Appendix C

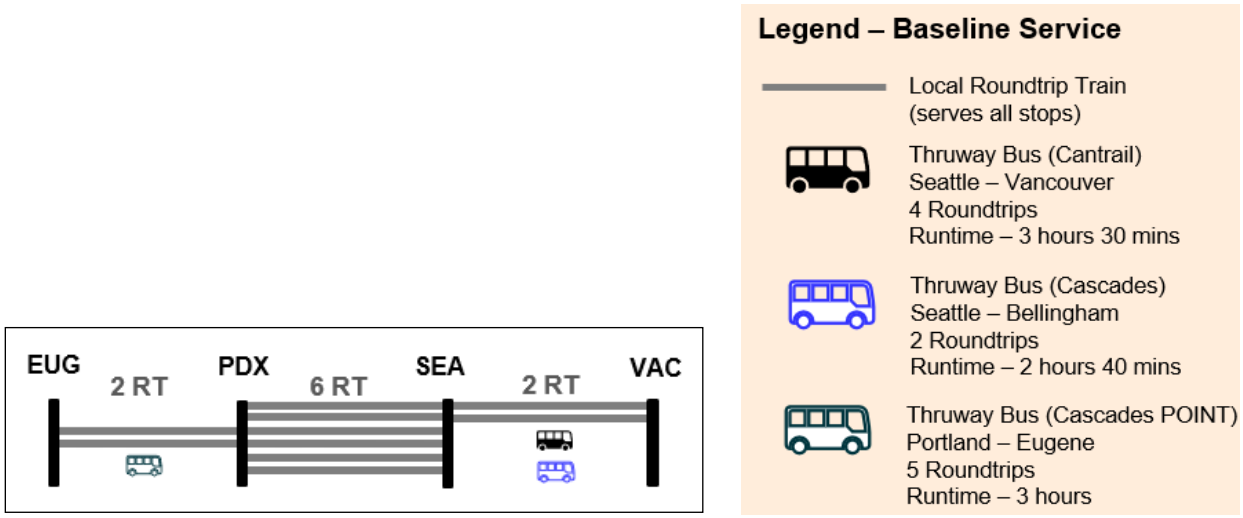
Initial Service Options and Ridership Forecasting Methodology

Initial Service Options

Initial service options

WSDOT first established the baseline Service to use it as a benchmark to compare the future ridership growth of different service options. The Baseline Service, as depicted in **Exhibit 1**, represents the fully restored Amtrak Cascades service operating as of December 2023. It includes six roundtrips between Seattle and Portland, two roundtrips between Vancouver, BC, and Seattle, and two roundtrips between Portland and Eugene in Oregon.

Exhibit 1: Baseline Service Diagram (Operating by the end of 2023)



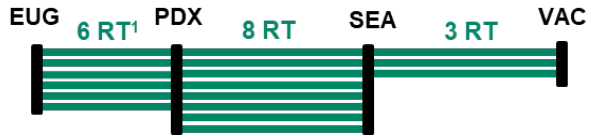
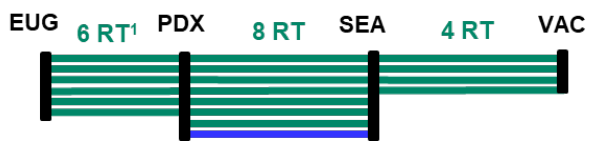
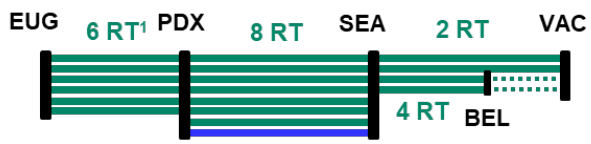
WSDOT developed a total of 13 initial service options based on key service characteristics including service frequency and stopping patterns. The service options were organized into four groups based on the level of service frequency: low, medium, high, and highest service level. Except for the highest service option group, each group identifies four service options, combining different station stopping patterns and service frequency. Low, medium, and high service option groups consider various stopping patterns such as express/limited service, all local service, and connecting bus service between Bellingham and Vancouver BC.

