

Metro | Agenda

Meeting: SW Corridor Plan Steering Committee
Date: May 11, 2015
Time: 9:00am to 11:00 a.m.
Place: Tualatin Police Station (8650 SW Tualatin Rd.), Police Department Conference/Training room
Purpose: Progress update on engagement; Shared Investment Strategy roadway, bike and pedestrian improvements; discussion of tradeoffs associated with direct vs. indirect access to PCC Sylvania and considerations for tunnel construction.

9:00 a.m. Welcome and introductions Co-chair Stacey

ACTION ITEM

9:10 a.m. Consideration of the Steering Committee meeting summary from March 9, 2015 **ACTION REQUESTED** Co-chair Stacey

DISCUSSION ITEMS

9:15 a.m. Materials and calendar overview Malu Wilkinson, Metro
Short review of meeting materials and upcoming decisions.
Discussion: Any questions regarding materials and calendar?

9:20 a.m. Engagement update Noelle Dobson, Metro
Summary of place-focused engagement activities in PCC-Sylvania, online input period, and upcoming community forum.
Discussion: Any questions or ideas about upcoming and future engagement?

9:30 a.m. Tunnel construction considerations Isabelle Lamb, McMillen Jacobs Associates
Dave Unsworth, TriMet
Overview of geologic and logistical components possible in the tunnel options to be considered as part of the July Steering Committee Recommendation package.
Discussion: Is this the right amount of information for the Steering Committee to inform action in July?

10:00 a.m. PCC Sylvania key issues discussion Brian Harper, Metro; PCC
Overview of tradeoffs for direct vs. indirect access to PCC Sylvania campus based on local considerations and corridor wide implications.
Discussion: What options provide the best balance between campus access and community impacts?

10:30 a.m. Shared Investment Strategy project update: I-5 & 217 Alan Snook, ODOT
Overview of recent work and future plans for I-5 and OR-217 in the Southwest Corridor.
Discussion: Any questions or ideas about other SIS projects to focus on?

PUBLIC COMMENT

10:45 a.m. Public Comment Co-Chair Stacey
Opportunity for citizens to provide short testimony (3 minute maximum) and/or submit written comments to inform the Steering Committee.

11:00 a.m. Adjourn

Materials for 5/11/2015 meeting:

- 3/9/2015 meeting summary
- PCC Sylvania Area Key Issues
- HCT Technical Modifications Memo
- 2015 SWCP Calendar
- Tunnel memo



Southwest Corridor Plan Steering Committee
Monday, March 9, 2015
9:00a.m. to 11:00a.m.
Tigard Public Library

Committee Members Present

Craig Dirksen, Co-chair
Bob Stacey, Co-chair
John Cook
Steve Novick
Krisanna Clark
Linda Tate
Suzan Turley
Monique Beikman
Dan Blocher
Rian Windsheimer

Metro Council
Metro Council
City of Tigard
City of Portland
City of Sherwood
City of Durham
City of King City
City of Tualatin
TriMet
ODOT

Metro Staff

Malu Wilkinson, Elissa Gertler, Noelle Dobson, Matt Bihn, Michaela Skiles, Brian Harper, Mei Yong, Jessica Martin, Heather Coston

1.0 Welcome and introductions

Co-chair Stacey called the meeting to order at 9:05am and welcomed the committee members and audience to the meeting. He announced that there would be reports from staff about two key issues, Hillsdale and South Portland, the committee would not be making any decisions today. Decisions would be made at the July 2015 meeting. Committee members introduced themselves.

2.0 Consideration of the Steering Committee meeting summary from December 8, 2014.

Co-chair Stacey asked the committee for approval of the meeting summary from December 8, 2014. With all in favor, the meeting summary was accepted unanimously.

3.0 Calendar overview

Co-chair Dirksen directed the committee to review the SW Corridor Plan Timeline (included as part of the meeting record). He informed the committee that there are three main decision points: July 2015, December 2015, and April 2016. At the December 2014 steering committee meeting, the committee agreed on the approach to define a Preferred Package of Investments that best supports the corridor vision for our communities. The Preferred Package contains three main elements –

- A definition of the high capacity transit project for further study, including what the preferred mode might be-- light rail transit or bus rapid transit, what the terminus and alignment would be, as well as what the associated roadway, pedestrian, and bike lanes improvements would be;
- An action plan for the roadway, bicycle and pedestrian projects that were identified in the Shared Investment Strategy and are not part of a high capacity transit project;
- To develop a strategy to support partnerships and implementation of community visions. The committee also agreed to consolidate and simplify the decision making process to provide sufficient time for public review and input throughout the next year.

Co-chair Dirksen gave an overview of the three main decision points:

- In July 2015, the committee will focus on tunnel versus surface access to key destinations which are Marquam Hill, Hillsdale, and PCC Sylvania, and to narrow high capacity transit options through Tigard. The committee will also discuss concepts for implementing the projects in the Shared Investment Strategy.
- In December 2015, the committee will decide on the draft preferred package for public input for the remaining high capacity transit alignment options, the high capacity transit mode and terminus, an action plan for implementing the roadway, bicycle and pedestrian projects, and the development of a strategy concept.
- In April, the committee will recommend a Preferred Package.

Co-chair Dirksen stated that the committee would be mindful of the ambitious schedule as they work to carefully manage the collective resources. Public engagement is critical to the success of the projects over the next year. Co-chair Dirksen introduced Ms. Noelle Dobson, Metro staff, to give the committee an update on the current and upcoming engagement activities.

4.0 Engagement update

Ms. Dobson presented an overview of recent place-focused engagement activities, mostly in the South Portland and Hillsdale communities, as well as a preview of upcoming public engagement events for the PCC-Sylvania area, Tigard and corridor wide. Ms. Dobson referred to the timeline document and provided an overview (included as part of the meeting record). Ms. Dobson made a request to the steering committee to inform her of what, if any, other information she should be seeking from the communities to help the committee make their decisions in July. She presented testimonies of local citizens in the South Portland and Hillsdale communities that she had engaged with over the past ten weeks. Ms. Dobson encouraged the public audience to access these stories and the engagement calendar on the Metro's website.

5.0 Shared Investment Strategy: road, bike, and pedestrian projects

Co-chair Dirksen introduced Mr. Brian Harper, Metro staff, who reviewed the process of the Shared Investment Strategy and the elements that are in the strategy.

Mr. Harper gave a background of the Shared Investment Strategy. He provided a brief description, current status and next steps for the projects. Mr. Harper explained that the Shared Investment Strategy focuses on roadways, bike paths, pedestrian and transit projects as there isn't a single transportation project that will solve all the issues of the corridor. The Shared Investment Strategy will address the broader challenges of the corridor.

Some of the challenges include:

- High travel demand within and through the corridor,
- Insufficient and unreliable transit options,
- Lack of safe infrastructure to provide connectivity for all modes of travel and;
- Unreliable traffic conditions that require travelers to plan for worst-case conditions to ensure being on-time

Mr. Harper informed the committee that some projects are already moving forward, such as the Tualatin River Greenway Gap, 99W and 72nd/Dartmouth improvements, and SW Multnomah Boulevard.

He outlined the next steps in the strategy which include:

- Focusing on "must-have" projects that have the best chance of early implementation (low-hanging fruit),
- Determining which projects are attached to an HCT project and would be studied further in the DEIS with advancement of HCT and;
- Identifying possible funding sources for projects that are not tied to the HCT investment (5-15 year time frame).

6.0 South Portland and Hillsdale key issues

Co-chair Dirksen introduced Mr. Matt Bihn, Metro staff, who provided an overview of the tradeoffs for direct versus indirect access to Marquam Hill and Hillsdale based on local considerations and corridor wide implications.

Ms. Malu Wilkinson, Metro staff, offered that there are two key issues memos (included as part of the meeting record), South Portland and Hillsdale, and a short executive summary of each of the documents.

Mr. Bihn informed the meeting that everything that he would present to the committee is included within the two key issues documents. He added that there is a summary of all the technical items on page seven in both documents.

Mr. Bihn said that he would be looking for two key decision points from the steering committee in July and December 2015. In July, the key decision for South Portland is to consider two options: tunnel versus surface. Staff believes the surface alternatives, Barbur and Naito, require further analysis that would occur in a Draft Environmental Impact Statement (DEIS) for a decision to be made.

The options presented in July would be:

1. Which South Portland alternatives should be studied in the DEIS?
 - a. Marquam Hill – Hillsdale Tunnel (light rail transit only)
 - b. Surface alignments – Barbur and Naito
 - i. Either surface alignments includes study of the Marquam Hill Connector
 - ii. Naito alignment includes study of Ross Island Bridgehead project
2. How should Hillsdale be served?
 - a. Directly with HCT – study in DEIS
 - i. Marquam Hill – Hillsdale Tunnel (light rail transit only)
 - ii. Hillsdale Loop with cut-and-cover tunnel
 - b. Surface alignment along Barbur -- continue with high level of local service with emphasis on connections to Barbur high capacity transit stations

Key decisions for the steering committee to consider for South Portland and Hillsdale in December 2015 include:

1. Is BRT or LRT the preferred HCT mode for the corridor?
2. What is the best implementation approach for corridor connection projects – roadway, bike, and pedestrian projects that are not part of the HCT project but are identified in the Shared Investment Strategy?

Mr. Bihn talked about the high capacity transit options for South Portland. The Naito and Barbur surface options include a new pedestrian and bike connection from the Lair Hill neighborhood near Gibbs Street to Marquam Hill, and would connect to the existing pedestrian bridge providing access between the neighborhood and South Waterfront. The tunnel option would provide stations under Marquam Hill and Hillsdale with more direct access to OHSU/VA on Marquam Hill, but would not include the pedestrian and bike connection, so it would not provide access to neighborhoods down below or to the South Waterfront (except via the tram).

Mr. Bihn proceeded to provide technical data on the following items within the Key Issues documents:

1. Transit Performance
2. Community Development

3. Mobility
4. Capital Costs
5. Engineering Complexity and Risk
6. Community Impact

Mr. Bihn summarized the timeline for the steering committee key decisions. PCC Sylvania and Tigard, as well as the HCT technical modifications memo, would be discussed at the next steering committee meeting. These discussions would prepare the steering committee for decisions in July 2015. The rest of the alignment will be discussed after July for decisions needing to be made in December. In January 2016, staff will have the draft Preferred Package ready. In May 2016, staff will bring the Preferred Package to the steering committee for decisions, which include:

- **HCT Preferred Alternative:** Preferred HCT alignments to study further in a DEIS, including mode, alignments, terminus, and associated roadway, bicycle, and pedestrian projects
- **Corridor Connections:** Potential funding source and timeframe for each of the roadway, bicycle, and pedestrian projects identified in the Shared Investment Strategy
- **Land use and development strategy:** Partnership agreements and other pre-development work to activate land use and place-making strategies identified in local land use visions

Co-chair Stacey inquired about the Marquam Hill tunnel option. He expressed concern about the high cost attached to the option. Co-chair Stacey asked if there would be a geo technical analysis and how much money will be added to the estimated cost of the project because of unforeseen issues. Mr. Bihn responded that TriMet is preparing a tunnel geotechnical study that is expected to be completed by late April or early May.

Mr. Bihn talked about the transit performance of the options based on year 2035 modeling performed at Metro-

- While a Marquam Hill-Hillsdale tunnel LRT would have more line riders than an alignment on Barbur, many of these additional riders would transfer from local buses to light rail in either Hillsdale or downtown Portland and travel one stop. If high capacity transit is used on Barbur or Naito instead, many of these riders are projected to take a bus to the new connection from Barbur. Those local bus riders would not count as light rail riders, even though in either scenario they are still taking transit to Marquam Hill. As a result, the number of new transit riders would not rise as much as the number of line riders with a tunnel alternative compared to a surface alternative.
- With the tunnel alternative, a station in Hillsdale would become a major transfer location, with nearly twice the number of transfers that would occur at the Barbur Transit Center.
- With a Hillsdale loop cut-and-cover tunnel alternative, line ridership and the number of new transit riders would drop compared to a surface HCT alternative. Even though a station in Hillsdale would attract more riders, the additional travel time required to reach the station would result in losses in ridership elsewhere.

Mr. Bihn continued his presentation with the Hillsdale community development. Some concerns included:

- The Town Center has low projected growth totals over the next 25 to 30 years relative to other locations in the corridor.

- There are limited redevelopment opportunities, even with increased market rents that might occur from an HCT investment.
- Major traffic impacts and business access issues would occur with a cut-and-cover tunnel construction.
- If we choose to locate the line on Barbur, we would need to enhance connections between HCT and the Hillsdale town center, i.e. better transit connections, bike facilities, more sidewalks, etc.

Mr. Bihn described engineering complexities and risks with the South Portland tunnel and surface options:

Tunnels:

- Large area needed for portal staging areas
- Risk of complications with boring / cost overruns
- Traffic and physical roadway impacts from excavation hauling
- Potential impacts to Duniway Park (Section 4(f))

Surface:

- Right of way impacts
- Barbur alignment – potential impacts to Duniway Park (Section 4(f))
- Naito alignment – complexity of modifications to Ross Island bridgehead and to existing structures

Next, Mr. Bihn explained the engineering complexities and risks with the Hillsdale area.

Hillsdale Loop with cut-and-cover tunnels:

- Requires new structure transitioning between Barbur and Capitol
- Large retaining walls due to steep slopes along Capitol Hwy
- Cut-and-cover tunnel complexity including utility relocation, sequencing to maintain traffic during construction, and archeological risks

Barbur:

- Potential right of way impacts
- Barbur viaduct replacement (LRT, BRT) or possible parallel structure (BRT only) that would result in complete bike lanes and sidewalks
- Complicated widening north of viaducts requiring retaining walls

Mr. Bihn emphasized that project staff want to understand how different alignment choices may impact different population groups so that they can work toward a final project that would equally distribute the benefits and burdens to all groups throughout the corridor. Staff overlaid demographic maps for low-income, people of color, senior, and non-English speaking on top of the alignment maps. Staff also utilized data from the 2010 census. In this draft, staff conducted spatial analyses not only to see how alignments run through areas identified as higher than the regional average, but also to assess how alignment choices may impact access to key services that we know are important to all residents, including education centers, employment and retail areas, and health care. Some potential community impacts in the South Portland project area include:

Demographic Impacts:

- Slight differences between alignments in overlay with low-income and senior populations

Tunnels:

- Most direct access to education, employment and health care on Marquam Hill
- Limited access to retail, employment, health care on Naito and South Waterfront
- Potential impacts to Duniway Park

Surface:

- More direct access to education, health care, employment services on Naito, Barbur and in South Waterfront

Potential community impacts to the Hillsdale area are –

Demographic impacts:

- Slight differences between alignments in overlay with low-income and senior populations
-

Marquam Hill-Hillsdale Tunnel:

- Most direct access to education, employment and health care on Marquam Hill
-

Hillsdale Loop Tunnel:

- Most direct access to retail and employment in Hillsdale, Capitol Hwy, Barbur Boulevard south of Terwilliger
- Most direct access to K-12 schools
- Significant construction impacts to Hillsdale Town Center businesses, elementary school

Potential community impacts to the South Portland and Hillsdale area include:

Property impacts:

- Large variation in potential property impacts
- Property impacts will be evaluated with and without lane conversions

Projected vehicle frequencies:

- BRT : 20 vehicles / hour to meet peak hour, peak direction demand
- LRT: 8 vehicles / hour (meets demand with capacity remaining)

Mr. Bihn reminded the committee of the Southwest Corridor Plan timeline. A document outlining the timeline was provided within the meeting packet.

Co-chair Dirksen inquired about the Hillsdale and the Barbur viaducts where the right of ways are restricted. He assumed that it would be difficult and expensive to widen them. He asked if lane conversion is required. If bus rapid transit mode is chosen, would it mean that the vehicles would run in mixed traffic which may result in slow transit travel in congestion, or is there a choice? Mr. Bihn responded that there is a choice in this situation. He said that if bus rapid transit mode were chosen, the committee can make the choice not to widen the right of way by converting a traffic lane for BRT use or by operating BRT in mixed traffic. The other choice would be to widen the right of way by replacing the viaducts, which would retain the existing number of travel lanes and provide the BRT with an exclusive transit lane. The new viaducts would also include bike lanes and pedestrian sidewalks. If BRT is used in mixed traffic, we would build a parallel facility for bike lanes and sidewalks.

Co-chair Dirksen said that a concern that was raised in outreach efforts in the Hillsdale project area was that a lot of people park and ride in the neighborhood. With the project moving forward, residents are concerned about the increased parking needs. He asked if there are plans to build a structured lot with the new transit center. Mr. Bihn responded that there are no plans to build a structured parking lot in Hillsdale and that the location is intended to be a transfer station between bus and light rail. He said that building a parking lot in Hillsdale would encourage people to drive in rather than take public transportation.

7.0 Public comments

Ms. Sue Christenson said it is easy to support the light rail transit option because it will redevelop the entire Portland Metro area. She said that the option will pull together all communities into a comprehensive plan. She provided several points to support the light rail option. Ms. Christenson said that BRT may be cheaper now, but not later. BRT is more expensive due to capacity. Buses carry 86 passengers. It will reach capacity in 2035 at which time more buses and more money will be needed. LRT carries 266 passengers and will not reach capacity in 2035 and will still run every 7 ½ minutes and will not require more money. She said that she interviewed many PCC students who lived in the Beaverton and Tigard area. They all chose LRT over BRT. Ms. Christenson said that LRT is the better option because it is safer, sustainable, environmentally friendly, cheaper, better quality, and reliable. She said that the Portland Metro is one of the fastest growing areas in the nation. There is also a large aging population. She said that we cannot continue to expect our aging citizens to drive in high density population. Finally, Ms. Christenson said that a website named Havbu.com states that there is asphalt under Marquam Hill that could pose problems with tunneling.

Ms. Elise Shearn, a Tigard resident, said that Tigard's road congestion is at capacity. She said that Tigard is a pass-through for thousands of people. 18,500 Tigard residents work outside of the city. 37,000 to 40,000 jobs are filled by people from outside communities. She said that 111,000 commuter trips pass through Tigard on a daily basis, not including freight, shoppers and tourists. Tigard's aging population, veterans, low and fixed income citizens, and immigrants have to travel out of Tigard to access vital services. Ms. Shearn said that HCT would relieve the traffic congestion situation. As for parking issues, she urged people to use local churches' underutilized parking lots instead of building a park and ride.

Mr. Steve Schopp, a Tualatin resident, said that he has followed these processes for many years. He stated his lack of support for the project and questioned the integrity of the public outreach efforts. Mr. Schopp added that critics of the project appear to be considered to have ulterior motives by Metro. He stated that Metro has mitigated the processes to avoid putting these projects to the vote in order to hide the fact that the SW Corridor project will face a similar fate to that of the CRC project. He added that Mr. Jason Tell, the former manager of Region 1 of ODOT, informed the steering committee last June that this project could cost as much as the CRC project and will meet with the same fate. Mr. Schopp expressed his disappointment that the steering committee had not discussed this concern. Without public input with a vote to approve bonding, he feels that all of the local match which will be \$1.5 billion would be taken from the central services current revenue stream which, he added, is the way the Portland-Milwaukee light rail is currently funded. He urged the committee to consider the facts that would make this project a failure, which are enormous cost, low public approval, no sense of funding locally and misappropriation of funds.

Co-chair Stacey acknowledged his concerns and made a request to project staff to provide the steering committee, at an appropriate point in the process, a breakdown of the current \$1.9 billion estimated

cost of the project that would differentiate the purely transit components, such as streets construction or re-construction, sidewalks construction and other community investments that would otherwise be borne solely by the gas tax.

Mr. Jim Howell, a member of the Association of Oregon Rail and Transit Advocates (AORTA), said that the SW Corridor project failed to study the systems that relate to ridership. He said that he has some serious concerns about the tunnel alignment design. He handed each of the committee members a printout from a website called AORTArail.org on AORTA's Vision on Portland's future rapid transit system. He proposed three different options in this document and asked the committee members to consider the options to ease traffic congestion on I-5.

Ms. Vera Keller said that her house sits directly above one of the proposed alignment of a deep bored tunnel. She expressed concerns that she has not seen any information or discussions about potential impacts on boring under homeowners' properties. She hopes to see more data on potential impacts on homeowners' properties. Ms. Keller also expressed concerns of potential impacts on Duniway Park. She said that South Portland has been sacrificed many times to transportation projects since the mid-twentieth century. Ms. Keller said that they have lost any community amenities recently, such as the Portland Childrens' Museum and the Craft museum. The Historical Community Library is now only used as PP&R offices. The Duniway Park is one of the only community resource left in the neighborhood. It is a beautiful park and many people in and outside of the community use the park. Ms. Keller is concerned that surface portal transport would negatively impact Duniway Park. She supports light rail on Naito because it will not only avoid potential impacts on Duniway Park, but it will preserve the South Portland neighborhood as well.

Co-chair Stacey encouraged Ms. Keller to connect with Ms. Noelle Dobson for more information on potential impacts on homeowners' properties because of bored tunnels.

Mr. Floyd Smith, a Southwest Portland resident, testified. He is a board member of AORTA. He highly supports the proposals presented by Jim Howell of a tunnel with four deep stations. He requested the committee consider the study of such an option.

Mr. Ralph Hughes, a Tigard resident, stated his previous support for the Vote No on 34210. He does not agree that the public should be micro managing the city government and officials. He stated his support for Metro and its partners to move forward with the planning process. He added that whatever option is chosen, a corridor needs to be established now, not later.

Co-chair Stacey reminded the committee that the next meeting would be held on May 11, 2015. The focus at that meeting will be on PCC Sylvania and some of the Tigard key issues. The May meeting would not be a decision making meeting.

8.0 Adjourn

There being no further business, Co-chair Stacey adjourned the meeting at 11:00am.

Attachments to the Record:

Item	Type	Document Date	Description	Document Number
1	Agenda	03/09/15	Meeting agenda	030915swcsc-01
2	Summary	06/09/15	06/09/14 meeting summary	030915swcsc-02
3	Document	03/04/15	SW corridor plan timeline discussion draft	030915swcsc-03
4	Report	03/02/15	Key Issues: South Portland	030915swcsc-04
5	Report	03/02/15	Key Issues: Hillsdale	030915swcsc-05
6	Report	03/02/15	Executive Summary Key Issues: Hillsdale	030915swcsc-06



Southwest Corridor Plan
Key Issues: PCC - Sylvania Area
Discussion Draft, April 13, 2015

Updated May 4, 2015



Key Issues: PCC-Sylvania Area

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PCC-Sylvania Area Key Issues: introduction and summary

Southwest Corridor Plan overview

The Southwest Corridor Plan is a comprehensive approach to achieving community visions through integrated land use and transportation planning. The Southwest Corridor Plan incorporates high capacity transit (HCT) alternatives, roadway, bicycle and pedestrian projects and adopted local land use visions, including the Barbur Concept Plan, the Tigard High Capacity Transit Land Use Plan, Linking Tualatin and the Sherwood Town Center Plan. The Plan is exploring Bus Rapid Transit (BRT) and Light Rail Transit (LRT) alternatives for several alignments that connect the Portland Central City, Southwest Portland, Tigard, and Tualatin.

In July 2013, the Southwest Corridor Plan Steering Committee recommended a Shared Investment Strategy (SIS) that includes key investments in transit, roadways, active transportation, parks, trails and natural areas. A refinement study was initiated in August 2013 to narrow HCT options, identify a preferred alternative and create a subset of road and active transportation projects. In June 2014, the Steering Committee accepted the recommendation of a narrowed set of HCT design options and requested additional refinements work from staff.

In December 2014, the Steering Committee directed project staff to use these findings and further community input to develop a Preferred Package of transportation investments to support community land use goals. The Preferred Package is anticipated to be defined in spring 2016.

After the Steering Committee approves the Preferred Package, then the identified HCT mode, alignment options, roadway, bicycle and pedestrian projects will receive full environmental review in a Draft Environmental Impact Statement (DEIS) under the National Environmental Policy Act (NEPA). It is anticipated that additional roadway, transit, bicycle and pedestrian projects will be studied, funded and implemented through other collective federal, state, regional and local efforts.

Desired outcome: Preferred Package

Project partners will work together to develop a Preferred Package by spring 2016 that addresses the needs and aspirations of Southwest Corridor residents and businesses. The Preferred Package will include the following components:

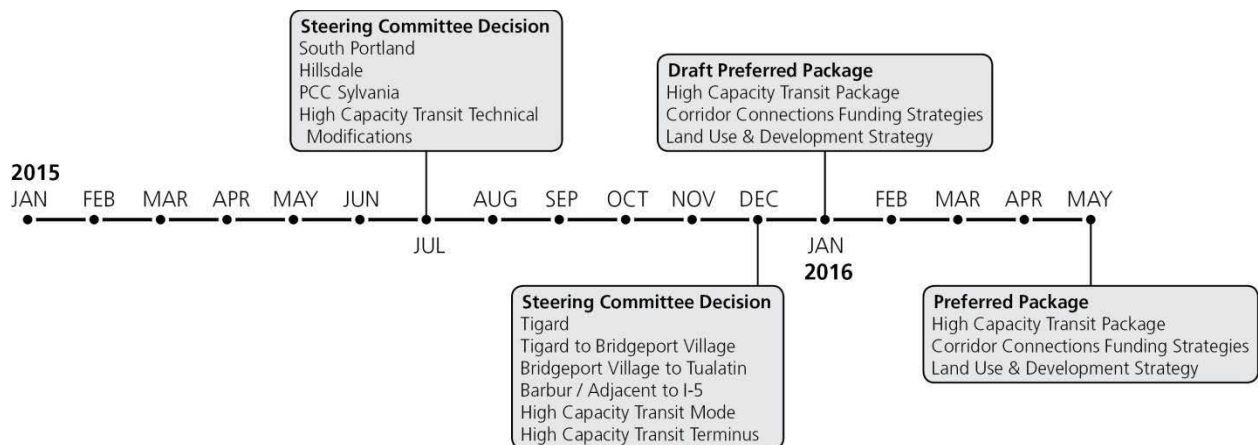
- **HCT Preferred Alternative:** Preferred HCT alignments to study further in a DEIS, including mode, alignments, terminus, and associated roadway, bicycle, and pedestrian projects
- **Corridor Connections:** Potential funding source and timeframe for each of the roadway, bicycle, and pedestrian projects identified in the Shared Investment Strategy

- **Land use and development strategy:** Partnership agreements and other pre-development work to activate land use and place-making strategies identified in local land use visions

Identifying the Preferred Package: 2015-2016 timeline overview

To reach a Preferred Package by spring of 2016, two key Steering Committee decision-making points have been identified in 2015: July and December. Technical analysis, place-based public outreach, and partner conversations will precede each Steering Committee decision. A draft recommendation report will be presented at community forums before each decision-making point, including public comment gathered during the place-based outreach period and any additional technical analysis compiled.

The July Steering Committee decision will focus on surface versus tunnel access to key destinations in the corridor including Marquam Hill, Hillsdale, and the Portland Community College (PCC) Sylvania Campus, as well as technical modifications to other HCT alignments. The December Steering Committee decision will focus on the remaining HCT alignments and terminus options as well as an HCT mode decision between LRT and BRT. In January 2016, the Steering Committee will identify a Draft Preferred Package, including HCT mode, alignment options, terminus options, and associated roadway and active transportation projects for further study in a DEIS, a funding strategy for additional priority roadway, bicycle, and pedestrian projects throughout the corridor, and integrated land use and development strategies.



How to use this Key Issues memo

The Southwest Corridor project partners are taking a place-based approach to understanding the key issues related to potential HCT and transportation investments as they relate to local concerns and community aspirations. The place-based key issues will be reviewed by the public and the Steering Committee in the context of their implications for achieving the multifaceted goals for the corridor as a whole. Decision makers and the public will have several months to discuss this report through public meetings and online engagement.

This document fits into a broader array of technical information that supports Steering Committee decision making during this phase of the Southwest Corridor Plan. **Appendix A** lists the anticipated major project documents and their estimated dates of completion.

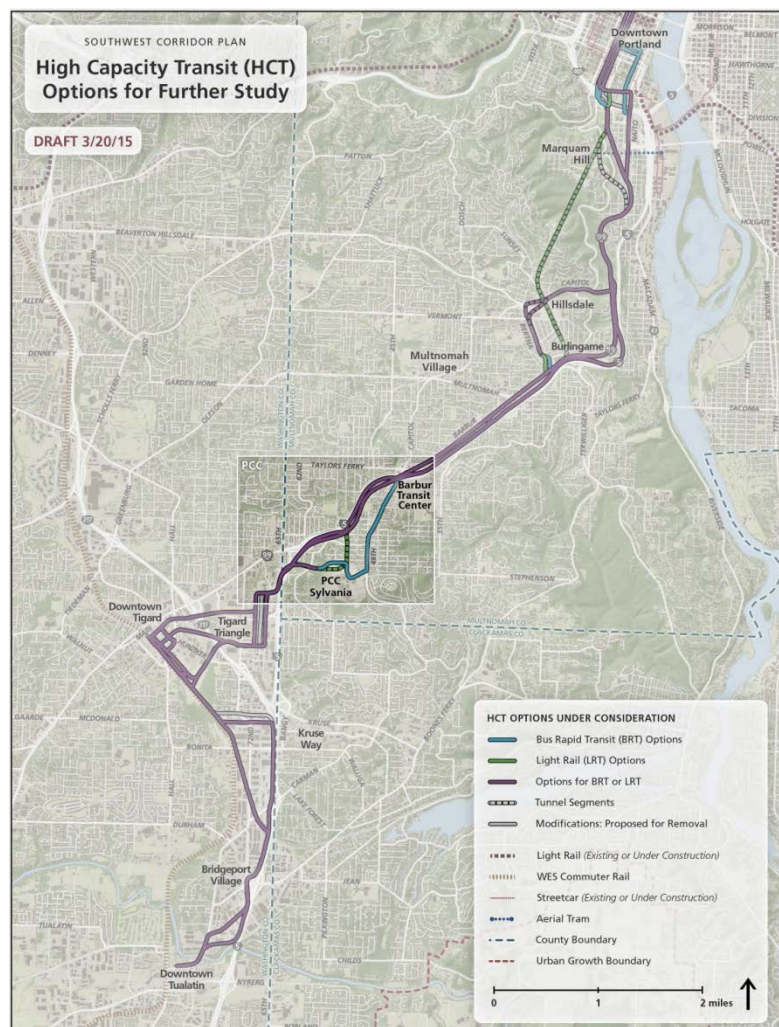
Information from this report and other Key Issues memos will be combined with technical evaluation of the options in South Portland, Hillsdale and PCC-Sylvania areas to form a draft Evaluation Report expected in May 2015. A staff recommendation report focusing on HCT options in the South Portland, Hillsdale, and PCC-Sylvania areas will be available prior to the July 2015 Steering Committee meeting and will include a summary of stakeholder feedback. The remaining place-based evaluation and recommendation reports will be available before the December 2015 Steering Committee decision.

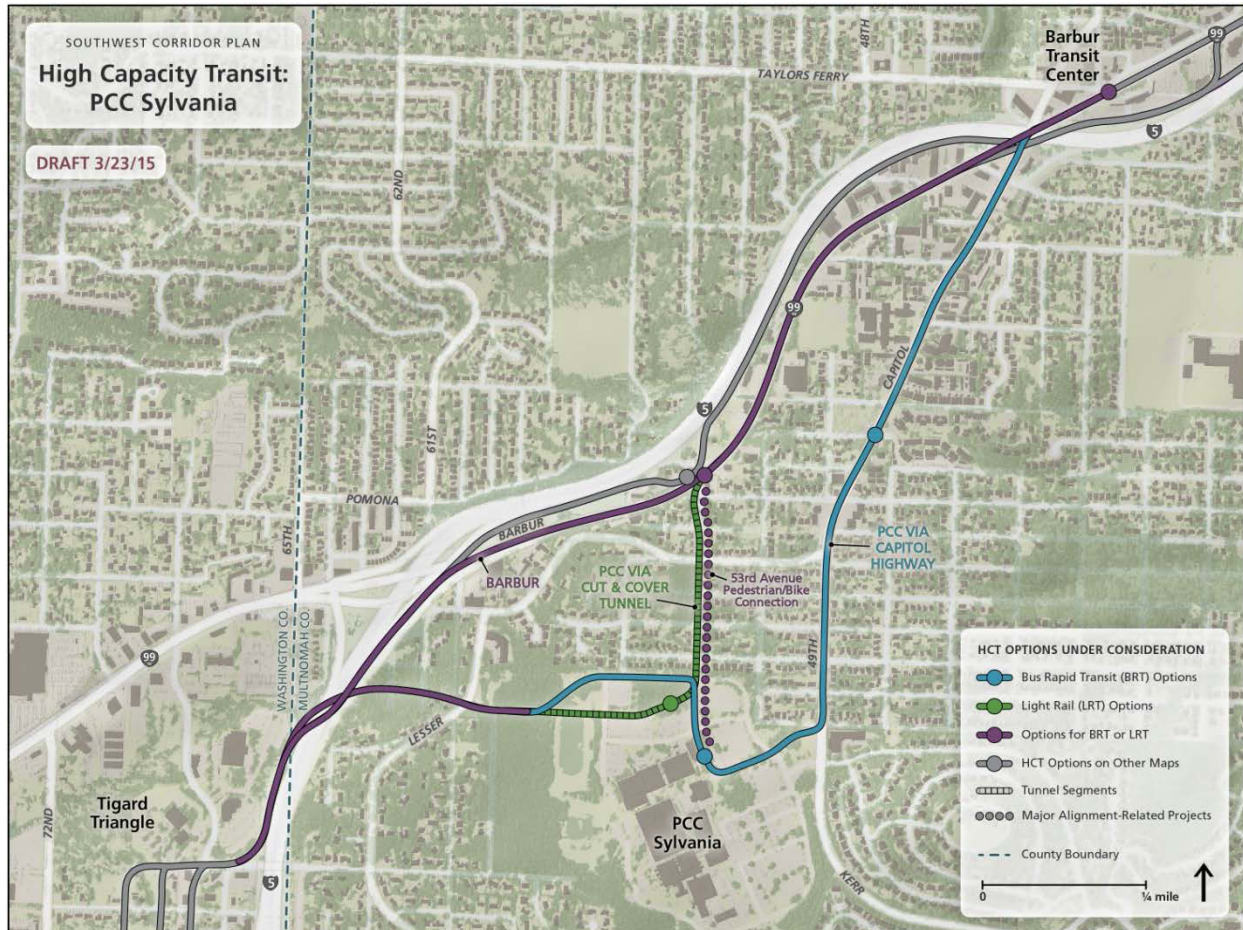
This document includes an overview of the decision making process as it relates to the key issues in the PCC-Sylvania area, a description of the three proposed high capacity transit alignments to serve the campus, a summary of technical information and a description of key issues for decision makers and the public to consider. Appendices contain supplemental information including maps and project lists of Shared Investment Strategy road, bicycle and pedestrian projects being considered for the PCC-Sylvania area, a discussion of general transit mode considerations, and maps highlighting demographic factors in the study area.

