System Planning and Plan Amendment Case Study Analysis

February 2022

Introduction

Metro and the Oregon Department of Transportation (ODOT) are working together to update the regional mobility policy and related mobility measures for the Portland metropolitan area. The goal of this update is to better align the policy and measures with the comprehensive set of shared regional values, goals, and desired outcomes identified in Metro's Regional Transportation Plan (RTP) and 2040 Growth Concept, as well as with local and state goals.

The policy also needs to be updated to better define expectations about mobility for different travel modes based on land use context and state and regional functional road classifications in the Oregon Highway Plan and RTP. The updated policy will describe the region's desired mobility outcomes and more thoroughly and explicitly define mobility for people and goods traveling through the transportation system in the Portland area.

The project team followed a four-step process to narrow a list of 38 mobility performance measures identified through a review of best practices to the 12 most promising. Based on further evaluation, eight of the 12 measures were advanced for testing through case study applications. Table 1 on the following page shows the eight measures tested through the case studies. These measures are further explored through case study applications included in this memorandum.

What we want to learn from the case studies:

1. How well does the measure help compare outcomes in Equity Focus Areas (EFAs) to other areas?
2. How sensitive is the measure to changes in land use?
3. How could measures that are not sensitive to land use changes be applied in plan amendments?
4. Does Metro's Dynamic Traffic Assignment (DTA) model identify different needs than the travel demand model at the system level? Does it offer significantly different post-processed intersection volumes?

Metro

OREGON DEPARTMENT OF TRANSPORTATION

Table 1. Mobility Measures Evaluated and Tested

Current mobility policy measure	**V/C Ratio**	The ratio of traffic volume to the capacity of a roadway link or intersection during a specified analysis period.
Vehicle-focused measures*	**Duration of Congestion**	Hours of congestion (HOC) is the number of hours within a time period, most often within a weekday, where a facility's congestion target (such as v/c ratio or acceptable speed) is exceeded or not met.
	Queuing	The extent of vehicles queued on intersection approach lanes, including on and off ramps, during a specified analysis period (typically a peak hour).
	Travel Speed	Average or a percentile speed between origin-destination pairs, during a specific time period.
	VMT/Capita	Compares the number of miles traveled by motorists within a specified time period and study area to the number residents or employees in the area. VMT/capita can indicate how much people who live and work in a study area must drive to meet their obligations and daily needs.
Multimodal measures	**Access to Destinations/ Opportunity** (all modes)	The number of essential destinations within a certain travel time or distance, by different modes.
	Bicycle Level of Traffic Stress (LTS)	Level of traffic stress (LTS) classifies points and segments on routes into different categories of stress ranging from 1 (low stress) to 4 (high stress) based on factors that correlate to the comfort and safety of the bicyclist or pedestrian using that facility.
	Pedestrian Crossing Index	The percent of a corridor or roadway segment meeting the pedestrian crossing target spacing.
	System Completion (all modes)	The percent of planned facilities that are built within a specified network or on a specified corridor/roadway segment.

*These measures impact travel by bus transit and may be able to evaluated for transit trips specifically, such as travel time and speed.

Question 1: How well does the measure help compare outcomes in Equity Focus Areas (EFAs) to other areas?

Answer:

Each of the measures allows equity focus areas to be compared with non-equity focus areas or to the area as a whole. The measures that are best for identifying disparities and prioritizing projects that address them are **access to destinations** and **system completeness**.

Question 2: How sensitive is the measure to changes in land use?

Answer:

The current measure (**V/C ratio**) and each of the vehicle-focused measures are sensitive to land use changes. When measured with the regional travel demand model, neither V/C ratio nor travel speed is very sensitive to small changes in land use; however, when the model volumes are post processed and applied at the intersection level, V/C ratio is very sensitive to small land use changes, especially in congested conditions. **Travel speed** can only be applied at the link level, so is slightly less sensitive to land use changes.

Access to destinations is sensitive to land use changes, but assessing whether a comprehensive plan amendment or zone change translates into increased access to destinations is difficult. The measure can tell you if an area has high access to destinations. In these areas, adding more people would increase the number of people with access. It can also tell you where residential areas are lacking in access because of a lack of transportation options, or if land use changes (such as adding more non-residential uses) would help increase access to destinations.

VMT/capita is sensitive to land use changes at the system level and is good for comparing different subareas. Small land use changes would not be reflected at the regional or even sub area level and could give misleading results if looked at for a single Transportation Analysis Zone (TAZ).

The multimodal measures including **bicycle level of transportation stress (BLTS)**, **pedestrian crossing index**, and **system completion** are not impacted by changes in land use although major changes in land use could change the desired roadway cross-sectional elements. Roadway volumes are used to determine BLTS for mixed traffic roadways only, and therefore is sensitive to land use changes in specific conditions.

Question 3: How could measures that are not sensitive to land use changes be applied in plan amendments?

Answer:

For a measure such as **system completion** that is not sensitive to land use changes, it could be applied to plan amendments as follows:

- Identify system gaps and deficiencies (all modes) impacted by the plan amendment.
- Determine whether the planned system is adequate considering bicycle and pedestrian access needs and desired crossing spacing and consider whether the proposed land use change is likely to increase access to destinations or reduce the area's VMT/capita.

Question 4:
Does Metro's Dynamic Traffic Assignment (DTA) model identify different needs than the travel demand model at the system level? Does it offer significantly different post-processed intersection volumes?

The DTA model is currently calibrated on a project-by-project basis. Calibration is important because the DTA model is capacity-constrained and assigns trips to network links based on congestion and volumes. When a link is reaching or at capacity, the model will no longer assign trips to that link and will instead assign trips along alternative routes or to the next analysis hour.

The regional travel demand model (RTDM), on the other hand, is not capacity-constrained. A link volume can exceed the link capacity. This can result in unrealistic forecast link volumes on major roadways during peak periods, when in reality many drivers will reroute their trip to avoid delays.

The DTA model is a more rigorous tool than the RTDM. It is currently most often used for corridor and subarea level analysis. The DTA model is currently set up for the AM and PM peak periods of the day only.

Based on a review of travel speed output within Oregon City for the 2015 base year and 2040 constrained networks, the DTA model shows less congested peak hours on major roadways. Comparing post-processed intersection volumes using the two models, volumes and queuing projections are less with the DTA model outputs compared to the RTDM outputs at the major intersections. Therefore, when intersection solutions are developed solely based on future intersection volumes developed from the RDTM, there is potential to overbuild solutions and even induce demand. Instead of focusing on minimizing delay at a specific intersection, potentially shifting a bottleneck downstream, it may be more useful to consider overall progression of a facility.

Fact Sheet

Congestion Measures

Travel speed, **V/C ratio**, and **queuing** are vehicle-focused measures that support reliability and efficiency outcomes. Current uses of the interim regional mobility policy rely heavily on V/C ratio to determine where congestion is unacceptable and to identify needed improvements and mitigations. It may be possible to use travel speed, V/C ratio, and queuing measures in tandem for peak period analysis, depending on the methodologies used and questions that need to be answered by the analysis.

			System Planning		Plan Amendments: Large-Scale/ Areawide		Plan Amendments: Small-Scale/Site-Specific	
	Current mobility policy measure	Evaluating Outcomes for Equity Focus Areas	Applying a Target to Identify Needs and Develop Plan	Setting Standard based on Plan	Show measurable impact (from added trips, any mode)	Identify mitigations if standard exceeded	Show measurable impact (from added trips, any mode)	Identify mitigations if standard exceeded
Vehicles	V/C Ratio	A	❚❚ ✚	❚❚ ✚	❚❚ ✚	❚❚ ✚	❚❚ ✚	❚❚ ✚
Vehicles	Duration of Congestion	A	❚❚ ✚	❚❚ ✚	❚❚ ✚	❚❚ ✚	❚❚ ✚[5]	❚❚ ✚
Vehicles	Queuing		❚❚[1] ✚	❚❚[1] ✚	❚❚[1] ✚	❚❚[1] ✚	❚❚[1] ✚	❚❚[1] ✚
Vehicles	Travel Speed	A	❚❚ ✚[2]	❚❚ ✚[2]	❚❚ ✚	❚❚ ✚[3]	❚❚[4] ✚[4]	❚❚[3] ✚[3]

❚❚ =Thruway ✚=Arterial/Collector

A. Measure can be evaluated and compared for different geographic areas related to concentrations of disadvantaged populations and can be used to evaluate equity.

1. Off-ramps only.

2. The target travel speed on arterials/collectors should have a maximum consistent with area context and the desired posted speed and a minimum threshold for congestion.

3. Intersection v/c ratio analysis can be used to help identify mitigations to improve travel speed.

4. Travel demand model or microsimulation can support the analysis but the impact may be very minimal.

5. Travel demand model or microsimulation can support the analysis but the impact will be negligible.

Case studies: what did we learn?

The study team applied congestion metrics through several case studies from regionwide reviews to subarea sensitivity testing. Key questions reviewed were whether the DTA model identifies different results, what differences occur when using different congestion measures, and how sensitive the measures are to land use changes.

Useful Findings

V/C ratio and travel speed show very similar locations and levels of congestion depending on the thresholds used. Travel speed is more relatable to the public for policy discussions, is consistent with how systems are managed, and switches to a target that cannot be inappropriately applied at the intersection level. Hours of congestion can be applied effectively with either V/C ratio or travel speed. This measure can be used to look at the severity of congested areas and help prioritize bottleneck improvements. It will need to be part of the policy, but it would only be sensitive to change at the system planning level or following major changes in roadway pricing or capacity. Lower travel speed targets would be needed for arterials than for throughways as a percentage of posted or free-flow speed given the presence of traffic signals. Signal delay results in average speeds below posted or free-flow speed, even in uncongested time periods.

Based on the case studies, the DTA model shows less congested peak hours on major roadways. Comparing post-processed intersection volumes using the two models, volumes and queuing projections are less with the DTA model outputs compared to the RTDM outputs at the major intersections.

When measured with the regional travel demand model and reported at the link level, neither V/C ratio nor travel speed are very sensitive to small changes in land use; however, when the model volumes are post processed and applied at the intersection level, V/C ratio is very sensitive to small land use changes, especially in congested conditions. Travel speed can only be applied at the link level, so is slightly less sensitive to land use changes.