The highest service group only considers one option, defined as providing the highest number of roundtrips, stopping at all stations with full rail service to Vancouver BC.

The highest service option group includes a single option with the highest number of roundtrips and maximum number of station stops. This option was added based on the results of the initial ridership sensitivity analysis, which determined that ridership peaks at 16 round trips for Seattle-Portland.

Below are the groupings of service options**. Exhibit 2, Exhibit 3, Exhibit 4**, and **Exhibit 5** show the groupings of service options and provide a diagram for each service option.

Exhibit 2: Low Service Option Group

Service Option 1	
Service Option 2	
Service Option 3	
Service Option 4	

Local (All-Stops) Service
Limited Stop Service
Express Service
Thruway Bus Service
RT = Round Trip

EUG = Eugene
PDX = Portland
SEA = Seattle
BEL = Bellingham
VAC = Vancouver, BC

Exhibit 3: Medium Service Option Group

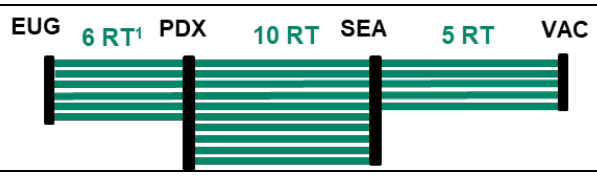
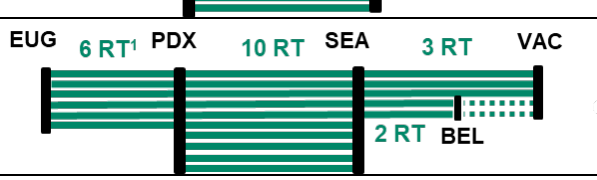
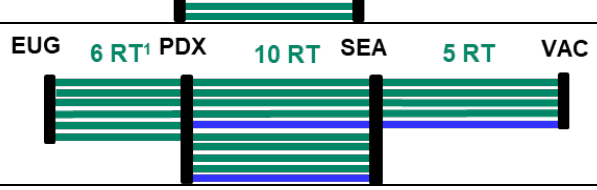
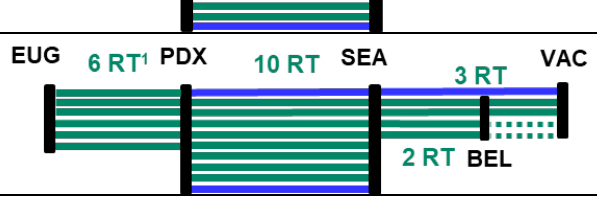
Service Option 5	
Service Option 6	
Service Option 7	
Service Option 8	

