as a priority for the Northgate Pedestrian and Bicycle Bridge project. The project provides an exciting opportunity to create a substantial and lasting connection between communities, and the public's input, views, and ideas are important to ensuring the best possible outcome. Specifically, a robust outreach and communications effort was identified as critical to the realization of the following project goals:

- defining good connections for the community;
- developing connections and supporting elements that benefit users (bicyclists, pedestrians, ADA users);
- ensuring safety for users and the general public;
- considering environmental factors and construction impacts when evaluating design alternatives and construction approaches; and
- designing a structure that is aesthetically pleasing.

Outreach strategy was developed in early 2014 and articulated in the Public Involvement Plan, which detailed outreach goals, objectives, and mechanisms, provided demographic information, and identified key stakeholders. This plan laid the groundwork for future outreach activities.

STAKEHOLDERS

Key stakeholders and partner organizations were identified early in the life of the project. Agency and organization stakeholders have received briefings on project information and progress reports since the project's inception, and community stakeholders received briefings in the spring of 2014.

Public Engagement Mechanisms

The following mechanisms have been employed to inform and engage the community within and near the proposed project area:

- **Project Website.** A project website dedicated to the Northgate Pedestrian and Bicycle Bridge was developed to convey general project information, announce upcoming events, and make available collateral materials and meeting materials.

- **Fairs and Festivals.** Project staff participated in two area public events hosted by other organizations: the Sound Transit 90% Design Open House on March 12, 2014, and the Maple Leaf Summer Social on July 30, 2014.
- **Project Materials.** Through the screening processes, a set of materials was produced in support of the project. These included a fact sheet, brochure, presentations, a Frequently Asked Questions (FAQ) document, and meeting materials. (See Project Brochure below, Figure C-1.)

Figure C.1—Project Brochure

Northgate Pedestrian & Bicycle Bridge

JUNE 2014

PROJECT OVERVIEW

The Northgate Pedestrian and Bicycle Bridge project will design and construct a pedestrian and bicycle overpass across Interstate 5 (I-5) that will connect the communities, neighborhoods, businesses and schools in the Northgate area. The bridge will be in the vicinity of NE 100th and NE 103rd streets and will likely be between 1,800 and 2,200 feet long. Possible alignments, bridge types and connection points to other assets are being evaluated by the project team, with the goal of selecting a preferred option by fall of 2014.

PROJECT NEED

The Northgate area is one of the Puget Sound region's major residential and employment centers. The Northgate Pedestrian and Bicycle Bridge will enable more people to access transit, and create easier movements for residents on both sides of I-5. It is anticipated that more than 7,000 people would use the bridge daily. The existing transit center currently serves over 6,000 passengers a day, and the future light rail station is expected to serve over 15,000 passengers per day.

PROJECT LOCATION

PROJECT BENEFITS

The Northgate Pedestrian and Bicycle Bridge project benefits the area by:

- Increasing ridership at the Transit Center and future Light Rail station.
- Creating an easier connection for students to and from North Seattle College by shortening the walk distance from the Transit Center by almost a mile.
- Providing important access for bicyclists and pedestrians to other improvements coming to the Northgate area.

SDOT

Seattle Department of Transportation

Stakeholder Briefings

Area stakeholders and special interest groups (such as bike, pedestrian, and transit advocacy organizations) are crucial to the successful communication and outcome of the project. As such, the project team briefed these organizations over these months:

Figure C.2—Team Briefings

Organizations	Date
Seattle Bike Advisory Board	February 5, 2014
Seattle Pedestrian Advisory Board	February 12, 2014
Northwest District Council	April 23, 2014
Maple Leaf Community Council	April 30, 2014
Haller Lake Community Club	May 1, 2014
North District Council	May 7, 2014
Licton Springs Community Council	May 21, 2014
Thornton Creek Alliance	June 26, 2014

OPEN HOUSE

Prior to completion of the Step 2 Screening, the project team hosted a public open house on Tuesday, June 3, 2014. This was the primary outreach mechanism used in this phase of the project and provided the opportunity to discuss bridge considerations and to hear from the public. The event was hosted at Olympic View Elementary School between 5:30 and 7:30 p.m. Objectives of the open house were to:

- raise public understanding about the project's purpose, need, and benefits;
- provide an update on the program's elements and schedule;
- introduce the project team;
- emphasize commitment to working with stakeholders and the broader community; and
- provide opportunities for the public to comment on possible routes and bridge types and to receive answers to any questions.

An open house on Tuesday, June 3, provided the project team with an opportunity to discuss bridge considerations and to hear from the public.

The primary means of public notification for the open house were:

- a postcard mailer to more than 23,000 area addresses;
- social media;
- e-mails to stakeholders; and
- posts on area community calendars.