Considerations for the mobility policy

If travel speed is used in the mobility policy, major considerations include:

What speed variable will be the denominator for determining a travel speed threshold?

Options include posted speed, free-flow speed and base link speed from the travel demand model.

- For this analysis, the base link speed from the 2015 travel demand model was used because it was a readily available output that could be easily incorporated into GIS-based calculations. Base link speed is not a measured or designated speed; it is an input that is part of the travel demand model. It is often close to or equal to the posted speed, but it can vary from the posted speed if needed to yield accurate travel times in calibration.
- Whichever speed variable is used, a dataset where the model output and the speed variable data have the same link segmentation will need to be created to simplify requests to Metro and/or the calculation process. Posted speed was not used for this analysis due to the effort required to match the two datasets for use in the calculations.

Key Takeaways

- Travel speed is relatable and consistent with facility management
- Travel speed reduces overemphasis/over design on long-term intersection operations
- Intersection v/c still has a place in planning and near-term mitigations
- Hours of Congestion will need to be considered in the policy for either congestion metric
- Queuing will need to be considered in the policy for either off-ramps only or for arterial intersections as well

How would thresholds be decided?

- 75 percent is currently used by ODOT for the Portland Region Traffic Performance Report (PRTPR) and Corridor Bottleneck Operations Study (CBOS).
- 75 percent may not make sense on roadways that are controlled (versus uncontrolled roadways such as freeways). Roadways that have more traffic control, such as signals and roundabouts, will experience more delay and slower speeds. Thresholds or targets would need to take that into consideration. Potentially using a threshold based on measured speeds (like average travel speed for the link) would provide a realistic base for developing a threshold.
- 75 percent may not make sense for roadways that have low posted speeds (or base link speeds). Minor variations of travel speed (such as a change in 2 mph) would show large percentage changes.

Guidance would need to be developed related to calibration and validation of Metro models in relation to speed if it is going to be used as a measure with a target.

Currently, most of the speed-related measures are used for relative comparisons between various alternatives, not as a measure against a target.

Metro modeling staff notes that there is some calibration related to travel times, which has a direct relationship to travel speeds. The base year link speeds are generally set to yield accurate travel times in calibration. Horizon year speeds may be adjusted when speed changes are known or expected in future year models.

Should the DTA model be used for congestion-based metrics?

Overall, the DTA model provides volumes that are more spread out on the system and likely more realistic for peak travel periods, decreasing volumes on throughways that are congested and adding volumes to parallel arterial routes. Similar to in-the-field conditions, the DTA theoretically never has a V/C ratio greater than 1.0, which would help with target and threshold setting. The RTDM will assign trips to a link even if it is at or over capacity already, which is not possible on the ground.

Although more realistic, Metro does not have a regional DTA. It would take significant time and resources to develop and calibrate the DTA for each area of the region.

It is unclear if there is any feedback to MetroScope/land use and demographic allocation with the current DTA model. The entire region would need to be covered by a DTA model to get that type of feedback into the regional MetroScope and land use tools.

The region's agencies may have other tools like HERS, Fixit, RITIS, etc. that would be more useful for considering land use changes.

If V/C ratio is used in the mobility policy, major considerations include:

- The comparison of post-processed volumes from the RTDM model and the DTA model confirm that volumes from the RTDM are likely to be overestimated in congested areas and could result in overbuilt solutions that induce demand. Consideration should be given to specifying the use of DTA for intersection analysis for plan amendments where the targets are applied as standards to ODOT facilities. Alternatively, an adjustment could be made to the V/C targets or an adjustment could be made to the forecast traffic volumes when a DTA model is not available.

Questions for Stakeholders

- Which measure should be used for congestion, and should it be applied to arterials in addition to throughways?
- If so, should it be applied to all arterials or just those outside of 2040 centers?
- What thresholds/targets should be applied based on the measure selected?

Fact Sheet

Efficiency Measures

Both **VMT per capita** and **access to destinations/opportunity** reflect how well the land use and transportation systems are coordinated and work together, and both respond to the same types of changes in those systems. Neither of these measures evaluates how well the transportation system itself operates.

		System Planning		Plan Amendments: Large-Scale/ Areawide		Plan Amendments: Small-Scale/Site-Specific	
	Evaluating Outcomes for Equity Focus Areas	Applying a Target to Identify Needs and Develop Plan	Setting Standard based on Plan	Show measurable impact (from added trips, any mode)	Identify mitigations if standard exceeded	Show measurable impact (from added trips, any mode)	Identify mitigations if standard exceeded
VMT/Capita[11]	AB	●	●	●	●[1]	Caution[4]	●[5]
Access to Destinations[11]	AB	●	●	●[2]	●[3]	●[2]	●[3]

● =Area

A. Measure can be evaluated and compared for different geographic areas related to concentrations of disadvantaged populations and can be used to evaluate equity.

B. Measure relates to increased access to non-auto modes which are accessible to people without access to vehicles.

1. Mitigations would need to be changes in land use or significant travel demand management (TDM) measures

2. Land use changes would increase or decrease the number of destinations that are accessible but not how far the area of accessibility is

3. Mitigations would need to be changes in land use or significant changes in the transportation network.

4. When looked at in a localized area, VMT/capita may increase for the localized area while contributing to lower VMT/capita for the jurisdiction. This would occur if the projected VMT/capita for the localized area were projected to be below the jurisdiction's average. It would indicate that increased development in that area is more efficient than other areas.

5. Mitigations would need to be changes in land use or land use intensity which may not be effective based on the land use patterns and surrounding transportation network. If not effective, would need to mitigate with TDM or TSMO.

Case studies: what did we learn?

VMT/capita metrics for land use subareas were compared to regional and citywide averages and to the current Oregon Transportation Planning Rule (TPR), which targets a VMT/capita reduction of 5 percent and requires that new plans increase VMT/capita by no more than 5 percent. Proposed updates to the TPR may require further reductions in VMT/capita.

VMT/Capita

Whether measured using a ratio metric (VMT/capita and VMT/employee) or a rate metric (Home-based VMT/capita and Commute VMT/employee), VMT/capita is projected to decline from 2015 to 2040 in greater Portland and in several plan areas. Where VMT/capita is

VMT/Capita...

- Can be modeled and forecasted, showing if the planned land use and transportation systems are moving in the right direction, more efficient to serve
- Demonstrates if planned land use changes result in less vehicle travel
- Can show incremental improvements

projected to increase, those increases are small (less than 5 percent) and in conformance with TPR guidance that cities should limit VMT/capita growth to 5 percent or less. The variation between VMT/capita results can be attributed to increasing the availability of non-driving travel options and increased density and mixing of land uses.

The sensitivity testing conducted in the Colwood and South Hillsboro plan amendment study areas indicates that VMT/capita metrics are reliably responsive to modeled land use changes. In-depth sensitivity testing to evaluate how different infrastructure packages would affect these metrics has not been completed.

The 2018 RTP evaluated VMT/capita and VMT/employee for multiple scenarios; however, the small differences between the fiscally-constrained and strategic scenarios indicates that either VMT/capita is not particularly sensitive to infrastructure changes alone or that the strategic infrastructure package includes elements that would both reduce and increase VMT/capita.

Access to destinations/opportunity

Access to destinations/opportunity can be estimated with great accuracy and precision for existing conditions and with much less accuracy and precision for future (forecasted) conditions. Metro's travel model includes forecasts for jobs and population growth, but does not forecast changes in the locations of community destinations. Analysts must either make assumptions about the future locations of community destinations or assume they will not change over the next 10-20 years.

Travel times by different modes, which are inputs to the measure, can be estimated with great accuracy for existing conditions but not for forecasted conditions, due to how the model estimates transit travel time and its relatively coarse assessment of traffic congestion. The 2018 RTP found that the travel demand model is limited in its ability to evaluate walking and bicycling modes, due to the model's scale of analysis and assumptions about travel behavior. Therefore, while access to destinations/opportunity can be accurately evaluated for walking and bicycling under existing conditions, it cannot be accurately evaluated under forecasted conditions.

Key Takeaways

Regional Transportation Plan

- All scenarios have decreases in average VMT/capita but none achieve the 10 percent target.
  - No-Build: -1.2%
  - Constrained: -4.0%
  - Strategic: -4.0%

Central City MMA

- Home-based VMT/capita of 4.2 compared to 11.0 in region overall
- Able to double population and jobs with minimal increase in VMT/capita
- Able to reduce VMT/employee by 72 percent

Oregon City MMA

- VMT/employee increases by 1.8 percent for the subarea; Oregon City increases by more than 2 percent (conforming to the TPR requirement that new plans not increase VMT/capita by more than 5 percent)

South Hillsboro Community Plan

- Despite the plan area's pedestrian-oriented design and mixed-use town center land uses, people living in South Hillsboro (10.9) would generate more VMT/capita than all residents of Hillsboro (8.5), at an amount close to the Metro Region average (10.5). This demonstrates that infill is more efficient than urban growth areas. This indicates that infill development can support more efficient vehicle travel than development in urban growth areas.
- People working in South Hillsboro (9.2) would generate VMT/employee close to the Metro Region average (9.5) and lower than the Hillsboro average (10.7). This demonstrates the benefit of adding more housing to support Hillsboro jobs.

Useful Findings

TSPs and comprehensive plans collectively can reduce VMT/capita; however, the contributions of specific projects are challenging to measure when considered individually.

When looked at in a localized area, VMT/capita may increase for the localized area while contributing to lower VMT/capita for the jurisdiction as a whole. This would occur if the projected VMT/capita for the localized area were projected to be below the jurisdiction's average. It would indicate that increased development in that area is more efficient than in other areas.

The case studies indicate VMT/capita can be applied at the system planning level and for larger land use changes. For smaller scales, the measure should be used with caution when an increase results in a potential reduction for the larger area, as described above.

The measure is not sensitive to small transportation changes and can show increased VMT/capita when evaluating individual capacity-increasing projects that may be needed to support efficient development.

Access to destinations can be applied at the regional level, but is challenging to apply at the local jurisdiction or subarea plan levels because it requires staff with specialized skills and access to detailed datasets and spatial analysis tools. The measure can also be challenging when evaluating land use and zoning changes in small areas, since the eventual outcomes of zoning changes can be hard to predict.