Exhibit 4: High Service Option Group

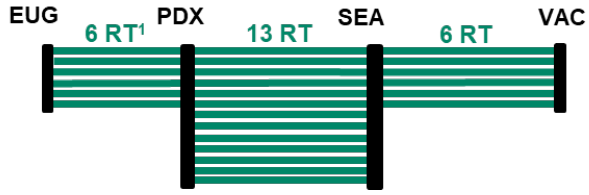
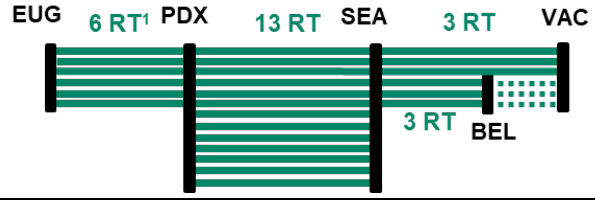
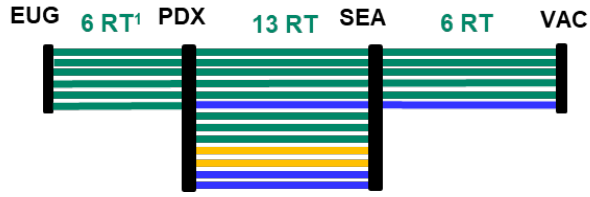
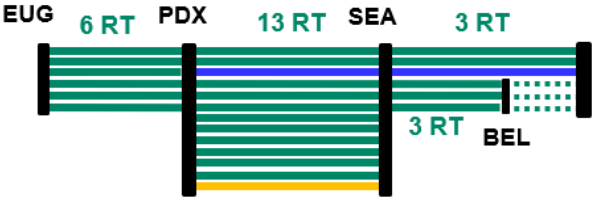
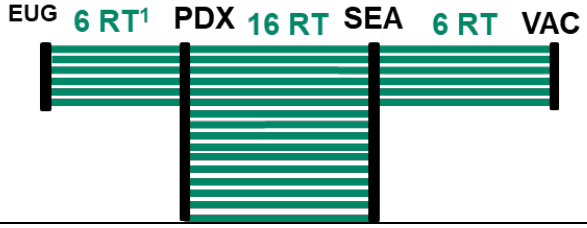
Service Option 9	
Service Option 10	
Service Option 11	
Service Option 12	

Exhibit 5: Highest Service Level Group

Service Option 13



Local (All-Stops) Service

EUG = Eugene
PDX = Portland
SEA = Seattle
BEL = Bellingham
VAC = Vancouver, BC
RT = Round Trip

Screening and evaluation results of service options

The service option screening analysis assessed 13 service options representing different combinations of service characteristics. The following process was employed for the service option screening:

- Develop five evaluation criteria based on the Preliminary Purpose and Need: high-level ridership growth[1], feasibility, multimodal connectivity, equity, and travel time improvements
- Evaluate and score each service option using these five criteria
- Choose at least one highest-scoring option from each service option group to advance as preliminary alternatives

The analysis looked at 13 service options representing different combinations of service characteristics, including covering a range of low, medium, and high service frequency increases. Each service option was evaluated and scored using initial, high-level ridership estimates, feasibility, travel time improvements, multimodal connectivity, and equity. The evaluation criteria and methods for scoring the service options are shown in **Exhibit 6**.

Exhibit 6: Evaluation criteria descriptions and measurement methods

Criteria	Description	Measurement method
 Ridership	Projected high-level ridership increases over baseline service	Quantitative measure based on % of ridership growth over baseline service. The total range of growth (%) for all service options was split evenly into five categories: Low, Low/Medium, Medium, Medium/High, and High. Each service option was assigned a category from its growth percentage result.
 Feasibility	Existing corridor constraints and magnitude of service improvements affect feasibility	Qualitative measure considering corridor constraints and magnitude of service improvements. Service options with higher frequencies are assumed to require more service improvements and therefore assigned lower feasibility rankings.
 Equity	Service options stopping at all existing stations provide more equitable access to Amtrak Cascades service	Qualitative measure based on the proportion of total daily skipped stations compared to local service. The total range of the proportion is split into five categories: Low, Low/Medium, Medium, Medium/High, and High. Service options with all local services were assigned a High ranking.

[1] These initial ridership estimates did not use the full ridership model for the service options. Given there were 13 initial service options to considered, the approach was to conduct what is referred to as “ridership sensitivity testing”, which provides initial estimates based on a simple approach. In lieu of fully developed timetables, runtimes used for the ridership sensitivity testing were determined through the utilization of train performance standards discussed in the “Evaluation of high-level operational considerations” section above. The purpose of this approach was to be one factor considered in the screening the long list of possible service options.