The open house drew more than 70 area residents and businesspeople, as well as representatives of neighborhood organizations and pedestrian and bicycle advocacy groups. Fourteen display boards arranged around the perimeter of the room welcomed attendees to the event, allowed attendees to mark where they lived in relation to the project area, and provided information about pedestrian bridge options, selection criteria, project timeline, and contact information. A presentation was given, followed by a brief question-and-answer period.

The presentation began with an overview of SDOT's goals, missions, and values, presented by Barbara Lee, SDOT's project manager, and previewed the purpose and need for the project. Next, Stephen Van Dyck, lead architect on the project, reviewed the various walk times, bridge types, and approaches that are under consideration. David McMullen, principal-in-charge and project manager, presented how the various approaches and spans would be analyzed and screened.

Finally, Art Brochet, communications lead, reviewed the outreach process to date and discussed next steps. Residents asked questions on a wide range of topics, with many questions focusing on pedestrian and bicycle connections off the bridge as well as safety concerns.

Comment forms were collected throughout the evening, and a project brochure was available for review. In addition, three models of the potential bridge design offered attendees an exciting opportunity to engage with the project, to visualize details, and to ask additional questions.

Open House Feedback

In total, 25 comment forms were received at the open house, and 13 e-mails were received after the meeting with comments pertaining to the project. There was generally very positive support of the project, with some concerns and questions among the comments received.

Key themes included:

- **Safety for Bridge Users**
  - Many comments were received pertaining to lighting, suicide prevention, and deterring homeless encampments.
  - Many comments expressed a need for clear separation of bicyclists and pedestrians for the safety and comfort of all users.
- **Bridge Type and Connection Preferences**
  - Support for the various bridge types was varied, but the tube/truss and cable-stay bridge types garnered the most interest.
  - Connection location and alignment preferences were fairly mixed, with good connectivity to North Seattle College and Sound Transit light rail station cited as the most important.
  - Those who commented on bridge type said it was important to make an iconic or aesthetically interesting bridge.
- **Bicycle Amenities and Connections Off the Bridge**
  - The Northgate Pedestrian and Bicycle Bridge is one of many bicycle and pedestrian improvement projects in the area. Attendees were very excited about the other projects in the Northgate area.
  - Attendees additionally had some questions about connections from those amenities to the bridge.

- **Funding for the Bridge**
    - As previously stated, many in attendance were strongly in favor of building the bridge and wanted to ensure its completion. There were some comments encouraging the use of Sound Transit or other agency money to support the construction of the bridge.

Appendix D
Basis of Design

DESIGN STANDARDS AND REFERENCES

Pedestrian Facilities

1. Washington State Department of Transportation (WSDOT)—*Pedestrian Facilities Guidebook, Incorporating Pedestrians into Washington's Transportation System*, September 1997
2. American Association of State Highway and Transportation Officials (AASHTO)—*Guide for the Development of Bicycle Facilities, 4th Edition*, 2012
3. WSDOT—*Design Manual*, July 2014
4. AASHTO—*A Policy on Geometric Design of Highways and Streets, 6th Edition*, 2011
5. Institute of Transportation Engineers—*Design and Safety of Pedestrian Facilities*, March 1998
6. American with Disabilities Act Accessibility Guidelines (ADAAG)
7. Draft Public Rights of Way Accessibility Guidelines (PROWAG)

Bridge and Structures

8. *AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, 2nd Edition*, with 2015 Interim Revisions
9. *AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition*, with Interim Revisions
10. *AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition*, with Interim Revisions
11. *AASHTO LRFD Bridge Construction Specifications, 3rd Edition*, with Interim Revisions
12. *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, 6th Edition*, with Interim Revisions
13. *WSDOT Bridge Design Manual*, February 2014
14. ASCE 7-10: *Minimum Design Loads for Buildings and Structures*
15. *WSDOT Geotechnical Design Manual*, August, 2014
16. *Seattle Right-of-Way Improvement Manual*, V 3.0

MATERIAL PROPERTIES

- Cast-in-place concrete—f'c = 4,000 psi
- Structural steel—fy, min = 50ksi
- Reinforcing steel—fy, min = 60ksi
- Weathering steel will not be used

DESIGN LOADS

Dead Loads

- Concrete—150 pcf [10]*
- Lightweight concrete—110 pcf [10] *
- Steel—490 pcf [10] *

Live Loads

- Pedestrian load—90 psf [8] *
- Vehicular load—H10 truck (10 tons) [8] *

Wind Loads

- Basic wind speed = 90 mph [12] *
- Ir = 1.15 [12] *
- Vertical uplift = 20 psf [12] *