PCC-Sylvania Area Key Issues summary

The PCC-Sylvania area encompasses the project area between the Crossroads intersection (SW Barbur Boulevard, SW Capitol Highway, and I-5 ramps just south of the Barbur Transit Center) to the northeast and the Tigard Triangle to the southwest and includes three HCT options under consideration:

1. Barbur Boulevard between Crossroads and the Tigard Triangle (BRT or LRT)
2. PCC campus via Capitol Highway (BRT only)





3. PCC cut-and-cover tunnel (LRT only)

Major decisions in the PCC-Sylvania area

In July 2015 the Southwest Corridor Plan Steering Committee will be asked to make a decision on which of the proposed HCT alignment choices for serving the PCC-Sylvania area will advance to further environmental review through a DEIS that could begin as early as late 2016. The Barbur Boulevard surface HCT alignment with a surface pedestrian/bike connection to the PCC-Sylvania campus will continue to be studied beyond July 2015 and is anticipated to be included in the DEIS for detailed analysis. The Steering Committee will decide in July 2015 whether the alignments that would directly serve the PCC-Sylvania campus will also proceed for further environmental review. This document focuses on the substantial tradeoffs between options so that the public and decision makers can be confident that all options that will enter the DEIS are viable and aligned with project goals.

Timeline of Major Decisions in the PCC-Sylvania area

July 2015:

- Should the DEIS include study of a direct access BRT option along Capitol Highway to PCC-Sylvania?
 - What are the travel time and ridership tradeoffs of a lengthier direct BRT route to campus?
- Should the DEIS include study of a direct access LRT option with a cut-and-cover tunnel to PCC-Sylvania?
 - What are the construction impacts and cost tradeoffs of this option? Are future campus plans commensurate with such an investment?
- Should the DEIS include study of a Barbur option with a surface pedestrian/bike connection between a Barbur station and the PCC-Sylvania campus? How viable would such a connection be for providing campus access and how would it impact the neighborhood?
- Will the local transit service improvements proposed in TriMet's Southwest Service Enhancement Plan provide the necessary connections and service frequency to the campus, with or without an HCT investment?

December 2015:

- Is BRT or LRT the preferred mode to study in the DEIS?
- What is the timeframe for designing and implementing local transit service improvements to enhance connections to and through PCC-Sylvania to connect to the HCT project?
- What is the best implementation approach for roadway, bicycle and pedestrian Corridor Connections projects defined in the Shared Investment Strategy for the PCC-Sylvania area?

Evaluation factors

Deliberation and decision making will be driven by how well each element of the proposed project meets the Southwest Corridor Plan's overarching Purpose and Need, including improved mobility and safety for all users and modes of transportation, efficient and reliable transportation choices, wise use of public resources, improved access to key places, and equitable distribution of the benefits and burdens of transportation and land use development.

Key Considerations

This PCC-Sylvania Area Key Issues memo outlines data collected through technical analysis, local knowledge and partner discussions that will influence this decision including:

- Transit performance
- Community development
- Mobility
- Capital cost estimates
- Engineering complexity and risk

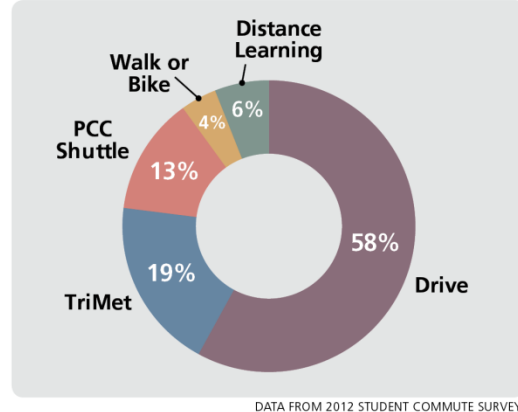
- Community impacts

Portland Community College: Sylvania Campus

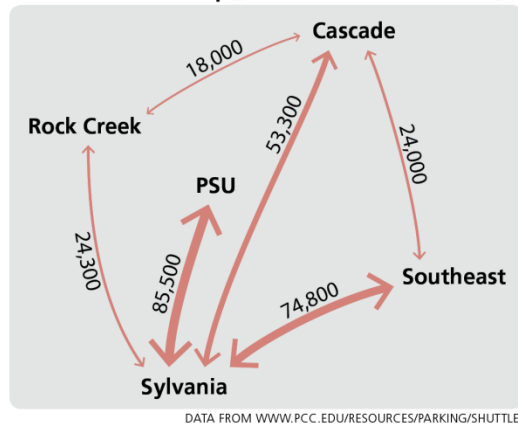
Sylvania campus in context

- First PCC campus, opened in 1968
- 120 acres with 900,000 developed square feet
- Campus facilities were upgraded through a 2000 bond, and are continuing to be upgraded through a 2008 bond
- Largest enrollment of the four campuses: 31,868 students in the 2012-2013 academic year, or a full-time equivalent of 12,137 students
- Permitted under a conditional use master plan, but now at the limits of the plan, so future development would require a new campus master plan

How do students get to the Sylvania campus?

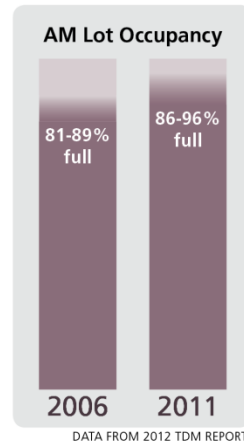


PCC shuttle ridership (2012-2013 Academic Year)



Parking at Sylvania

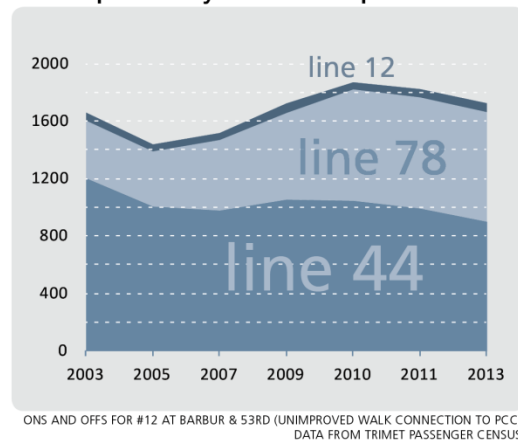
- Capacity: 2,421 vehicles
- Parking permits cost \$5 per day, \$50 per term for students, or \$37.50 per term for faculty and staff
- Parking permit fees cover cost of street maintenance



TriMet bus access to campus



Ridership at PCC Sylvania bus stops



PCC-Sylvania area summary

The following table summarizes key considerations, evaluation factors, and analysis results for consideration in the PCC-Sylvania area.

Key considerations	Evaluation factors	Barbur – (BRT or LRT)	PCC via Capitol (BRT)	PCC via cut-and-cover tunnel (LRT)
Transit Performance <ul style="list-style-type: none"> How should the tradeoffs in transit performance be weighed between alignments that serve PCC directly and those that stay on Barbur, including travel time, cost, construction complexity and risk, and community development impacts? 	<i>2035 new transit trips</i>	New transit trips: 8,400 (BRT) 15,700 (LRT)	New transit trips: 9,700	New transit trips: 17,800
	<i>2035 line riders</i>	Line riders: 30,800 (BRT) 43,500 (LRT)	Line riders: 32,900	Line riders: 46,200
	<i>Travel time (PSU to Tualatin)</i>	Travel time: 34 minutes (BRT) 31 minutes (LRT)	Travel time: 36 minutes	Travel time: 32 minutes
Community Development <ul style="list-style-type: none"> Can local transit and an improved bike and pedestrian connection on or near 53rd Ave effectively connect the PCC Campus to an HCT alignment on Barbur? Are there land use changes that could occur on the PCC-Sylvania campus in the next 15-20 years that would support a high-cost tunnel investment required for a direct LRT connection? 	<i>Access</i>	<ul style="list-style-type: none"> Station at Barbur and 53rd Ave with improved walk/bike connection to campus (1/3- to ½- mile uphill to campus) 	<ul style="list-style-type: none"> PCC campus station Station on Capitol near Comus serving diverse neighborhood 	<ul style="list-style-type: none"> PCC campus station
	<i>Redevelopment potential</i>	<ul style="list-style-type: none"> Some redevelopment potential at Barbur and SW 53rd Ave 	<ul style="list-style-type: none"> Opportunity for significant campus redevelopment Current PCC master plan would require changes to allow redevelopment 	<ul style="list-style-type: none"> Opportunity for significant campus redevelopment Current PCC master plan would require changes to allow redevelopment
Mobility <ul style="list-style-type: none"> How do alignment choices affect cars, bikes and pedestrians? How do alignment choices impact road, bike and pedestrian improvement projects that could serve PCC and the neighborhood? 	<i>Accessibility</i>	<ul style="list-style-type: none"> Includes sidewalk/bike improvements along Barbur Includes sidewalk/bike improvements along 53rd to link PCC to Barbur station (1/3- to ½- mile uphill to campus) Could consider converting lanes on Barbur to HCT-only 	<ul style="list-style-type: none"> Includes sidewalk/bike improvements along Capitol and to access station Could consider converting lanes on Capitol to HCT-only 	<ul style="list-style-type: none"> Includes sidewalk/bike improvements to access station and along Barbur east of 53rd Could consider converting lanes on Barbur to HCT-only

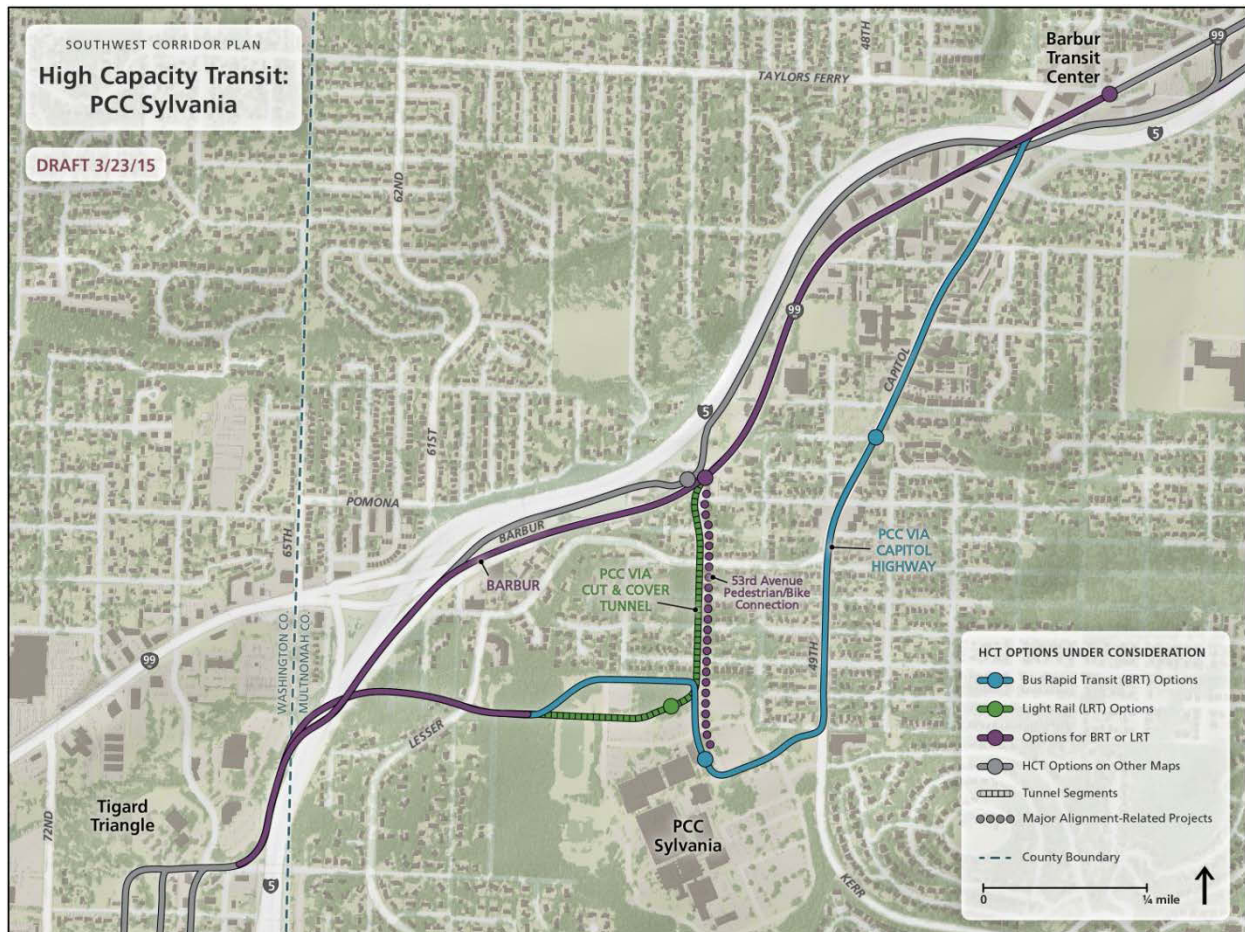
Discussion Draft: PCC Sylvania Area Key Issues – updated 5/4/15

Key considerations	Evaluation factors	Barbur – (BRT or LRT)	PCC via Capitol (BRT)	PCC via cut-and-cover tunnel (LRT)
	<i>Mode considerations</i>	<ul style="list-style-type: none"> • 23 BRT vehicles per hour in the peak • 10 LRT vehicles per hour in the peak 	<ul style="list-style-type: none"> • Same as Barbur alignment option 	<ul style="list-style-type: none"> • Same as Barbur alignment option
Capital Costs <ul style="list-style-type: none"> • Are the trade-offs between cost of a project and other factors such as reliability, safety, access and community development opportunities clear? • How does cost impact the length of the final high capacity transit alignment? 	<i>Cost estimates in 2014 dollars</i>	<ul style="list-style-type: none"> • LRT: \$1.9B - \$2.4B line, \$272M PCC area segment • BRT: \$680M - \$1.2B line, \$140M PCC area cost 	<ul style="list-style-type: none"> • \$144M segment cost 	<ul style="list-style-type: none"> • \$515M segment cost • (\$244M more than LRT on Barbur)
Engineering complexity/risk <ul style="list-style-type: none"> • What are the benefits and risks associated with construction of a deep-bored tunnel or a cut-and-cover tunnel? • What aspects of each alignment option present noteworthy risk? 	<i>Risk</i>	<ul style="list-style-type: none"> • At-grade option with station on Barbur • Requires major improvements to 53rd Avenue to provide walk access from station (1/3- to ½- mile uphill to campus) 	<ul style="list-style-type: none"> • At-grade option with dedicated transitway on PCC campus 	<ul style="list-style-type: none"> • Requires cut-and-cover tunnel along length of 53rd Avenue • Potential geotechnical and construction risks involved with mining operation
Community impacts <ul style="list-style-type: none"> • How would construction of a cut-and-cover tunnel impact the neighborhood? • How would the Barbur to PCC campus bicycle and pedestrian connection along 53rd Ave impact the neighborhood? 	<i>Access Property Impacts</i>	<ul style="list-style-type: none"> • Shortest in-vehicle travel time but longest walk between station and campus • Opportunity for station area and park and ride along Barbur near 53rd Avenue 	<ul style="list-style-type: none"> • Provides more direct service to diverse Capitol Highway neighborhoods • Provides front door service to PCC Sylvania staff and students 	<ul style="list-style-type: none"> • Substantial construction impacts and potential displacement of neighborhood residents along cut-and-cover tunnel alignment • Provides station at edge of campus

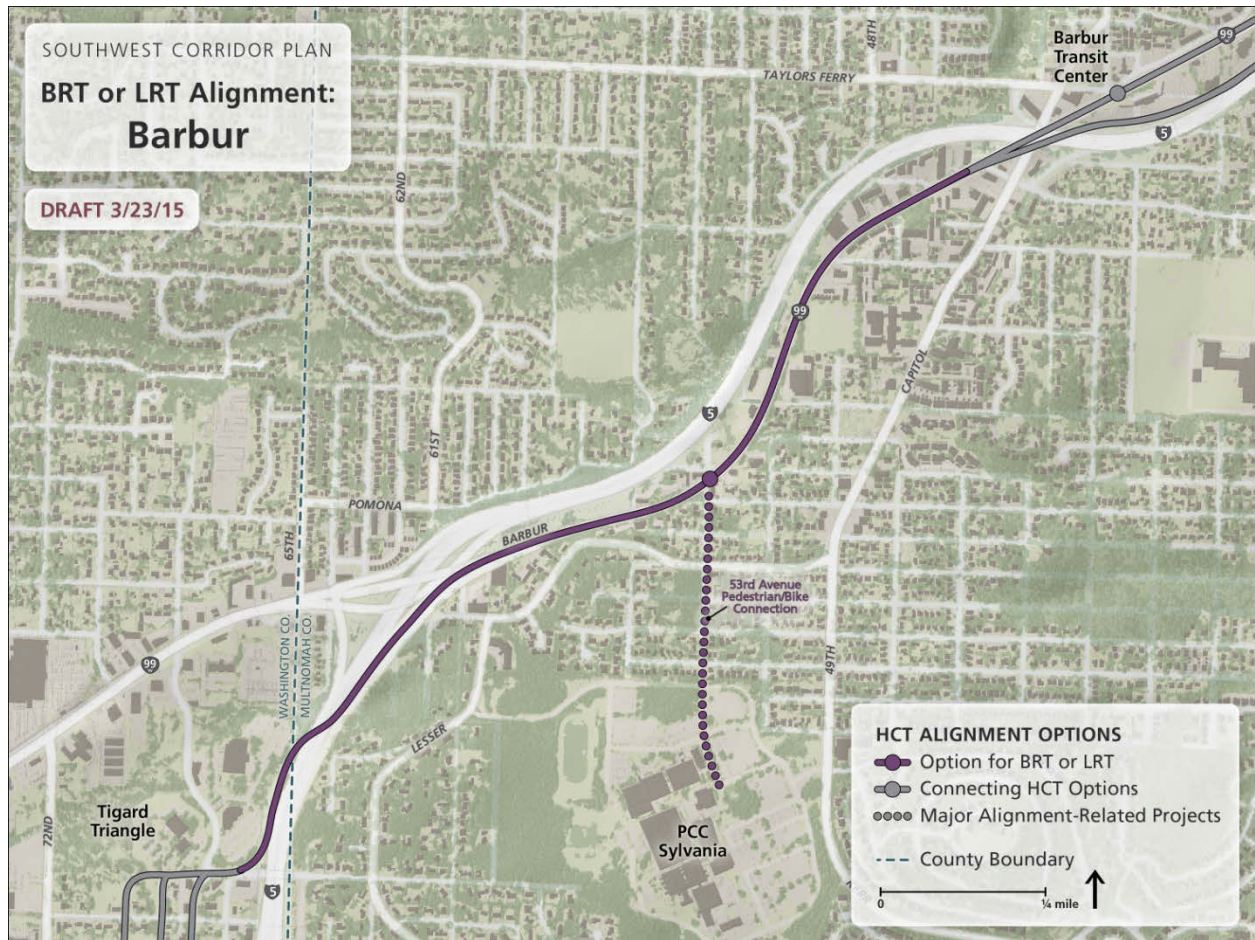
PCC-Sylvania Area Key Issues

There are three HCT alignments in the vicinity of PCC-Sylvania: one that would remain on or parallel to Barbur Boulevard and would serve the campus with an improved pedestrian and bike connection from a station in the vicinity of Barbur and SW 53rd Avenue (BRT or LRT), and two that would diverge from Barbur to serve the campus directly (one with a BRT surface alignment and one an LRT tunnel alignment). A number of other HCT alignment options were removed from further consideration by the Steering Committee in April and June 2014. More information on these options may be found on the Southwest Corridor Plan website: <http://www.oregonmetro.gov/public-projects/southwest-corridor-plan/project-library>.

PCC-Sylvania HCT alignment option descriptions



Barbur Alignment with improved connection to PCC



Looking north-to-south, this alignment would run along Barbur Boulevard from the Crossroads intersection to approximately 60th Avenue, where it would turn south to cross over the freeway on a new bridge and descend into the Tigard Triangle area at Atlanta/Haines Street and 68th Avenue. The station near 53rd Avenue would serve both the PCC-Sylvania campus and a new park and ride lot to the southwest. The station would include an enhanced pedestrian and bike connection along 53rd Avenue to provide safe, comfortable access to the PCC campus. The alignment would include parallel bike and pedestrian facilities along its length, including on the new crossing over I-5 connecting Barbur Boulevard and the Tigard Triangle.

The analysis to date assumes the conversion of one auto lane in each direction for exclusive HCT use along this stretch of Barbur (southwest of the Crossroads intersection) in order to minimize impacts to adjacent properties compared to an alignment that maintains all auto lanes. Based on preliminary traffic analysis the lane conversion appears to function for both cars and HCT as this segment has fewer cars than the segments of Barbur/99W to both the north and south where travel lanes would not be converted for HCT use. The final design could include such a conversion or could maintain all current

auto lanes. Future work will include an analysis of the impact when traffic is diverted to Barbur Boulevard due to an incident on I-5.

An option that would include HCT operating adjacent to I-5 instead of on Barbur is under development. This option would include the identical station, park and ride lot, and pedestrian connection to PCC-Sylvania as the Barbur option, but would not convert any travel lanes in this section. This option will be addressed in the Barbur/Adjacent to I-5 Key Issues Memo anticipated in October 2015. That memo will focus on options to operate adjacent to I-5 along Barbur Boulevard from the Burlingame area through the PCC-Sylvania area.

BRT in this area is currently designed to operate in exclusive transit right of way to avoid interaction with other traffic and maximize transit travel speeds. One of the benefits of BRT is that it can operate in mixed traffic where necessary to preserve auto and freight capacity or to minimize cost. Future design options could consider BRT in mixed traffic in this area to preserve auto travel lanes.

PCC Direct Connection

PCC via Capitol Highway (BRT only)



This alignment is unique to BRT due to the steep slopes approaching and departing the PCC Campus which LRT cannot operate on. Looking north-to-south, the route would depart Barbur Boulevard at the Crossroads intersection and run in the center of Capitol Highway and 49th Avenue to the PCC-Sylvania campus. The option assumes the conversion of one auto lane in each direction to exclusive HCT use to limit impacts to adjacent properties. The lane conversion appears to maintain adequate traffic flow for both cars and HCT, based on preliminary traffic analysis. The final design could include such a conversion or could maintain all current auto lanes.

Once at the PCC campus, BRT would head west through campus and then run on a new structure stretching from Lesser Road across I-5 to the Tigard Triangle. This new bridge would include bike and pedestrian facilities to provide a safe and comfortable connection for those modes between PCC and the Tigard Triangle. This alignment would include a station at the “front door” of the PCC campus, as well as a station at Capitol Highway and Comus Street, near Holly Farm Park and the Capitol Hill Library. The alignment would include parallel bike and pedestrian facilities along its length, including on the new crossing over I-5 connecting Barbur Boulevard and the Tigard Triangle.

PCC via cut-and-cover tunnel (LRT only)



Looking north-to-south, this LRT-only alignment would run along Barbur Boulevard from the Barbur Transit Center to 53rd Avenue, and then enter a cut-and-cover tunnel running underneath 53rd toward the PCC campus. An underground station would serve PCC near the northern edge of campus. LRT would then run westward and emerge from the cut-and-cover tunnel near Lesser Road. As with the direct BRT connection alignment, LRT would travel through a wooded area and across I-5 into the Tigard Triangle on a new bridge for transit, bicyclists and pedestrians.

The option assumes the conversion of one auto lane in each direction to exclusive HCT use to limit impacts to adjacent properties. Based on preliminary traffic analysis the lane conversion appears to function for both cars and HCT as this segment has fewer cars than the segments of Barbur/99W to both the north and south. The final design could include such a conversion or could maintain all current auto lanes. Another option that parallels I-5 and would not convert any travel lanes in this segment could serve as an alternative approach to the cut-and-cover tunnel. This option will be addressed in the Barbur - Adjacent to I-5 Key Issues Memo anticipated to be completed in October 2015.

This alignment would include bike and pedestrian facilities along Barbur Boulevard east of 53rd Avenue, and on the new bridge crossing over I-5 connecting Barbur Boulevard and the Tigard Triangle.

Roadway, pedestrian and bicycle projects

All alignment options include a range of roadway, pedestrian and bicycle improvements to better connect the HCT corridor to the surrounding neighborhoods. The specific improvements vary depending on the alignment and multimodal needs. Maps and lists of potential roadway, pedestrian and bicycle projects that would accompany HCT alignments in South Portland are included in Appendix B. One major project, the Barbur Boulevard-PCC Creative Connection, is described in more detail below.

Barbur-PCC Creative Connection

An HCT alignment that stays on Barbur Boulevard to the north of the PCC Sylvania Campus would require either a walk or a bicycle ride of up to a ½ mile between the station near Barbur Boulevard and 53rd Avenue and the PCC-Sylvania central campus area, or a transfer to a local bus or PCC shuttle bus at the Barbur Transit Center or another station. Several ideas for strengthening bicycle and walk connections between PCC and a station at 53rd Avenue will be the subject of an upcoming study. Ideas include: improvements to 53rd Avenue including new sidewalks or a multi-use path on one side with improved drainage, lighting and accessibility. Steep grades in several locations may require ramps, stairs and/or elevators. Another idea is to explore the opportunity for a partnership with PCC to establish a shuttle service between a 53rd Avenue station using Pomona Street and/or Capitol Highway to connect to the campus directly.

PCC-Sylvania analysis and findings

Transit performance

Key considerations:

- For both BRT and LRT, how would an alignment with a direct connection to the PCC-Sylvania campus perform relative to a Barbur alignment with a station at 53rd Avenue that includes an improved pedestrian and bike connection to campus?
- For BRT, would the more direct connection with a campus station justify the longer travel times and higher cost required to reach PCC-Sylvania?
- For LRT, would the more direct connection with a campus station justify the community impacts and higher cost required to construct a cut-and-cover tunnel?

Key findings:

- A direct connection to PCC-Sylvania would result in slightly slower travel compared to alignments on Barbur Boulevard.
- A campus station would attract more daily ons and offs compared to a 53rd Avenue station with the Barbur alignment.
- With a direct connection to campus, the longer travel time compared to options on Barbur Boulevard would result in slightly lower ridership at stations outside of the PCC-Sylvania area. The combination of higher ridership on campus and lower ridership elsewhere would still result in increases in line and system ridership.

Transit performance analysis in the PCC-Sylvania area focuses on differences between direct HCT access to the campus and HCT service on Barbur Boulevard with an improved walk connection. Since direct access requires different routings for BRT and LRT, both direct access options were modeled and compared to separate Barbur options differentiated by mode (BRT or LRT). As a result, four travel demand model runs were completed for this analysis:

1. BRT on Barbur Boulevard
2. BRT to PCC via Capitol Highway
3. LRT on Barbur Boulevard
4. LRT to PCC via a cut-and-cover tunnel

A future Key Issues memo will compare the overall corridor performance of BRT to LRT. This memo compares the PCC via Capitol BRT option to the Barbur BRT option, and the PCC via tunnel LRT option to the Barbur LRT option. All model results are preliminary. Refinements of HCT options, traffic analyses and local bus service assumptions will result in updated modeling assumptions and new model runs during the DEIS process.

Travel time and reliability

Compared to the Barbur BRT option, the PCC via Capitol BRT route directly to the campus would add 1.6 minutes of travel time, or five percent of the line time between Tualatin and Portland State University. The longer travel time would result from the slightly longer alignment (0.3 miles) and also from stopping at an additional station on Capitol Highway near SW Comus Street. Both options assume BRT operating in exclusive right of way along the entire alignment in this section, but with less grade change and fewer curves, the Barbur alignment can be assumed to be slightly more reliable in staying on schedule than the alignment directly serving campus.

Compared to the Barbur LRT option, the PCC via tunnel LRT would add approximately 48 seconds of travel time, due to a slightly longer alignment and slower speeds through the curve in the tunnel. Since both options assume LRT operating in exclusive right of way and because the Barbur option would not cross major intersections, both options can be assumed to be similarly reliable.

Corridor line ridership, system transit ridership, and station activity

Future HCT ridership projections are largely determined by the speed of the service relative to competing modes and by the numbers of people and jobs the HCT line serves. Ridership is expressed in three ways:

- **Line ridership** measures the number of daily riders on the specific HCT line between the terminus and downtown Portland—this includes both new transit riders and those who would ride local buses in a no-build scenario (without the HCT project).
- **Change in system transit trips** measures the growth of total transit system ridership in the entire transit service area with implementation of the proposed project compared to a no-build alternative—this isolates new transit riders only. While shifts of modeled riders from local buses to HCT service indicate benefits from improved accessibility gained with a project, new riders represent shifts in mode, usually from autos to transit, that are more likely to benefit the transportation system as a whole.
- **Station ons and offs** measures daily activity at specific transit stops. All measures are for forecast year 2035.

For both modes, direct service with a station on the campus would add transit riders in the PCC-Sylvania area, but the additional travel time required to reach the campus would negatively impact ridership elsewhere along the line.

The PCC via Capitol BRT alignment would attract 4,300 daily ons and offs at a campus station. This represents an increase of over 1,900 ons and offs compared with a 53rd Avenue station with the Barbur BRT route, including patrons of the assumed new park and ride lot near the station. The PCC via Capitol BRT alignment would result in 1,300 additional new system transit trips and 2,100 additional line riders compared to the Barbur BRT option, or increases of 15 percent and 7 percent, respectively. The PCC via Capitol BRT alignment would also include an additional station near SW Comus Street, which would

provide access to the neighborhood and is projected to attract an additional 1,140 daily ons and offs. This station would have important equity considerations as described in the Community Development – Access section.

The PCC via tunnel LRT alignment would attract 6,800 daily ons and offs at a campus station, an increase of 3,200 daily ons and offs compared to a 53rd Avenue station with the Barbur LRT option, including park and ride patrons. The PCC via tunnel LRT alignment would result in 2,100 additional system transit trips and 2,700 additional line riders compared to the Barbur LRT option, or increases of 13 percent and 6 percent, respectively.

PCC-Sylvania mode considerations

Appendix C includes a general discussion of differences between BRT and LRT modes and their corridor-wide impacts. This section addresses issues particular to the PCC-Sylvania area.

Consideration should be made for the number of transit vehicles travelling along Barbur Boulevard and through the campus. Today three local bus routes (lines 12, 64, and 96) operate along Barbur Boulevard with up to 17 buses an hour in peak periods, and two routes (lines 44 and 78) operate on or through the campus, with up to 5 buses an hour in peak periods. PCC also operates a shuttle bus system between campuses.

TriMet's Southwest Service Enhancement Plan envisions new all-day frequent service between downtown Portland, Hillsdale, Multnomah Village, and the Portland Community College Sylvania campus using the current line 44, with plans for every other line 44 trip to Mountain Park, Lake Grove, Bridgeport Village, Durham, and Downtown Tualatin via Kerr Pkwy, McNary Pkwy, Monroe Pkwy, Boones Ferry, Bridgeport, Upper Boones Ferry, Boones Ferry, and the Tualatin WES Station. This expanded local service, or introduction of HCT regardless of mode, could reduce the number of PCC shuttles needed to serve the campus

Because of differences in carrying capacities, more BRT vehicles than LRT vehicles would be needed to carry an equivalent passenger load (see Appendix C). The projected 2035 demand in the northern section of the alignment would require up to 23 BRT vehicles per hour in the peak, while LRT would require 10 vehicles per hour.

Community development

The information presented in this section is meant to highlight the trade-offs between serving PCC-Sylvania directly with the cut-and-cover LRT tunnel alignment or the Capitol surface BRT alignment, or less directly via a surface alignment on Barbur Boulevard.

Key considerations:

- Can local transit, and an improved surface bike and pedestrian connection effectively connect the PCC Campus to an indirect surface alignment on Barbur?

- Are there potential land use changes that could occur on the PCC-Sylvania campus in the next 15-20 years that would be commensurate with a tunnel investment?
- Would construction of a cut-and-cover tunnel cause significant disruption to traffic flow and neighborhood access?

Key findings:

- Future redevelopment on the PCC campus could offer enhanced ridership opportunities via a direct HCT connection.
- Current transit service needs to be assessed to determine what changes/additions would optimize service.

The Barbur Boulevard surface alignment would include a station at Barbur Boulevard and 53rd Avenue. The direct PCC via Capitol BRT option would have a station located on the PCC campus, while the PCC cut-and-cover LRT tunnel option would have an underground station that would surface on the northern edge of the campus. The PCC via Capitol BRT option would also include an additional station on Capitol Highway near Comus Street, providing access to a diverse neighborhood.

PCC-Sylvania is currently served by two bus lines, the 44 and the 78, neither of which offers all-day frequent service. Work to optimize current and future service is underway as part of the Service Enhancement Planning process led by TriMet. Potential upgrades to the line 44 bus include all-day frequent service and routing further south to Lake Oswego and Tualatin.

Access

There are a significant number of student trips, up to 17,500, to the PCC campus each day. The majority of those trips are occurring in cars. A 2012 Travel Demand Study conducted on all PCC campuses showed that the mode split for PCC-Sylvania is 58 percent auto, 19 percent transit, 13 percent PCC shuttle, and four percent bike/walk. Several factors may contribute to the high auto mode share in the area. First, the campus has a large amount of inexpensive surface parking available to students. Second, there are not enough transit lines offering direct, frequent service to the campus. Although PCC runs an intra-campus shuttle system, it only carries a small percentage of the daily trips to the Sylvania campus.