Criteria	Description	Measurement method
Multimodal Connectivity	Service options with higher frequency create more opportunities to use complementary transportation systems	Qualitative measure based on frequency of service. Multimodal connectivity is correlated to the frequency of service, with higher frequencies supporting increased multimodal use.
Travel Time Improvement	Service options with express and/or limited-stop service patterns provide travel time improvements compared to local service	Quantitative measure based on the proportion of Travel Time Savings through skipping station stops. The total range of the travel time improvement proportion for all service options was split evenly into five categories: Low, Low/Medium, Medium, Medium/High, and High. Service options with all local services were assigned a Low ranking.

WSDOT advanced at least one of the initial service options from each service option group. The one with the highest raw score was selected from each group, except the high group. The high group had three options with the same high score. From this group, two options were chosen to compare the effectiveness of limited and express trips with all-local service. Options 10 and 12 are the same except for this one difference.

The evaluation process resulted in identifying five service options, including one from the low service level group, one from the medium, two from the high, and one from the highest service level group. Those five are advanced for further operational, infrastructure and detailed ridership analysis. The screening results are documented in **Exhibit 7**, **Exhibit 8**, and **Exhibit 9**.

Exhibit 7: Scoring of low service increase options

Initial Service Option / Potential Evaluation Criteria	Service Option 1	Service Option 2	Service Option 3	Service Option 4
Ridership Growth	L (35%)	L (35%)	L (35%)	L (35%)
Implementation Feasibility	H	H	M	H
Multimodal Connectivity	L	L	L/M	L/M
Equity	M	M	L/M	L/M
Travel Time Improvement	L	L	L/M	L/M
Raw Score	**9**	**9**	**9**	**9.5**
Recommendation	**Eliminate**	**Eliminate**	**Eliminate**	**Advance**
Explanation				Highest scoring option from 'Low' service option group

Exhibit 8: Scoring of medium service increase options

Initial Service Option / Potential Evaluation Criteria	Service Option 5	Service Option 6	Service Option 7	Service Option 8
Ridership Growth	M (64%)	M (59%)	M (60%)	L/M (56%)
Implementation Feasibility	L/M	M/H	L/M	M/H
Multimodal Connectivity	M/H	M/H	M/H	M/H
Equity	H	H	L/M	L/M
Travel Time Improvement	L	L	M/H	M/H
Raw Score	**10**	**11**	**10**	**10.5**
Recommendation	**Eliminate**	**Advance**	**Eliminate**	**Eliminate**
Explanation		Highest scoring option from 'Medium' service option group		

Exhibit 9: Scoring of high and highest service option groups

Initial Service Option	High				Highest
Potential Evaluation Criteria	**Service Option 9**	**Service Option 10**	**Service Option 11**	**Service Option 12**	**Service Option 13**
Ridership Growth	M/H (89%)	M/H (82%)	M/H (83%)	M/H (82%)	H (99%)
Implementation Feasibility	L	L/M	L	L/M	L
Multimodal Connectivity	H	H	H	H	H
Equity	H	H	L	M	H
Travel Time Improvement	L	L	H	M	L
Raw Score	11	11	10.5	11	11
Recommendation	**Eliminate**	**Advance**	**Eliminate**	**Advance**	**Advance**
Explanation	Lower feasibility than Service Option 10 Six rail roundtrips for the northern segment is advanced by Service Option 13	Higher feasibility than Service Option 9 Provides a benchmark for further express & and limited-stop service pattern analysis in Service Option 12	The lowest scoring option from "High" service option group	Higher feasibility than Service Options 9 and 11 Provides travel time improvement over Service Options 9 and 10	Only option under the highest group

Ridership forecasting methodology

Ridership performance was based on the development of Amtrak Cascades ridership forecasts for Baseline Service and the five preliminary alternatives in 2045. The difference in ridership between the preliminary alternatives and Baseline Service indicated the ridership performance for each.