Snow Loads

- Snow load—20 psf [14]*
- Rain-on-snow surcharge—5 psf [14]*

Temperature Loads

- Temperature range: 0°F to 120°F [13]*
- Normal installation: 64°F [13]*

*Seismic Parameters [10]**

- Probability of exceedance—7% in 75 years
- Site class—TBD through geotechnical analysis
- Seismic design category—TBD after site class
- Spectral response acceleration
- Short period, Ss—0.909 g
- 1-Second period, S1—0.308 g
- Peak ground acceleration—0.408 g

*Collision Loads [10]**

- Railing will be designed for concurrent 50 plf horizontal and vertical loads.
- Longitudinal rails will also be designed for a 200-lb. concentrated load acting concurrently with the above loads [10]*
- Coordinate with WSDOT for design of collision loads or barrier protection at columns near I5 travel lanes

PERFORMANCE PARAMETERS

*Vibration [8]**

Vibrations shall be investigated in accordance with the *LRFD Guide Specification for the Design of Pedestrian Bridges*

Vertical modes shall meet either of the following criteria:

- Fundamental frequency shall exceed 3.0 hertz, <u>or</u>
- Weight of Supported Structure (kips) ≥ $180e^{-0.35\text{frequency}(\text{Hz})}$

Lateral modes shall meet either of the following criteria:

- Fundamental frequency shall exceed1.3 hertz; <u>or</u>
- Complete an evaluation of the dynamic performance to explore and evaluate possible methods of mitigation for lateral structural accelerations (side sway) from footfall patterns that cause pedestrian discomfort

*Deflection [8]**

- Unfactored Live Load Vertical Deflection < L/360
- Unfactored Wind Load Lateral Deflection < L/360

GEOMETRIC PARAMETERS

Path Geometry

- Path Clear Width = 20 feet
- Cross Slope shall not exceed 2%
- Vertical Grade shall not exceed 5%
- Horizontal curves shall have no less than a 27-foot radius for bicycle users

Vertical Clearance

- Minimum vertical clearance over interstate shall be no less than 17’-6”
- Vertical clearance above city streets shall be no less than 16’-6”
- Vertical clearance above pedestrian paths (sidewalks) shall be no less than 10 feet (WSDOT Design Manual)

Foundations

- No piers will be placed in areas identified as wetlands unless agreed to by the City
- 40’-0” no build setback West of I-5 for construction future lane (assume from fog-line)
- All piers shall be no closer than 15’ from existing I-5 traffic lanes (assumed measured from fog-line)
- All piers shall be no closer than 3’ from existing city street traffic lanes (assumed measured from fog-line)
- 4’ minimum clearance at pier locations in sidewalks
- Intermediate pier location in WSDOT right-of-way is TBD without WSDOT approval

Station Connection

- Non-load bearing connection at mezzanine level
- 170 feet South of NE 103rd Street(see Sound Transit station plans)
- Foundation for pier adjacent to station shall be located in the 12’x23’ clear area provided by Sound Transit, 3 feet and 1 feet minimum clear from curb and station respectively

BRIDGE FEATURES

Bridge Railing

- Handrail shall be continuous and provide a barrier that prevents the passage of a 4-inch-diameter sphere from the finished grade to the top of handrail
- Railing height will be no less than 54 inches above the walking surface [13])

Throw Barrier

- Minimum combined height of a barrier rail with curved fence shall be 8 feet, or with a straight fence shall be 10 feet
- Throw barrier infill shall prevent the passage of a 2-inch diameter sphere

Drainage System

- TBD

Deck Joints

- Expansion joints shall be sized based on AASHTO; joints at the riding surface shall not exceed ¼-inch vertical amplitude or ½-inch gap in the riding surface

Lighting

- 20 Lux Minimum

Stairway

- TBD

Elevation

- TBD

Bridge Mounted Signs

- None

Rain Protection

- TB

Wind Protection

- TBD

Noise Protection

- TBD

Deck Deicing System

- None

LANE CLOSURES ON I-5

Nighttime Closures

- TBD

Express Lane Closures

- TBD

Full Closures

- TBD

Lane Closures

- TBD

Construction Laydown Areas

- TBD

BRIDGE AND APPROACHES LAYOUT

The alignment layout shows the alignment recommendation resulting from the draft, "Northgate Pedestrian and Bicycle Bridge Alternative Development and Selection Report." (See next page.)