Considerations for the mobility policy

Both VMT/capita and access to destinations/opportunity reflect the efficiency of land use and travel, and how well land use and the transportation system are coordinated to reduce reliance on the automobile. Of the two, VMT/capita can be evaluated in congruent ways for both existing and future conditions, and can be evaluated for multiple scales, from plan amendments to regional evaluations.

VMT/capita could be applied through the regional mobility policy using the following approach:

- Apply VMT/capita as a primary system performance measure alongside performance measures that evaluate both system operations and system completeness. VMT/capita can be applied in the following ways:
  - » **Identifying system needs and system adequacy during system planning:** For TSPs and large subarea plans, forecasted VMT/capita can be compared to existing conditions to determine if land use changes or improvements to multimodal access are needed or would help to reduce VMT/capita.
  - » **Evaluating the transportation/mobility impacts of land use decisions in plan amendments:** For TSPs and large subarea plans, forecasted VMT/capita can be compared to the existing condition to determine if the plan amendment would result in a reduction in VMT/capita or an increase, which could have a negative impact that requires mitigation or changes to the plan.
  - » **Evaluating mitigations when a threshold of significance is exceeded:** For system planning and subarea planning, Metro's TDM can be used to evaluate the VMT/capita differences between plan alternatives with different levels of land use density and mix of land uses.

Access to destinations/opportunity could still be used as a planning tool, especially when:

- Planning networks for specific travel modes, to ensure they meet community needs;
- Evaluating alternative land use and transportation scenarios in a comprehensive plan; and
- Measuring overall system usefulness for different populations within greater Portland.

Questions for Stakeholders

- Should VMT/capita be incorporated into the mobility policy to ensure that all plans and plan amendments contribute to reaching the regional target?
- If so, should the thresholds/targets be consistent with the TPR targets for Metro?*

*Note: Proposed updates to the TRP to include Climate-Friendly and Equitable Communities (CFEC) may include VMT/capita reduction targets.

Multimodal Measures

The measures evaluated in the case studies to help assess the multimodal system and its safety and comfort for all users included **system completion**, **bicycle level of traffic stress (BLTS)**, and **pedestrian crossing index**. These measures support equity, access, safety, efficiency and options.

		System Planning		Plan Amendments: Large-Scale/ Areawide		Plan Amendments: Small-Scale/Site-Specific	
	Evaluating Outcomes for Equity Focus Areas	Applying a Target to Identify Needs and Develop Plan	Setting Standard based on Plan	Show measurable impact (from added trips, any mode)	Identify mitigations if standard exceeded	Show measurable impact (from added trips, any mode)	Identify mitigations if standard exceeded
LTS	AB	+	+	+[1]	+[1]	NO	NO
Ped. Crossing Index	AB	+	+	+[2]	+	+[2]	+
System Completion	AB	II +	II +	+[3]	+	+[3]	+

II =Thruway + =Arterial/Collector

A. Measure can be evaluated and compared for different geographic areas related to concentrations of disadvantaged populations and can be used to evaluate equity.

B. Measure relates to increased access to non-auto modes which are accessible to people without access to vehicles.

1. Only sensitive to large changes in volumes or looking at access to LTS routes

2. Can document impact on warrants for a protected crossing

3. Can document impact on signal warrants, and number of trips added to system by mode, and if they are impacting an incomplete mode, but difficult to calculate their impact or proportionate share

Case studies: what did we learn?

LTS

LTS analyses most often use a target of 2, which is the minimum LTS level that will encourage most of the potential bike-riding population to consider riding. A BLTS 2 target can be difficult to meet, especially on high-speed roadways. Most local system planning does not attempt to meet a BLTS 2 on all non-freeway throughways and arterials because it is cost-prohibitive. Often, completing the system is prioritized over creating a fully low-stress system. However, many system plans do identify a portion of their bicycle network that is intended to be low stress.

Pedestrian Crossing Index

Metro does not currently have a full pedestrian crossing dataset, but there is an Open Street Maps (OSM) dataset that can be accessed. The OSM dataset is a useful first step toward creating a full pedestrian crossing dataset for the region. It will take significant effort to update the data to be usable for regionwide and subarea analyses, including determining completeness of the dataset and updating or creating attributes. Attributes that are necessary or desirable include roadway ID for the street that is crossed, milepoint of the crossing, roadway classification that is linked to target setting (i.e., regional design classification), and type of crossing (e.g., marked, signalized, enhanced).

ODOT has a pedestrian crossing inventory for their roadways and has a process and script for calculating the pedestrian crossing index. ODOT's methodology is not easily applied to the OSM data because the script requires an identified set of study roadways. The case studies used a manual process, but if pedestrian crossing index is moved forward as a measure for the RMP, a script similar to ODOT's could be created to streamline the process. Additional effort will also be needed to update the OSM dataset to include the street crossed and identify the target spacing for each roadway using Metro's *Designing Livable Streets and Trails Guide* and ODOT's *Blueprint for Urban Design.*

System Completion

The system completion measure can be used in system planning in several ways, including:

- **Establishing the planned system:** An outcome of system planning is creating a vision for the future transportation system, most often by mode or service. These planned networks become the base for the system completion calculation. Once there is a planned regional or local network established through system planning, future plan amendments, developments, and projects can determine whether the networks are helping further the completion of the planned system. Targets for completion of the planned system can be set, evaluated and monitored over time.
- **Comparing alternatives:** Once they have envisioned the overall planned system, many agencies find they will be unlikely to be able to acquire the funding to fill all the gaps in the system. Determining the system completion of a fiscally constrained system can show the need for additional funding for completing the multimodal networks.

Useful Findings

Bicycle Level of Traffic Stress

Setting a low-stress target for all roads or certain roadway classifications (arterials, for example) is not practical to achieve. However, BLTS is a tool that should be used to identify a network of low-stress routes (current and future) that connect as many destinations as possible with low-stress routes. The low-stress designation can be part of the system completion assessment for those routes.

Pedestrian Crossing Index

Applying the pedestrian crossing index using spacing targets from the *Livable Streets Guide* and *Blueprint for Urban Design* is useful for identifying areas potentially in need of additional crossings; however, a facility-specific target should be set through local planning. This target could then be used as part of an assessment of system completion.

Key Takeaways

- Complete system definition should be set through system planning and include lanes, turn lane policy, bicycle, pedestrian, transit and TSMO/TDM components
- Setting a low-stress target for all roads or certain roadway classifications (arterials, for example) is not practical to achieve
- Crossing spacing targets and LTS should be used to plan the complete system

System Completeness

System completeness can be used to identify needs, but the term "complete" needs to be defined through system planning. The definition should include level of street connectivity, future number of through travel lanes, policy on turn lanes, type and locations of planned bicycle and pedestrian facilities, target pedestrian crossing spacing, type and location of planned transit facilities and service and TSMO/TDM plan elements.

The definition of "complete" will vary based on modal functional classification and design classification, and can be refined by facility in system plans.

Considerations for the mobility policy

In planning modal networks and identifying transportation projects that enhance the comfort and safety of the multimodal network for all users, the following could be considered:

- Define the complete walking and biking networks that maximize access to destinations with low-stress routes and address disparities in EFAs.
- Identify locations where lack of safe crossings is limiting access to destinations for people walking, biking and riding transit. Set spacing targets for each facility based on the changing land use context.

- Identify high-priority locations for additional or enhanced crossings that connect low-stress walking and biking routes and provide access to transit or that are in high-crash locations.
- For the vehicle network, identify the number of through lanes and turn lanes or merge lanes (if applicable) that will be considered the maximum cross-section within the planning horizon. Identify strategies such as demand management, congestion pricing, complete non-auto modal networks, and land use changes to ensure access and mobility in the area.
- Metro and local agencies will set the planned system by planning modal and service networks. Some or all of the following could be included in the system completeness evaluation:
  - » Pedestrian, which could include planned crossings based on pedestrian crossing index
  - » Bicycle, which could include a low-stress network based on bicycle LTS
  - » Transit
  - » Vehicle, which could build off policies in Chapter 3 of the RTP, such as street connectivity/spacing and maximum number of through lanes
  - » TSMO
  - » TDM

Once a complete system is defined, evaluation of land use plan amendments should focus on whether the amendment changes the definition of the complete system for the facilities in the plan area.

Questions for Stakeholders

- Which measure(s) should be incorporated into the mobility policy?
- If only system completeness is included in the policy, should any guidance be provided about the use of pedestrian crossing index and/or bicycle level of traffic stress?

Attachment A: Supporting Materials

Memo

Oregon Department of Transportation

Metro

600 NE Grand Ave.
Portland, OR 97232-2736

Date:	February 7, 2022
To:	Kim Ellis, Metro, and Lidwien Rahman, ODOT
From:	Susan Wright, PE and Molly McCormick, Kittelson & Associates, Inc. Sarah Peters, Fehr & Peers
Project:	Regional Mobility Policy Update
Subject:	Task 7.1 and 7.2: System Planning and Plan Amendment Case Study Analysis - **DRAFT**

INTRODUCTION

Metro and the Oregon Department of Transportation (ODOT) are working together to update the regional mobility policy and related mobility measures for the Portland metropolitan area. The goal of this update is to better align the policy and measures with the comprehensive set of shared regional values, goals, and desired outcomes identified in Metro's Regional Transportation Plan (RTP) and 2040 Growth Concept, as well as with local and state goals.

There is also a need to update the mobility policy to better define expectations about mobility for different travel modes based on land use context and state and regional functional classification(s) of roads in the Oregon Highway Plan and RTP. The updated policy will describe the region's desired mobility outcomes and more robustly and explicitly define mobility for people and goods using the transportation system in the Portland area.

The project team followed a four-step process to narrow a list of 38 mobility performance measures identified through a review of best practices to the 12 most promising. Based on further evaluation, 8 of the measures were advanced for testing through case study applications. Table 1 shows the 8 measures tested through the case studies.