Direct access to the campus, either through the cut-and-cover LRT tunnel or the Capitol surface BRT route, would likely influence future mode splits on the campus. This, in turn, would likely free up some of the existing surface parking for other uses. Without more detailed knowledge of future land use changes that may be explored on the campus, it is difficult to predict the impact direct service would have on land use patterns. Trade-offs associated with either direct service option (such as travel time impacts from a BRT connection or neighborhood impacts from tunnel construction) are explored further in the Transit Performance and Community Impacts section of this memo. The PCC via Capitol BRT alignment would also include an additional station near Comus, which would provide additional access to the neighborhood that is home to the Islamic Center of Portland-Masjed As-Saber, Oregon's largest mosque, and a Somali population.

A surface HCT alignment on Barbur would not directly serve the PCC-Sylvania campus. Access to the campus would be via enhanced local bus service, improved bike and pedestrian facilities, and/or a continued PCC shuttle system. Upgrading the line 44 bus to all-day frequent service with routing to Tualatin would increase cross-corridor connections and allow for more frequent access to the PCC campus from areas that currently do not have that opportunity. The project is also exploring a re-design of 53rd Avenue to provide a direct bike and pedestrian route to the campus from a stop along Barbur Boulevard. The street would remain open to local vehicle access but would retain the auto barrier at the south end of the street to prevent auto through traffic in the neighborhood. A walk/bike connection would remain within the ½ mile boundary typically considered viable for transit access, but it would have to address the significant grade change between Barbur and the campus. Staff anticipates design concepts for a potential bicycle/pedestrian connection to be available for discussion in May or June 2015.

Redevelopment potential

Although no specific redevelopment plans have been defined, PCC staff has mentioned the need to re-examine the current land use assumptions on campus. Until PCC takes a more comprehensive look at its land use goals for the campus and its master plan, it will be hard to accurately determine what redevelopment opportunities exist. As previously stated, a direct HCT connection to the campus would likely influence mode splits in a way that would reduce the need for the amount of surface parking that exists today. This could allow PCC to explore redevelopment opportunities on the campus.

Redevelopment analysis done during the 2014 Station Area Planning phase of this project did not consider any of the property on-campus. The existing parking lots provide opportunity for the college to add on-site housing for students and retail and service amenities toward the center of campus and the HCT station, with minimal impact to the surrounding residential neighborhoods. Future retail and service amenities on sites near the campus entrance could be oriented to serve both students and neighborhood residents.

The station proposed at Barbur Boulevard and 53rd Avenue for the Barbur alignment could spur redevelopment on properties immediately adjacent to Barbur. However, the vast majority of properties identified in 2014 Station Area Planning work as possible redevelopment sites are found closer to the Barbur Transit Center, further north. A park and ride facility at this location could influence redevelopment opportunities that would serve commuters, but redevelopment at this location would likely be limited due to geographic constraints along Barbur Boulevard.

Support of local land use plans

The City of Portland's Barbur Concept Plan identifies a potential transit node along Barbur Boulevard as the SW 53rd Focus Area. The Focus Area is identified as being somewhat isolated from other retail areas and has lower market potential for retail opportunities. The Concept Plan also calls for increased investment in sidewalk and bike lanes along Barbur Boulevard in this location, which would be addressed through the construction of an HCT project along Barbur. The Barbur Concept Plan identifies the importance of this Focus Area as:

“...its connection with the PCC campus and potential for additional housing on the campus to accommodate students, as well as leasing opportunities as a potential revenue stream for the campus. It is understood that vehicle access to the campus will primarily continue to be served by Capitol Highway and Lesser Road, but improved pedestrian and bike connections to Barbur can position this node for a future High Capacity Transit station area serving this major growing institution.”

PCC started working on a Framework Plan for the Sylvania campus in 2010 that focused on analyzing the campus at a macro level. Among the topics explored were campus entry and circulation for motorists, bicyclists and pedestrians, stormwater management, and site design to support campus wayfinding and signage for pedestrian navigation and learning lab opportunities. Although these issues are of importance to the ongoing maintenance and success of the campus, they do not address the potential for future development on the campus that could support, and be supported by, a regional HCT investment. There has been talk in recent months of PCC re-examining their long term vision for the campus, with a focus on future campus development, but no work has yet started on that effort.

Mobility

Key considerations:

- Can high capacity transit be designed to minimize negative impacts to auto, freight, bicycle and pedestrian mobility and access?
- How do alignment choices impact road, bike and pedestrian improvement projects that could serve PCC and the neighborhood?

Key findings:

- None of the alignments options overlap with regional or statewide freight routes, but do overlap local (city) freight routes on Barbur and Bertha.
- The Barbur Boulevard surface alignment would include design treatments that could improve pedestrian and bicycle facilities and road safety for all users on Barbur. These design treatments would likely include improved bicycle treatments, sidewalks, and crossings.
- The PCC-via-Capitol BRT alignment would include design treatments that could improve pedestrian and bicycle facilities and road safety for all users on Capitol Highway.
- Each alignment could consider the conversion of travel lanes on Barbur for exclusive transit use.

Motor vehicle and freight mobility

Both Barbur Boulevard and Capitol Highway south of Crossroads have lower traffic volumes than the segment of Barbur Boulevard to the north of Crossroads. As a result, traffic impacts in this segment would be less significant and could largely be managed with minor geometric or operational solutions, such as signal timing. This also could provide opportunities for converting travel lanes for transit use without unacceptable impact to motor vehicle traffic.

Barbur Boulevard and Bertha Boulevard are both designated Major Truck Streets by the City, while Capitol Highway is designated a Truck Access Street. Freight stakeholders have expressed interest in

avoiding overlap between HCT and freight routes, and in ensuring that freight is appropriately accommodated on all streets. None of the alignment options overlap with regional or statewide freight routes. Transit designs would be required to accommodate freight trucks including vertical and horizontal clearances for all alignment options.

Initial traffic analysis considered traffic operations on the Barbur and PCC via Capitol surface alignments. The following table summarizes the intersections analyzed and the initial findings:

Intersection	Meets motor vehicle performance target?*	
	2035 No-Build	2035 Build
SW 49 th Ave. (Capitol) & Hidalgo St. (PCC Access)	Yes	Yes
SW Barbur Blvd. & 53 rd Ave.	Yes	Yes

* Within permitted margin of accuracy

Source: *Final SW Corridor Traffic Analysis and Operations Memorandum, DKS, July 29, 2014*

During the DEIS phase, more detailed traffic analysis will be performed including queuing analysis, and mitigation would be developed for intersections not expected to meet the 2035 motor vehicle performance target. This could include changes in lane configurations, traffic signals, or other mitigation options.

Pedestrians and bicycles

The Barbur surface alignment and PCC via Capitol alignment could both improve pedestrian and bicycle facilities along their respective routes. The Barbur route would address the lack of continuous sidewalks between Crossroads and SW 60th Avenue. The Capitol route already has continuous sidewalks and bike lanes, and opportunities for improving these would be explored. Both would explore adding additional crossings for pedestrians and bicyclists. The cut-and-cover tunnel option would improve pedestrian and bicycle facilities along Barbur Boulevard east of 53rd Avenue where the transit would run in-street.

All options would include a new bicycle and pedestrian connection between Barbur Boulevard and the Tigard Triangle with a new HCT, bicycle and pedestrian bridge.

Safety

Neither Barbur Boulevard nor Capitol Highway along these alignment options has a history of high-severity crashes, although the intersection of Barbur, Capitol, and I-5 (“Crossroads”) does. As part of any project, design treatments to address observed crash types and improve pedestrian and bicycle facilities could improve safety.

Access

Presuming use of center-running transit for the in-street segments, the Barbur and Capitol alignment options would both result in changes to motor vehicle access. On Barbur Boulevard, there are relatively few destination and access points, resulting in relatively minor impacts to access. On Capitol Highway, there are more frequent access points, resulting in moderate access impacts. Both options would likely

involve elimination of some left-turn accesses, but changes to circulation patterns to continue to provide access would be evaluated.

Lane conversions

The only places in the corridor being considered for lane conversion are sections of roadways that currently appear to have excess capacity based on early traffic analysis. Two of these locations occur in this segment: Barbur Boulevard between the Barbur Transit Center and the Tigard Triangle, and Capitol Highway between Barbur Boulevard and PCC. Both of these segments currently have two northbound and two southbound travel lanes but have relatively little traffic for a four-lane facility. The project team is studying the potential to convert one travel lane in each direction of these segments to exclusive HCT use in order to reduce cost and minimize impacts to adjacent properties. If needed, designs can be modified to maintain existing lane configurations, with the tradeoff of more property impacts. For BRT, the project team is studying options for both exclusive BRT lanes and running the BRT vehicles in mixed traffic in both of these segments.

As the project progresses, further traffic analysis will look in detail at traffic flows at intersections as well as in the broader network to confirm whether lane conversions could work and whether additional mitigations might be needed to allow conversion, such as new turn lanes or signals. Additionally, more detailed consideration of the property impacts of different lane configurations will allow for a discussion about the trade-offs between minimizing impacts and maintaining existing auto capacity. A sensitivity analysis will be conducted to determine the effects on Barbur with lane conversions when an incident occurs on I-5.

Cost Estimates

Key considerations:

- Are the trade-offs between cost of a project and other factors such as reliability, safety, access and community development opportunities clear?
- How does cost impact the length of the final high capacity transit alignment?

Key findings:

- Corridor-wide BRT estimates range from \$680M to \$1.2B in 2014 dollars.
- Corridor-wide LRT estimates that include a cut-and-cover tunnel in Hillsdale and PCC-Sylvania range from \$1.9B to \$2.4B in 2014 dollars. This does not include the cost of a Marquam Hill-Hillsdale bored Tunnel.

Current cost estimates for corridor HCT alignments are based on conceptual designs. Estimates will continue to be refined during the DEIS process as options are narrowed and designs progress, but are useful now in demonstrating the relative differences between current options. **All figures are in year 2014 dollars, and exclude escalation and finance costs.** Cost estimates are not yet complete for all modes, options, and segments; estimates will be updated and reported as the project progresses.

Corridor-wide costs

Current estimates for a BRT alignment from downtown Portland to Tualatin range from \$680M to \$1.2B. The range reflects options for cut-and-cover tunneling and for infrastructure improvements to allow BRT to operate in dedicated transit lanes.

Costs for an LRT alignment extending from downtown Portland to Tualatin would range from \$1.9B to \$2.4B. The range is inclusive of surface and shallow cut-and-cover tunnel options in Hillsdale and at PCC but excludes the deep-bored tunnel option under Marquam Hill, which is estimated to add an additional \$732-\$900M to the overall project cost. More expensive HCT alignment options such as tunnels may impact the final length of the HCT project and the ability to serve more communities to the south.

PCC-Sylvania area costs

The PCC via cut-and-cover tunnel alignment for LRT would have considerably higher capital costs relative to the PCC via Capitol alignment for BRT or the Barbur alignment for either mode (costs for segment from Crossroads to Tigard Triangle below).

- BRT to PCC via Capitol: \$144M
- BRT on Barbur (with 53rd bike/ped improvements): \$140M
- LRT to PCC via cut-and-cover tunnel: \$515M
- LRT on Barbur (with 53rd bike/ped improvements): \$272M

Engineering complexity and risk

Key considerations:

- What are the risks associated with construction of a cut-and cover tunnel?
- What aspects of each alignment option present noteworthy risk?

Key findings:

- There would be significant potential geotechnical and construction risks involved with a mining operation involved with cut-and-cover tunnel construction; details about impacts and risks are being developed in a separate tunneling technical report
- A Barbur option for either LRT or BRT with a station at 53rd Avenue would require major improvements to 53rd Avenue to provide walk access from the station to the PCC-Sylvania campus.
- All options include a new structure over I-5 connecting the PCC-Sylvania area to the Tigard Triangle for use by transit, bikes, and pedestrians.

Barbur

A number of different HCT configurations are possible on Barbur Boulevard. LRT along Barbur would likely require an elevated structure for LRT beyond a station at 53rd Avenue. The current slope of Barbur Boulevard is approximately 5 percent. In order to create a level area for a station, the alignment would

be elevated. Anytime a significant structure is involved there is a risk that subsurface conditions will present unexpected challenges.

PCC via Capitol Highway (BRT only)

This alignment has fairly low engineering risk and complexity within the Capitol Highway right of way as a result of the flexibility offered by the BRT vehicle. Engineering risks exist insofar that lane conversion on Capitol Highway is or is not a possibility. However, the BRT could run in mixed traffic to avoid potential risk. Without lane conversion the necessary space for turn lanes and other traffic mitigation would not be available without potentially significant property impacts. This option would share a new structure that would extend straight from PCC G Street over I-5 and land at the top of the Tigard Triangle. This structure and the slope below could introduce unanticipated engineering challenges related to drainages and unstable slope or other subsurface conditions.

PCC via cut-and-cover tunnel (LRT only)

Tunnels are inherently risky given the variety of unanticipated subsurface conditions that might be encountered. Subsurface conditions of a cut-and-cover tunnel can be more effectively explored with borings, unlike the deeper bored tunnel under Marquam Hill and Hillsdale. While the tunnel under consideration would likely be no deeper than 60' to 70' the character of the materials to be encountered is currently unknown. A study which will broadly categorize the likely materials and challenges to be encountered is expected to be completed in early May 2015.

Community impacts

Key considerations:

- How would construction of a cut-and-cover tunnel impact the neighborhood?
- How would the Barbur-PCC pedestrian and bicycle Creative Connection impact the neighborhood?
- Can benefits and burdens of a high capacity transit alignment be equally distributed among all population groups in the corridor?
- Do surface or tunnel alignments offer the greatest access to key places such as education, employment, health care and retail centers?
- How do HCT options compare in providing access to SW neighborhoods in addition to access to PCC?

Key findings:

- Construction of a cut-and-cover tunnel could require acquisition of properties along the tunnel route.
- The Barbur-PCC Creative Connection would improve right of way along SW 53rd for pedestrian and bike traffic, but would not create new access to campus for cars.

- Based on spatial analysis of demographic maps, there is no significant difference in how each alignment option runs through areas of non-white, non-English speaking, low-income or senior populations.
- Subsequent analysis and conversations with residents, employees and visitors to the corridor will further detail the potential for unequal distribution of benefits and burdens of high capacity transit construction and service.

Property impacts

The options under consideration all have varying levels of impact to adjacent private properties. In many cases, property impacts are limited to only a narrow strip of area needed to widen the roadway and sidewalks. In other instances, temporary construction easements may be all that is needed to allow for construction of new roadway and sidewalks. In other cases, large or complete acquisitions may be necessary when impacts to buildings or other major infrastructure are unavoidable. The project team is currently quantifying the areas of potential impact on each of the options and will be presenting the level of impact of the various options relative to one another once the data is assembled. In areas where converting an auto travel lane to a transit lane is under consideration, property impacts will be evaluated for scenarios both with and without the lane conversion in order to facilitate discussion about the trade-offs of minimizing impacts and maintaining auto capacity.

Of particular concern in this area is the impact of cut-and-cover tunnel construction. While the homes and other structures along the excavated street may not need to be disturbed during construction, access to those buildings can be expected to be precluded for two years or more. This impact would likely require full property acquisitions along much of the proposed tunnel alignment through the residential neighborhood.

The Barbur-PCC Creative Connection, the improved pedestrian and bicycle connection between a 53rd Avenue station and the campus, would be part of a Barbur option with BRT or LRT. The approximately 1/2 mile connection has not yet been designed, but would likely include street paving, sidewalks, and lighting to improve walk and bike access to campus. Foot traffic would increase along the street, but the connection would not include a new through route for autos. Property impacts will be determined through the design.

Demographics

Demographic maps for non-white, non-English speaking, low-income and senior populations were overlaid with maps of the proposed HCT alignments (see Appendix D). Subsequent discussions with residents, employees and visitors to these areas will help us to further understand how different racial, ethnic and language groups may be impacted by the proposed alignments.

Non-white and non-English speaking populations

Based on spatial analysis of the maps, the northern part of the alignment options would run through areas with higher than average non-white and non-English speaking populations. Disaggregation by

ethnicity shows that the northern parts of the alignment options would run through areas with higher than average concentrations of Black populations. The PCC via Capitol BRT alignment would include a station near Comus that could serve the Islamic Center of Portland-Masjed As-Saber, Oregon's largest mosque, and a nearby Somali population.

Low-income and senior populations

Based on spatial analysis of the maps, none of the alignment options would run through areas with higher than average concentrations of low-income populations. The southern portion of the alignment options would run through areas with higher than average concentrations of senior populations.

Access to services

Investments in the transportation systems throughout the Southwest Corridor aim to improve access to important community services such as education, health care, retail and employment centers for all residents.

PCC Sylvania campus is the only education center identified in this portion of the study area. A bus rapid transit option on Capitol Highway or a PCC cut-and-cover tunnel would provide more direct access to the PCC Sylvania campus than the Barbur alignment.

Next steps

This Key Issues Memo formally introduces to decision-makers and the public information relevant to a decision on high capacity transit alignments in the PCC-Sylvania area. Between March and July 2015, project staff will present information on PCC-Sylvania and other Southwest Corridor Plan issues and invite public comment at numerous public meetings, including a Community Planning Forum and a Community Technical workshop. An updated calendar can be found on our website:

<http://www.oregonmetro.gov/public-projects/southwest-corridor-plan>

May 2015: Staff will produce a technical evaluation report that will include assessments of options accessing South Portland, Hillsdale, and PCC-Sylvania, followed by staff recommendations to the Steering Committee in early June.

July 13, 2015: The Steering Committee will be asked to consider making decisions on what options in these four areas should continue to be studied in a DEIS.

December 2015: The Steering Committee will be asked to consider making a recommendation on the mode, terminus and remaining HCT alignments to be studied further in a DEIS, along with an implementation strategy for the corridor connection projects defined in the Shared Investment Strategy.

April 2016: The Steering Committee will consider recommending a final Preferred Package to JPACT and the Metro Council.

Appendices

Appendix A: Anticipated major project documents and estimated dates of completion

Appendix B: Shared Investment Strategy roadway and active transportation projects

Appendix C: Corridor-wide mode considerations

Appendix D: Demographic map

Appendix A: Anticipated major project documents and estimated dates of completion

July Steering Committee decision: direct vs. indirect service to Marquam Hill, Hillsdale and PCC-Sylvania

- Key Issue Memos:
 - South Portland – March
 - Hillsdale – March
 - PCC-Sylvania – May
- Draft Evaluation Report – May
- Evaluation Report and Recommendation – June
- Supplementary documents:
 - Tunnel fact sheet – March
 - Modeling report – May
 - Cost estimate report – May
 - Tunnel technical memo – May

December Steering Committee decision: remaining HCT alignments, mode, and terminus and SIS funding strategy

- Key Issue Memos:
 - Tigard – May
 - Tigard to Bridgeport Village – September
 - Bridgeport Village to Tualatin – September
 - Barbur / Adjacent to I-5 – October
 - HCT mode – October
 - HCT terminus – October
- Draft Evaluation Report – October
- Evaluation Report and Recommendation – November
- Supplementary documents:
 - Modeling report – October
 - Cost estimate report – October
 - Traffic report - October
- Funding strategy for Shared Investment Strategy roadway, bike and pedestrian projects – December

Appendix B: Shared Investment Strategy roadway and active transportation projects

The information in this appendix will be further developed and presented as a stand-alone document.

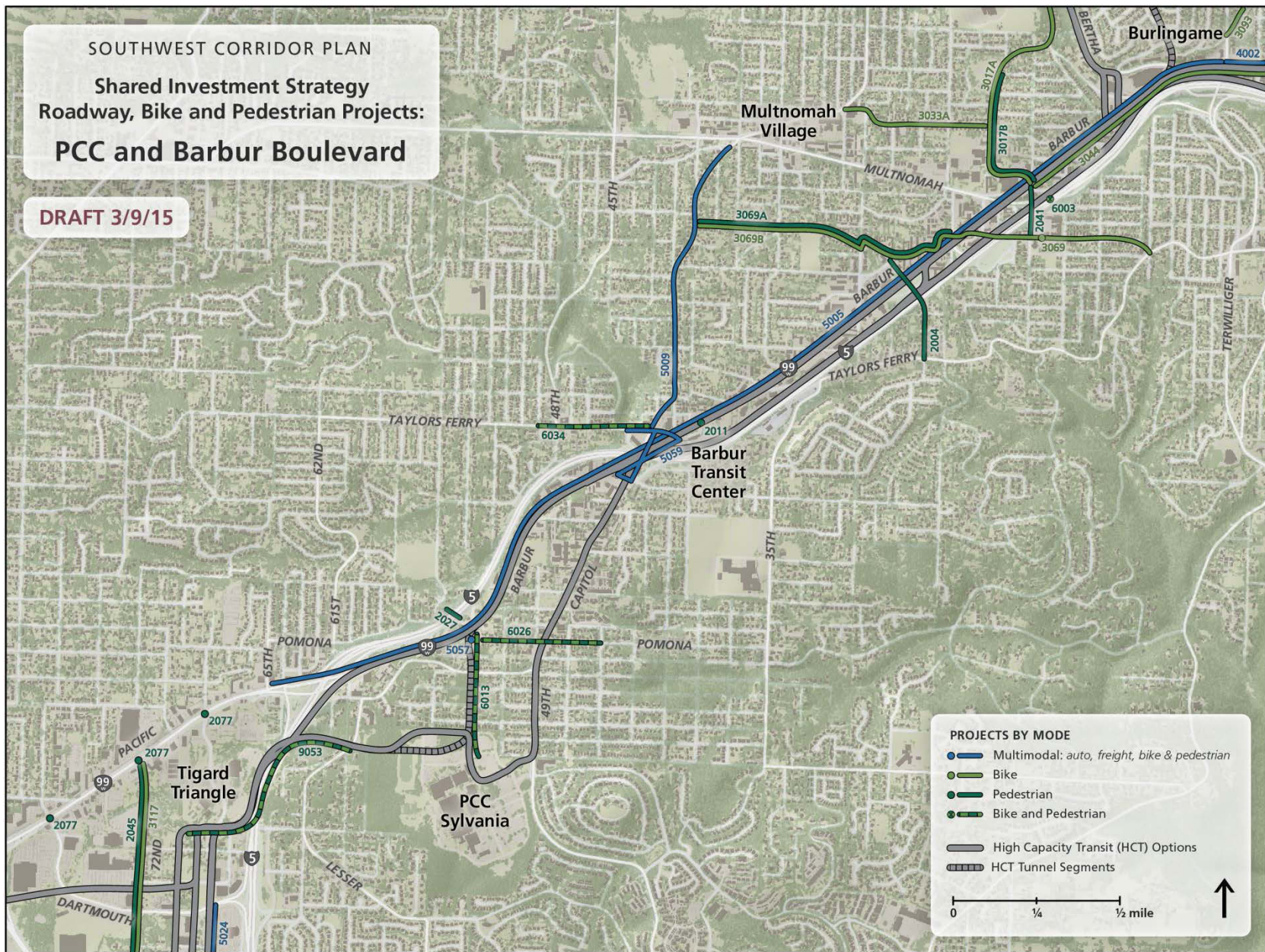
The Shared Investment Strategy (SIS) Roadway and Active Transportation Project List includes projects that improve access to both key places in the corridor and to the high capacity transit (HCT) alignments currently under consideration:

- **HCT-aligned projects** are roadway, bikeway and pedestrian projects that were initially identified in the SIS in July 2013, and then were further refined in July 2014 as the HCT alignments were narrowed. These projects either run along the HCT alignment (and would be incorporated into HCT designs and cost estimates) or improve access to station areas.
- **Corridor Connections** are roadway, bikeway and pedestrian projects that improve connectivity and mobility across the corridor, beyond the immediate geographic area of a potential HCT line. These were identified in the SIS in July 2013 as critical for the support of land use goals in essential and priority places.

Some of the projects identified as HCT-supportive are also critical land use supportive projects, and will remain on the SIS Roadway and Active Transportation Project List as Corridor Connections projects if their associated HCT station or alignments are removed from consideration. Other HCT-supportive projects that do not support key land uses will be removed from the SIS project list as their associated HCT alignments or stations are removed from consideration.

For all projects on the SIS Roadway and Active Transportation Project List, potential funding sources will be identified. For HCT-supportive projects, one potential funding approach will be as part of the HCT package, but other potential funding sources will be identified for each project to support their implementation whether as part of a transit project or as a standalone project. Some of the projects will require traffic analysis and evaluation of other impacts prior to project partner support for implementation.

The following map and list show both the HCT-supportive and corridor connections projects in the PCC and Barbur Boulevard area.



Multimodal

Auto/Freight

Bicycle

Pedestrian

Bike/Ped

Cost: ¢ - up to \$500,000; \$ - up to \$5 M; \$\$ - up to \$10 M; \$\$\$ - up to \$20 M; \$\$\$\$ - More than \$20 M

Project # Location/ Ownership	Title Description	Cost	Primary Mode	Primary Project Type	Time- frame	Potential Funding Sources	Notes
2004 Portland	26th Ave, SW (Spring Garden - Taylors Ferry): Pedestrian Improvements Construct a walkway for pedestrian travel and access to transit and install street lighting	¢	Pedestrian	HCT Supportive		HCT Package	With HCT station at Barbur & 26th: Include Include with station at Barbur & 30th?
2011 Portland ODOT	Connections to Transit/Transit Improvements: Barbur & Taylors Ferry New steps/ramp connecting SW Taylors Ferry frontage road to Barbur across from transit center at existing signalized crossing.	¢	Pedestrian	HCT Supportive		HCT Package ODOT	
2027 Portland ODOT	Pedestrian Overpass near Markham School Construct pedestrian path and bridge over Barbur Blvd. and I-5 to connect SW Alfred and SW 52nd to the rear of Markham School.	\$\$	Pedestrian	HCT Supportive		HCT Package	With HCT station at Barbur & 53rd: Include
2041 Portland	SW 19th Ave sidewalks: Barbur - Spring Garden Construct new sidewalks where none exist (DA)	¢	Pedestrian	HCT Supportive		HCT Package	With HCT station at Barbur & Capitol Hill/19th: Include
2045 Tigard	72nd Avenue sidewalks: 99W to Bonita Complete gaps in sidewalk on both sides of street from Highway 99W to Bonita Road	\$	Pedestrian	HCT Supportive		HCT Package	With all HCT options: Include one side from 99W to Dartmouth (25%) With HCT station at Beveland: Include one side from Dartmouth to Hunziker (25%) With HCT station at 72nd & Tech Center Drive: Include west side from Tech Center Drive to south of Landmark Lane (20%) With HCT station at WES & Bonita: Include east side from Bonita to Landmark Lane (10%)

Project # Location/ Ownership	Title Description	Cost	Primary Mode	Primary Project Type	Time- frame	Potential Funding Sources	Notes
3017A Portland	Capitol Hill Rd bikeway -from SW Barbur Blvd to SW Bertha Blvd. Multiple bicycle facility types: bicycle boulevard or enhanced shared roadway (Barbur - Troy; 21st - Custer); bicycle boulevard or advisory bike lane (Troy - 21st); enhanced shared roadway (Custer - Bertha)	¢	Bicycle	HCT Supportive		HCT Package	With HCT station at Barbur & Capitol Hill/19th: Include
3017B Portland	Capitol Hill Rd sidewalks -from SW Barbur Blvd to SW Bertha Blvd. Install sidewalk on Capitol Hill Road from Barbur to Bertha.	\$	Pedestrian	HCT Supportive		HCT Package	With HCT station at Barbur & Capitol Hill/19th: Include from Barbur to existing sidewalk at Custer Park (35%)
3033A Portland	Inner Troy bikeway -from SW Capitol Hwy to SW Capitol Hill Rd. Bike boulevard from SW Capitol Hwy to SW Capitol Hill Rd	¢	Bicycle	HCT Supportive		HCT Package	With HCT station at Barbur & Capitol Hill/19th: Include
3044 Portland ODOT	Middle Barbur bikeway -from SW 23rd Ave to SW Capitol Hwy-Barbur Blvd Ramp. Separated bicycle route in-roadway. Listed as a Regional Bicycle Parkway in the Regional Active Transportation Plan (5/9/13).	\$	Bicycle	HCT Supportive		HCT Package	With HCT adjacent to I-5: Include within 1/2 mile of stations With HCT on Barbur: Include
3069A Portland	Spring Garden, SW (Taylors Ferry - Capitol Hwy): Bikeway Complete bicycle boulevard and bike lanes.	\$	Bicycle	HCT Supportive		HCT Package	With HCT station at Barbur & 26th or Capitol Hill/19th: Include low-cost elements, such as striping or neighborhood greenway treatments (25%)
3069B Portland	Spring Garden/Dolph Ct, SW (Capitol Hwy - Barbur): Sidewalks Install sidewalk along Dolph Ct from Capitol Hwy to 26th Way and along Spring Garden from 26th Way to Barbur.	\$	Pedestrian	HCT Supportive		HCT Package	With HCT station at Barbur & 26th or Capitol Hill/19th: Include from 27th Ave to intersection of 26th Way and Dolph Court (15%)
3093A Portland	Terwilliger bikeway gaps Separated bicycle route in-roadway. Eliminate key gaps in the Terwilliger Blvd bikeway	¢	Bicycle	HCT Supportive		HCT Package	With HCT station at Barbur & Terwilliger: Include lower section near Barbur (50%)

Project # Location/ Ownership	Title Description	Cost	Primary Mode	Primary Project Type	Time- frame	Potential Funding Sources	Notes
3117 Tigard Tualatin	72nd Avenue bikeway: 99W to city limits Install bike facilities on both sides of the street from Highway 99W to South City Limits	\$	Bicycle	HCT Supportive		HCT Package	With all HCT options: Include if done through re-striping (conversion from 3-lane to 2-lane with bike lanes)
4002 Portland ODOT	Barbur Blvd, SW (3rd - Terwilliger): Multimodal Improvements Construct Improvements for transit, bikes and pedestrians. Transit improvements include preferential signals, pullouts, shelters, left turn lanes, sidewalks, and crossing improvements.	\$\$	Multimodal	HCT Supportive		HCT Package	With HCT on Barbur Boulevard: Include
5005 Portland ODOT	Barbur Blvd, SW (Terwilliger - City Limits): Multimodal Improvements Complete boulevard design improvements including sidewalks and street trees, safe pedestrian crossings, enhance transit access and stop locations, and bike lanes (Terwilliger - SW 64th or Portland City Limits).	\$\$\$\$	Multimodal	HCT Supportive		HCT Package	With HCT adjacent to I-5: Include within 1/2 mile of stations (20%) With HCT on Barbur Boulevard: Include
5009 Portland	Capitol Hwy Improvements (replace roadway and add sidewalks) Improve SW Capitol Highway from SW Multnomah Boulevard to SW Taylors Ferry Road per the Capitol Highway Plan. Replace Existing Roadway and add sidewalks, bike lanes and green stormwater features.	\$\$\$	Multimodal	HCT Supportive		HCT Package	
5024 Tigard	68th Avenue (widen to 3 lanes) Widen to 3 lanes or for transitway including sidewalks and bike lanes between Dartmouth/I-5 Ramps and south end	\$\$\$	Multimodal	HCT Supportive		HCT Package	With all HCT options: Include sidewalk on one side from Atlanta to south of Baylor With HCT on 68th Avenue: Include
5057 Portland	SW 53rd and Pomona (improves safety of ped/bike users) Reconfigure and improve intersection to manage traffic turning speeds, and improve safety of ped/bike users between Barbur and Pomona.	¢	Multimodal	HCT Supportive		HCT Package	With HCT station at Barbur & 53rd: Include

Project # Location/ Ownership	Title Description	Cost	Primary Mode	Primary Project Type	Time- frame	Potential Funding Sources	Notes
5059 Portland ODOT	SW Portland/ Crossroads Multimodal Project (roadway realignments and modifications to Barbur Blvd., Capitol Hwy., and the I-5 southbound on-ramp) Implement Barbur Concept Plan walk audit recommendations in the SW Portland TC, including modifications to Barbur Blvd., Capitol Hwy., and the I-5 southbound on-ramp to support safer and more efficient operation for all modes. Project specifics include intersection types and roadway realignments to be refined.	\$\$\$\$	Multimodal	HCT Supportive		HCT Package	With all HCT options: Include multimodal investment at the Barbur/Capitol/Huber/Taylors Ferry intersections at this location (5%) Includes improved pedestrian crossings
6003 Portland	Multnomah viaduct bicycle and pedestrian facilities Construct new bicycle and pedestrian facilities at/parallel to Multnomah St. viaduct	\$	Bike/Ped	HCT Supportive		HCT Package	With HCT on Barbur Boulevard: Include
6013 Portland	Barbur/PCC ped/bike Connection Neighborhood greenway connection between Barbur and PCC via SW 53rd.	¢	Bike/Ped	HCT Supportive		HCT Package	With HCT station at Barbur & 53rd: Include
6026 Portland	Pomona St: Bicycle and Ped improvements (35th to Barbur) provide bike lanes and sidewalks	\$	Bike/Ped	HCT Supportive		HCT Package	With HCT station at Barbur & 53rd: Include from 53rd to 45th (50%)
6034 Portland	Taylors Ferry, SW (Capitol Hwy - City Limits): Bicycle & Pedestrian Improvements SW Taylors Ferry Rd: Provide bicycle lanes, including shoulder widening and drainage, and construct sidewalks for access to transit.	\$	Bike/Ped	HCT Supportive		HCT Package	With all HCT options: Include from Capitol Highway to 49th (40%)
9053 Portland Tigard	Ped/Bike Connection between Tigard Triangle and PCC-Sylvania Provide pedestrian/bicycle connection between the Tigard Triangle area and PCC-Sylvania	\$	Bike/Ped	HCT Supportive			

Appendix C: Corridor-wide mode considerations

The information in this appendix will be further developed and presented as a stand-alone document.