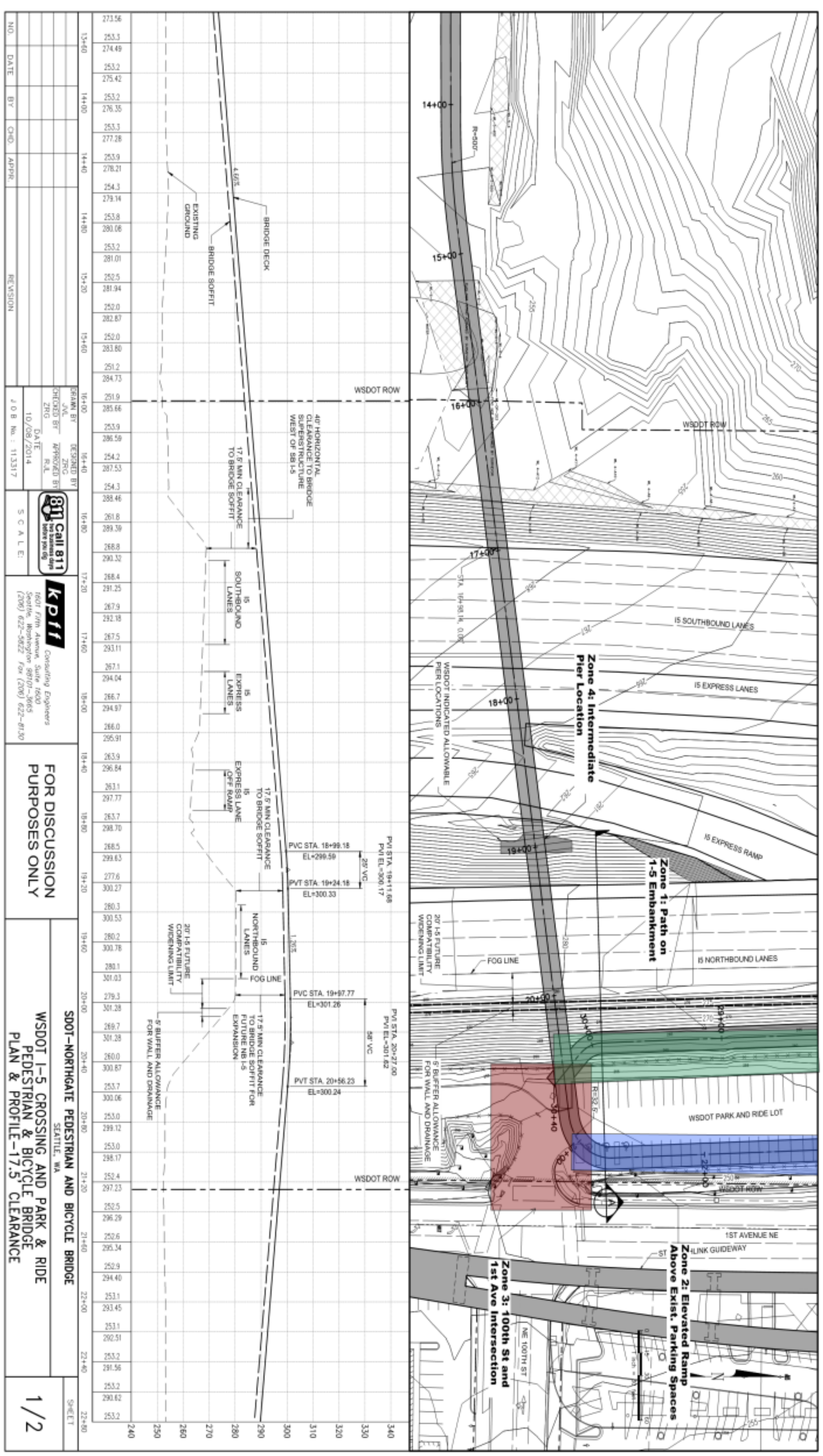
Finalization of a bridge and ramp layout is necessary before final design of the structure can begin.

The layout and location of the Eastern ramp includes:

- East embankment of I-5 Northbound lanes supporting the East Approach path and associated retaining walls (see Zone 1)
- Removing existing parking spaces to accommodate ramp foundations (see Zone 2)
- Path terminus at 100th street intersection (See Zone 3)

Layout and location of the intermediate pier:

- The location of the intermediate pier between the I-5 Express lanes and the I-5 Northbound lanes (See Zone 4)


FOR DISCUSSION PURPOSES ONLY
SDOT–NORTHGATE PEDESTRIAN AND BICYCLE BRIDGE
SEATTLE, WA
WSDOT I-5 CROSSING AND PARK & RIDE
PEDESTRIAN & BICYCLE BRIDGE
PLAN & PROFILE–17.5' CLEARANCE
1/2
kpff
Call 811
Zone 1: Path on I-5 Embankment
Zone 2: Elevated Ramp Above Exist. Parking Spaces
Zone 3: 100th St and 1st Ave Intersection
Zone 4: Intermediate Pier Location
WSDOT ROW
I5 SOUTHBOUND LANES
I5 EXPRESS LANES
I5 EXPRESS RAMP
I5 NORTHBOUND LANES
WSDOT PARK AND RIDE LOT
1ST AVENUE NE
LINK GUIDEWAY
BRIDGE DECK
BRIDGE SOFFIT
EXISTING GROUND