Table 1. Mobility Measures Being Evaluated and Tested

Current Mobility Policy Measure	V/C Ratio	The ratio of traffic volume to the capacity of a roadway link or intersection during a specified analysis period.
Vehicle Focused Measures	Duration of Congestion	Hours of congestion (HOC) is the number of hours within a time period, most often within a weekday, where a facility's congestion target (such as v/c ratio or acceptable speed) is exceeded or not met.
	Queuing	The extent of vehicles queued on intersection approach lanes, including on and off ramps, during a specified analysis period (typically a peak hour).

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	Travel Speed	Average or a percentile speed for a network segment or between key origin-destination pairs, during a specific time period.
	VMT/Capita	Compares the number of vehicle miles traveled by motorists within a specified period and study area to the number of residents or employees in the area. VMT/capita can indicate how much people drive to meet their obligations and daily needs, and can be evaluated for specific types of travel, such as home-to-work commutes.
Multi-modal Measures	Access to Destinations/Opportunities	The number of essential destinations (such as jobs, schools, services, etc.) within a certain travel time or distance, by different travel modes.
	Level of Traffic Stress (LTS)	Level of traffic stress (LTS) classifies points and segments on routes into different categories of stress ranging from 1 (low stress) to 4 (high stress) based on factors that correlate to the comfort and safety of the bicyclist or pedestrian using that facility.
	Pedestrian Crossing Index	The percent of a corridor or roadway segment meeting the pedestrian crossing target spacing.
	System Completion	The percent of planned facilities that are built within a specified network or on a specified corridor/roadway segment.

The measures outlined above are further explored through case study applications included in this memorandum. What we want to learn from the case studies includes:

- How well does the measure help compare outcomes in Equity Focus Areas (EFAs) to other areas?
- How sensitive is the measure to changes in land use?
- How could measures that are not sensitive to land use changes be applied in plan amendments?
- Does Metro's Dynamic Traffic Assignment (DTA) model identify different needs than the travel demand model at the system level?
- Does the DTA model result in significantly different post-processed intersection volumes for use at the intersection level?

Travel Speed, V/C Ratio, and Queuing

Travel speed is the average or a percentile speed for a network segment or between key origin-destination pairs, during a specific time period.

Volume to capacity ratio (v/c) is the ratio of traffic volume to the capacity of a roadway link or intersection during a specified analysis period.

Queuing is the extent of vehicles queued on intersection approach lanes, including on and off ramps, during a specified analysis period (typically a peak hour).

Travel speed, v/c ratio, and queuing measures are vehicle-focused measures that support reliability and efficiency outcomes. Current uses of the interim regional mobility policy relies heavily on v/c ratio to determine where congestion is unacceptable and to identify improvements and mitigations. Travel speed, v/c ratio, and queuing measures may be able to be used in tandem for peak period analysis depending on the methodologies used and questions that need to be answered by the analysis. The project team explored the following questions for these measures, as summarized in the following sections:

- For travel speed thresholds, does the DTA model identify different needs than the travel demand model at the system level?
- Does the DTA model result in significantly different post-processed intersection volumes for use at the intersection level?
- Do different definitions of “congestion” identify different needs at the system level?
- How sensitive are the model outputs to changes in land use?

Does the DTA model identify different needs than the travel demand model at the system level?

One question that the project team explored was whether investing the time and effort to calibrate a region-wide Dynamic Traffic Assignment (DTA) model would be beneficial to identifying regional needs and developing the RTP. The DTA model is currently calibrated based on a project-by-project basis. For example, the Oregon City subarea was calibrated as part of another project in the region, which is why this section focuses on that subarea. Calibration is important because the DTA model is a capacity-constrained model that assigns trips to network links based on congestion and volumes. When a link is reaching or is at capacity, the model will no longer assign trips to that link and will instead assign trips along alternative routes or to the next analysis hour. The link volumes should never exceed the link capacity. The regional travel demand model (RTDM), on the other hand, is not capacity constrained. A link volume can exceed the link capacity. This can result in unrealistic forecast link volumes on major roadways during peak periods when in reality many drivers will reroute their trip to avoid delays.

As noted by Metro modeling staff, the DTA model is a more rigorous tool than the RTDM and currently most often used for corridor and subarea level analysis. In addition, the DTA model is currently set up for the AM and PM peak periods of the day only. Although the trip assignments are more realistic in the DTA model than the RTDM for the peak periods, link volumes are fairly similar between the two models during non-congested time periods.

With pros and cons to both models, the project team reviewed travel speed output within Oregon City for the 2015 base year and 2040 constrained networks. Figures 1 through 4 compare the DTA and RTDM output by showing if each link is congested for one or two hours within the AM or PM peak period. DTA output is represented by the thicker lines and RTDM by the thinner lines. “Congested” is defined in this exercise as when a link travel speed is less than 75 percent of the base link speed. The base link speed is often, but not always, similar to the posted speed limit .

Figure 1. Congestion (Travel Speed Threshold) Oregon City – 2015 Base Year AM Peak Period

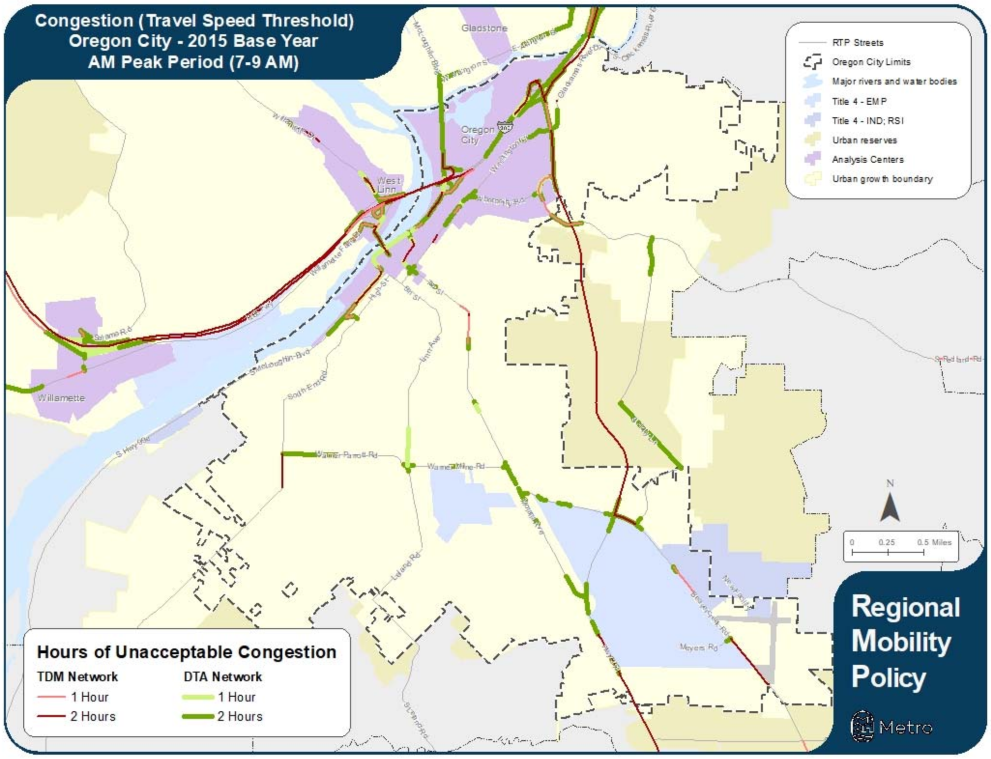


Figure 2. Congestion (Travel Speed Threshold) Oregon City – 2015 Base Year PM Peak Period

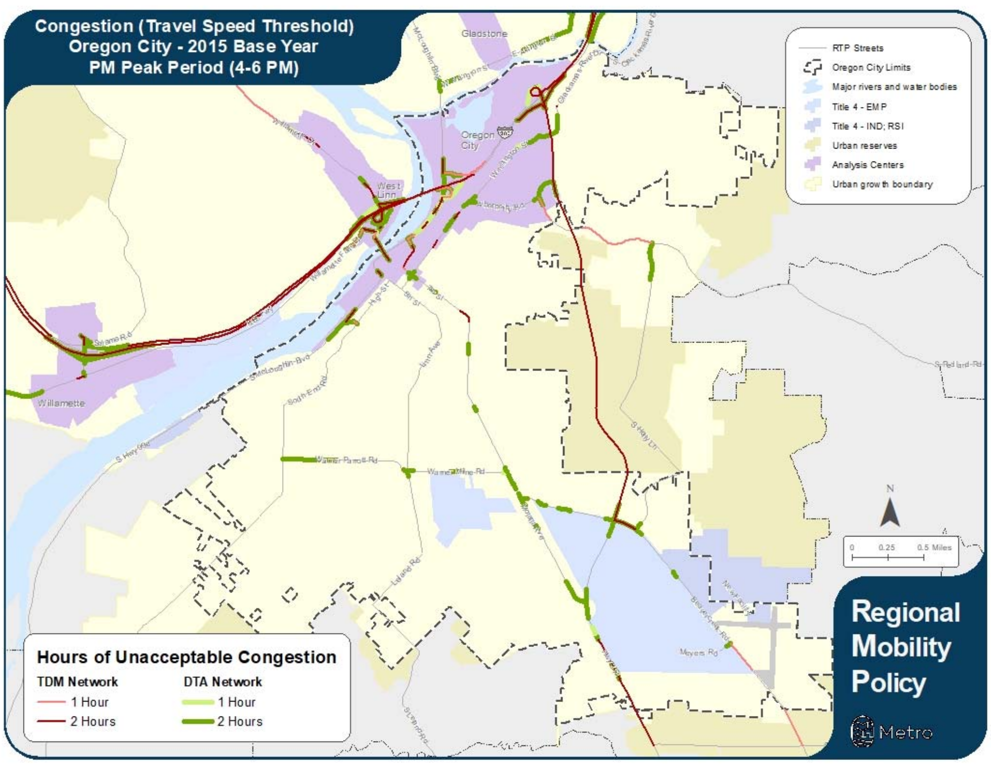


Figure 3. Congestion (Travel Speed Threshold) Oregon City – 2040 Constrained AM Peak Period