Two high capacity transit (HCT) modes are under consideration for the corridor:

- Light rail transit (LRT)
- Bus rapid transit (BRT)

Bus Rapid Transit description

There are currently four operating LRT (or MAX) lines and one under construction in the Portland area. In 2014, BRT was selected as the preferred mode for the under-development Powell-Division Transit Development Project, but to date BRT does not operate in the region. Typically, BRT is differentiated from standard bus service by several characteristics:

- Fifty percent or more of the alignment operate in dedicated transitway lanes to increase speed and reliability.
- Portions of the alignment may have queue bypass lanes, signal priority, or other design elements to speed travel.
- Vehicles are larger capacity and have multiple doors for entry and exit.
- Fare payment is made off-board to reduce dwell times.
- Stations are similar to LRT or streetcar stations, and are spaced further apart than local service bus stops for faster service.

Capital costs

Depending on the percentage of dedicated transitway for a BRT alternative, capital costs to construct physical infrastructure are more expensive for LRT, which operates in fully dedicated transitway, in large part due to right-of-way acquisition of property required for construction. It is important that BRT planning consider the risks of “watering down” a project by deciding to operate BRT in congested roadways to avoid high capital costs or engineering complexity. This can diminish the effectiveness of BRT service as the most difficult places to attain exclusive right of way are often the places it is most needed.

Capital costs are a one-time cost shared by many partners including the federal government, which usually contributes 50% of a project’s capital cost, as well as state and local governments, municipal planning organizations, transit agencies, and other private partners.

Operating and maintenance costs

The vehicle operator accounts for the largest share of operating costs regardless of mode. Since an LRT vehicle has greater capacity compared to a BRT vehicle (266 versus approximately 86), fewer LRT vehicles are required to carry an equivalent passenger load, making LRT less expensive to operate than BRT. SW Corridor model runs indicate that in the year 2035 the 7.5 minutes assumed peak headway

(number of minutes between vehicle arrivals) for LRT is sufficient to accommodate peak-hour, peak-direction demand. For BRT, however, the peak frequencies would need to be increased to 3 minute headways to accommodate demand. This would result in higher operating costs for BRT for the lifetime of the service. On-going operating and maintenance costs are largely locally funded.

Speed, service and ridership

LRT attracts more riders than BRT. Because LRT always operates in exclusive transit lanes and because it is more likely to be granted signal priority at intersections, light rail is faster and more reliable than BRT. Stated preference surveys also show that LRT attracts more discretionary riders than BRT, due to speed advantages but also to better perceived ride quality compared to BRT.

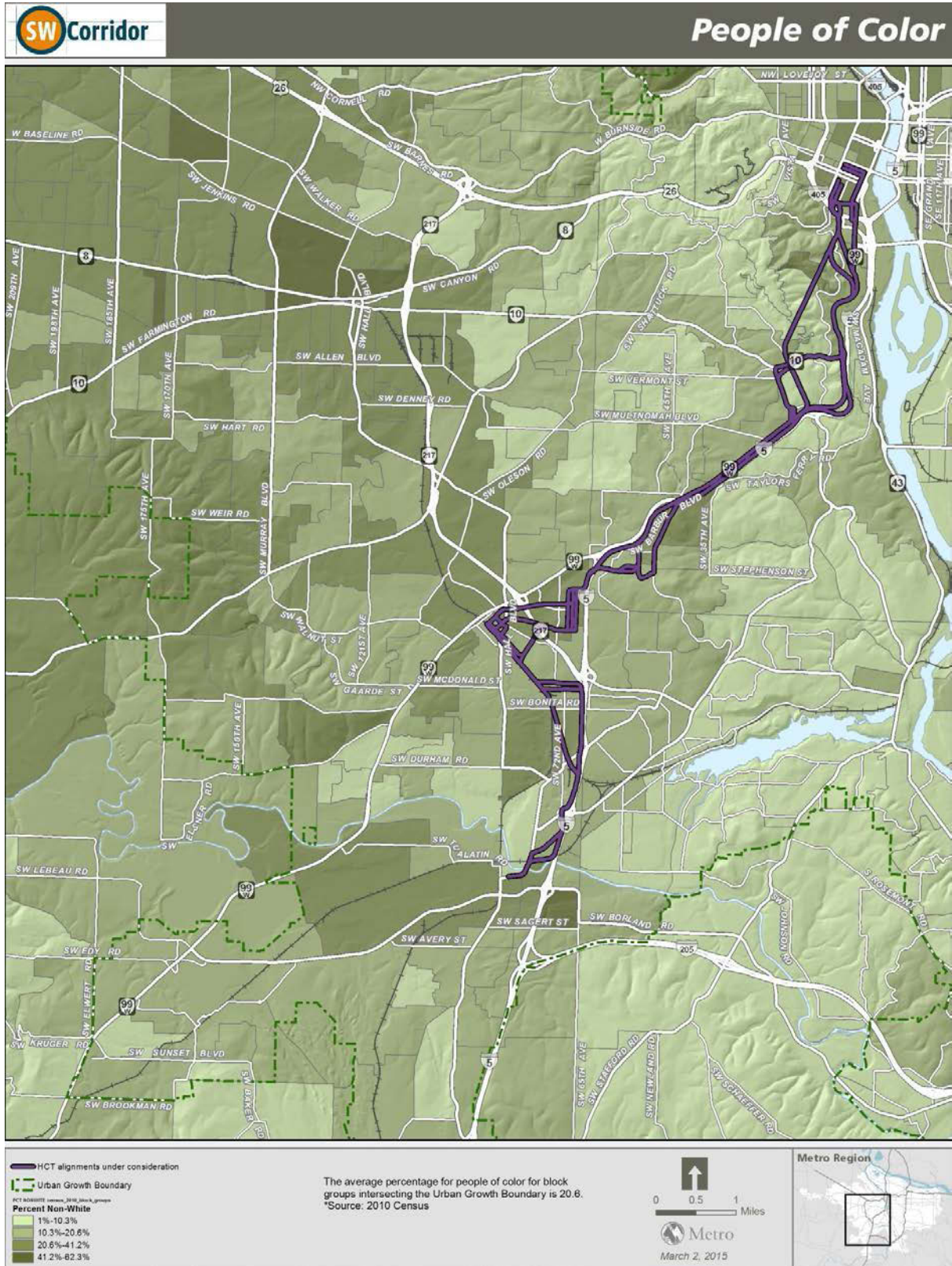
Models indicate that in 2035 the demand for HCT in the Southwest Corridor would require 20 BRT vehicles per hour in the peak, while LRT is assumed to operate with eight vehicles per hour in the peak with enough capacity still available to accommodate ridership growth beyond 2035. For BRT, growth above the projected 2035 demand would require yet more increases in service.

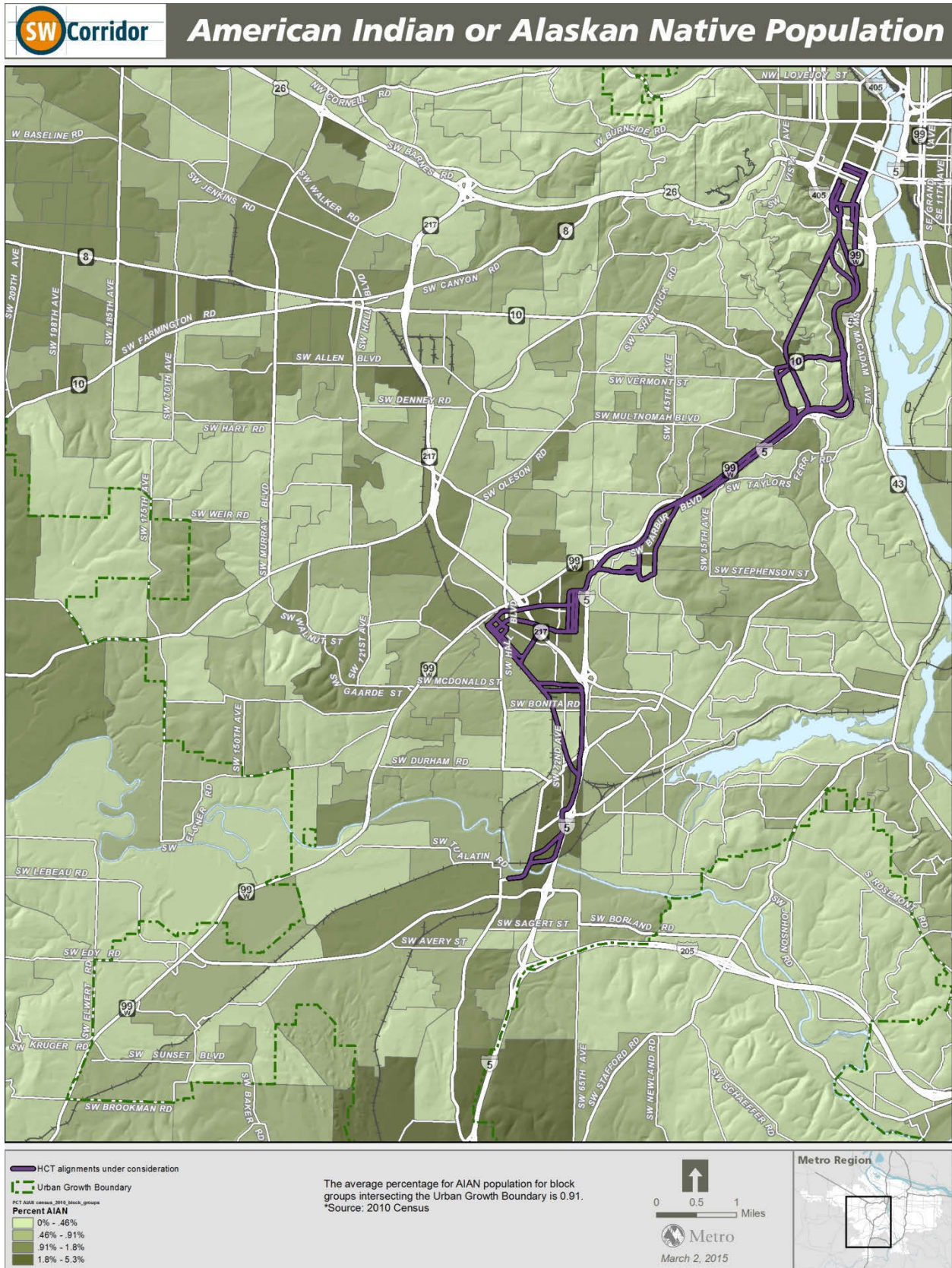
HCT service provides travel time advantages over local buses because of exclusive right of way but also because of longer distances between stations and signal priority at intersections. The high number of hourly vehicles required for BRT can be expected to diminish some of the travel time benefit from signal priority. The more frequently HCT vehicles pass through an intersection, the less likely signal priority can be given to the transit vehicles over autos. When the frequency of signal priority requests interferes with auto movement, priority for HCT vehicles is limited. It's expected that traffic would be largely unaffected by the eight LRT vehicles per hour assumed in the peak in 2035; however, the frequency required for BRT would likely prohibit full priority.

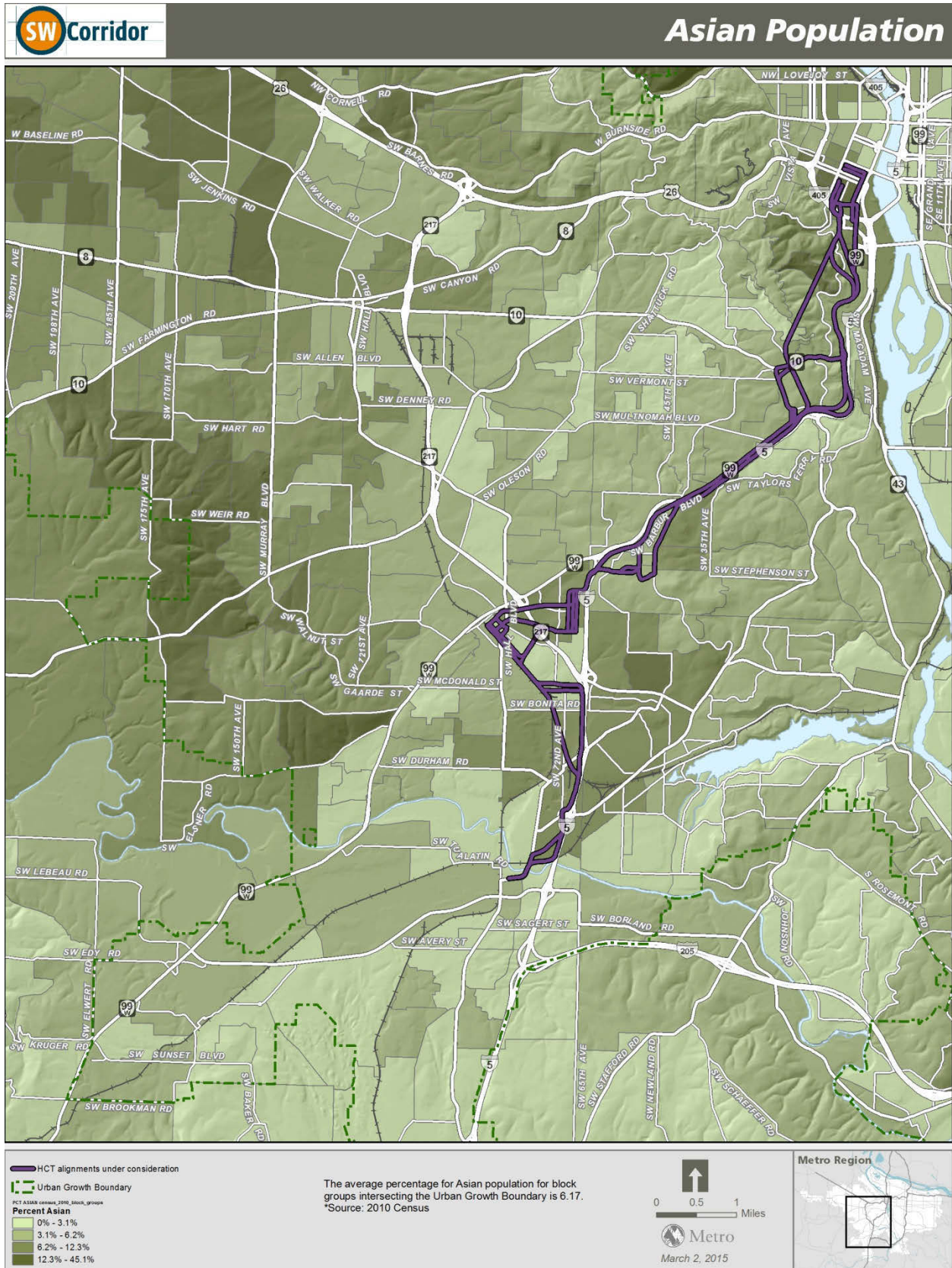
Development

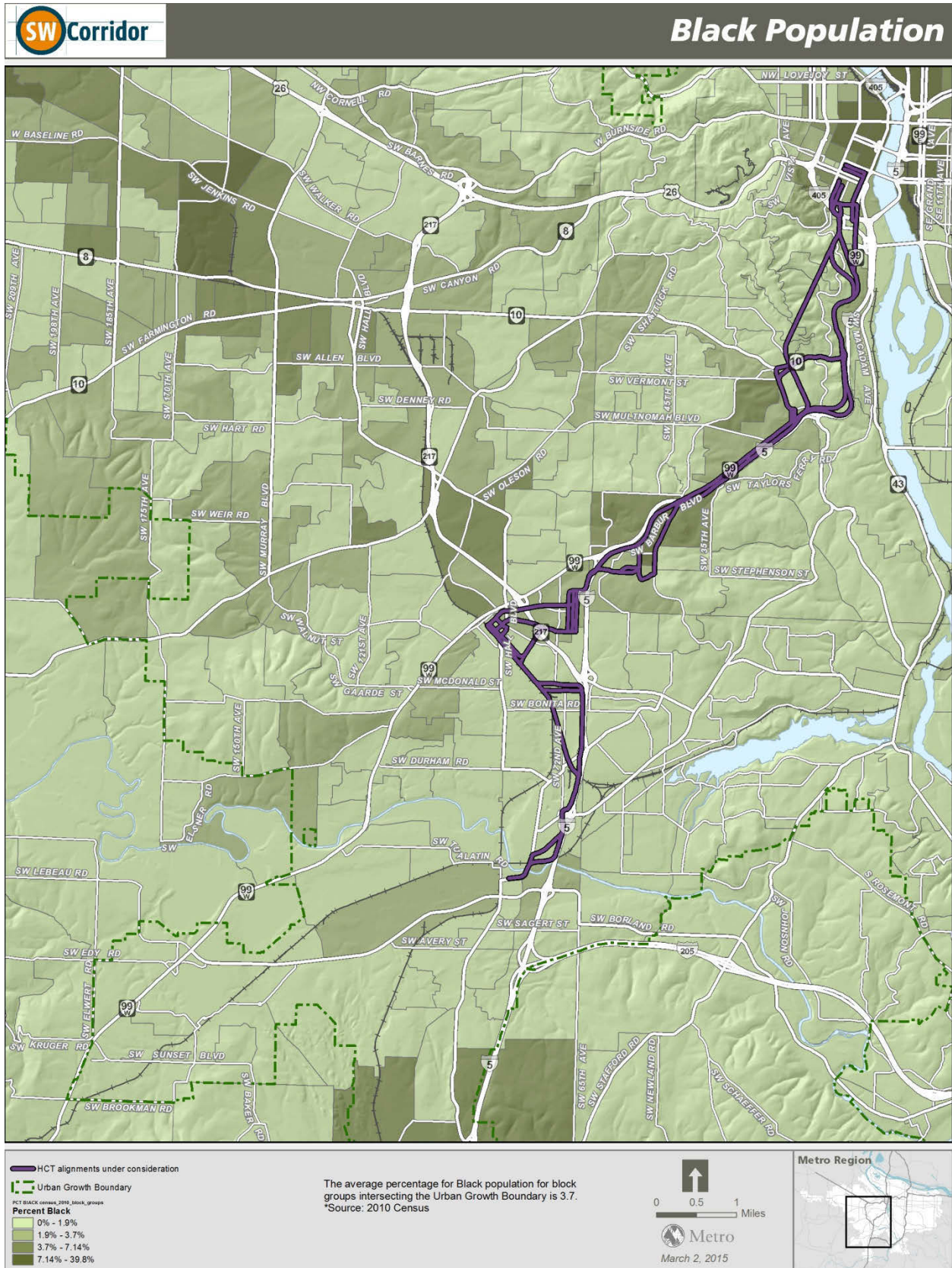
Both BRT and LRT would leverage private development investment at station areas. Available research assessing the difference in scale of development by mode is inconsistent and contradictory. Staff will address development by mode over the course of the next year.