Model approach

WSDOT developed Amtrak Cascades ridership forecasts using AECOM's National Intercity Model. The model incorporates all major travel modes for passenger trips, including auto, air, bus, and rail. The ridership forecasting approach used a two-stage model system:

- The first stage forecasts the growth in the total number of person trips in each market
- The second stage (mode choice module) predicts the share of total person travel by each mode and produces a ridership forecast for Amtrak Cascades

The key markets are defined by geographical location (i.e., origin-destination zone pair). Both stages are dependent on the service characteristics of each mode and the socio-economic characteristics of the corridor.

The mode choice module uses the following key variables for auto, air, rail, and intercity bus modes to predict mode share:

- Travel time (minutes)
- Travel cost (dollars)
- Frequency (departures per day)

The mode choice model was calibrated to match the existing corridor by running the time, cost, and frequency characteristics of the existing Amtrak service, with current population, employment, and income data. The model parameters were then adjusted until the forecasted output corresponds with the actual ridership data.

Study area geography

The geographic area for ridership forecasting includes the entirety of the PNWRC between Eugene, OR and Vancouver, BC, to capture the overall market flows of riders using the Amtrak Cascades service throughout the PNWRC. This enables the project to capture the total ridership estimates for the entire route, including those traveling to/from Eugene, OR onto the Washington Segment.

A zonal system with 73 zones was developed for the study area and defined the geographic level of detail at which the intercity travel demand forecasting process was applied. The study area is shown in **Exhibit 10**, including the zone system, Amtrak rail stations, and airports. The model relies on the zone system to incorporate demographic data, represent travel demand between zones, and forecast trips between zones by mode.

The zone system was based on the county-level divisions for the consistency of the demographic data, with a few county-subdivision-level splits in more urban areas to ensure consistency in access/egress times, even demographic coverage, and small enough zones to avoid multiple rail stations in a single zone. The zone system covers all rail stations and airports and their service areas,

which have a minimum 25-mile buffer around the corridor. In addition, the study area extends further around the terminal rail stations since they often attract more passengers than intermediate stations.

Exhibit 10: Cascades Study Area (with zone system)

Key data input and assumptions

The baseline year was assumed to be 2019, and the model was calibrated to match 2019 Amtrak Cascades rail ridership corridor wide and at a station level, with a target of being within 5% of actual 2019 boardings at Portland Union Station, Seattle King Street Station, and Vancouver, BC Pacific Central Station. 2045 was selected as the forecast year.

Key data that were collected during model development include the following:

- Existing and future population, employment, and income data for counties in Oregon and Washington and for the metro area of Vancouver, BC. Population data for Washington state is from the state's Office of Financial Management. Employment and income data are from TranSight and were provided by WSDOT.
- 2019 service plans for Amtrak's Cascades, Coast Starlight, and Empire Builder services
- 2019 trip tables for auto, air, bus, and rail modes
    - Auto trips were compiled from Replica and StreetLight trip data.
    - Air trips were compiled from the Bureau of Transportation Statistics (BTS) DB1B Market database.
    - Bus trips were estimated using an FHWA study with estimates for intercity bus trips between major markets. Where service existed but no FHWA estimate was available, intercity bus trips were estimated by assuming the number of bus trips equal to a fraction of auto trips.
    - Rail trips were compiled from Amtrak rail ridership data for Cascades, Coast Starlight, and Empire Builder services.
- Fare data
    - Rail fares are based on Cascades ridership data provided by WSDOT. Air fares are based on BTS air trip data. Bus fares were pulled from bus operators' websites and used in a linear regression equation to estimate intercity bus fares.

Key model assumptions include the following:

- Air, bus, and long-distance rail (Coast Starlight and Empire Builder) service frequencies were assumed to remain constant over time.
- Future service assumption for Sounder commuter rail is consistent with 2020 Sounder South Strategic Development and Implementation Plan.
- Rail and bus terminal times were assumed to be 20 minutes. Air terminal times were assumed to be 120 minutes.
- The ridership modeling does not include Cascadia Hight Speed Rail because the alignment, station locations, and future service characteristics have not been determined.