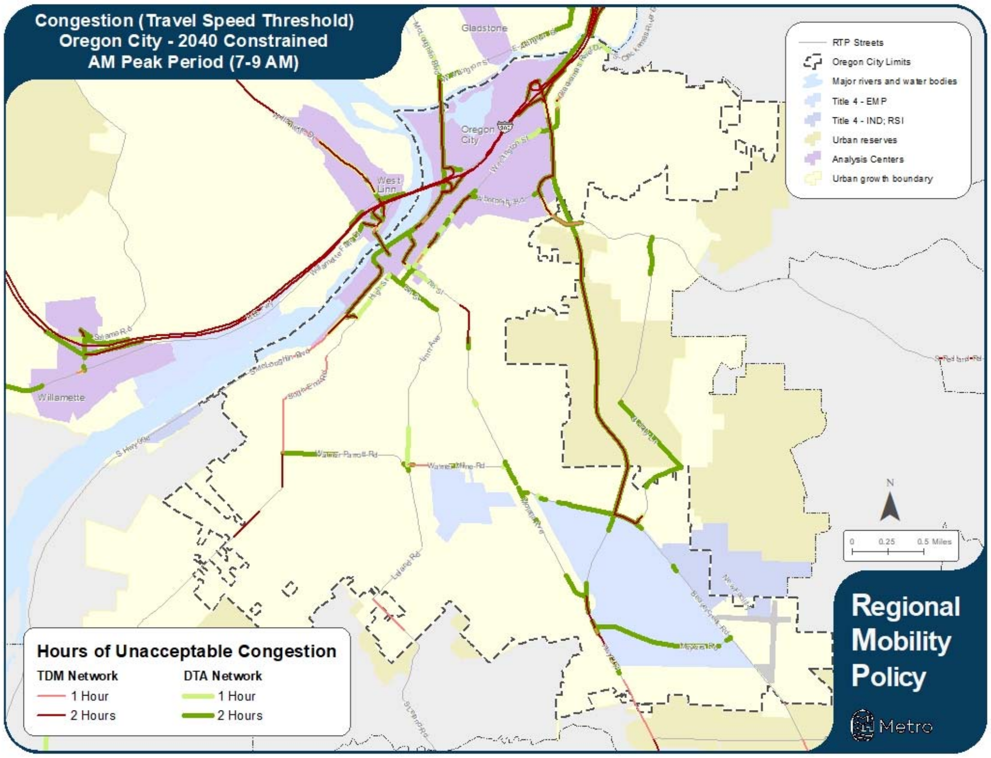
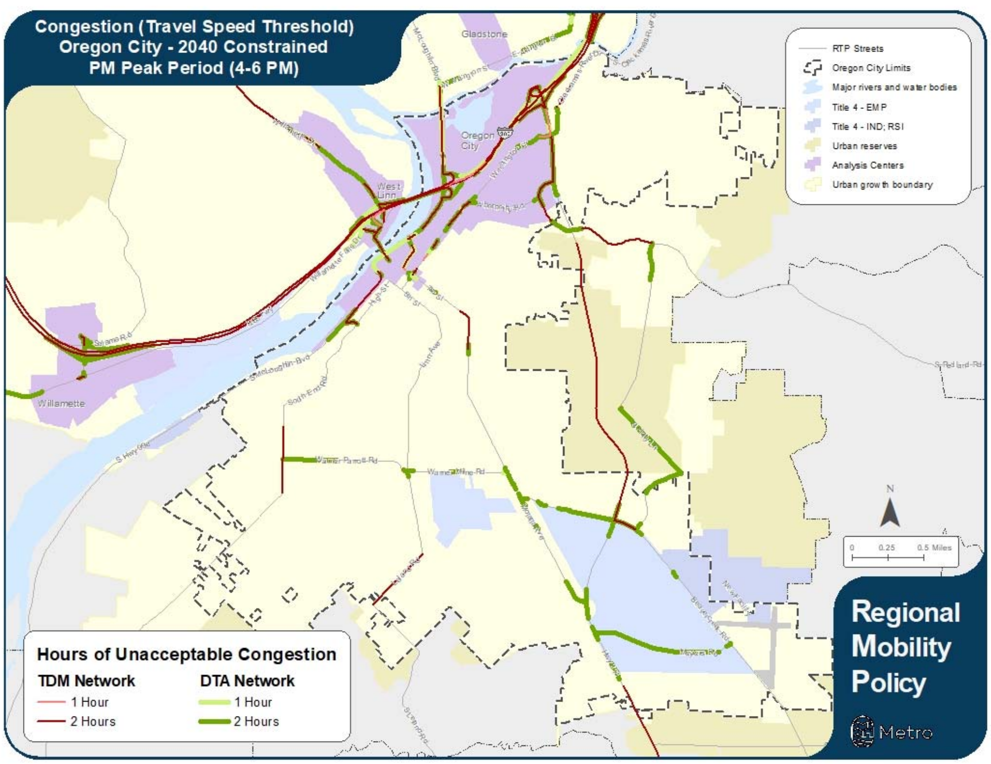


Figure 4. Congestion (Travel Speed Threshold) Oregon City – 2040 Constrained PM Peak Period



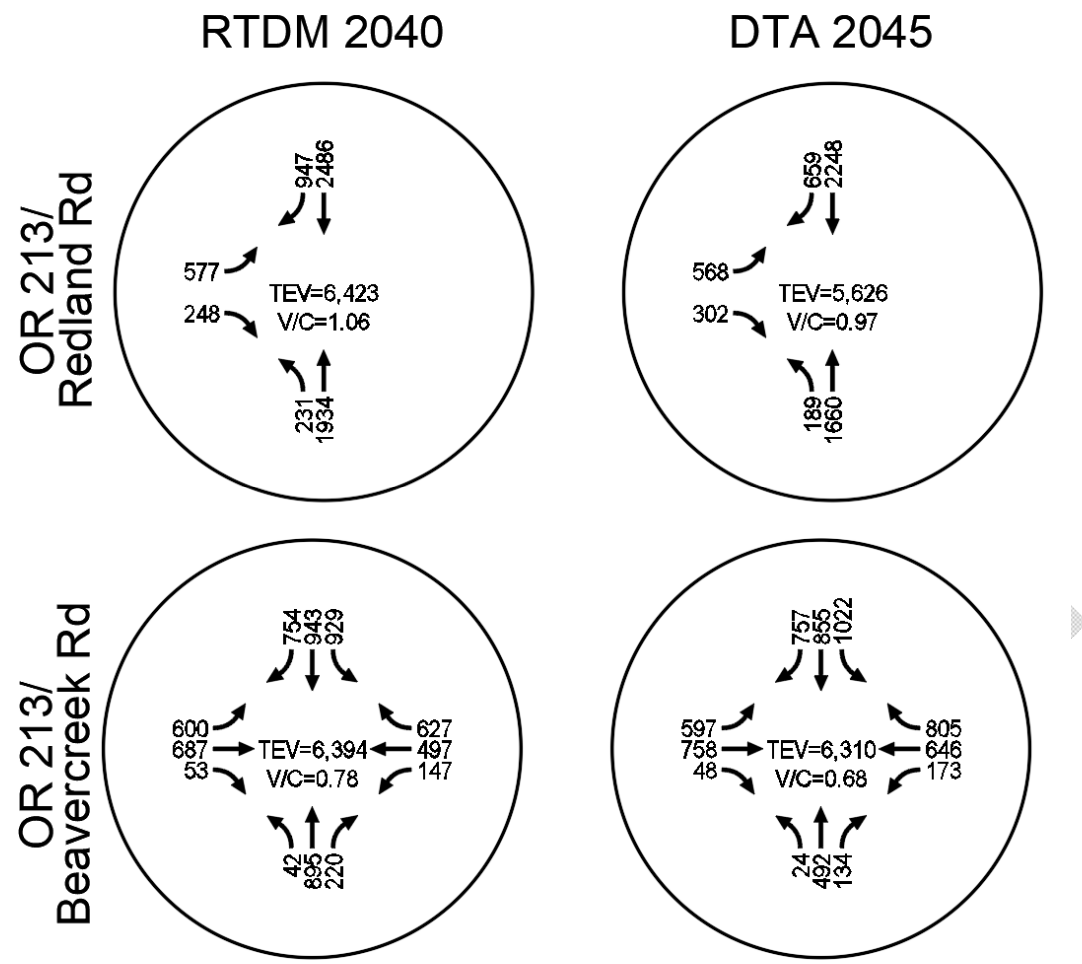
The DTA model shows less congested peak hours on major roadways and more congested hours on parallel routes. For example, the 2040 constrained PM peak period figure shows I-205 as congested for the two analysis hours based on RTDM output, where the DTA output shows segments between the ramps operating at an acceptable travel speed for one or two of the analysis hours. Based on RTDM output, OR 213 is also shown as congested for two hours with adjacent Holly Lane-Maplelane Road operating acceptably. The DTA output suggests that OR 213 operates acceptably and segments of the alternative route are congested for the two analysis hours.

Does the DTA model result in significantly different post-processed intersection volumes for use at the intersection level?

Model link volumes from the RTDM (base 2015 and future 2040) and DTA (base 2015 and future 2045) were used to develop future year turning movement counts at the two study intersections analyzed in the OR 213 Alternative Mobility Target case study: OR 213/Beavercreek Road and OR 213/Redland Road. In addition to link volumes, existing 2017 traffic counts from the case study were also utilized. The forecast traffic volumes were developed by applying the post-processing methodology presented in the National Cooperative Highway Research Program (NCHRP) Report 255 Highway Traffic Data for Urbanized Area Project Planning and Design.

The intersection operations analysis was conducted using Synchro 10, which is a software tool designed to assist with operations analyses in accordance with Highway Capacity Manual 6th Edition (HCM 6) methodologies. Because Synchro 10 does not report overall intersection v/c ratios, the overall intersection v/c ratios were hand-calculated in accordance with the methodologies outlined in ODOT's Analysis Procedures Manual (APM). Exhibit 1 summarizes the results of the intersection operations analysis. Attachment A contains the operations analysis worksheets.

Exhibit 1. Comparison of Regional Travel Demand Model and Dynamic Traffic Assignment Model Post-processed Future Volumes and Intersection V/C Ratios



TEV = Total entering volume

A queuing analysis was also conducted at the signalized study intersections using Synchro 10. Table 2 summarizes the 95th percentile queues during the weekday PM peak hour. Attachment A contains the queuing analysis worksheets.