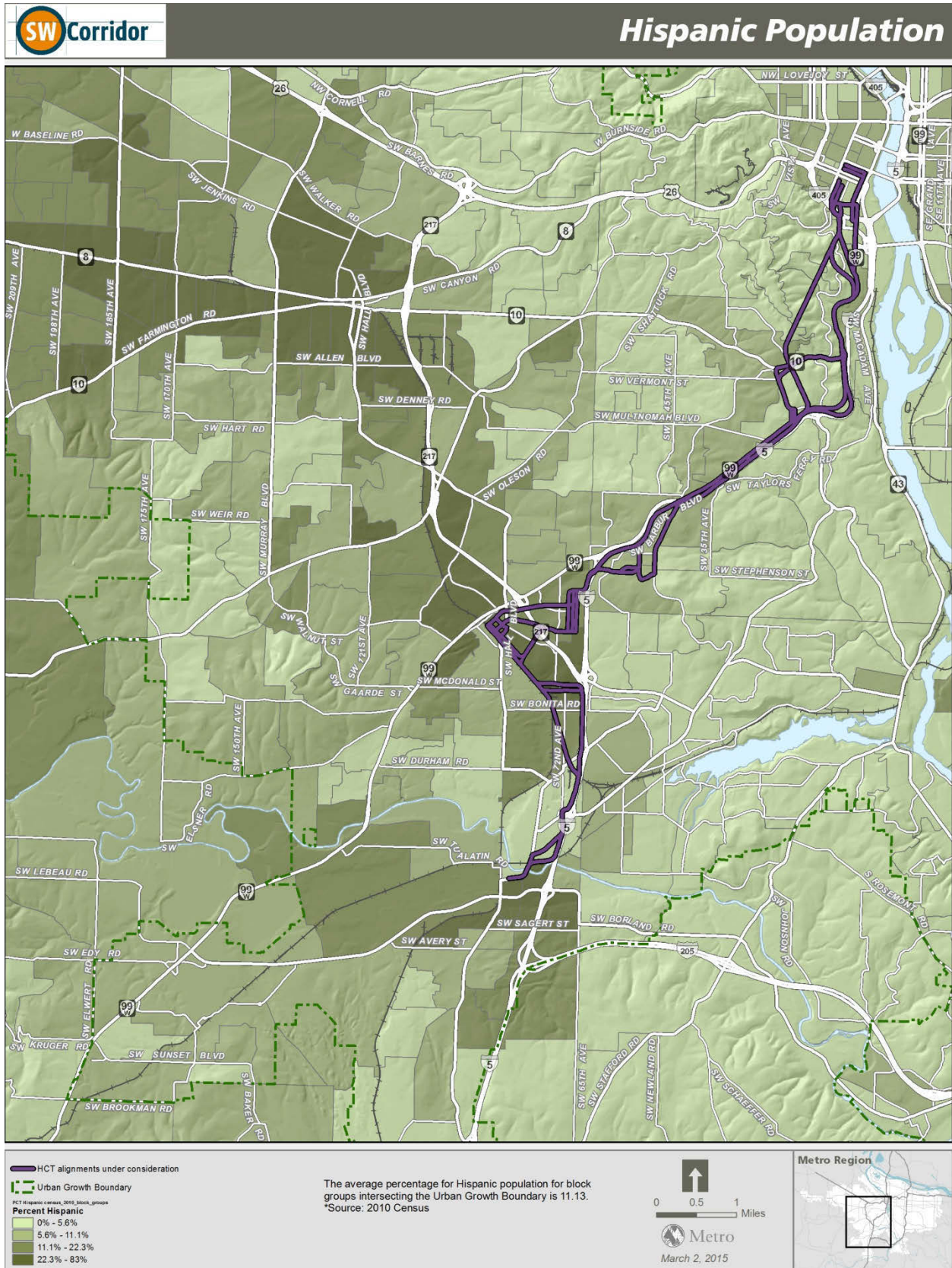
Appendix D: Demographic maps

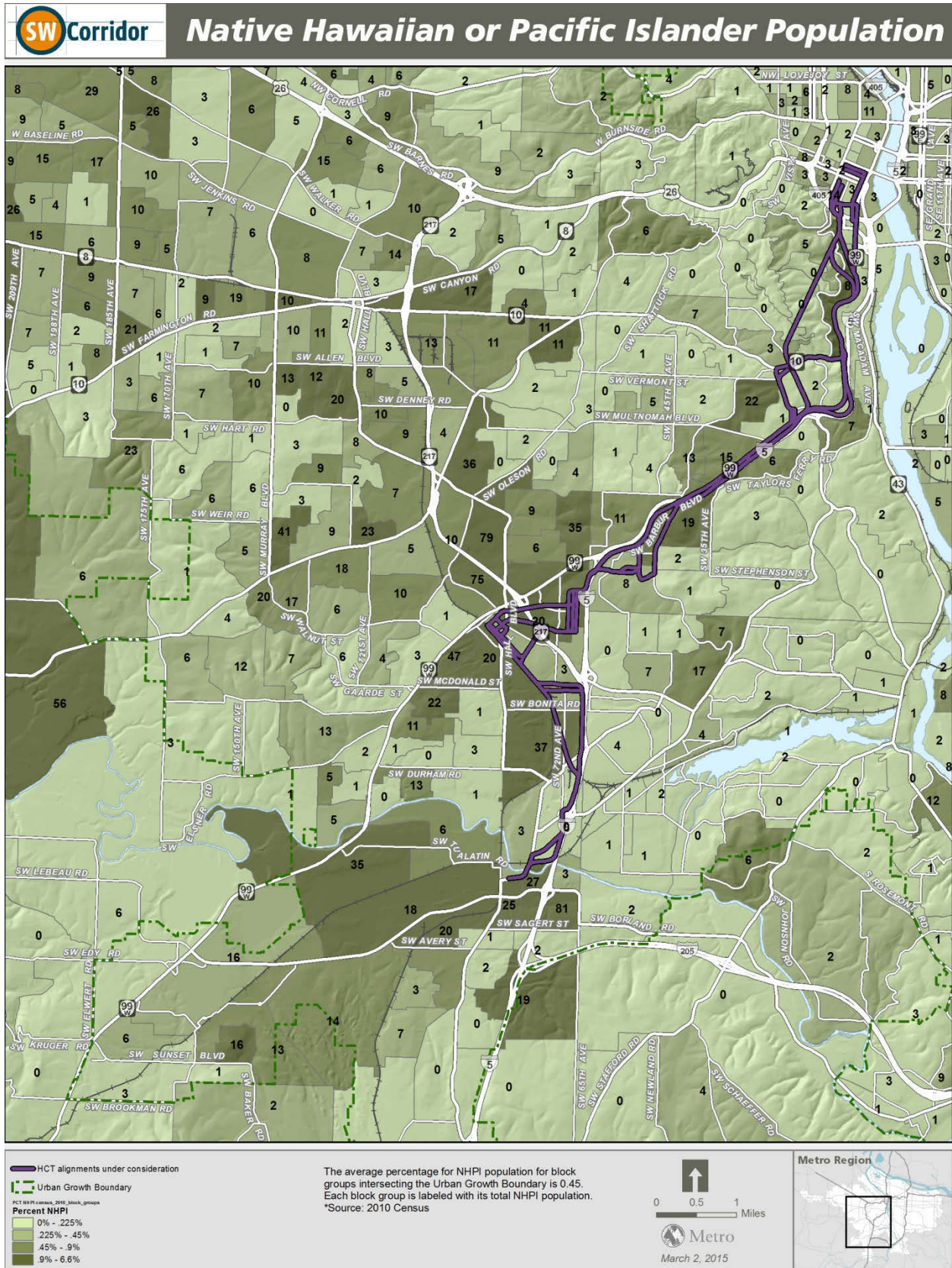


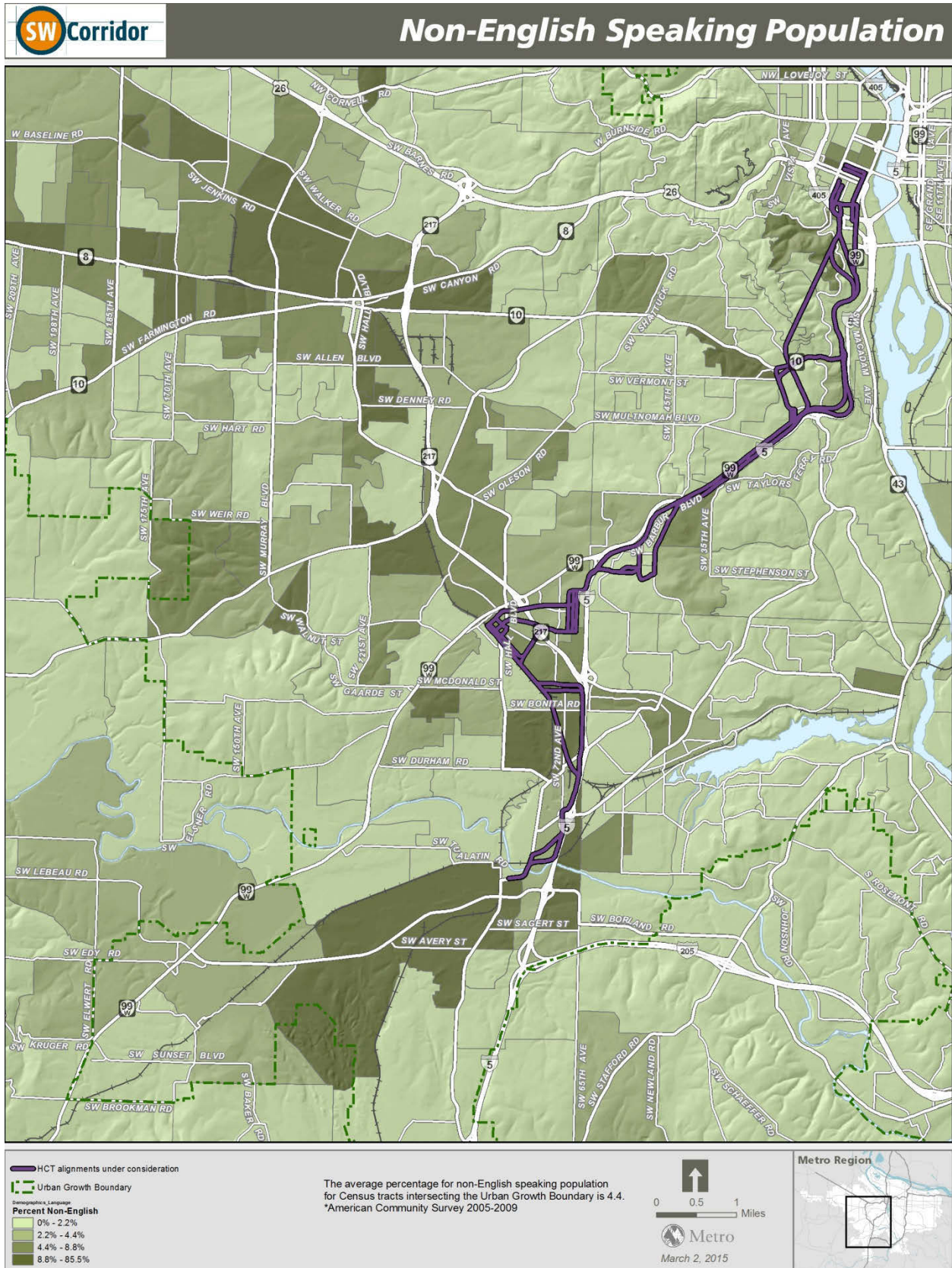


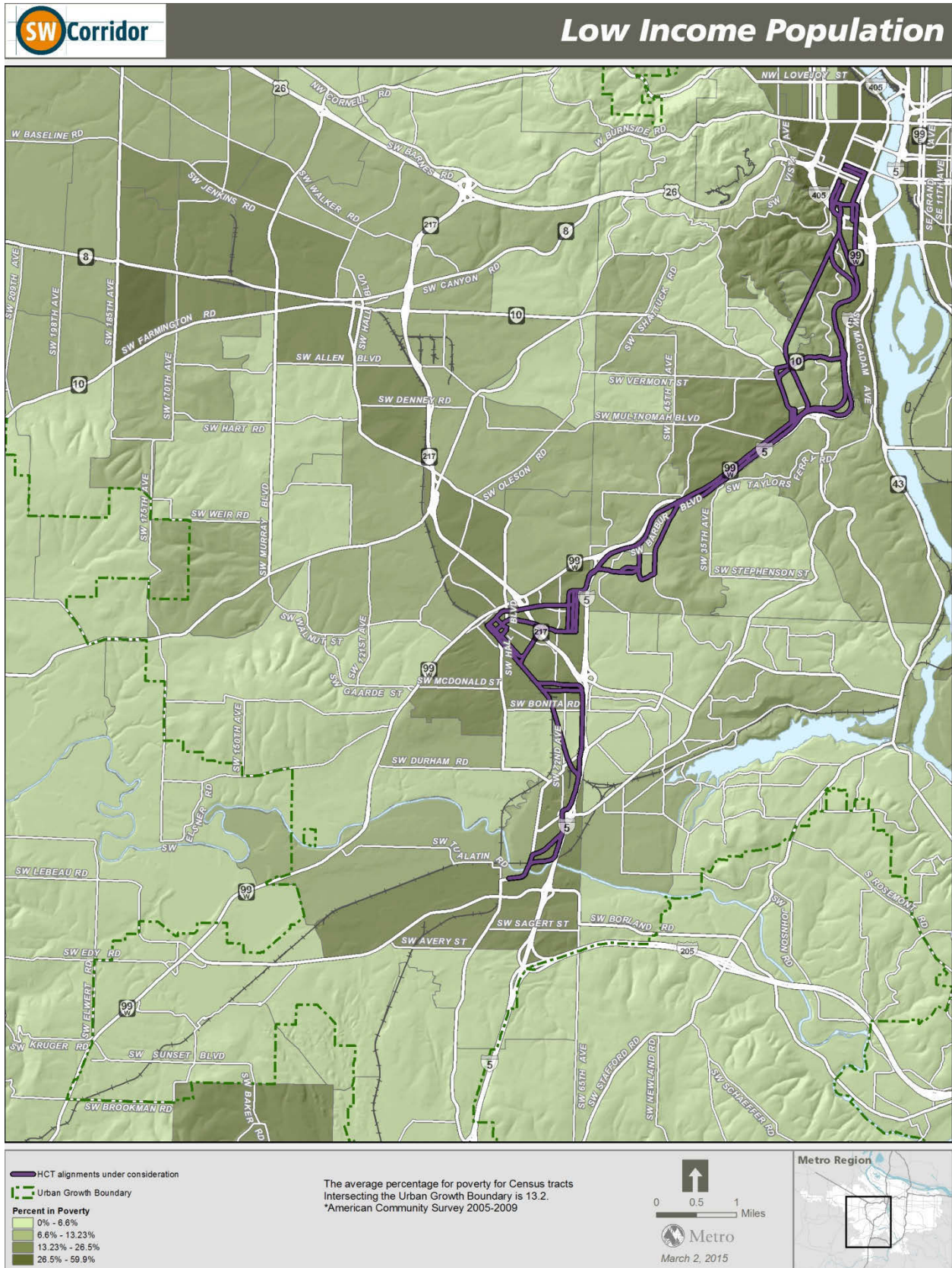


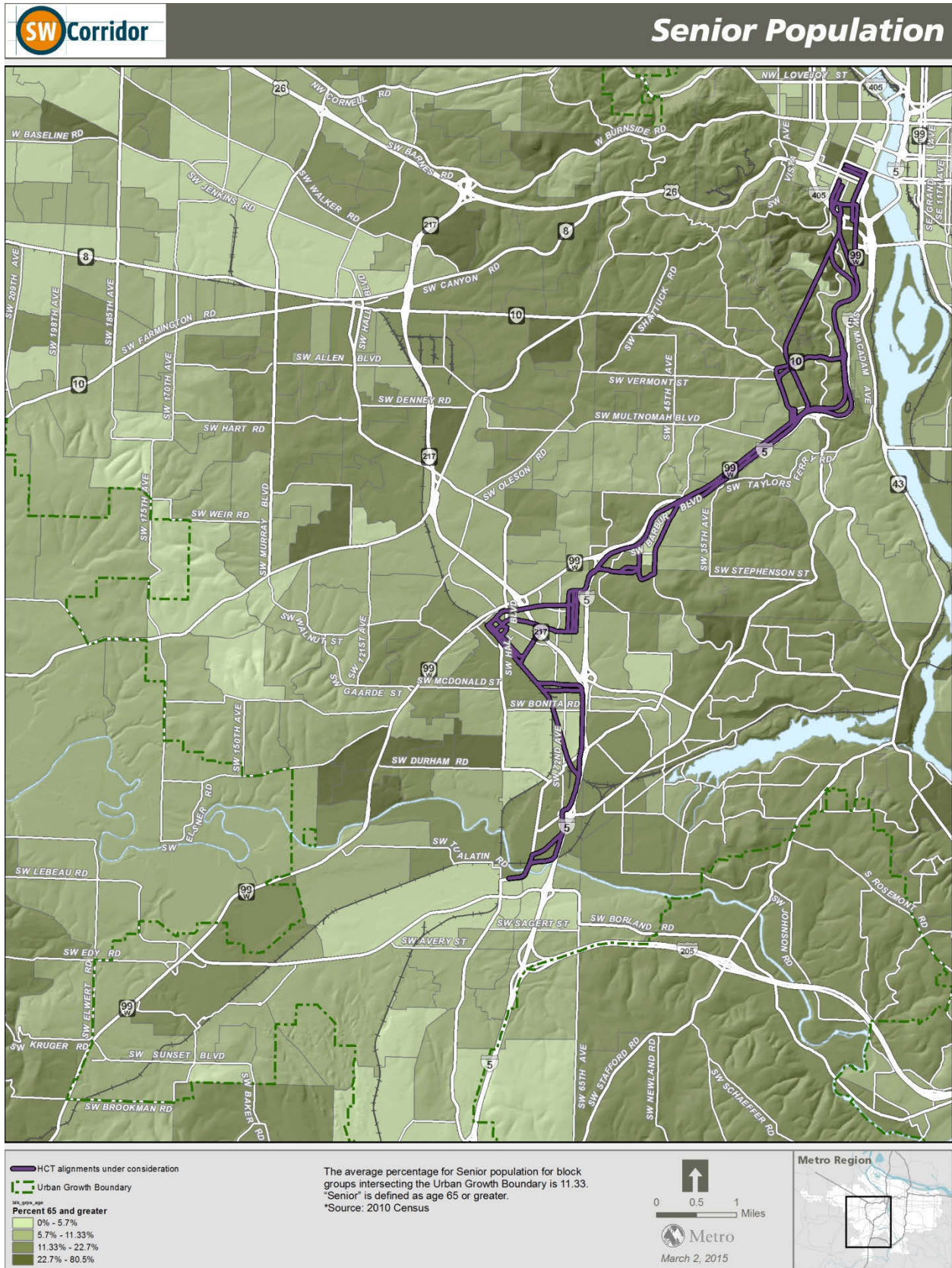










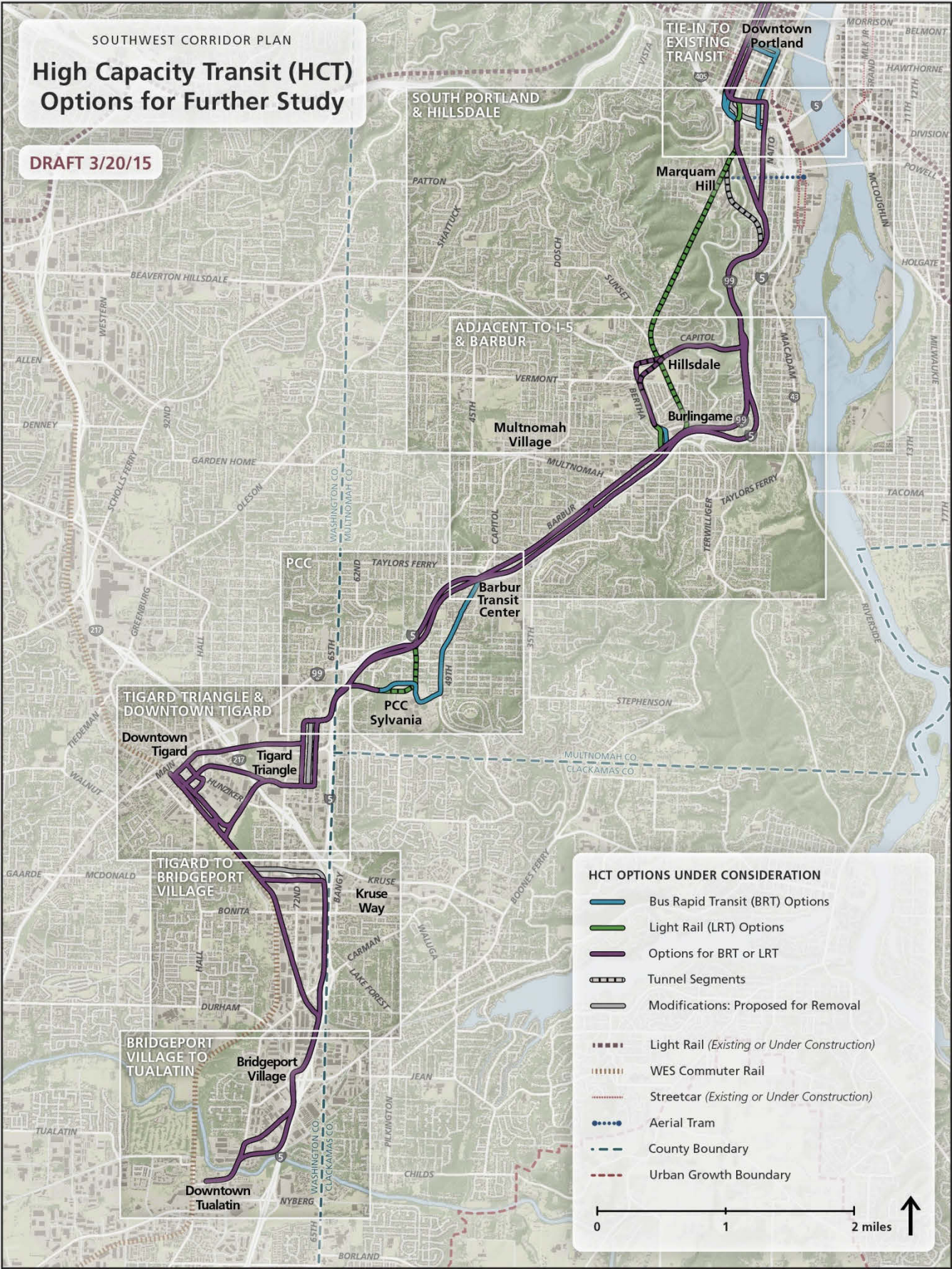


HCT alignment modifications based on technical analysis

Southwest Corridor Plan

DISCUSSION DRAFT 4/15/15

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Introduction

Overview of technical work completed during the focused refinement period

In June 2014, the Southwest Corridor Steering Committee directed project staff to address the following questions regarding the high capacity transit (HCT) alignment options in a focused refinement period prior to beginning the Draft Environmental Impact Statement:

1. **Tie-in to existing transit:** Determine the best approach to tie in to downtown Portland and the existing transit system through additional traffic analysis and partner discussion.
2. **Marquam Hill access:** Explore options for pedestrian/bicycle access to Marquam Hill from a surface alignment on Barbur or Naito.
3. **Tunnels to Marquam Hill:** Explore replacing the short tunnel that serves Marquam Hill with the medium tunnel that also serves Hillsdale.
4. **Hillsdale access:** Explore the benefits as compared to the costs and travel time of directly serving the town center, and look at enhanced pedestrian/bicycle connections from Barbur Boulevard.
5. **Adjacent to I-5:** Further explore and discuss the tradeoffs of providing HCT adjacent to I-5 rather than on Barbur Boulevard.
6. **PCC Sylvania access:** Assess the potential of a more robust pedestrian connection from Barbur Boulevard to PCC along SW 53rd Ave while working with PCC and the neighborhood to understand the trade-offs of direct service for future campus plans.
7. **HCT branch service to Tigard and Tualatin:** Explore opportunities to implement branched service to downtown Tigard and south to Tualatin to achieve operational efficiencies.

Since the June 2014 Steering Committee meeting, project staff completed additional traffic analysis, technical drawings, and transit demand model runs, focusing in particular on the tie-in to existing transit, tunnels to Marquam Hill, adjacent to I-5 routing and Barbur center-running alignments, and downtown Tigard and branch service options.

In addition to the questions presented by the Steering Committee, project staff responded to concerns raised with the existing alignments by further examining the existing options and developing new alignments as needed. Some new options emerged and some previously removed options resurfaced during this further technical analysis.

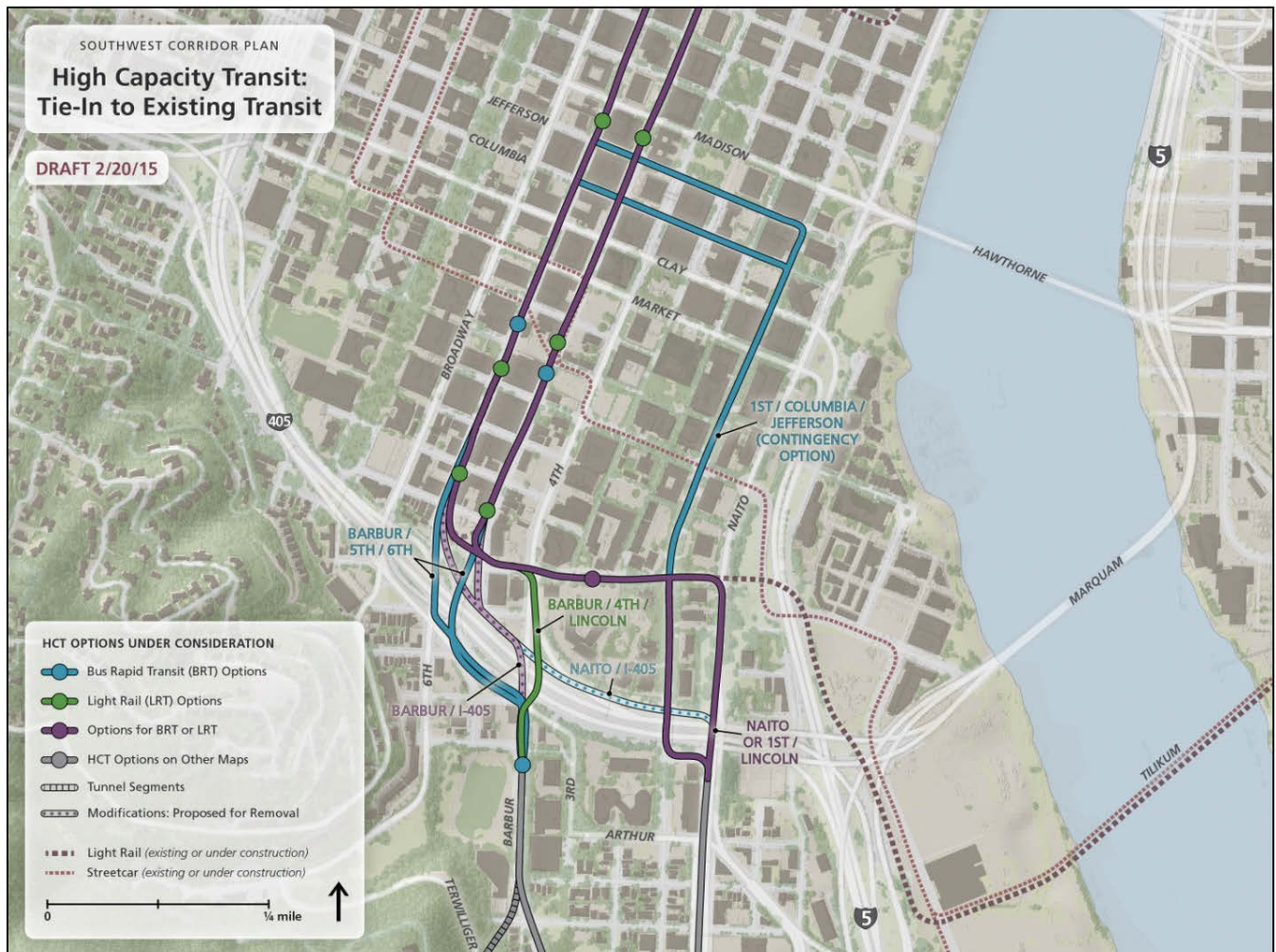
As a result of this technical work, project staff propose several modifications to the list of HCT alignment options currently under consideration, including removing, replacing, revising and adding options. Note that the alignments shown in this memo are subject to change upon further analysis and discussion, including changes in station locations.

Public input on these recommended changes will be gathered in May and June, leading up to a July 2015 Steering Committee decision. This memo outlines both the project team's response to Steering Committee questions and additional staff recommendations based on further technical analysis.

Project team response to Steering Committee questions

1. **Tie-in to existing transit:** recommend removing BRT and LRT options parallel to I-405 and keeping 1st Ave BRT as contingency option
2. **Marquam Hill access:** produced five different concepts for providing pedestrian/bicycle access from a surface alignment station on Barbur or Naito
3. **Tunnels to Marquam Hill:** recommend replacing Marquam Hill LRT tunnel (formerly “short tunnel”) with Marquam Hill-Hillsdale LRT tunnel (formerly “medium tunnel”)
4. **Hillsdale access:** have studied costs and benefits of direct service to Hillsdale; will continue to explore how Shared Investment Strategy projects help enhance a connection to Hillsdale if HCT is routed along Barbur Boulevard
5. **Adjacent to I-5 at mid-Barbur:** further evaluated cost, travel time, and property impacts of three segments of adjacent to I-5 alignment; identified new segment to evaluate between Barbur Transit Center and 60th Avenue; will release fall Key Issues memo with additional information
6. **PCC Sylvania access:** hired a design firm to work with PCC Sylvania staff and the surrounding neighborhood on a redesign of 53rd Avenue; will continue to communicate with PCC regarding the future land use vision for the campus and how HCT service relates to those plans
7. **HCT branch service to Tigard and Tualatin:** recommend adding branch service and Beveland to Ash options for both BRT and LRT

Tie-in to existing transit



Alignment options evaluated during focused refinement

In June 2014, the Steering Committee directed project staff to further evaluate the options under consideration for connecting to the downtown Portland Transit Mall, and to verify that the Transit Mall has capacity for Southwest Corridor BRT or LRT vehicles. Project staff completed more detailed analysis on the following options:

- A. **Barbur-Broadway (BRT only):** BRT would run along Broadway in between Barbur Boulevard and the 5th/6th Avenue Transit Mall. BRT would run within the existing 5th and 6th Avenue bridges over I-405. The southernmost BRT stations on the Transit Mall would be near Mill Street. BRT would also include a station at Barbur and Sheridan Street, near the existing athletic field, because of the long distance between the Mill and Gibbs Street stations.
- B. **Barbur-4th-Lincoln (LRT only):** LRT would run on a new structure parallel to the 4th Avenue bridge over I-405. At Lincoln, LRT would connect to the Transit Mall via the Portland-Milwaukie light rail (PMLR) tracks currently under construction. The southernmost LRT stations on the Transit Mall would be the existing PSU South stations at 5th/Jackson and 6th/College.

- C. **Barbur-I-405:** HCT would cross I-405 on a new structure parallel to the 4th Avenue bridge, then briefly parallel I-405 on the northwest side to connect to the Transit Mall at 5th/6th. BRT or LRT would include the same stations described for the Barbur-Broadway and Barbur-4th-Lincoln alignments.
- D. **Naito/1st-Lincoln:** HCT would cross I-405 on 1st Avenue or Naito Parkway, then run along Lincoln Street to the Transit Mall. LRT would tie into the PMLR tracks currently under construction and share the PMLR station at Lincoln. BRT would include a station nearby the light rail station on Lincoln. BRT could also run on 1st from Sheridan to Lincoln instead of Naito.
- E. **Naito-I-405 (BRT only):** BRT would cross I-405 on Naito Parkway, and then run parallel to I-405 on the northwest side to connect to the Transit Mall at 5th/6th.
- F. **Naito-1st-Columbia/Jefferson:** BRT would turn off Naito at Sheridan to cross I-405 on the 1st Avenue bridge, then continue along 1st until Columbia and Jefferson Street. BRT would connect to the Transit Mall eastbound on Columbia and westbound on Jefferson.

Proposed modification: remove options parallel to I-405 and keep BRT alignment on 1st Avenue as a contingency option

Project staff recommend removing the two alignment options that parallel I-405, C and E above, which have engineering challenges that may be very difficult to overcome and could hinder potential future modifications of I-405 ramps. Additionally, the Naito-I-405 alignment has limited options for a station to be located near the PMLR Lincoln station.

BRT on 1st north of Lincoln is recommended only as a contingency option for BRT on Naito due to the poor connection to PSU and slow travel times resulting from running in mixed traffic on 1st Avenue, Columbia and Jefferson. This alignment will only be evaluated further if running BRT on Lincoln is later found to be unfeasible.

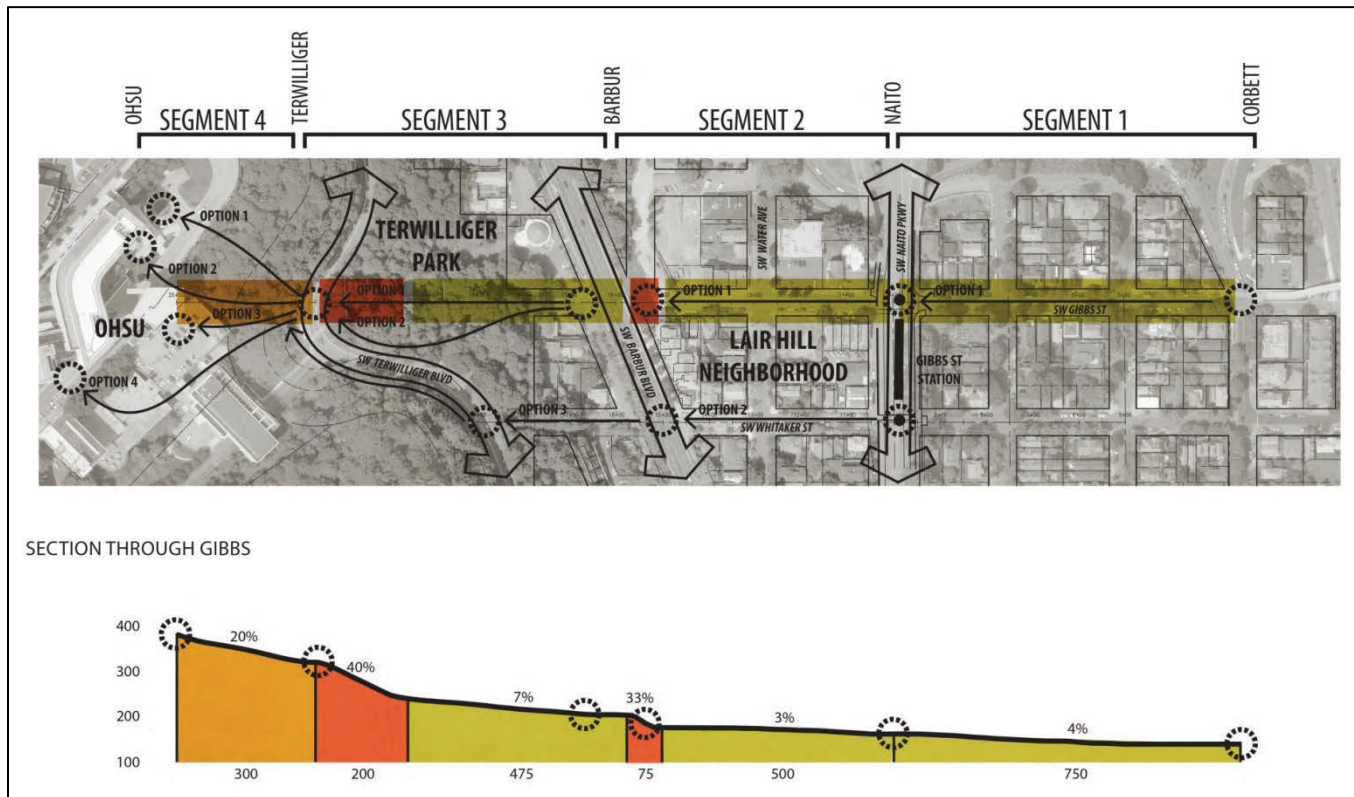
The remaining four alignments would have more direct connections to the Transit Mall with the fewer impacts. These four alignments provide each mode an option to tie in to existing transit from both the Barbur and Naito South Portland alignments.

Next steps

Because BRT and LRT each have one preferred means of connecting to the Transit Mall from either Naito or Barbur, the tie-in alignments will no longer be evaluated or narrowed independently, but rather will be linked to the South Portland alignment options for each mode.

The Barbur, Naito and Marquam Hill-Hillsdale tunnel alignments are discussed in more detail in the South Portland Key Issues memo, which was presented at the March 9th Steering Committee meeting. In July the Steering Committee will decide whether to continue studying the Marquam Hill-Hillsdale tunnel, but a decision between Barbur and Naito may not be made until after January 2017, when the project is expected to enter the Draft Environmental Impact Statement (DEIS) phase. More detailed traffic analysis on the tie-in to existing transit will be completed during the DEIS, including examining the interactions between SW Corridor HCT and the Powell-Division bus rapid transit project currently being planned.

Marquam Hill access



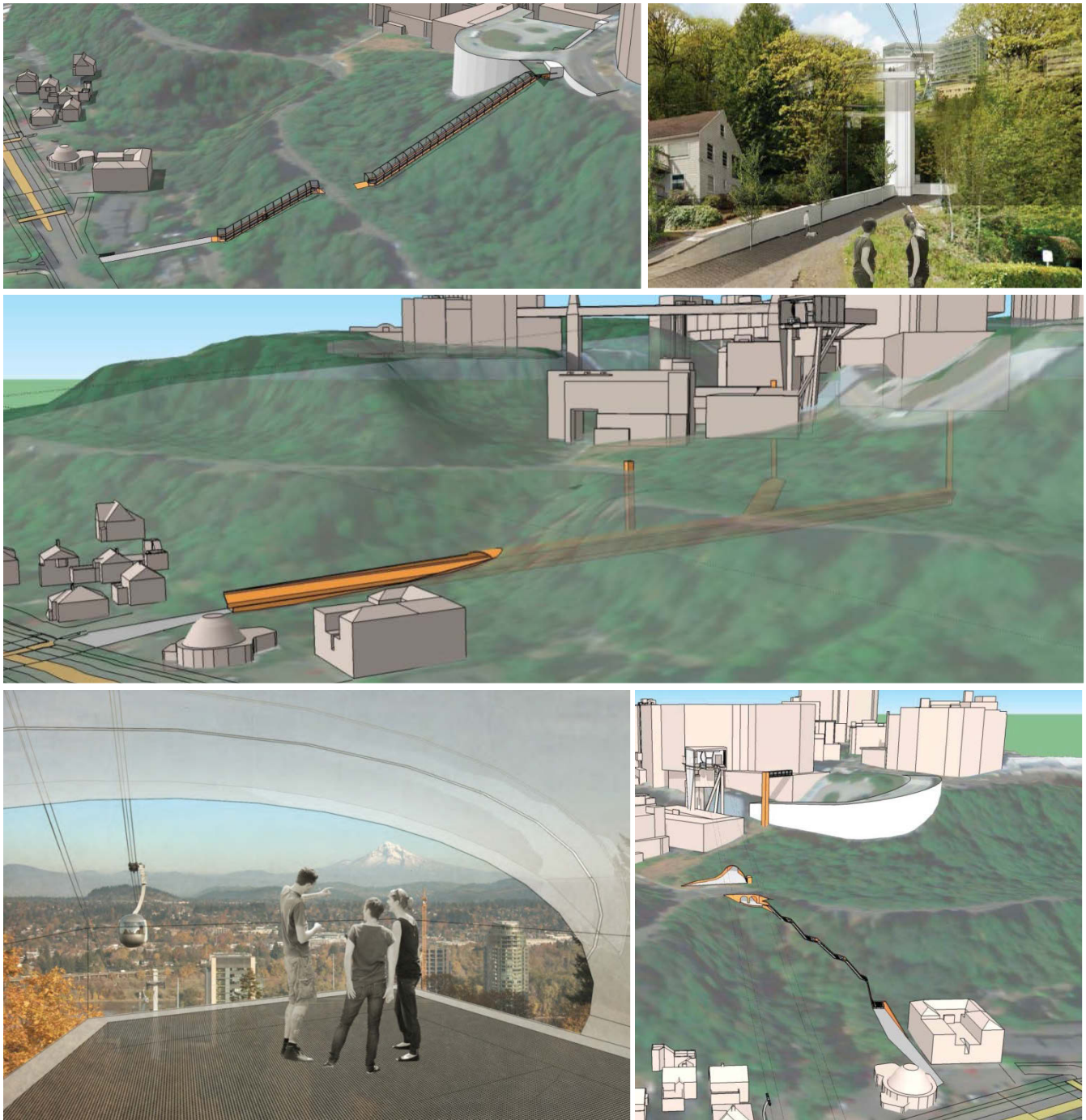
Otak diagram of the distance and elevation between OHSU Marquam Hill campus, Barbur Boulevard, and Naito Parkway.

Summary of work completed

In June 2014, the Steering Committee directed project staff to further explore a bicycle and pedestrian connection between the Oregon Health & Science University (OHSU) and VA Medical Center on Marquam Hill and an HCT station at either Barbur Boulevard or Naito Parkway near Gibbs Street. The horizontal distance between Barbur Boulevard and the OHSU aerial tram station on Marquam Hill is only approximately 1,000 feet, or just under two tenths of a mile (see diagram above). However, there is currently no safe and accessible means of traversing the steep, wooded hillside between Barbur and Terwilliger Boulevard.

In August 2014, the Otak and Mayer-Reed design firms were hired to conceptually design a connection between a Barbur or Naito HCT station and Marquam Hill that would accommodate both bicyclists and pedestrians. For this exploratory design exercise, the project engaged the surrounding neighborhood groups, adjoining property owners, and several health care providers, including the VA Medical Center, National College of Natural Medicine (NCCNM), and OHSU.

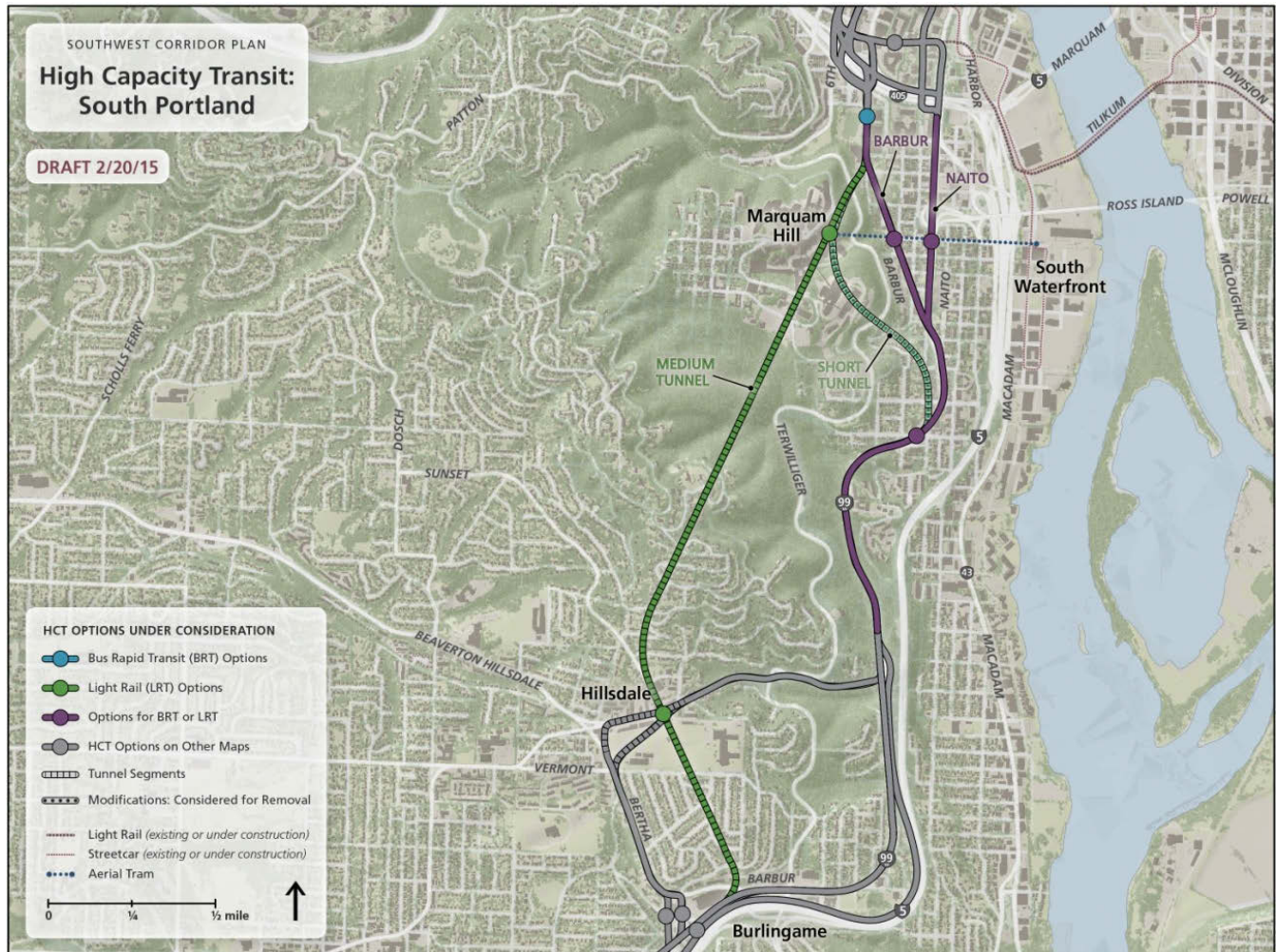
Options studied included elevators/bridges, escalators and a pedestrian tunnel, with access points at Terwilliger and/or within the OHSU campus (see images on opposite page for examples). From this work, it is clear that a well-designed connection from Barbur to the OHSU campus and beyond to the VA Medical Center is feasible, and it is assumed this connection would be constructed as part of a Barbur or Naito surface alignment.



Next steps

A summary of the Marquam Hill connection conceptual design work will be released by mid-May. The design process and further discussion of the trade-offs between different means of connecting Marquam Hill to a surface HCT station are now on hold while HCT alignment options are being evaluated and narrowed. Further design work will be undertaken during the DEIS phase.

Tunnels to Marquam Hill



Alignment options evaluated during focused refinement

In June 2014, the Steering Committee directed project staff to look into replacing the “short tunnel” to Marquam Hill with the “medium tunnel” to Marquam Hill and Hillsdale. These two light rail tunnel options were evaluated further during the 2014 focused refinement period:

- A. **Marquam Hill tunnel (formerly “short tunnel”):** Light rail would exit Barbur Boulevard near Hooker Street, and enter into a tunnel portal in the hillside below Terwilliger Boulevard. Light rail would emerge from the tunnel at a portal near Hamilton Street. An underground station would serve the OHSU Marquam Hill campus and the VA Medical Center. A surface station near Hamilton would serve the lower Homestead area and a portion of South Portland.
- B. **Marquam Hill-Hillsdale tunnel (formerly “medium tunnel”):** Light rail would exit Barbur Boulevard near Hooker Street, and enter into a tunnel portal in the hillside below Terwilliger Boulevard. Light rail would emerge from the tunnel at a portal near Barbur and Bertha Boulevard. One underground station would serve the OHSU Marquam Hill campus and the VA Medical Center, and another would serve the Hillsdale town center.

Proposed modification: replace Marquam Hill tunnel with Marquam Hill-Hillsdale tunnel

After further analysis, project staff recommend replacing the Marquam Hill tunnel with the Marquam Hill-Hillsdale tunnel due to the high fixed cost of bored tunnels, greater travel time savings, the opportunity to provide direct access to the Hillsdale town center, and community preference for the longer tunnel over the shorter tunnel.

The one-mile Marquam Hill tunnel would have a relatively high ratio of fixed to linear costs. The fixed costs, which include retaining walls at the portals, roadway modifications and a tunnel boring machine, would account for approximately 49 percent of the total cost of the tunnel (based on year 2014 dollars without financing or escalation costs). The remaining half of the cost would be from linear costs, including track, overhead wires, excavation and structural materials for the tunnel itself. In contrast, the total cost of the 2.8-mile Marquam Hill-Hillsdale tunnel would be composed of 24 percent fixed costs and 76 percent linear costs.

While the Marquam Hill tunnel would save approximately 24 seconds of travel time compared to light rail on Barbur Boulevard, the Marquam Hill-Hillsdale tunnel would save over one minute. These reductions in travel time would benefit riders beyond only those accessing Marquam Hill or Hillsdale. Model results show that the two tunnels would have a similar number of boardings at the Marquam Hill station, but the longer tunnel has a higher line ridership and more new system transit trips due to its greater travel time savings and direct access to Hillsdale.