Table 2. Comparison of Regional Travel Demand Model and Dynamic Traffic Assignment Model Post-processed Future Volumes and 95th Percentile Queues

Intersection	Movement	Volume			Queuing		
		RTDM	DTA	Difference	RTDM	DTA	Difference
OR 213/ Beavercreek Road	EBL	600	597	-3	450	448	-2
	EBT	687	758	71	372	413	41
	EBR	53	48	-5			
	WBL	147	173	26	136	167	31
	WBT	497	646	149	286	380	94
	WBR	627	805	178	488	842	354
	NBL	42	24	-18	92	56	-36

	NBT	895	492	-403	679	296	-383
	NBR	220	134	-86	114	20	-94
	SBL	929	1022	93	639	738	99
	SBT	943	855	-88	445	393	-52
	SBR	754	757	3	426	431	5
OR 213/ Redland Road	EBL	577	568	-9	529	519	-10
	EBR	248	302	54	321	429	108
	NBL	231	189	-42	496	398	-98
	NBT	1934	1660	-274	351	258	-93
	SBT	2486	2248	-238	1421	954	-467
	SBR	947	659	-288	351	150	-201

in Table 2, the largest volume and queuing reductions when using the DTA model instead of the RTDM are seen on OR 213, which is a primary north-south route. This aligns with the DTA methodology that reroutes trips onto alternative routes when users begin to experience delay due to high volumes.

Finding: When intersection solutions are developed solely based on future post-processed volumes, there is potential to overbuild solutions and even induce demand. Instead of focusing on minimizing delay at one spot location, it may be more useful to consider overall progression of a facility. There are locations where a spot treatment only shifts a bottleneck to the next intersection.

Note About Post-Processed Intersection Volumes

It is important to note that this post-processing methodology gives a false level of precision no matter whether the DTA or RTDM are used. Both models utilize the same transportation analysis zone (TAZ)-level inputs to estimate trips generated from a TAZ and assign them to the network. The model does not know where specific land uses are located within the TAZ or where all the driveway accesses are located. For example, trips generated by a grocery store with a driveway access to a facility on the east side of a TAZ may be assigned to enter the model network on a link south of the TAZ. Because of this, the link volume outputs immediately adjacent to the TAZ may not be realistic even though their assigned route based on origin and destination will overall be appropriate.

In addition, and because the model networks are not as detailed as the on-the-ground transportation system, the model may not have a specific local street link within the network. Similar to the driveway location example, the assigned trips make not load onto the network at the exact appropriate origin or destination, but the overall route will be intentional. Although it is the methodology currently used to determine turning movement volumes, the process utilizes link volumes that are better suited for a macro-level analysis instead of an intersection-level analysis.

Do different definitions of "congestion" identify different needs at the system level?

The project team explored two measures that could be used to determine locations of "congestion": v/c ratio and travel speed. Both measures can be provided as or calculated from link-level output from the regional models. The project team reviewed region-wide v/c ratio and travel speed output for the 2015 base year and 2040 constrained networks. For v/c, the current interim regional mobility policy thresholds were used to define "congested" links, which vary by roadway facility. Targets for the midday peak hour are either 0.99 or 0.90, first hour PM peak period targets are either 1.1 or 0.99, and second hour PM peak period targets are 0.99. For travel speed, "congested" was defined as when a link travel speed is less than 75 percent of the base link speed. The base link speed is often similar to the posted speed limit but is not exactly equal to it for all model links.

Figures 5 through 8 compare v/c and travel speed output by showing if each link is congested based on the above thresholds for one or two hours within the midday or PM peak period. V/C-based congestion output is represented by the thicker lines and travel speed-based by the thinner lines.

Figure 5. Congestion Measure Comparison Region-wide – 2015 Base Year Midday Peak Period

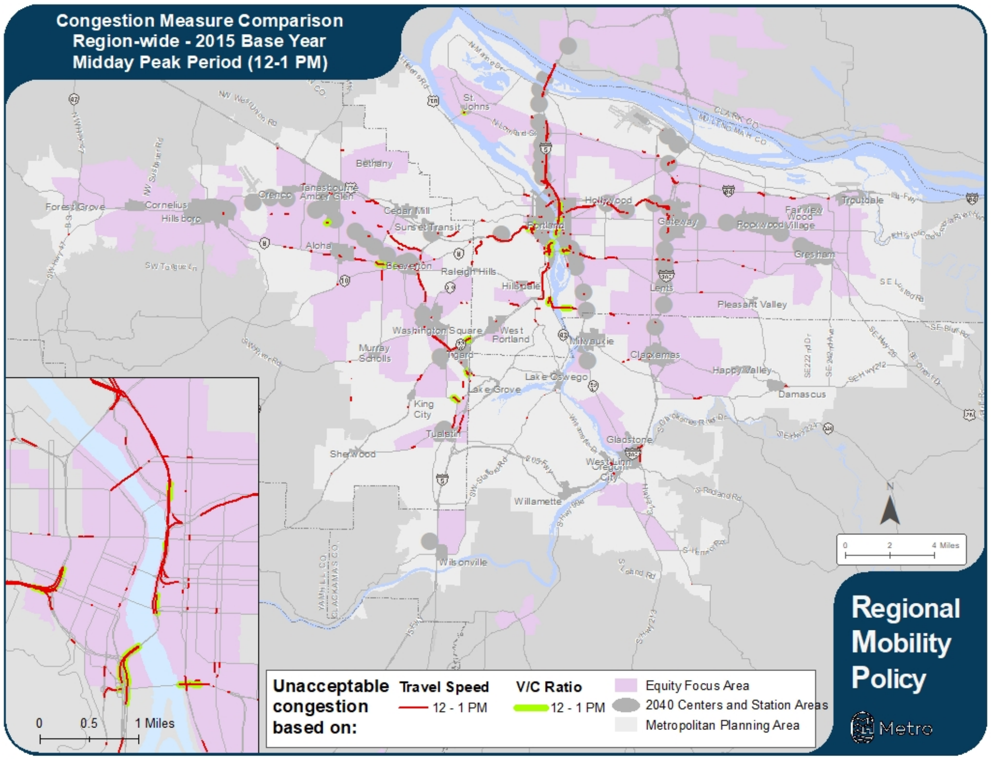


Figure 6. Congestion Measure Comparison Region-wide – 2015 Base Year PM Peak Period

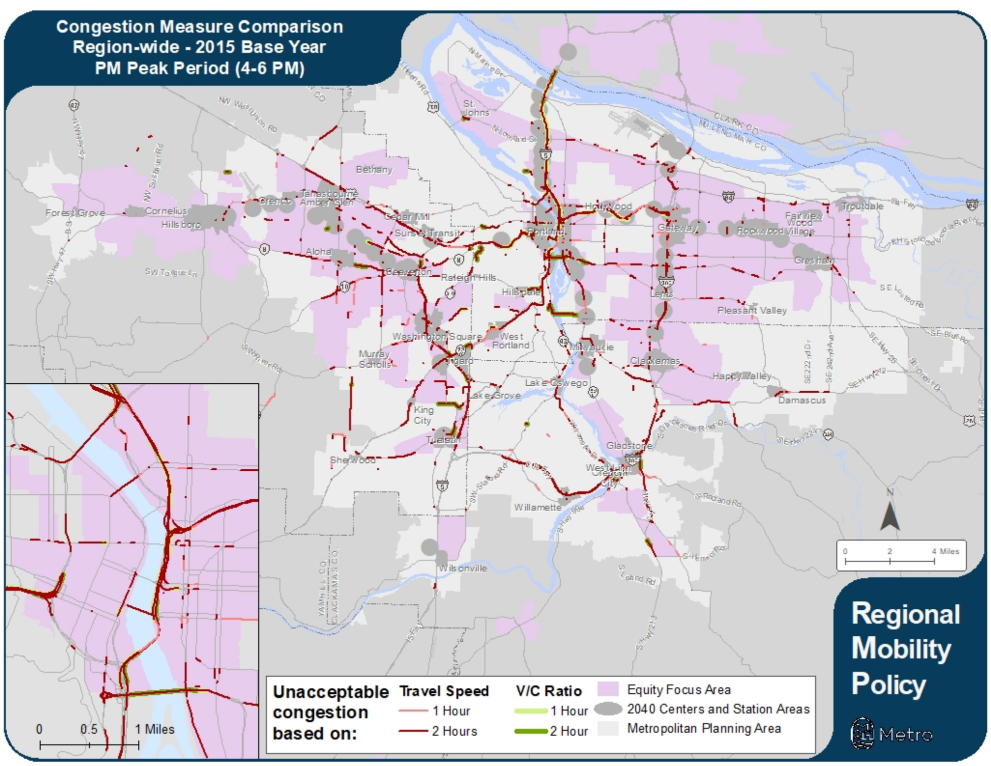


Figure 7. Congestion Measure Comparison Region-wide – 2040 Constrained Midday Peak Period

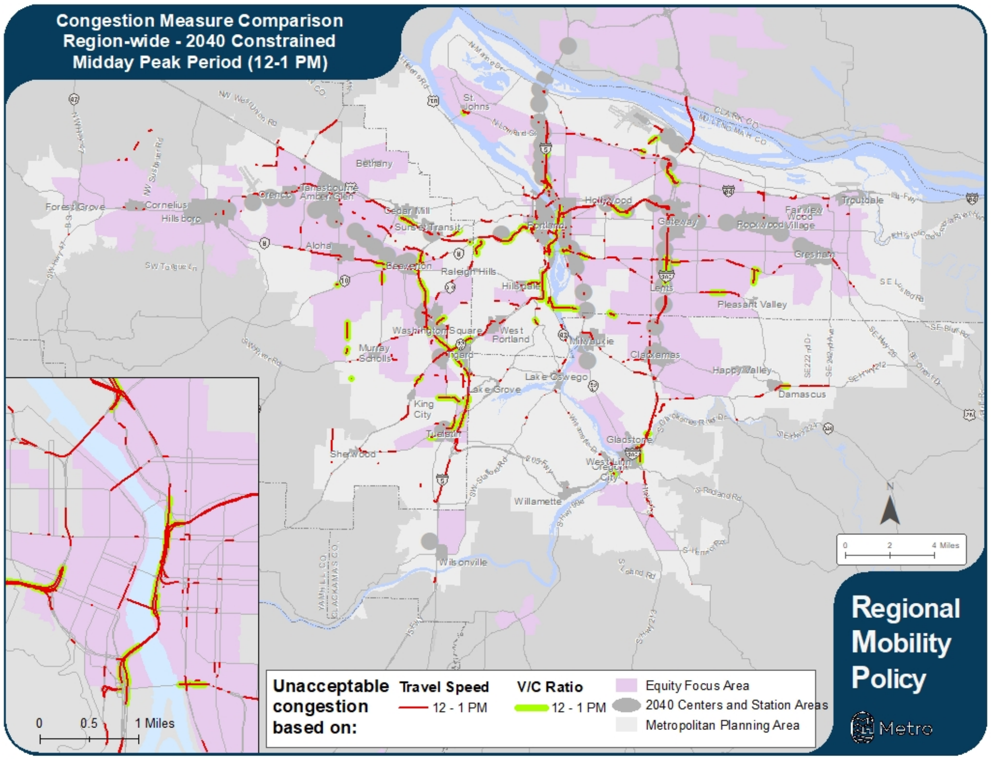
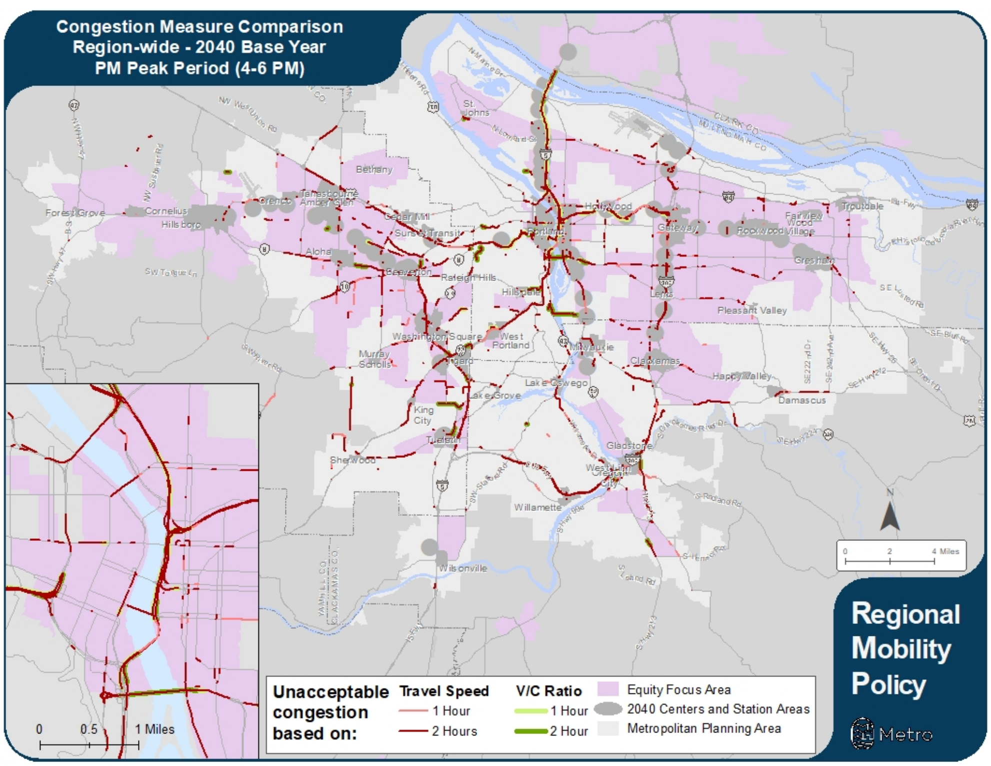


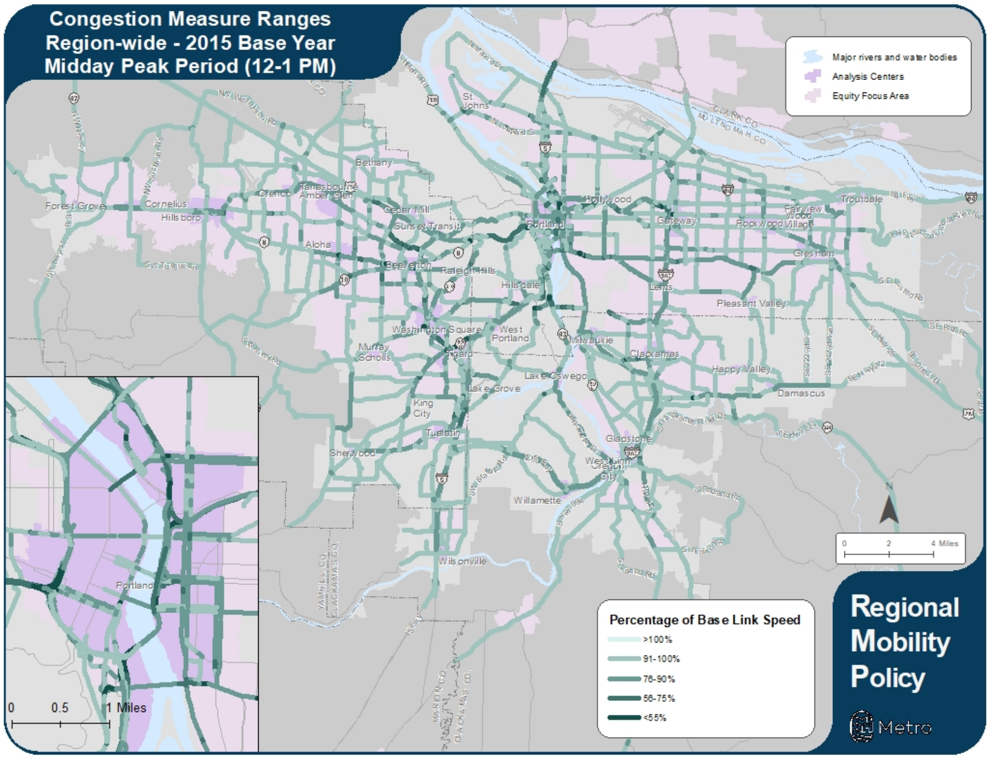
Figure 8. Congestion Measure Comparison Region-wide – 2040 Constrained PM Peak Period



With the thresholds used, v/c-based "congested" links were also "congested" based on the 75 percent travel speed threshold. Travel speed-based congestion was highlighted on more of the network and for more of the analysis period. For example in the 2040 constrained PM peak figure, there are several sections of OR 8 shown as congested based on v/c thresholds between SW 185th Avenue and SW Murray Boulevard. Those same segments are shown as congested based on travel speed and additional segments between SW 170th Avenue and SW Murray Boulevard are highlighted as well..

Findings: Travel speed is an interesting measure because it can use the same percentage-based threshold for all the roadway facilities, instead of determining different v/c ratio thresholds based on the facility type. Base link speeds, which could use posted speed limits, are set on a facility-by-facility basis. In addition to the facility type, the local context and safety considerations of the roadway are used by agencies to set posted speed limits. Posted speed limits can vary along a corridor based on these additional factors and help represent the intended use of the facility. In addition, travel speed is a direct output of the regional models, simplifying the process for calculating the measures. Measured data is also more easily captured through probe data. It is also a measure easily understood by the traveling public, as direction and map-based apps are more common. The biggest challenge to utilizing travel speed as the primary link-level congestion metric is the lack of historic use in the region for the non-highway network and a need to better understand the implications of determining certain thresholds. Figures 9 through 12 show the travel speed and v/c ratio ranges for the region, instead of showing just locations where a threshold is passed. If link travel speed and/or v/c ratio are part of the mobility policy, region-wide data will need to be further reviewed to recommend targets and thresholds.

Figure 9a and b. Congestion Measure Ranges Comparison Region-wide – 2015 Base Year Midday Peak Period