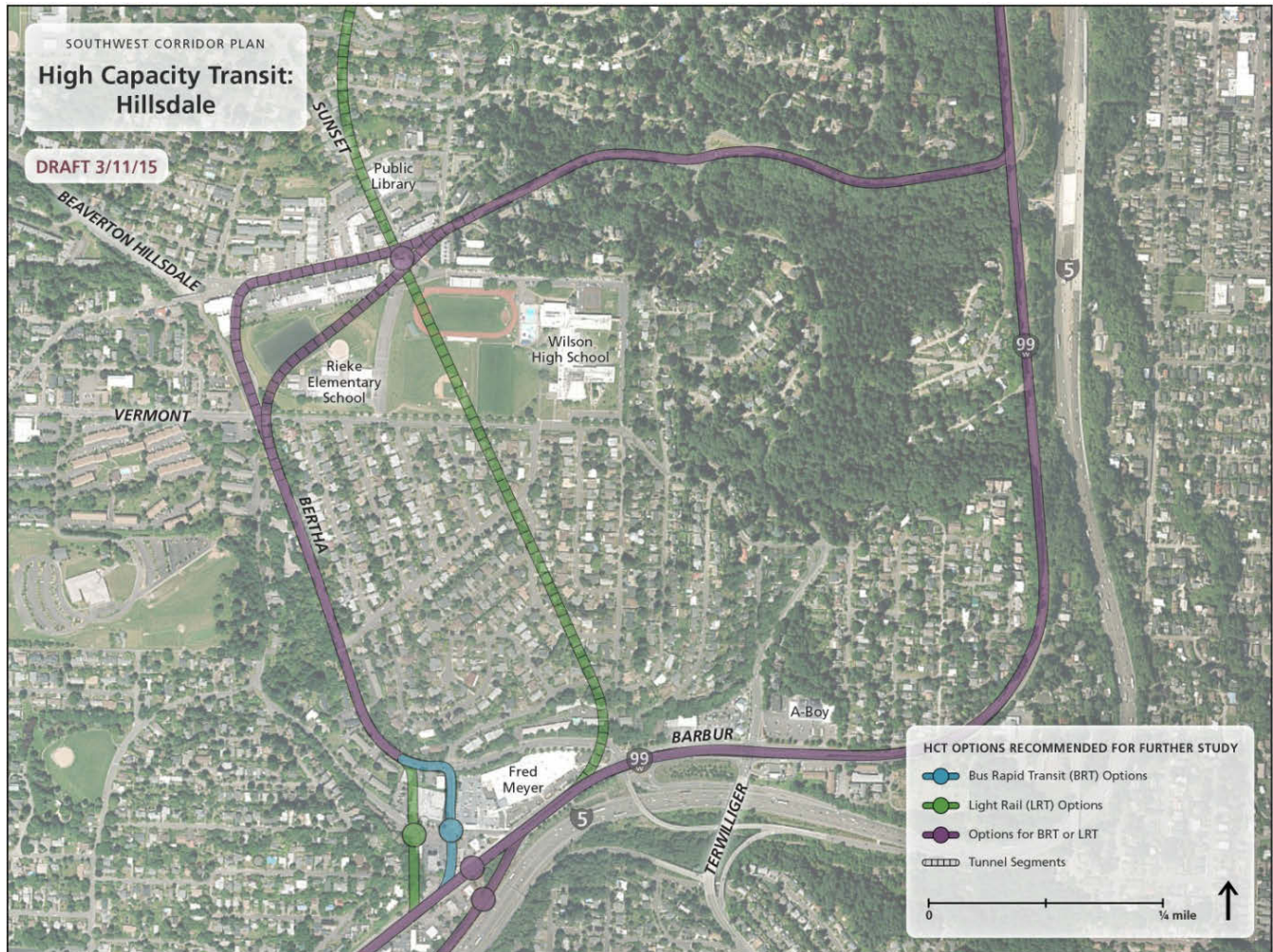
The Marquam Hill-Hillsdale tunnel, while more expensive than the shorter Marquam Hill tunnel, would provide greater benefits. During spring 2014 public outreach, community members expressed stronger support for the longer Marquam Hill-Hillsdale tunnel than for the short Marquam Hill Tunnel. As a result, project staff recommend replacing the Marquam Hill tunnel with the Marquam Hill-Hillsdale tunnel for further consideration.

Next steps

The South Portland and Hillsdale Key Issues memos, which were presented to the Steering Committee at the March 9 meeting, discuss the tradeoffs of the Marquam Hill-Hillsdale tunnel relative to the surface alignments on Barbur and Naito and the cut and cover tunnel to Hillsdale. The information in these Key Issues memos will be combined with more detailed evaluation ratings in a Draft Evaluation Report to be released by mid-May 2015. In addition to the evaluation report, TriMet is coordinating with geotechnical consultants to further analyze the risks and impacts associated with the bored and cut-and-cover tunnels under consideration. Key findings from this geotechnical work will be presented at the May 11 Steering Committee meeting and in a technical memo to be released by mid-May.

In July 2015, the Steering Committee will decide both whether to accept this staff recommendation to replace the Marquam Hill tunnel with the Marquam Hill-Hillsdale tunnel and also whether to study the Marquam Hill-Hillsdale tunnel further in a Draft Environmental Impact Statement.

Hillsdale access

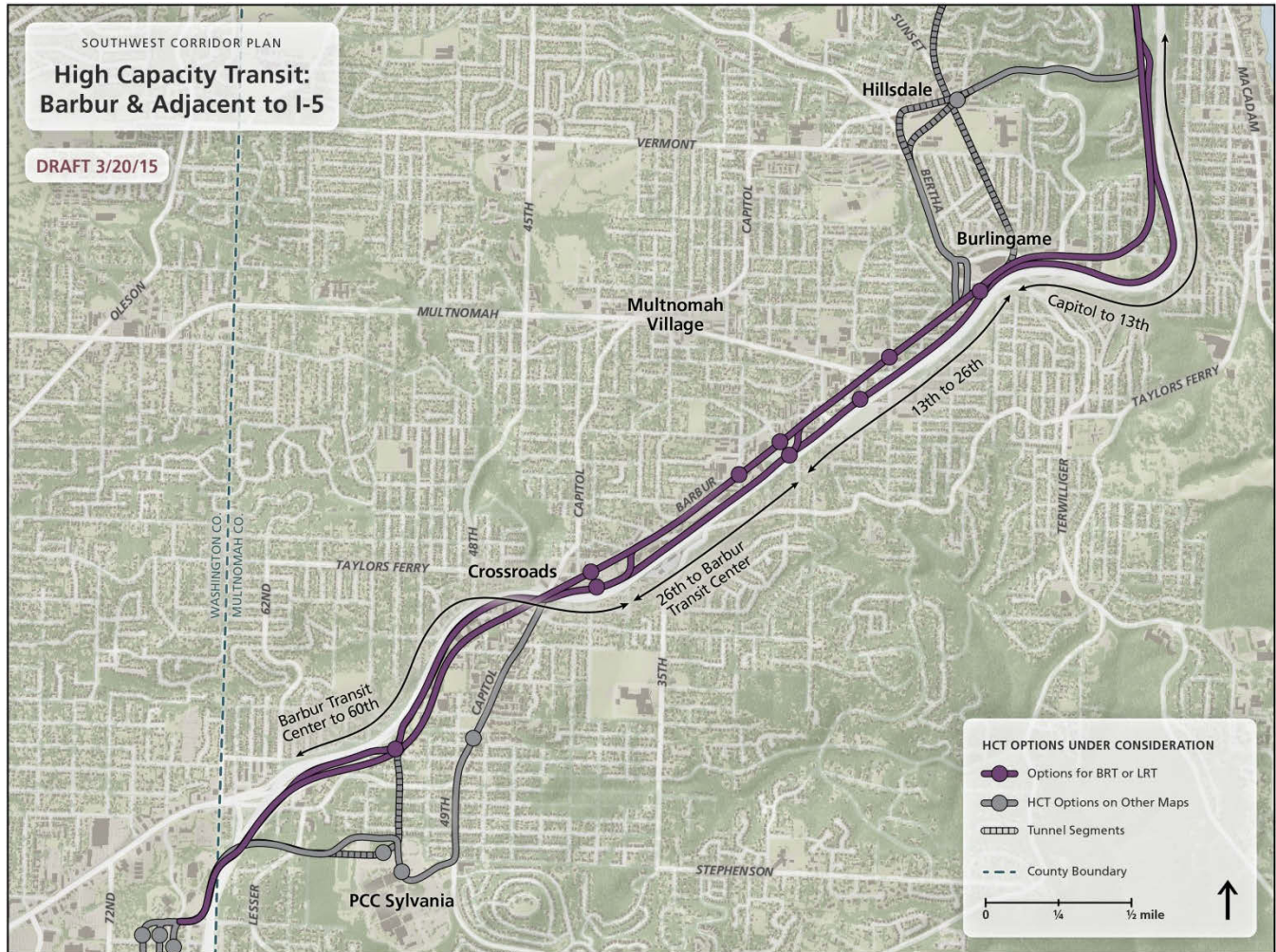


In June 2014, the Steering Committee directed project staff to further explore the costs and benefits of directly serving the Hillsdale town center, and to look at enhanced pedestrian/bicycle connections from a Barbur HCT alignment. In addition, project staff developed a modified cut-and-cover tunnel alignment option, described in more detail later in this memo. The Hillsdale Key Issues memo discusses the tradeoffs between the two cut-and-cover tunnel options, the Marquam Hill-Hillsdale tunnel, and the Barbur surface alignment in more detail.

The list of Shared Investment Strategy roadway and active transportation projects does not currently include an enhanced bicycle and pedestrian connection between Hillsdale and Burlingame HCT station. However, such a connection would be considered with a Barbur HCT alignment in addition to the local bus service improvements. Although Bertha Boulevard already has sidewalks and bike lanes, these could be further enhanced to improve the bike and pedestrian connection between Hillsdale and Burlingame. Bertha has a relatively wide and underutilized right-of-way, which could facilitate widening sidewalks and bike facilities.

In the Southwest Service Enhancement Plan, TriMet has identified promising potential upgrades to local bus lines in Hillsdale. These potential improvements include converting lines 44 and 54 to frequent service, which would include frequencies of 15 minutes or better throughout the weekday and improved service on weekends. These lines connect to Multnomah Village, PCC Sylvania, Beaverton Transit Center and downtown Portland.

Adjacent to I-5



Alignment segments evaluated during focused refinement

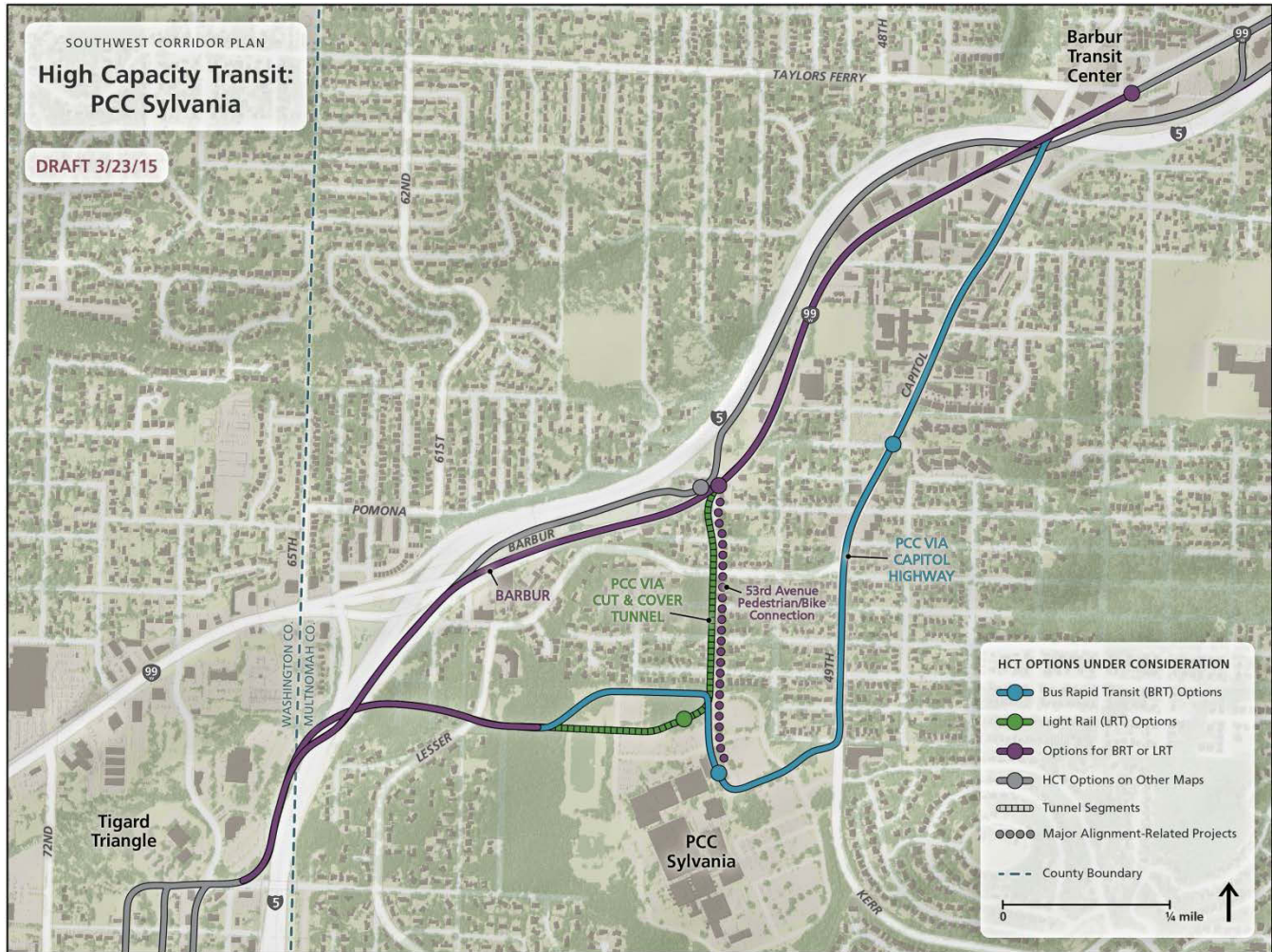
In June 2014, the Steering Committee directed project staff to study the adjacent to I-5 option in more detail than had been covered in the initial refinement phase. During the focused refinement period, the alignment was separated into three segments for further analysis. A new segment south of Barbur Transit Center was identified after the initial focused refinement analysis, resulting in the following four segments:

1. Capitol Highway to 13th Avenue
2. 13th Avenue to 26th Way
3. 26th Way to Barbur Transit Center
4. Barbur Transit Center to 60th Avenue

Next steps

From the four adjacent to I-5 segments, project staff will develop alignment options to evaluate in a fall 2015 Key Issues memo along with the Barbur Boulevard alignment. Further analysis of the changes in traffic operations with a center-running Barbur Boulevard alignment will be included in the discussion of trade-offs in the Key Issues memo. In December, the Steering Committee will decide which adjacent to I-5 segments should be included in the Draft Preferred Package of transportation investments to study further in a DEIS.

PCC Sylvania access



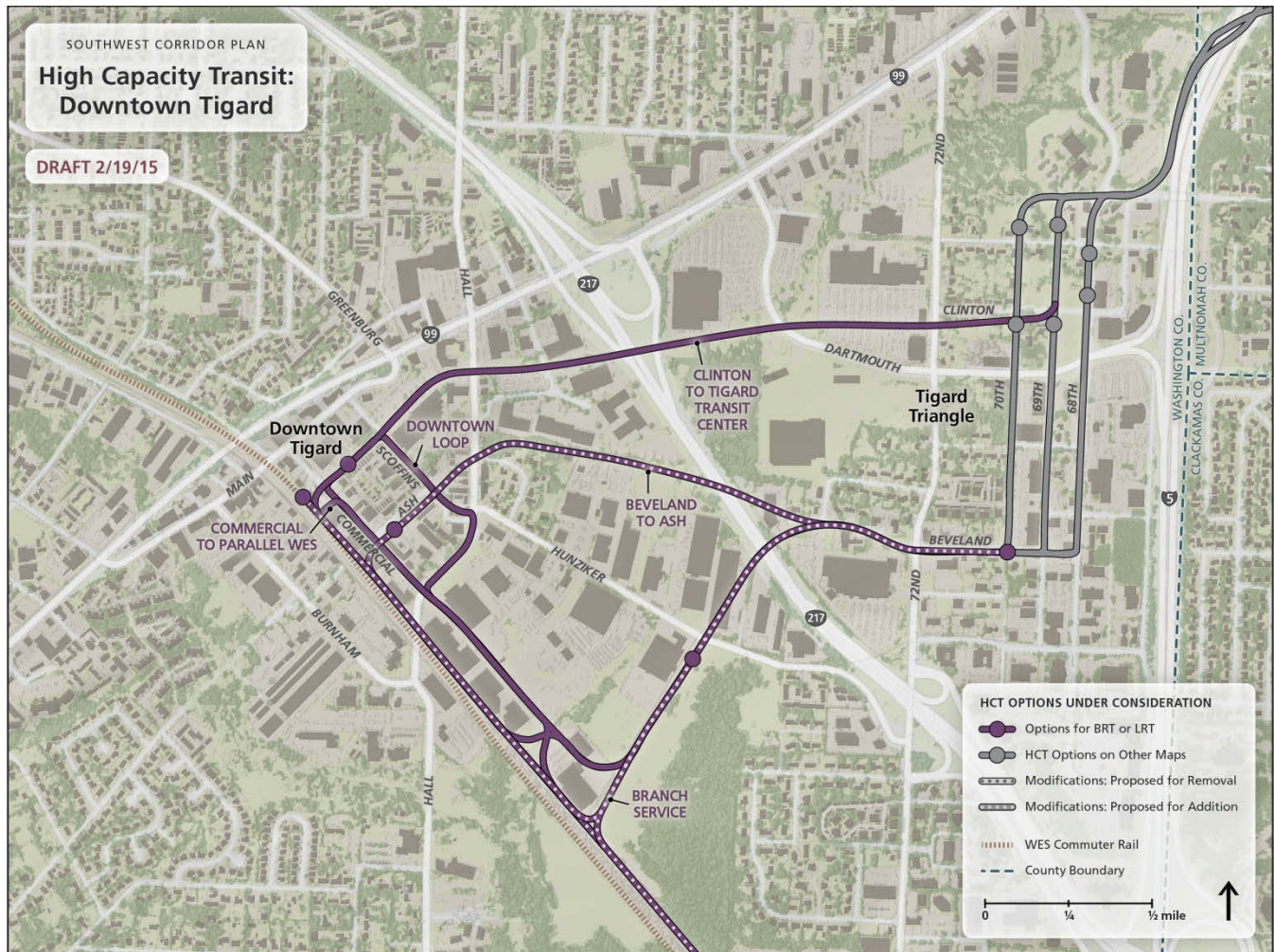
Summary of work completed

In June 2014, the Steering Committee directed staff to explore the potential of a more robust pedestrian connection from Barbur Boulevard to PCC along SW 53rd Ave while also working with PCC and the neighborhood to understand the impacts and benefits of direct service to the campus. Metro has recently hired the Mayer-Reed design firm to develop a conceptual design for enhancing 53rd Avenue from Barbur to the PCC Sylvania campus. Project staff is coordinating with PCC as they undertake a visioning process for the Sylvania campus to inform the City of Portland's Comprehensive Plan update.

Next steps

The 53rd Avenue design work is anticipated to be completed by mid-May, allowing for time to review the possibilities of enhanced surface connections to the campus. This design work will be performed concurrent with PCC's visioning work, allowing the public, policy makers and staff to gain a better understanding of transit needs and the benefits of direct transit access to the campus in the future. Options for an enhanced pedestrian and bike connection on SW 53rd will be included along with other analysis in the PCC Area Key Issues memo to be completed in May 2015.

Downtown Tigard



Alignment options evaluated during focused refinement

In June 2014, the Steering Committee directed project staff to explore opportunities for branched service to minimize travel time to Tualatin and reduce impacts to downtown Tigard. Project staff explored three potential branch service alignments and identified one of these alignments to evaluate further during the 2014 focused refinement period. Additionally, a promising new option emerged, which combined two options that had previously been removed in June 2014: “Beveland north” and “Ash Street.” Including these two new alignments, the options under consideration for downtown Tigard include:

- A. *Downtown loop:*** HCT would cross OR-217 at a new bridge curving from Beveland Street to Wall Street, which would also include facilities for cars, bikes, and pedestrians. The alignment would include a station with a new park-and-ride lot near Hunziker Road and Wall. HCT would continue southwest on Wall, then turn towards downtown Tigard along a new street extending southeast from Commercial Street. In downtown Tigard, HCT vehicles would run in a one-way counter-clockwise loop along Commercial, a new road south of Main Street, Scoffins Street and Hall Boulevard. Southbound vehicles would then return to the extension of Commercial Street, and then shift over to parallel the WES tracks near Wall to head toward the Bonita station.

- B. *Commercial to WES alignment:*** As with the downtown loop, HCT would cross OR-217 at a new bridge between Beveland Street and Wall Street, which would include facilities for cars, bikes and pedestrians. The alignment would include a station with a new park-and-ride lot near Hunziker Road and Wall Street. HCT would continue south on Wall, then turn towards downtown Tigard along a new street extending from Commercial Street. Instead of looping through downtown, the Commercial to WES Alignment would run in a one-way counter-clockwise loop along Commercial and parallel to the WES tracks, with a sharp turn near the existing Tigard Transit Center. The downtown Tigard station would be located near this turn.
- C. *Clinton to Tigard Transit Center (TC):*** HCT would run on a structure from 70th Avenue and Clinton Street across OR-217 to Hall Boulevard, then along a new street from Hall to Commercial. The alignment would then turn southeast to parallel the WES alignment, with a station near the existing Tigard TC.
- D. *Beveland to Ash:*** HCT would cross OR-217 on a new bridge between Beveland Street, passing behind industrial properties fronting Hunziker and cross Hall at Knoll Drive. This new OR-217 crossing would be open to bicyclists and pedestrians in addition to transit. A new auto, bike, and pedestrian bridge could connect from Beveland to Hunziker near Wall Street, as with the downtown loop and Commercial to WES alignment. From Hall, the alignment would connect to Ash Avenue, with a station on Ash between Scoffins and Commercial, and then turn southeast to parallel the WES tracks. The alignment may provide an opportunity to extend Ash Avenue across the WES and freight rail tracks with a new crossing, pending negotiations with the regulating authorities of the rail corridor.
- E. *Branch Service:*** As with the downtown loop option, HCT would cross OR-217 at a new bridge between Beveland Street and Wall Street, which would include facilities for cars, bikes, and pedestrians. The alignment would include a station with a new park-and-ride lot near Hunziker and Wall. From there, every other HCT vehicle would parallel the WES tracks heading into a terminus in downtown Tigard. These vehicles would reverse direction at the downtown Tigard station, and then return to the Hunziker/Wall station heading northbound to Portland. The other vehicles would parallel the WES tracks heading south toward Tualatin, bypassing the downtown Tigard station.

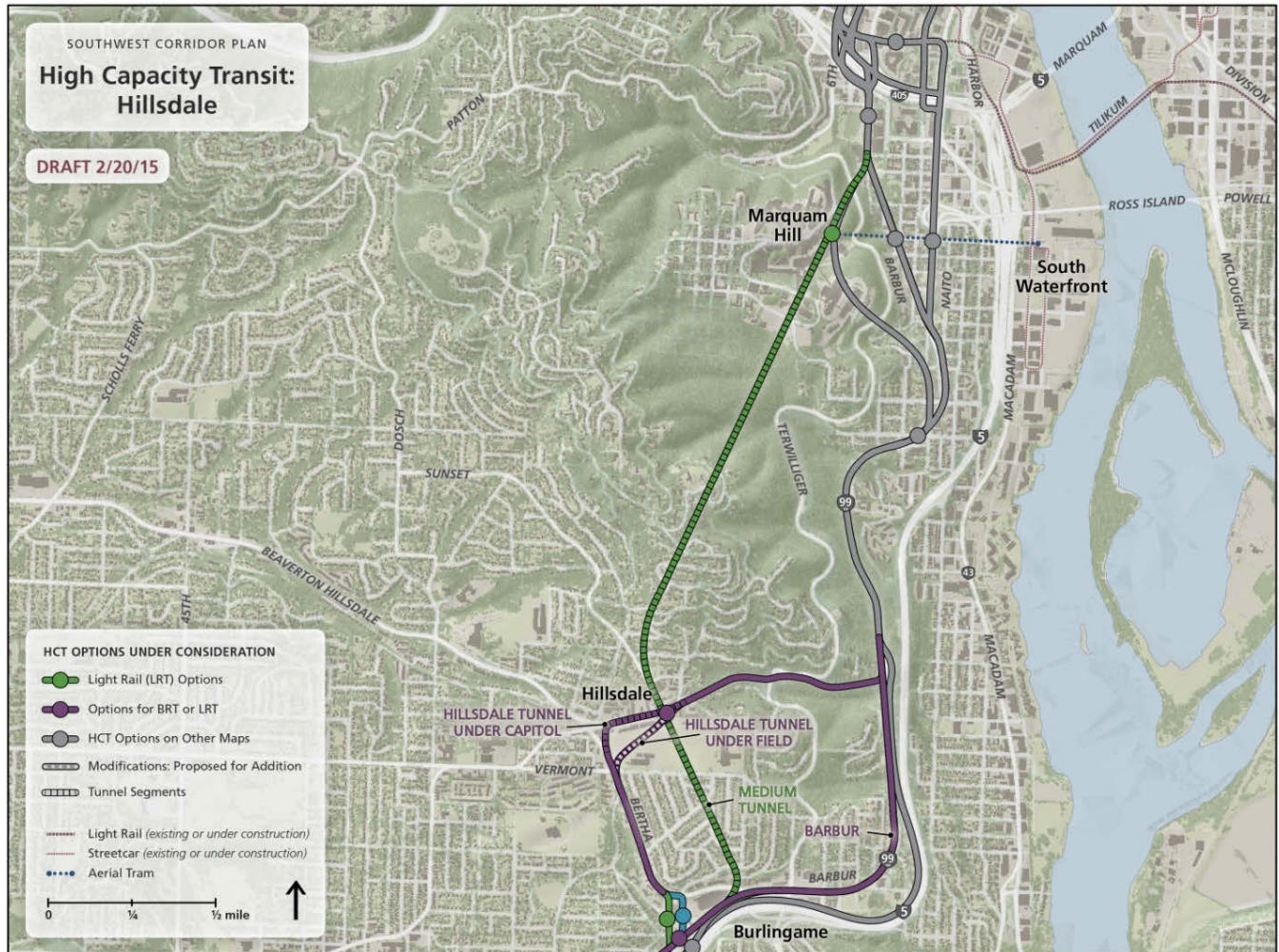
Next steps

A Key Issues memo with additional information on these five alignment options will be released in July 2015. In December 2015, the Steering Committee will identify the most promising Tigard alignment to include in the draft Preferred Package of transportation investments to study in a Draft Environmental Impact Statement.

Additional recommended modifications based on technical analysis

1. **Hillsdale:** add cut and cover tunnel alignment south of town center through play fields for both BRT and LRT
2. **Tigard Triangle:** replace 68th/69th Couplet with 68th/70th Couplet for both BRT and LRT
3. **Tigard to Bridgeport Village:** shift Tech Center option slightly to the south for both BRT and LRT
4. **Bridgeport Village to Tualatin:** add adjacent to I-5 and freight rail alignment option for both BRT and LRT

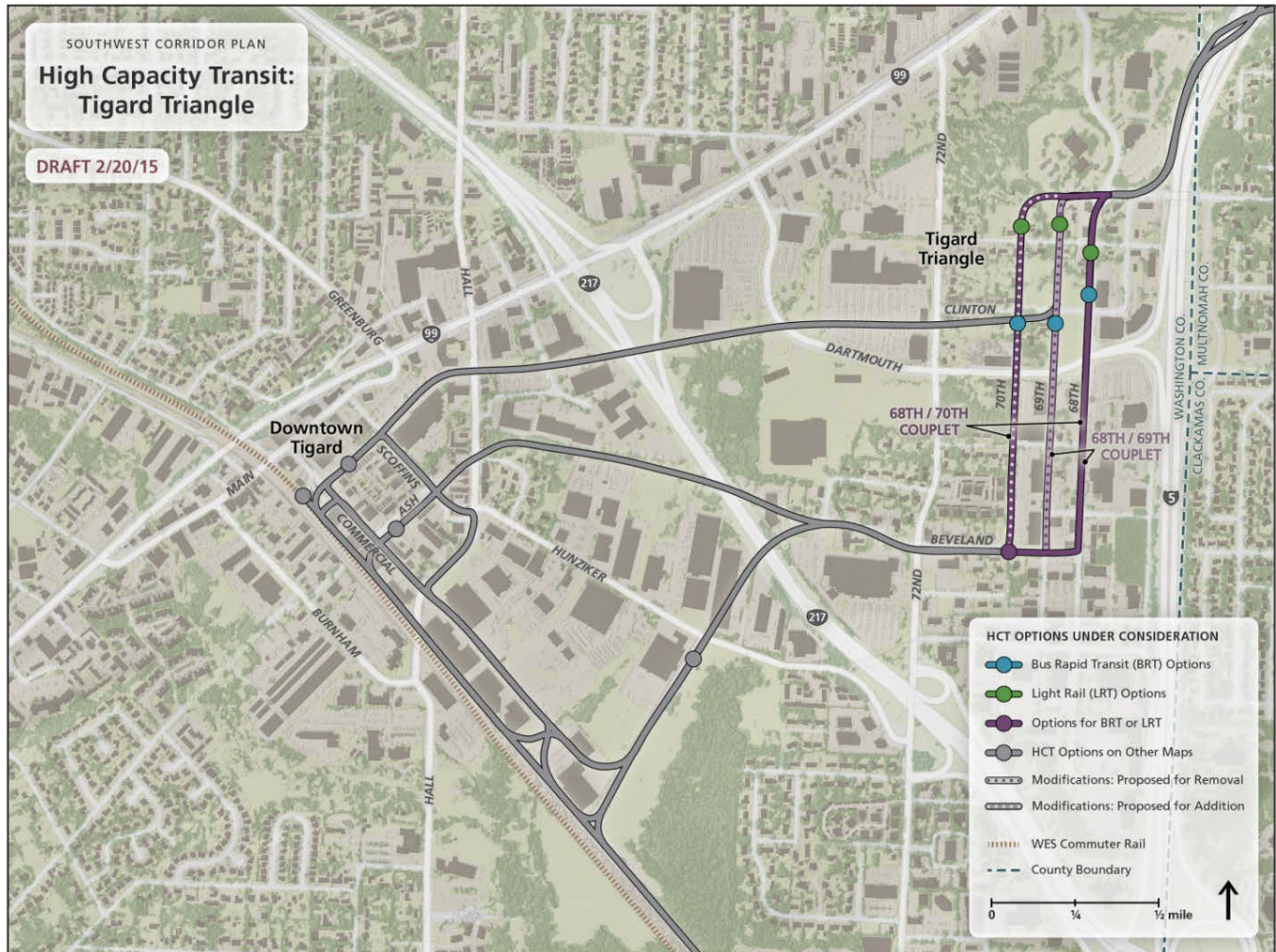
Hillsdale



Proposed modification: add cut-and-cover tunnel alignment south of town center through play fields

Due to concerns about the impacts of the Hillsdale cut-and-cover tunnel to the Capitol Highway main street, and based on suggestions from the public, project staff have developed a new tunnel alignment that departs Capitol Highway near Sunset Boulevard and continues toward Barbur underneath the field behind Rieke Elementary School. The Hillsdale cut-and-cover tunnel alignments are discussed in more detail in the Hillsdale Key Issues memo, and will be further analyzed in the May Draft Evaluation Report and June Evaluation Report and Recommendation. In July, the Steering Committee will decide whether to continue studying the Hillsdale cut and cover tunnels, as well as the Marquam Hill-Hillsdale tunnel.

Tigard Triangle



Proposed modification: replace 68th/69th Avenue couplet with 68th/70th Avenue couplet

In June 2014, the Steering Committee recommended to continue studying a 68th/69th Avenue couplet option in the Tigard Triangle and to remove the two-way 68th Avenue and 68th/70th couplet alignments from consideration. Following that decision, significant concerns were raised about how that decision impacted local land use planning that was underway in the Tigard Triangle. After carrying out further analysis during the project's 2014 focused refinement period, project staff recommend that the 68th/70th couplet alignment replace the 68th/69th couplet for further study.

The preliminary drawings of the 68th/69th couplet envisioned 68th running northbound and 69th running southbound, with HCT along the left side of each street, one lane of auto traffic in the middle, and a bike lane on the right. With this street configuration, access to properties between 68th and 69th would be limited to driveways connecting to the east-west cross-streets, which would have signalized intersections to allow vehicles to cross the HCT guideway. By shifting the southbound HCT alignment from 69th to 70th, properties located in between 68th and 69th would be able to maintain driveway access points along 69th as well as the cross-streets. This is an important consideration when viewed through the lens of the ongoing work of the Tigard Triangle Strategic Plan. This planning document identifies 69th Avenue as a pedestrian focused street, with wide sidewalks, bike lanes and on-street parking and a focus on ground floor retail uses. The plan specifically calls for

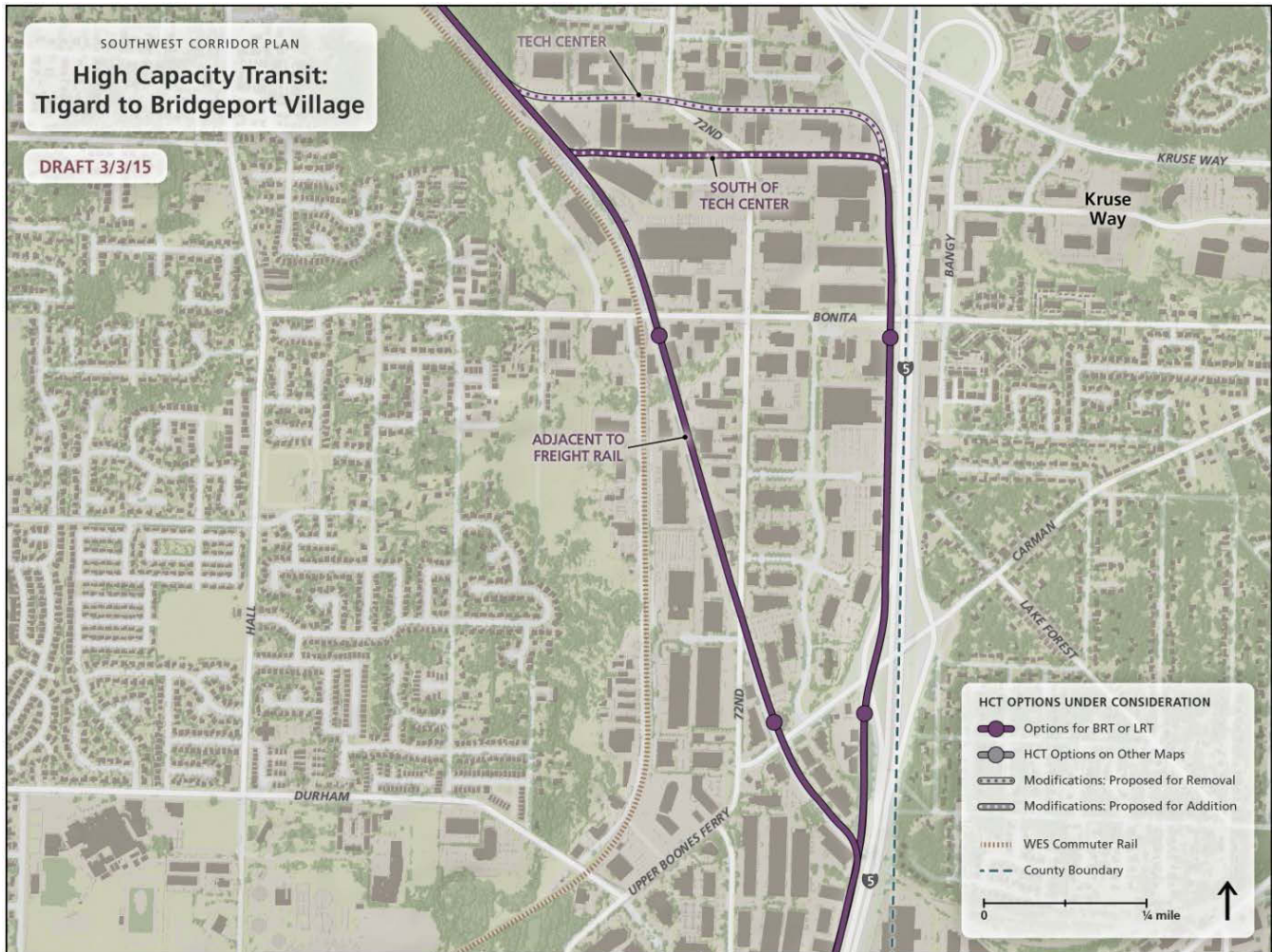
69th to be free of any form of HCT, allowing for a focus on slower traffic and a more enjoyable pedestrian and cycling experience. The removal of 69th Avenue as a consideration for HCT supports the land uses envisioned in the Tigard Triangle Strategic Plan along the street to become more viable.

In the June 2014 Draft Recommendation, the 68th/70th couplet option was not recommended for further consideration because it “would require significantly more structure and property acquisition compared to the 68th/69th couplet due to the narrow width and steep slopes on 70th Avenue.” Because 70th is not fully connected through the Triangle, and features a narrower right-of-way than 69th, the cost of converting 70th to a full street would indeed be greater than 69th. However, the City of Tigard’s Tigard Triangle Strategic Plan, which is currently under review, also recommends building these new connections along 70th. Routing HCT on 70th instead of 69th would provide an opportunity to leverage federal transit funds for the City’s broader goals for the Tigard Triangle area.

Next steps

Further analysis will be completed to confirm the technical feasibility of the 68th/70th couplet alignment and refine the preliminary cost estimates. In July, the Steering Committee will decide whether to replace the 68th/69th couplet with the 68th/70th couplet for further consideration.

Tigard to Bridgeport Village



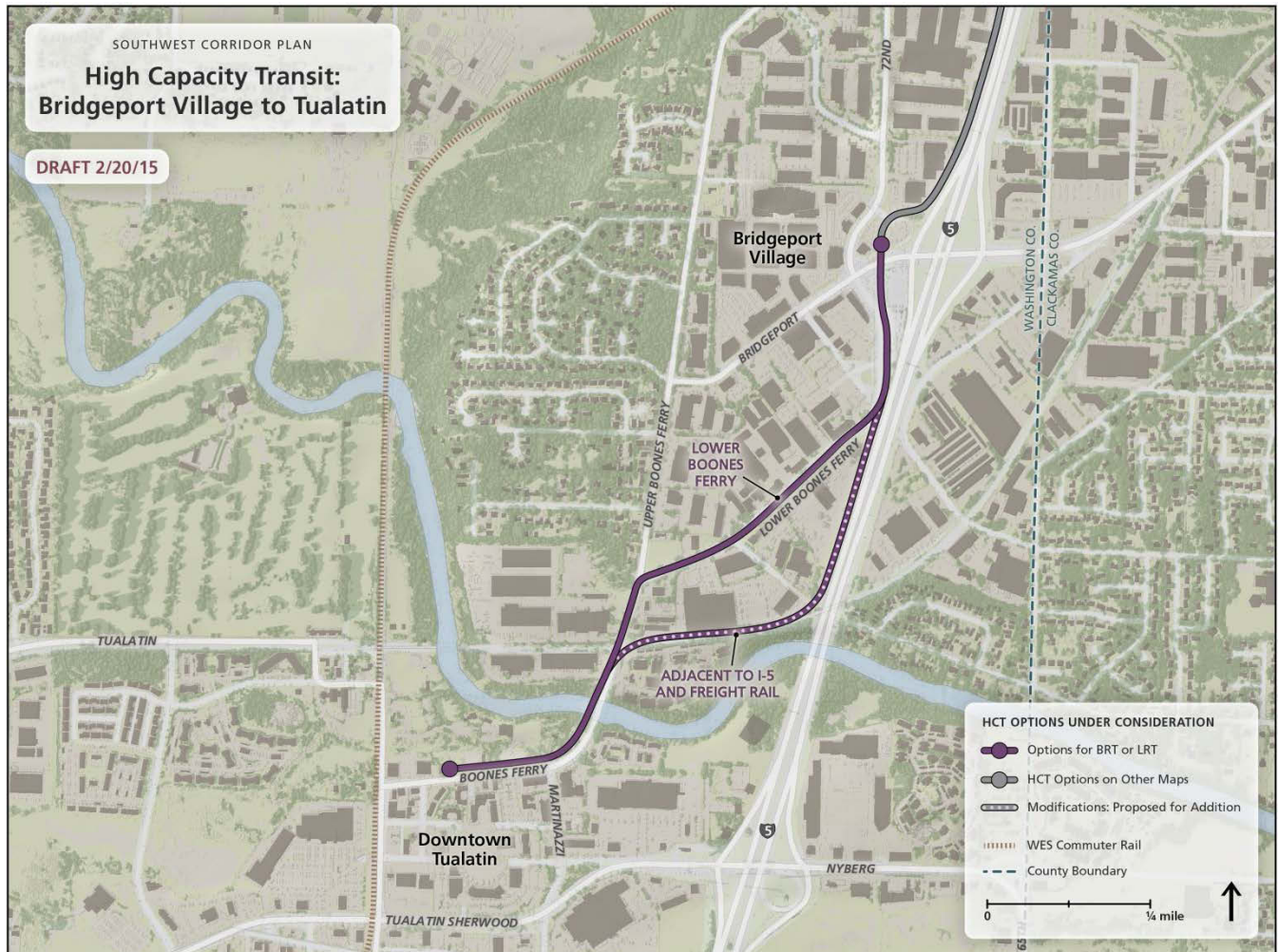
Proposed modification: shift Tech Center Drive alignment south to cut between industrial buildings

After further review, project staff recommend modifying the Tech Center option running from Tigard to Tualatin. The preliminary drawings showed HCT running along Tech Center Drive between the WES tracks and 72nd Avenue, then continuing directly west of Tech Center toward I-5. However, access impacts to adjacent properties and the steep slopes along this path added to the engineering complexity and cost of the alignment. Since these initial drawings, project staff have found that running HCT in between the industrial buildings just south of Tech Center, where the slopes are flatter and impacts to access of the adjacent parcels can be minimized, is a more promising alignment.

Next steps

In further study, the alignment will be renamed accordingly: south of Tech Center. This alignment will be evaluated in more detail in the second half of 2015. A Key Issues memo will be released in the fall in anticipation of a December Steering Committee decision on whether to include the south of Tech Center or adjacent to freight rail options in a draft Preferred Package of transportation investments to study in a DEIS.

Bridgeport Village to Tualatin

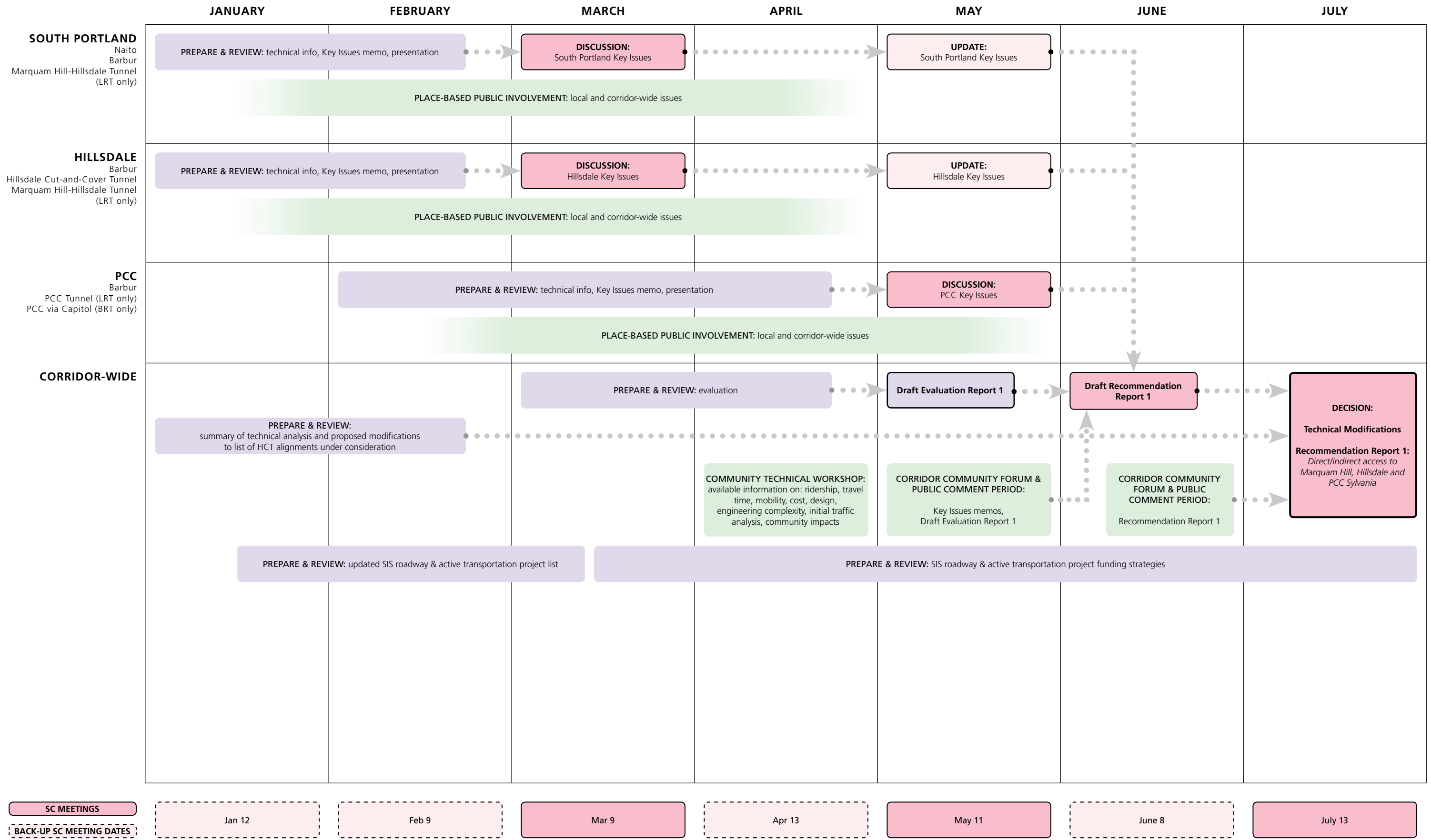


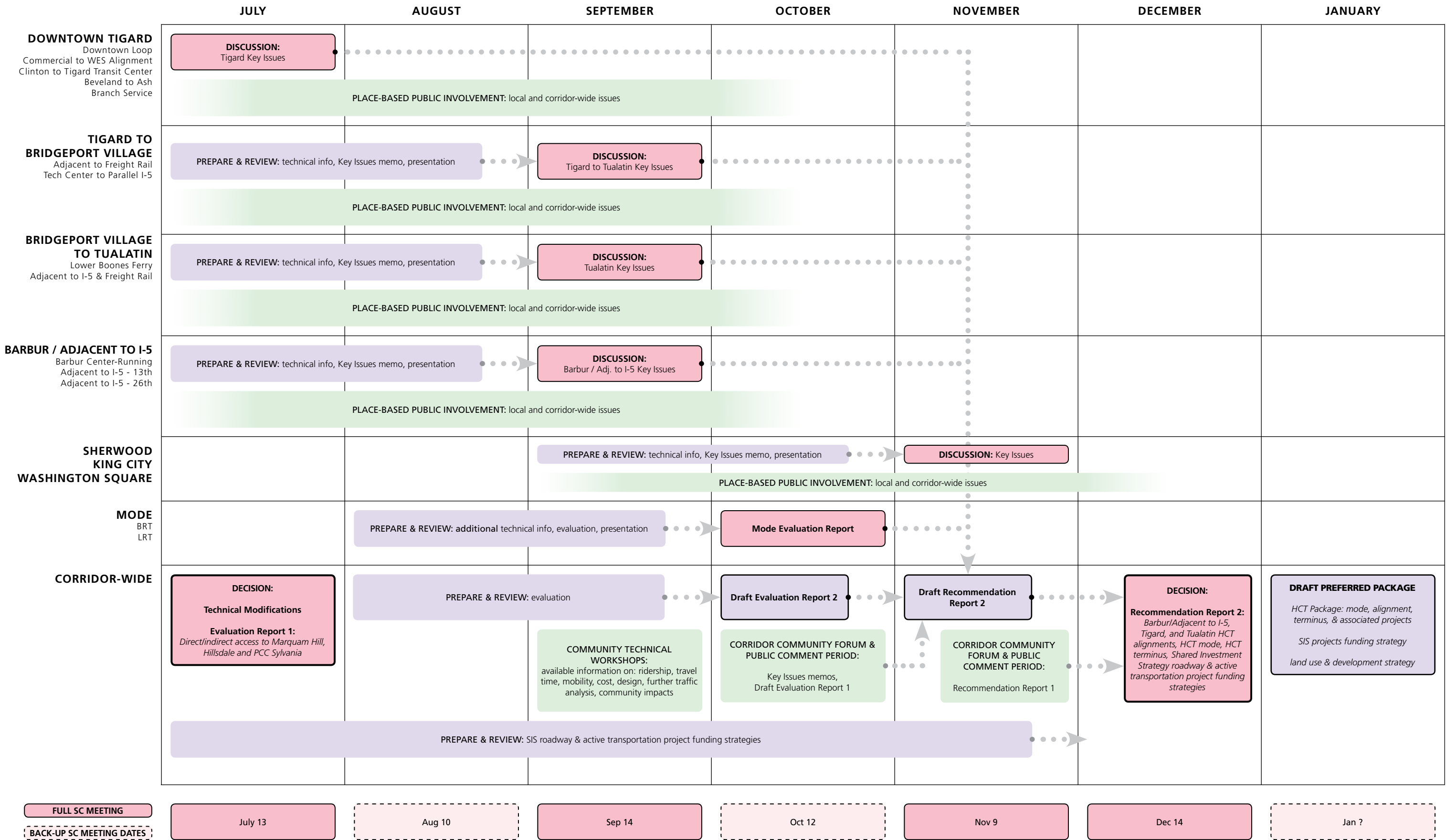
Proposed modification: add adjacent to I-5 and freight rail option

In Tualatin, the adjacent to I-5 and freight rail alignment has been developed as an option that avoids impacts to Lower Boones Ferry Road south of Bridgeport Village. This alignment continues along the west side of I-5 from Bridgeport Village, and then turns west to parallel the freight rail tracks between I-5 and Boones Ferry Road. At Boones Ferry the HCT alignment crosses over the freight rail tracks, Boones Ferry, and the Tualatin River on a new bridge. As with the Lower Boones Ferry alignment option, HCT terminates at a station just north of Boones Ferry and the Tualatin Commons.

Next steps

More detailed drawings of the alignment will be developed in the coming months, followed by a cost estimate to consider relative to the Lower Boones Ferry alignment. These two Tualatin options will be evaluated in more detail in a fall 2015 Key Issues memo, in anticipation of a December Steering Committee recommendation on the draft Preferred Package of transportation investments to study in a DEIS.





Tunnel Alignments

Executive Summary, May 2015

Three tunnel alignments are currently being considered to be part of a Southwest Corridor Plan high capacity transit project:

- Marquam Hill-Hillsdale 2.4-mile bored tunnel for light rail
- Capitol Highway/Hillsdale Loop cut and-cover tunnel for light rail or bus rapid transit
- A light rail cut-and-cover tunnel to Portland Community College (PCC) Sylvania

This summary highlights the geological conditions, likely construction techniques, and cost estimates for each of the three tunnels under consideration.

The plan's Steering Committee will decide in July 2015 whether any of these tunnel options should be considered for further study, and possible inclusion in the Preferred Package for the plan.

About Transit Tunnels

Tunnels are most often used when major ridership areas cannot effectively be served by surface alignments. In major transit systems in the country, including those in Portland, Seattle, and San Francisco, tunnels have been considered when these factors are present:

- slopes are steep (more than 5 to 6 percent)
- large physical barriers (hills, rivers) to cross
- right-of-way is inadequate for at-grade or elevated profiles
- the density of homes and businesses is high
- there is high ridership and high train or bus frequencies that would make street-level transit operations impractical

Tunnels carry greater design and technological challenges, are much larger undertakings, and have more construction risks. These factors results in tunnels carrying substantially greater costs.

Cut-and-cover construction excavates the tunnel or a station from the surface, creating a trench or box, and covers it up once the tunnel or station structure is in place. Cut-and-cover techniques are commonly used for stations unless they are very deep. All surface features above the tunnel alignment or the station must be removed.

Bored or mined tunnels are constructed underground using tunnel boring machines (TBMs). Many transit tunnels are actually two bored tunnels, with one tube for each direction. Bored-tunnel stations can be either mined from underground, or built from the surface as cut-and-cover. If stations are more than 100 feet deep, they are usually mined.

Tunnel Portals are permanent entrances to the tunnel. Portals are major points for construction. They are used to launch tunnel boring machines, remove tunnel spoils, bring in other equipment and materials, and provide workers access to the tunnel.

Tunnel stations need at least two points of entry from the surface, with connecting shafts for stairs, elevators, and, in some cases, escalators. They are several hundred feet long, with platforms large enough and long enough to handle peak passenger loads. They also have ventilation, power, transit control and extensive fire/life/safety systems.

Construction Staging Areas are needed at portals and stations and at other points where construction is at the surface. Three to six acres are usually needed at portals, and from one to four acres are desired for stations.



Tunnel portals and staging areas

Tunnel Options for the SW Corridor

Marquam Hill-Hillsdale Deep-Bored Tunnel for LRT

The 2.4 mile tunnel alignment would run under Marquam Hill through to Hillsdale and Burlingame and include two deep underground stations at Oregon Health Sciences University and Hillsdale. The north portal for the tunnel would be off SW Barbur Boulevard near Duniway Park. The south portal would emerge at Burlingame, near SW Bertha Boulevard and Barbur.

Geological conditions

Conditions in Marquam Hill are highly complex and challenging with a series of basalt stone layers, cut by faults and many transitions between different layers of earth. With two-thirds of the tunnel beneath the water table, groundwater will be present and in some areas high flows into the tunnel are expected. The tunnel would pass through multiple sections of solid rock, fractured stone, and looser soils with cobble- to boulder-sized blocks of intact rock, silt and clay.

Likely Construction Techniques and Impacts

Tunnel boring machines (TBMs) are best suited for Marquam Hill's varied geological conditions. The most likely method would be twin 20-foot-diameter bored tunnels, with two deep mined stations connected to the surface through 30- to 50-foot-diameter shafts.

The north portal would bring in the tunnel boring machine and other heavy equipment, tunnel linings and structures, and would continuously transport out large volumes of earth, rock and potentially groundwater. Similar tunnel projects have needed 5 or more acres for staging, and generated up to 200 truck trips daily. Deep mined stations also need several acres on the surface above for construction of surface features and shafts, and can generate 30 to up to 100 truck trips daily.

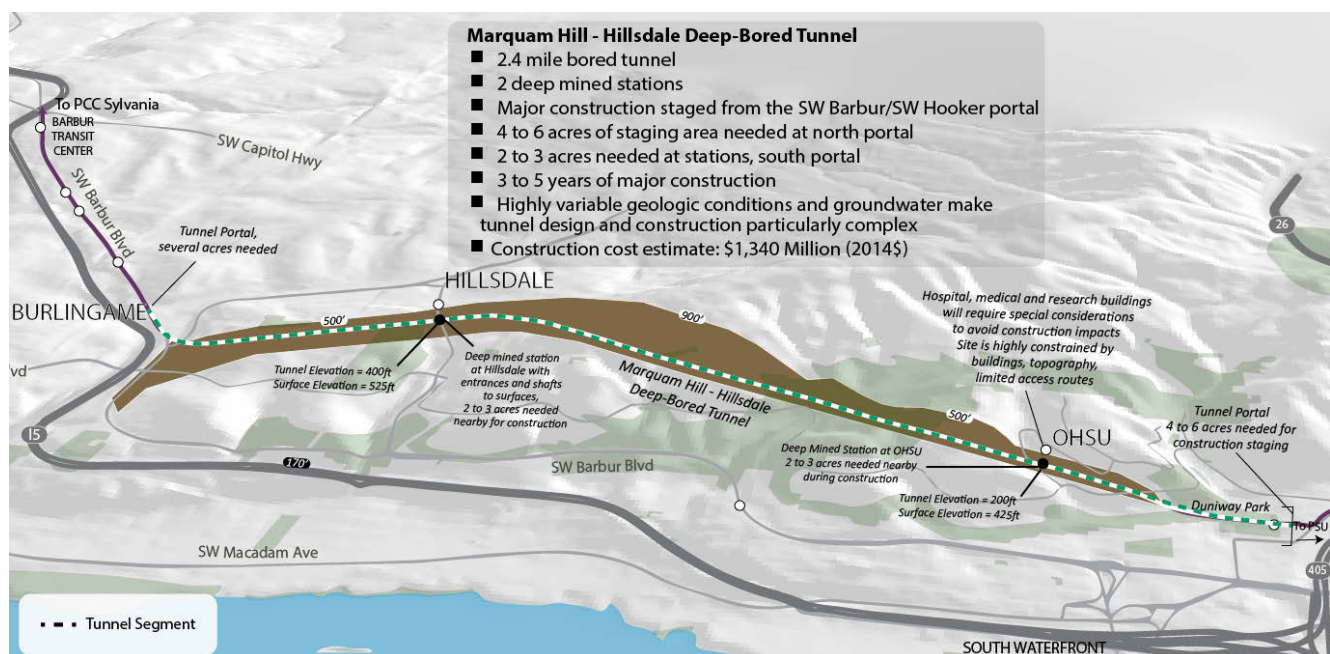
Blasting or other excavation methods are expected at the portals, stations, cross passages and other locations along the alignment.

Construction of a Marquam Hill-Hillsdale tunnel could last 3 to 5 years; construction costs are estimated in 2014 dollars to be \$1,340 million.

Tunneling Issues

There is little to no vacant land at the proposed locations for a tunnel portal and stations and impacts to adjacent properties appear unavoidable. At the north portal, the adjacent areas include Duniway Park, residences, and SW Barbur Boulevard. The south portal area is adjacent to residences and large businesses, which would be subject to trucking and several years of construction activities.

The OHSU complex has limited roadway access, hilly topography, and limited locations available for staging of the station entrance buildings and shafts. The OHSU complex includes buildings and operations with sensitive equipment and overnight patients,



these would be especially sensitive to the noise and vibration of tunneling and blasting. The impacts of trucks and large equipment on Terwilliger Boulevard is also an issue.

The Hillsdale station site is at a busy intersection of Capitol Highway, adjacent to two schools, residences and the commercial district. The staging area for the underground station would require several acres, which are not available without displacing multiple existing properties or affecting the schools.

Capitol Highway/Hillsdale Loop Cut-and-Cover Tunnel for LRT or BRT

This .3 mile tunnel would be 35 feet deep with an underground cut-and-cover station near SW Capitol Highway and SW Sunset Boulevard. The northeast portal to the tunnel would begin approaching Sunset Boulevard, and the southwest Portal would be near SW Vermont Street and SW Bertha Boulevard. Two locations for the cut-and-cover tunnel alignment are being evaluated—one along SW Capitol Highway that turns south at SW Bertha Boulevard and another crossing across an elementary school athletic field.

Geological conditions

The area consists of basalt rock below 15 to 40 feet of varied soils, including fill. Key geotechnical issues include the potential for rock excavation, perched groundwater, and loose soils.

Likely Construction Techniques

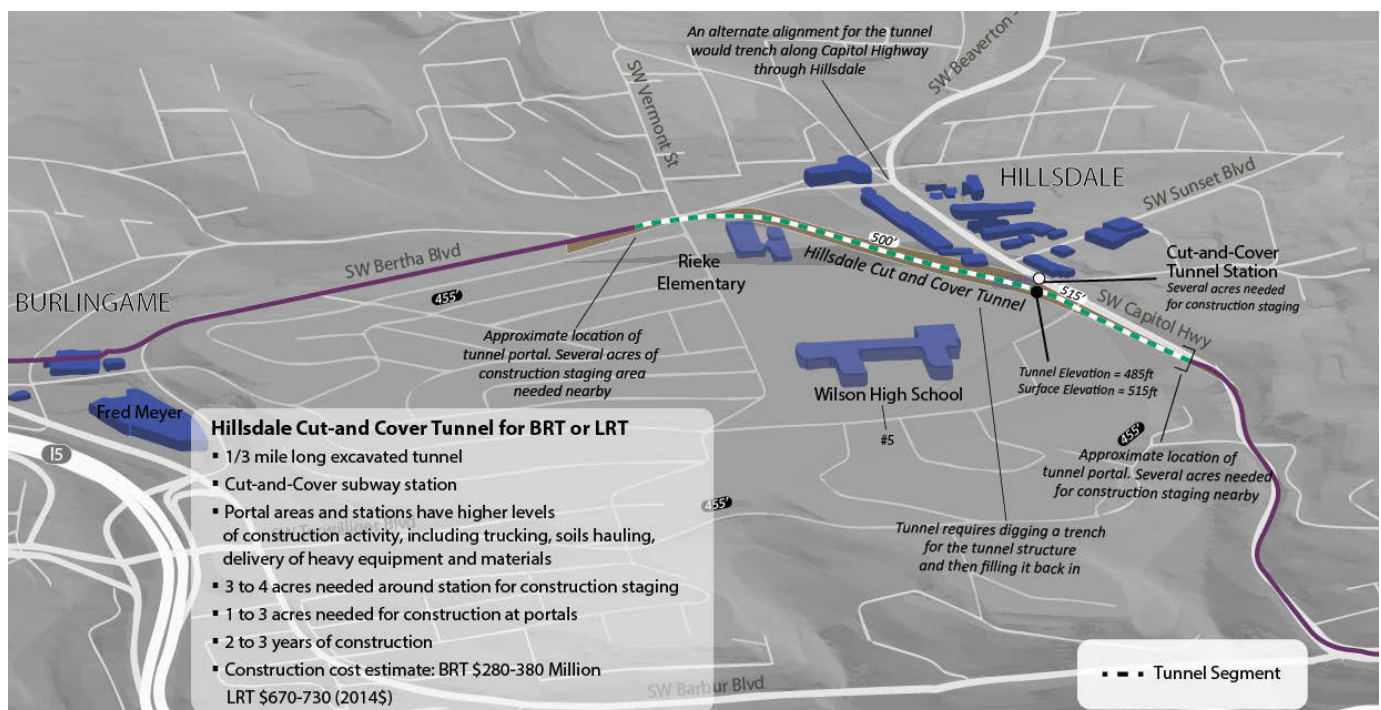
A 40-foot-deep, .5 mile trench would be dug for the tunnel and the station. Rock excavation may be required, which could be done with machines but may also involve drilling and blasting. Groundwater would need to be managed (by doing what??).

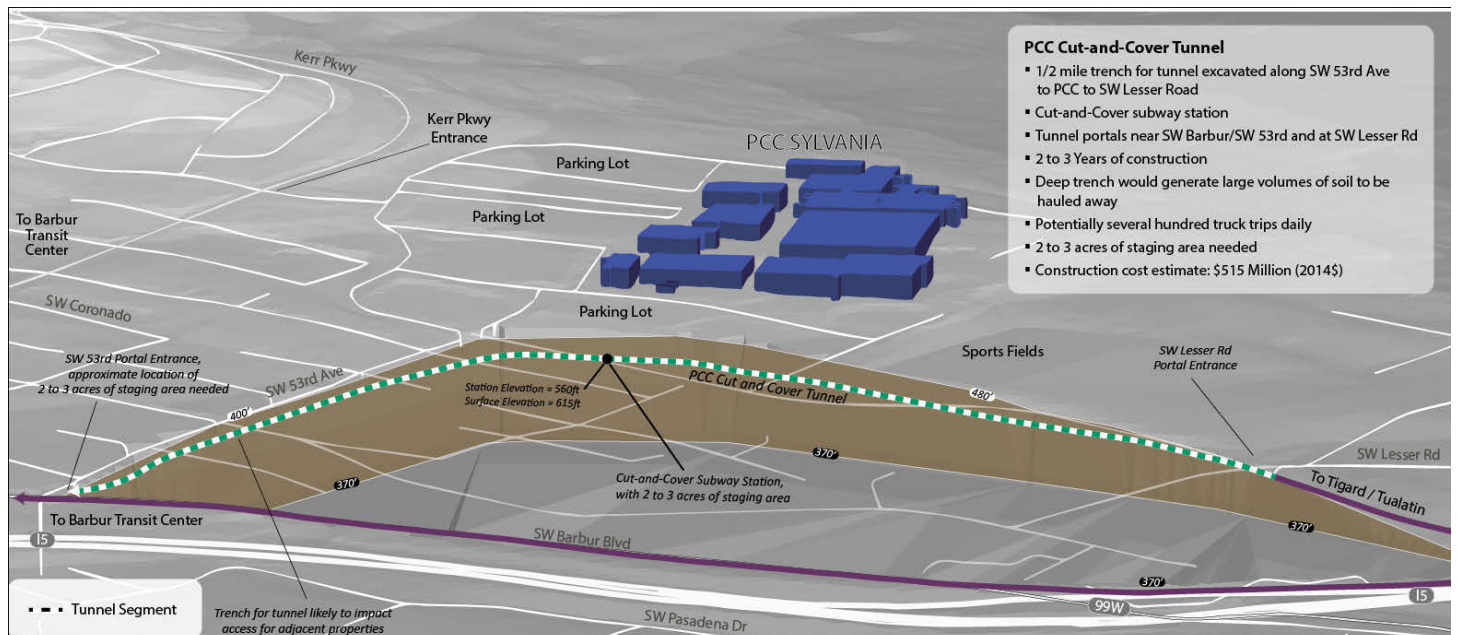
A large volume of soil and rock would be hauled away daily, creating 100 to 200 truck trips daily over an extended period. Vertical shoring walls needed during construction would require large equipment for drilling or pile driving. Streets or paths across the alignment would be closed or restricted during much of the construction period, and the areas along trench would be restricted as well.

Construction of a Hillsdale Loop cut-and-cover tunnel could take 2-3 years; construction costs are estimated in 2014 dollars to be \$670-\$730 million (light rail) or \$280-\$380 million (bus rapid transit).

Tunneling Issues

The trench for the cut-and-cover tunnel and station would be constructed in areas that are mostly developed. The construction area is bounded by a major roadway, a high school, an elementary school, residential neighborhoods and a commercial district. Property impacts to several blocks of the area appear unavoidable. One potential alignment would cross fields belonging to the elementary school, and the other alignment would affect the commercial district along Capitol Highway.







G R E A T P L A C E S

Corridor

Portland • Sherwood • Tigard • Tualatin
Beaverton • Durham • King City
Washington County • ODOT • TriMet • Metro

Tunnel Alignments Report

May 2015

Overview of the Corridor

The Southwest Corridor Plan is a comprehensive approach to achieving community visions through integrated land use and transportation planning. The Southwest Corridor Plan incorporates high capacity transit (HCT) alternatives, roadway, bicycle and pedestrian projects and local land use visions, including Barbur Concept Plan, Tigard High Capacity Transit Land Use Plan, Linking Tualatin and Sherwood Town Center Plan. The Plan is exploring Bus Rapid Transit (BRT) and Light Rail Transit (LRT) alternatives for several alignments that connect the Portland Central City, Southwest Portland, Tigard, and Tualatin.

Many of high capacity transit BRT or LRT alignments being considered for the Southwest Corridor Plan follow roadways or other rights-of-way to connect the Southwest corridor communities, but there are several areas where tunnels are being considered.

Tunnel alignments currently being considered are:

- Marquam Hill -Hillsdale 2.4-mile bored light rail tunnel;
- Capitol Highway/Hillsdale Loop cut and-cover tunnel for light rail or bus rapid transit; and
- A light rail cut-and-cover tunnel to Portland Community College (PCC) Sylvania.

The plan's Steering Committee is scheduled to make a decision in July 2015 about whether the tunnel options should be further considered for the HCT element of the Preferred Package for the plan.

Transit Tunnels

Tunnels are most often used when major ridership areas cannot be served in another way. Compared to standard at-grade or elevated alignments, tunnels must surmount more design and technological challenges as well as construction risks, and this in turn causes them to carry substantially greater costs.

In major transit systems in the country, HCT tunnels have been considered when these factors are present:

- slopes are steep (more than 5 to 6 percent);
- large physical barriers such as hills or rivers to cross;
- right-of-way is inadequate for at-grade or elevated profiles;

- the density of homes and businesses is high; or
- there is high ridership and high train or bus frequencies that would make street-level transit operations impractical.

Tunnel construction is a major undertaking for technological as well as logistical reasons, and the scale of construction activities is high and complex. Digging a tunnel means removing large volumes of rock or soil (and often groundwater). Large amounts of materials must also be brought in to build the tunnel structures. Tunnels require complex equipment and machinery. Multi-acre sites must be dedicated to construction use for several years. Other critical tunnel construction factors can vary greatly, including geological conditions, the construction approach, how work is sequenced, the techniques for building the tunnel and stations, the equipment used, and local permit conditions and constraints. This in turn affects how long construction lasts, the kinds of impacts that occur in surrounding areas, and the overall costs for a project. At all stages of construction, a builder must safeguard against a wide range of potential risks in order to protect workers, nearby structures, the environment and the public.

The two most common tunnel construction methods are cut-and-cover, or boring with machines, although other mining techniques may also be used.

Cut-and-cover construction excavates the tunnel from the surface. The most typical method is to create a trench and then cover it up with fill as the tunnel structure is completed. Cut-and-cover techniques are commonly used for stations unless they are very deep. Temporary or permanent sections of lids can be used during construction if access across the excavation is needed, but it complicates the construction.

Bored (or mined) tunnels are constructed underground from portals with 3- to 5-acre construction staging areas nearby. Bored-tunnel stations can be either mined or cut-and-cover, but if they are more than 100 feet deep, they are usually mined. Even a mined station would still need excavation to reach the surface above to allow for access, ventilation, and emergency systems.

Common Features of Transit Tunnels

Tunnel Portals

These entrances to a tunnel transition the transitway from the surface to underground. They can be placed into a hillside, often surrounded by retaining walls, or they can gradually descend into a trench and then underground. During construction, portal areas are the focus of soil removal, water removal, construction staging, and materials delivery for the tunnel. After service starts, the approaches to portals are usually walled or fenced and are restricted areas.

Tunnel Structures

Depending on the type of tunnel construction method, tunnels are either hollow boxes or tube “linings” that house and support all transit system features and operations. Each tunnel is unique because it must be designed to withstand a wide array of loads and forces presented by localized geological conditions and pressures, as well as by forces generated by the structure itself and the operating transit system. When they are built in areas with variable soils, they often include ground stabilization measures and supports. Where groundwater is present, tunnel linings must be waterproofed.

Tunnel Stations

The box or cylinder structure for a tunnel station must address the same array of forces and loads as the tunnel structure, but they are often about 50 feet or more wide and several hundred feet long. They also house facilities needed to operate the system and they include structures for passengers to safely and efficiently access the transit line from the surface. Tunnel stations need at least two points of entry from the surface, with stairs, elevators, and, in some cases,

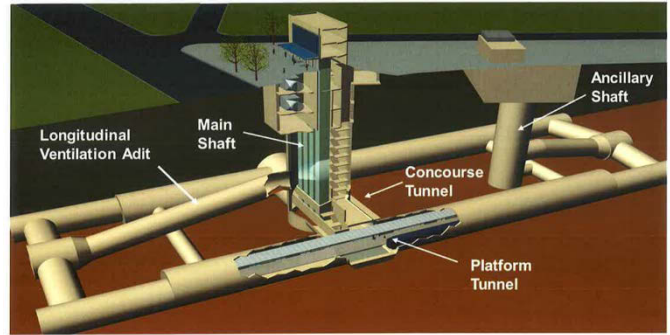


Diagram of deep tunnel station in Seattle

escalators. They need platforms large enough and long enough to handle peak passenger loads. They have systems that monitor and control ventilation, protect against flooding, and serve fire/life/safety functions, including those needed for emergency response or evacuation.

Ventilation Shafts and Structures

Most tunnels require vertical ventilation shafts with surface structures for emergency ventilation and climate control. These can be located at stations, but for longer tunnels with more widely spaced stations they can also be used for emergency access. The surface building for a shaft would include an exhaust and air intake system on its roof, a fan room, and space for electrical and communications equipment. Ventilation also is needed at the tunnel portals, where jet fans are used.

Construction Staging Areas

During tunnel construction, areas ranging from two to five acres are needed at the portals, and two to three acres are typically needed to construct stations. Larger staging areas at one of the portals may be needed if most of the construction hauling, equipment and materials storage is to be performed from a single access point. Additional areas are needed wherever other facilities reach the surface. For bored tunnels, construction staging areas are at the portals and at stations, while cut-and-cover tunnels can feature staging areas at various points along the trench. Since tunneling projects usually involve continuous construction, the staging areas are usually active 24-hours a day. They are the focus of the project's trucking for spoils hauling and materials and equipment delivery, as well as for storage, for equipment and materials staging, and for all other systems needed for tunnel construction.

Tunnel Options for the SW Corridor

Marquam Hill-Hillsdale Deep-Bored LRT Tunnel

The tunnel alignment under Marquam Hill through to Hillsdale and Burlingame is about 2.4 miles long. Based on the concept design, the deepest part of the tunnel



Tunnel portals in Seattle

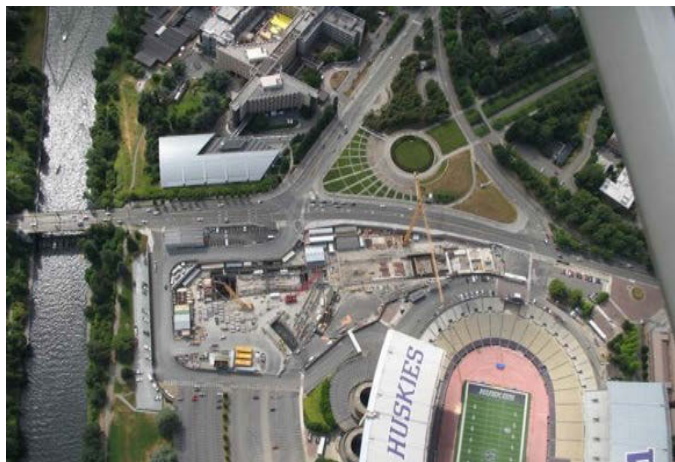
alignment is about 590 feet below the ground surface, but most other areas range from 100 to 350 feet below the surface. Large tunnel boring machines would be used due to the depth and length of the tunnel, and because they are best able to deal with the highly variable geological conditions involving basalt rock, various intermediate soils and layers, and the likelihood of high groundwater flows.

The option has two underground stations: one at the Oregon Health Sciences University (OHSU), about 200 feet deep, and another in the Hillsdale neighborhood, about 150 feet deep.

The north portal for the tunnel, where the tunnel boring machine would be launched and where it is likely most of the tunnel spoils removal and materials delivery activities would be based, would be off SW Barbur Boulevard near Duniway Park. The south portal would emerge at Burlingame, near SW Bertha Boulevard and Barbur.

Capitol Highway/Hillsdale Loop Cut-and-Cover LRT or BRT Tunnel

The Capitol Highway Hillsdale Loop option has a tunnel that is about 1/3 of a mile long, and the floor of the tunnel would be about 35 feet deep, based on the conceptual design currently being considered. An underground station is proposed near SW Capitol Highway and SW Sunset Boulevard, also about 35 feet deep. The tunnel and station would most likely be constructed using cut-and-cover techniques due to the shallow depths and soil conditions. The northeast portal to the tunnel would begin approaching Sunset Boulevard, and the southwest Portal would be near SW Vermont Street and SW Bertha Boulevard. Two options for the cut-and-cover tunnel alignment are being evaluated, including one along SW Capitol Highway and turning south at SW Bertha Boulevard, and the second crossing across an elementary school athletic field.



Tunnel and station construction staging in Seattle

Although the tunnel is relatively short, ventilation facilities on the surface would likely be needed for a Bus Rapid Transit tunnel to vent emissions from the buses.

PCC Cut-and-Cover LRT Tunnel

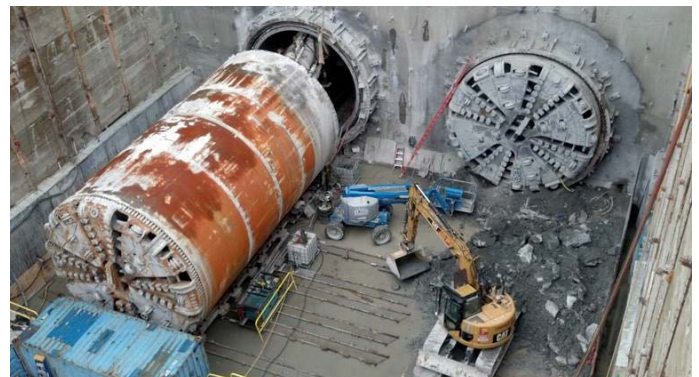
The PCC tunnel cut-and-cover is about ½ of a mile long, and up to 70 feet deep, based on the current concept design. One underground station is proposed at about 70 feet deep, in a parking area at the north side of the campus. The north end of the tunnel would begin near SW Barbur Boulevard and SW 53rd Avenue, proceed south to the campus before turning west for the station, and then continuing west to surface near SW Lesser Road before crossing over I-5.

Typical Tunnel Construction Activities

Bored Tunnel

Bored tunnels are used for longer, deeper tunnels, included those with highly varied geological conditions. The tunnels are built with special tunnel-boring machines (TBMs), or “moles.” TriMet’s Westside Light Rail project used a TBM for its tunnel. The machines are customized large multimillion-dollar pieces of equipment with cutting or excavating faces specifically designed or modified to handle the geological conditions of each specific tunnel. They can be designed to handle a wide array of ground types, from rock to partly rocky or mixed soils to areas with high amounts of groundwater. They automate the mining process from cutting to moving tunnel spoils out behind the machine, to helping support the emerging tunnel before other supports and parts of the permanent tunnel lining can be placed.

Even with a bored tunnel, some traditional excavation or mining may be needed with other equipment or the use of blasting. The construction of an access portal is often done by excavation. If a portal can be located on a hillside, it can be dug directly into the hillside by using excavation and structural support methods. In flatter areas, the tunnel can be excavated as a trench to a portal and then the tunnel continues to be dug to reach a depth



Tunnel boring machines emerging at a station in Seattle

where a tunnel boring machine can begin excavating earth.

Soils and muck are removed behind the tunnel boring machine and back through the tunnel to the portal, using conveyor belts or mining rail-cart systems. In areas where groundwater is present, a system for conveying the water out of the tunnel is needed. The large volumes of spoils that digging a tunnel generates, as well as the materials needed to build linings and supports as the tunnel progresses, are why multi-acre staging sites are needed in portal areas.

Portals are the hub of the construction activity for bored or mined tunnels, and trucking the materials in and out of the portal area often lasts for several years. While truck volumes depend on how quickly the tunnel is progressing, several hundred truck trips can occur daily to and from the staging areas at a portal, with 20 or more trucks an hour during high activity periods. This can create high levels of local congestion as well as congestion on haul routes, and this lasts for several years. Periodic road or lane closures or flagging are needed to allow trucks to enter and leave the staging site and onto the roadway network. Similar types of trucking, staging and hauling activities also occur in station areas, even with deep mined stations, although volumes are usually lower than at portals. Stations can generate up to 100 truck trips a day, or typically around 10 trips an hour.

Cut-and-cover Tunnels

Cut-and-cover excavation methods are used where tunnels are too short or shallow for boring, or where tunneling must avoid foundation elements of nearby buildings. They are also the most common method used for underground stations, even when the rest of the tunnel is bored, because it gives a contractor more flexibility in building the larger station structure.

The excavation method is also known as “sequential excavation mining” because it consists of smaller but defined steps to excavate a tunnel in sections. There

are techniques that cut an open trench from the surface, as well as techniques that build a lidding structure first and then dig the tunnel underneath. These techniques can use conventional excavation and construction equipment, such as might be used to create a deep foundation for a tall building or underground parking garage, or it can feature a rapid excavation machine designed for more linear excavations. Sequential excavation can be slower and more expensive than using a boring machine, and it usually requires removing the existing surface features along the tunnel alignment and above the station.

Construction Issues for the Tunnel Options

In developing the tunnel options, TriMet and Metro engaged a team of technical specialists with extensive experience designing and building transit tunnels and other types of tunnels in this region, as well as nationally and internationally. The team included geotechnical engineers, civil and structural engineers, construction managers, and environmental analysts, all with experience on successfully completed tunnel projects. Several of the team members worked on TriMet’s Westside Light Rail project tunnel or on Sound Transit’s tunnels and underground stations for the light rail system in Seattle.

The team reviewed the tunnel concepts, which are currently at a planning-level of design. They collected available information about geological conditions for the areas where the tunnel alignments are being considered, and they drafted a letter report on the geological conditions by area, focusing on elements that would likely affect tunnel design requirements, construction methods and issues, as well as factors affecting costs and general risks. They also advised TriMet and Metro on likely contractor needs for staging areas, both at portals and by station types, and outlined possible design or construction refinements that could be considered if the options were to move forward.

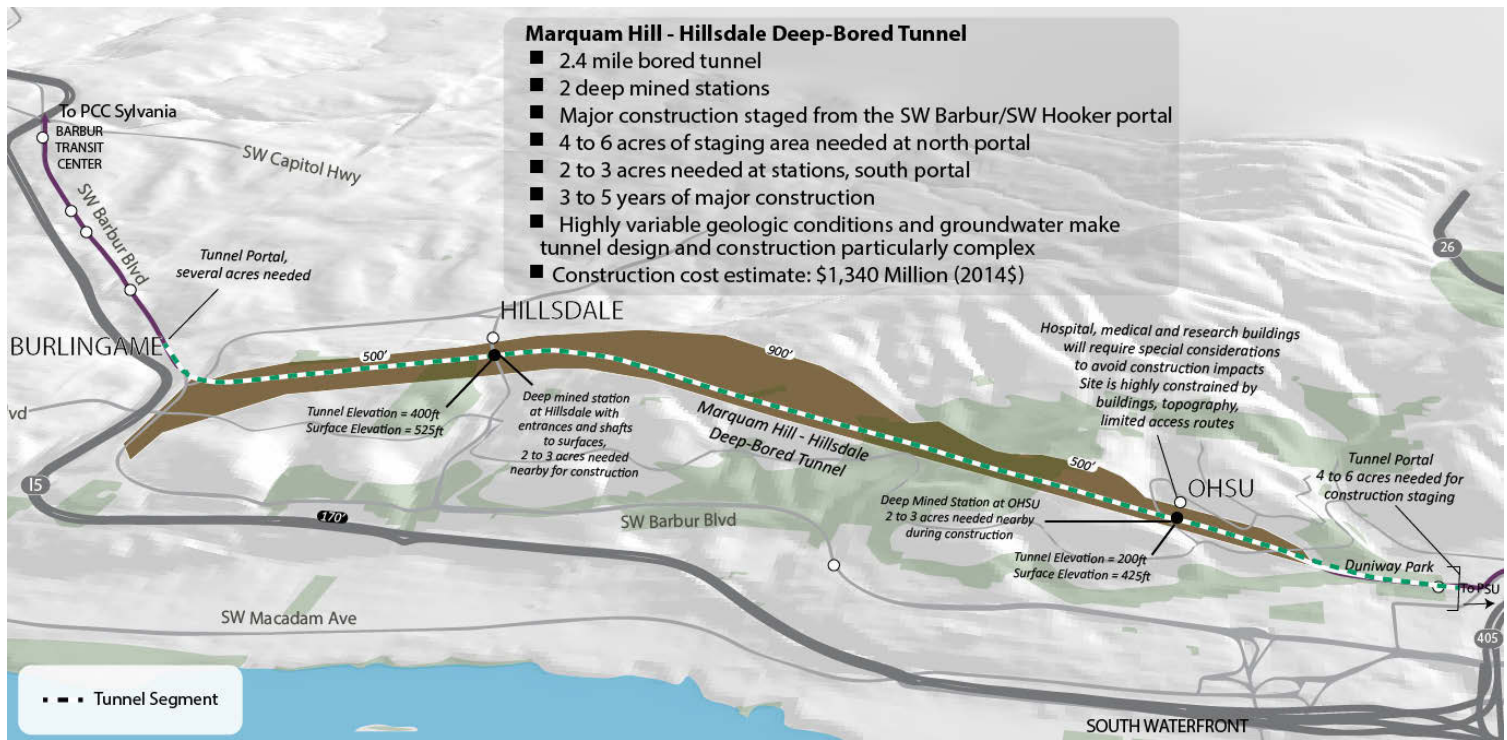
Marquam Hill-Hillsdale Deep-Bored Tunnel for LRT

Geological Conditions

The initial geotechnical review shows the alignment must cross through a complex series of basalt layers, with faults and variable transitions between layers and sections. Above the core of basalt are undifferentiated sedimentary soils with cobble- to boulder-sized blocks of intact rock, and silt and clay. The multiple layers of basalt, which were built up over time from volcanic flows, along with the presence of faults, indicates that the tunnel would move repeatedly through layers of rock and into fractured rock, sediments, and areas with loose or



Cut-and-cover construction for the downtown tunnel in Seattle (1980s)



less stable soils. Groundwater will be present, and high flows are more likely wherever there is a fault or transitions between rock layers. About two-thirds of the tunnel alignment, including the OHSU Station, would be partially or completely beneath the groundwater table. Large quantities of water may need to be handled during tunnel construction, although flows could be reduced if a watertight concrete liner can be installed during excavation.

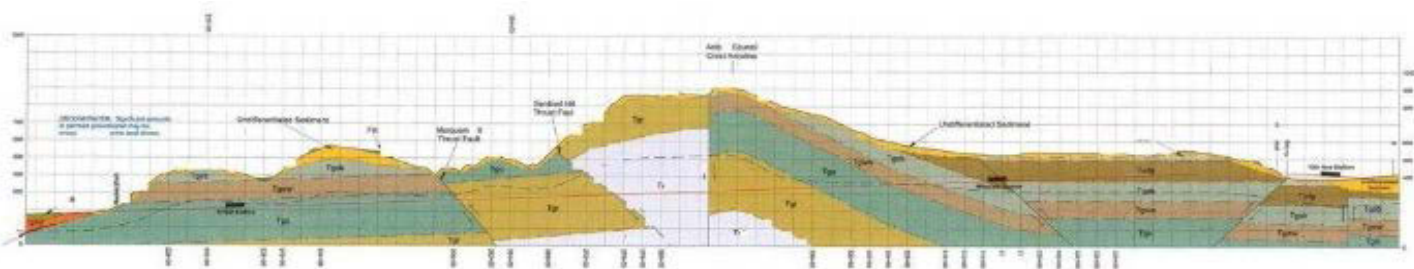
Likely Construction Techniques

Based on experience with similar tunnels (such as the Oregon Zoo tunnels and deep mined stations and shafts,) the tunnel would likely have twin 20-foot-diameter bored tunnels, with two deep mined stations connected to the surface through 30- to 50-foot-diameter shafts. An additional vent shaft would also likely be needed along the alignment between the stations. Because the area has highly variable ground conditions and high groundwater pressures, the design of the tunnel and the contractor's methods would need to address the potential for changes in how the tunneling is done as well as its structural elements, as the tunnel will be in areas with poor ground conditions,

as well as high water inflows. A much higher level of geotechnical information will also be needed to support the detailed design and construction planning that would be needed for the tunnel.

Based on available information, the tunnel would repeatedly cross various zones of rock and soils, including many with higher potential for collapse during construction. A tunnel boring machine that is capable of handling a wide range of ground conditions would be needed. The contractor would likely need to install precast lining segments that would support the ground around the tunnel and allow a waterproofing liner as the boring progresses. A variety of ground-supporting techniques will also be needed for the shafts, stations, and crossover tunnels.

Blasting is likely to be needed at the portals, stations and cross passages for the tunnel. The north and south portals could also require excavating 100- to up to 300-foot-long approaches cut into the hillside. This would allow the full diameter of the tunnel boring machine to be placed within rock and with at least 10 feet of rock cover above before boring starts.



Cross-section of Marquam Hill shows highly variable underground conditions

Tunneling Issues

All of the surface construction areas are highly constrained. It would be difficult to locate large enough staging areas at the tunnel portals and the stations because the areas surrounding these surface features of the tunnel are largely developed. At the north portal, where the tunnel boring would most likely be launched, an area from 3 to 5 acres would be needed, but the adjacent areas are part of Duniway Park, and residences are nearby. There are federal laws that restrict transportation projects from impacting parks when other options are available.

While the stations and the south portal could have smaller staging areas than the north portal, they would still need several acres. The south portal area in particular lacks any sizable vacant land, is adjacent to residences, and property acquisitions appear unavoidable. Trucking needed for soils removal, trucking equipment transport, and materials delivery, including large or oversize loads, would occur at all the staging areas and would last for several years. The highest concentration of truck trips would likely be at the north portal near Duniway Park, where several hundred truck trips could occur on a daily basis.

The OHSU as well as the Hillsdale stations have other considerations to address during construction. The OHSU complex has limited roadway access, hilly topography, and limited areas that could be used for staging around the station site. Emergency access routes to the hospital would need to be maintained at

all times. The OHSU complex is likely to be especially sensitive to the noise and vibration that tunneling activities would generate, including facilities using sensitive equipment, and where overnight patients reside. The impacts of trucks and heavy equipment getting to and from the site on Terwilliger Boulevard, one of the two routes to OHSU, is also an issue. The permits and agreements needed for construction in this sensitive area would likely place special conditions and constraints on a construction contractor.

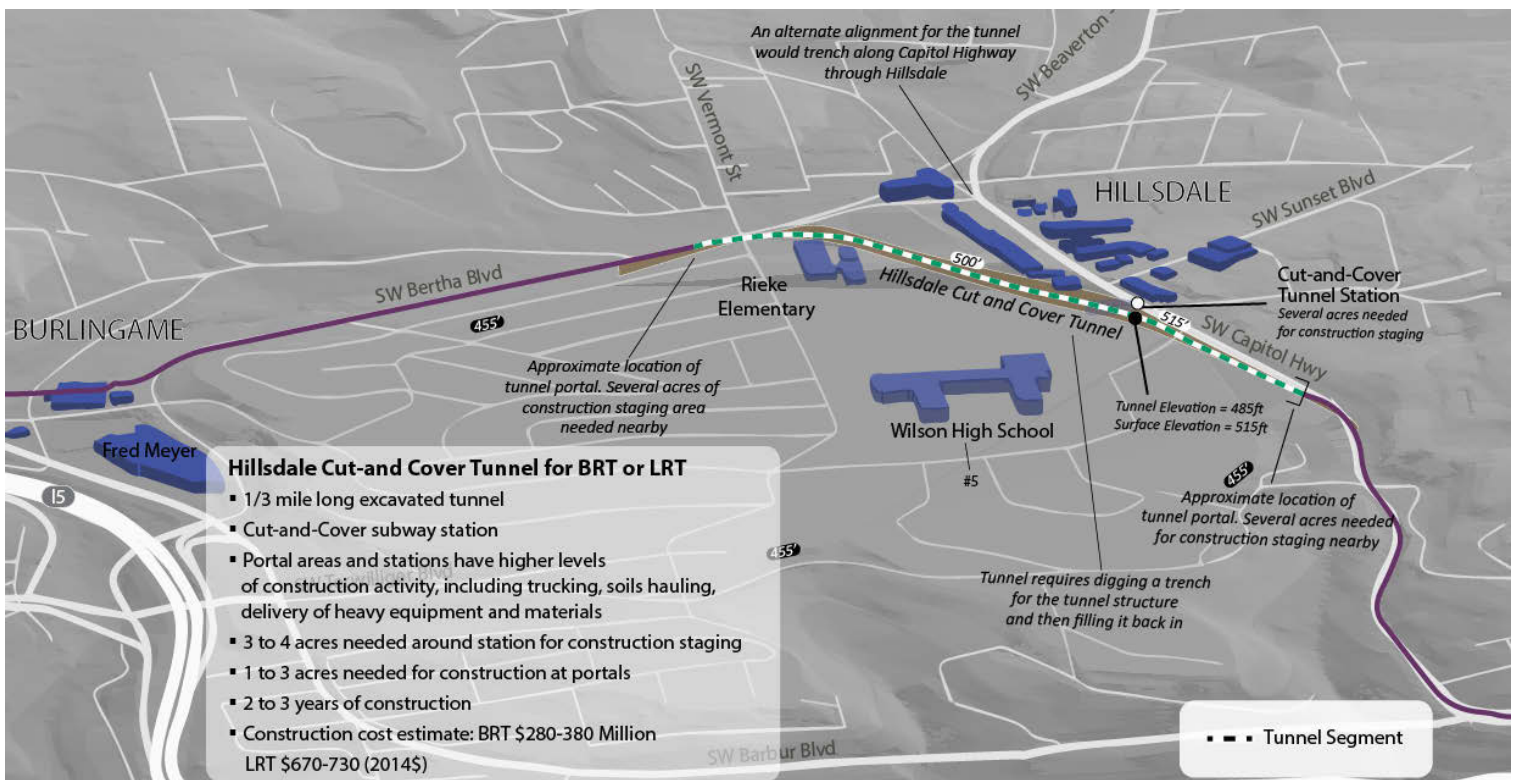
The Hillsdale station construction area is at a busy intersection of Capitol Highway, adjacent to two schools, residences and the commercial district. The staging area would likely displace existing properties, and the placement of the construction site, as well as the plan for construction itself would need to consider impacts to the schools, the neighborhood, businesses, and area transportation. These issues include congestion due to trucking to and from the site, noise, vibration, access, light and glare.

All of these factors, combined with the highly variable geological conditions for the tunnel itself, have a high potential to affect a contractor's schedule, efficiency, and costs for the tunnel.

Hillsdale Loop Cut-and-Cover Tunnel for LRT or BRT

Geological conditions

The tunnel alignment is in an area with basalt rock, overlain by about 15 to 40 feet of varied soils. In some spots, up to 30 feet of fill is in place. The alignment is



above an aquifer lying 300 feet below the surface, but groundwater has been measured at depths as shallow as 5 feet. Key geotechnical issues include the potential for rock excavation, perched groundwater, and supporting structures to avoid collapse of the soils exposed by the cut.

Likely Construction Techniques

The shallow depth of the alignment would involve excavating a trench for the tunnel and larger box for the station. The floor of the tunnel and station would be up to 40-feet deep, with widths of about 35 feet for the tunnels and 50 feet for the station. Rock excavation may be required, which could be done with machines but could also involve drilling and blasting. Perched groundwater may be encountered and would need to be managed and then disposed of to prevent groundwater flow into the excavation. The removed soils for the station and trench would likely need to be hauled away, and then new fill soils would be brought back to cover over the tunnel and underground station box. While the trench for the tunnel is being dug, vertical shoring walls will likely be needed to support the walls, and this could involve large equipment for drilling or potentially pile driving. Depending on a contractor's construction plans, portions of the cut for the station and the tunnel could be temporarily covered or lidded as construction progresses. However, streets or paths across the tunnel alignment would be closed or restricted during much of the construction period, and the areas along trench would be restricted as well.

Tunneling Issues

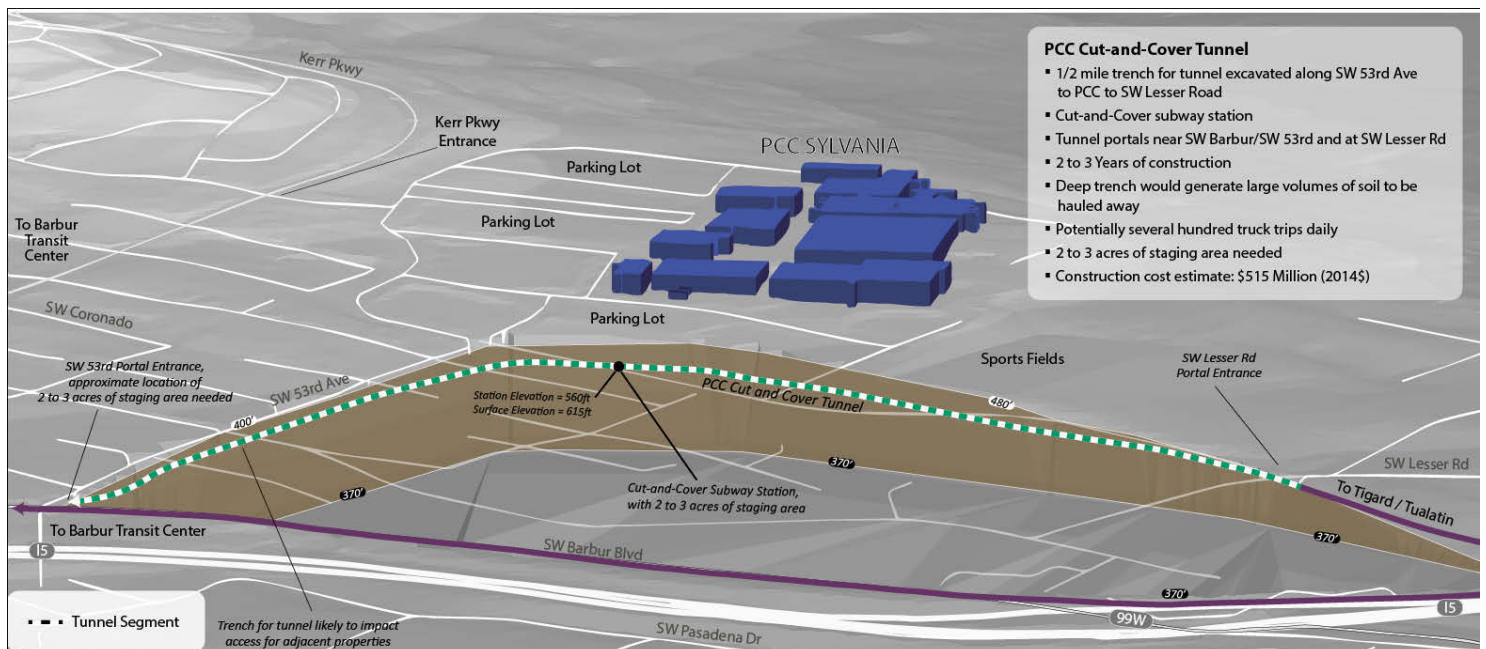
The trench for the cut-and-cover tunnel and station would be constructed in areas that are mostly

developed today. The site is adjacent to a major roadway, high school, elementary school, residential neighborhoods and a commercial district. The two to three acre area needed for station construction would need to be sited to maintain safe access to the nearby schools, and property impacts affecting several blocks appear unavoidable. While two routes for the tunnel have been outlined, one would involve crossing fields that are part of the elementary school, and the other would affect the commercial district along Capitol Highway. The presence of the schools is likely to require special measures and procedures to ensure the health and safety for students, and avoid disruptions to school operations or emergency access. Several years of construction would be needed, and the cut-and-cover tunnel and station sites would be restricted areas that would require alternative routes and detours, restricting movements in and through the Hillsdale area. As with any of the tunneling options, high levels of truck traffic would occur throughout much of the primary construction period, and congestion as well as roadway or lane closures would be involved. In addition to the traffic and property impacts, noise and vibration, light and glare would be other issues of concern for nearby residences and businesses.

PCC Cut-and-Cover Tunnel for LRT

Geological conditions

The alignment is on the flanks of an ancient volcano (Mount Sylvania), and has a core of basalt flows and volcanic cinders, with about 40 feet of silt, clay, some sand, gravel and cobbles up to the surface. The tunnel depths approach or intersect the transition between the upper soils and the underlying basalt rock layers. The conditions for the tunnel will be highly variable, and there



are boulders and blocks of rock in some locations in the upper soils.

While the tunnel is generally above the groundwater table, there are areas where pockets of water are likely to be encountered during construction.

Likely Construction Techniques

The fairly deep alignment poses challenges for cut-and-cover techniques, but the length and depth of the tunnel is also a challenge for other tunneling methods such as boring. The available right-of-way is narrow, and the alignment is up to 70 feet deep. To dig the trench for the tunnel, deep shoring walls or other measures will be needed to support in the soil and weathered rock, and the excavation will temporarily occupy and close an existing residential street. The soil over rock excavation conditions and the shallow depth are manageable but would pose other challenges for construction. Factors include groundwater and high variability in the rock surface and ground conditions. The contractor would likely need to use combination of soil excavation, soil treatments or ground condition, drill-and-blast rock excavation, and excavation support systems.

Some of these issues could be reduced if the alignment were deepened by 30 to 50 feet, potentially allowing a boring machine to be used. However, this would extend the length of the tunnel, and the station would likely need to be mined, which is a more costly method of construction.

Tunneling Issues

As the alignment is along a ¼ mile section of an existing residential street, access to the adjacent residences would be closed, and construction activities causing noise and vibration would also be present. The residences along the street would likely need to be purchased and the residents would be relocated. Houses along the street could also experience some settlement from the excavation, as well as potentially vibration-induced damage from blasting. Other areas needed for staging and construction appear to be available, although the high volume of trucks serving the construction area would affect surrounding areas.

Initial Capital Cost Estimates

TriMet has developed initial cost estimates for the tunnel alignments, based on the early conceptual designs alignments. These costs reflect projects of a similar type and scale, using recent TriMet project as well as other projects nationally. Costs were developed in year 2014 dollars (2014\$), and do not include inflation of finance costs. Operational costs are also not included.

The cost estimates by option:

- Marquam-Hillsdale bored tunnel for light rail: \$1,340 Million (2014\$)
- Capitol Highway/Hillsdale Loop cut and-cover tunnel (with two alignments and two modes considered)
 - light rail: \$670 to \$730 Million (2014\$)
 - bus rapid transit \$280 to \$380 Million (2014\$)
- A light rail cut-and-cover tunnel to PCC Sylvania
 - \$515 Million (2014\$)

This report prepared by Parametrix, 2015