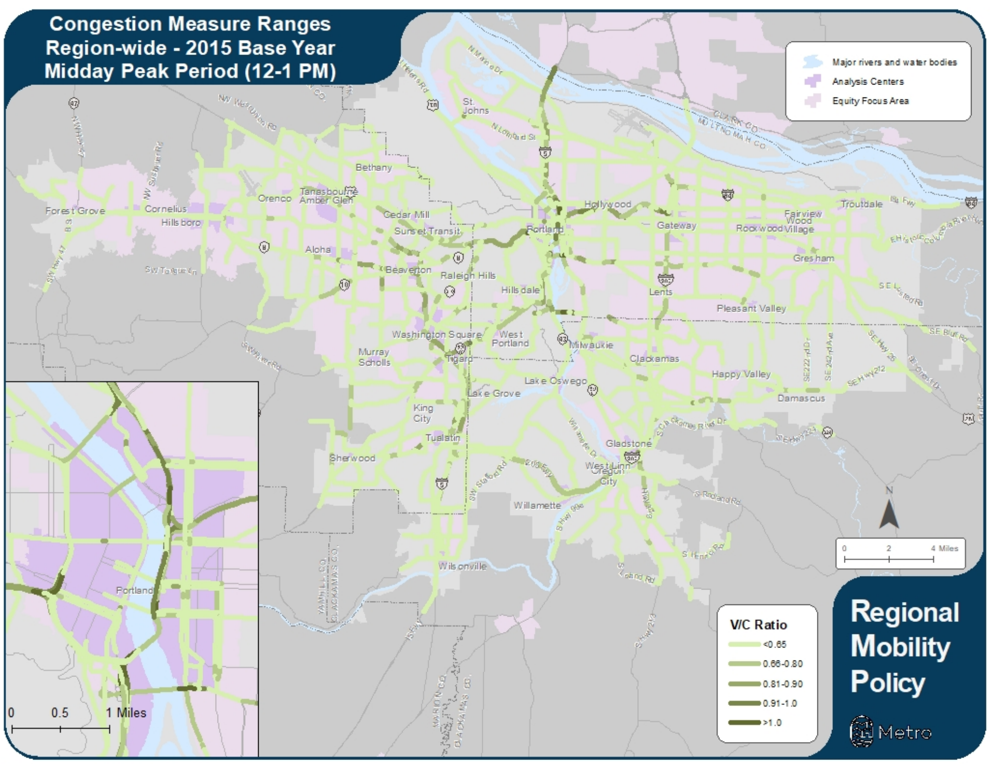
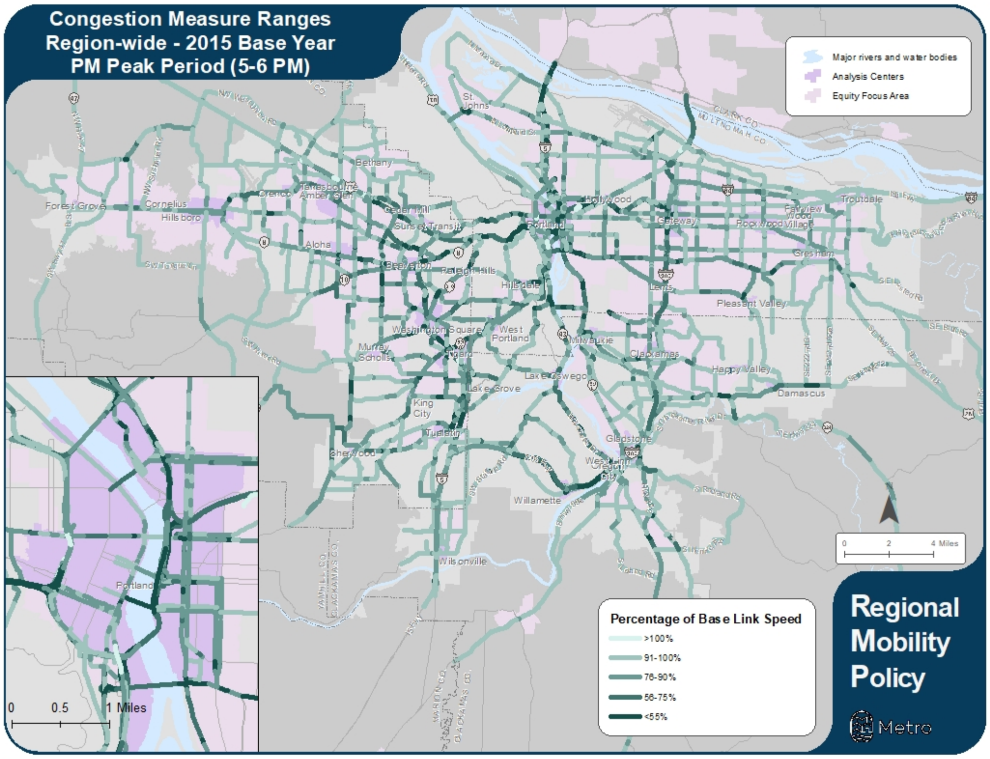


Figure 10a and b. Congestion Measure Ranges Comparison Region-wide – 2015 Base Year PM Peak Period



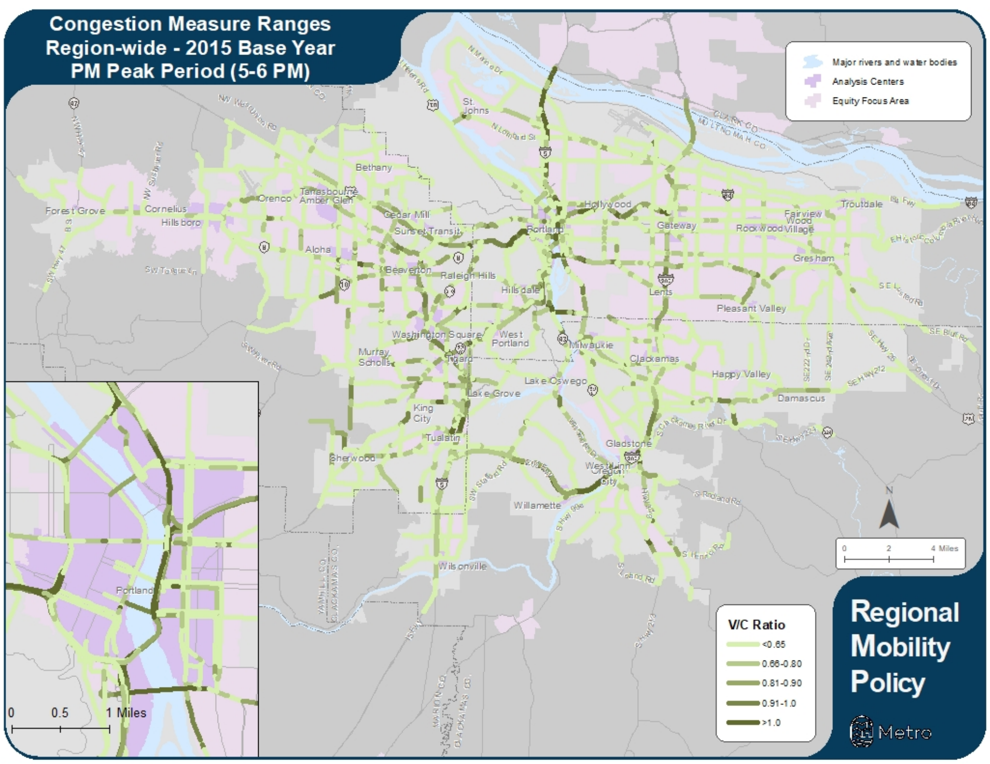
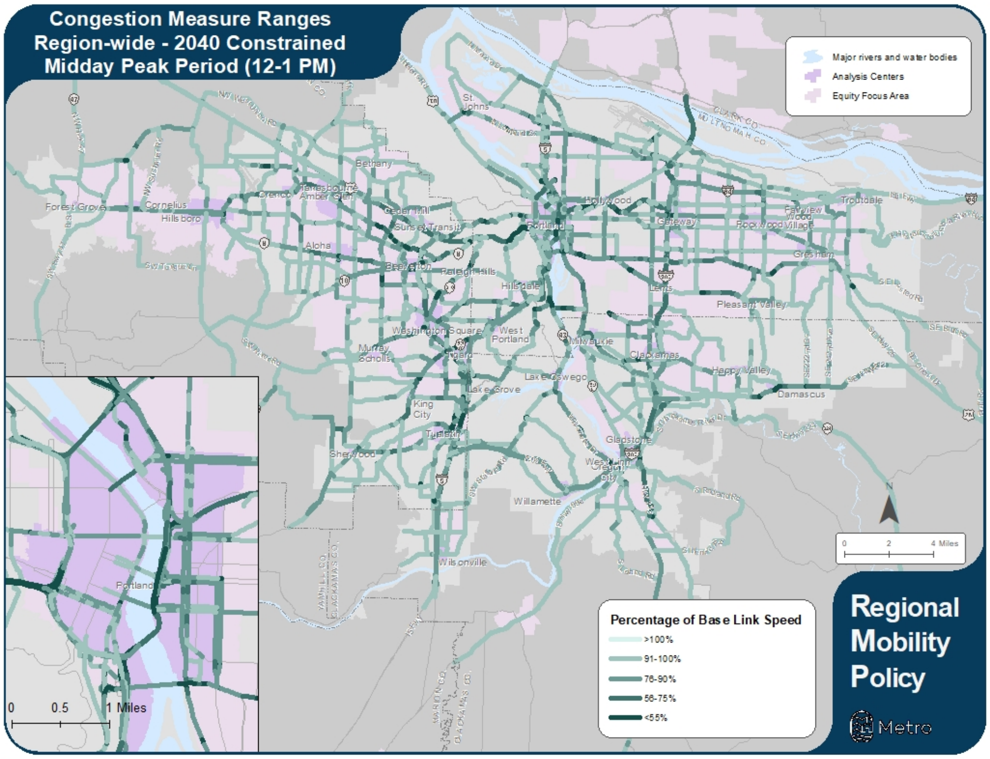


Figure 11a and b. Congestion Measure Ranges Comparison Region-wide – 2040 Constrained Midday Peak Period



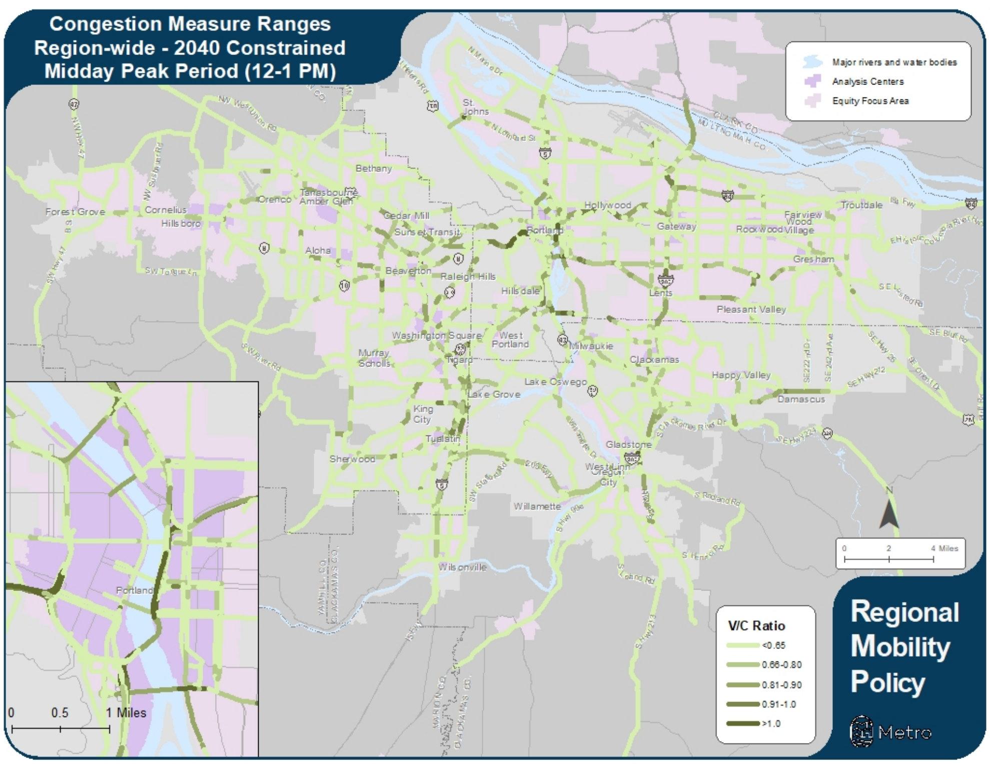
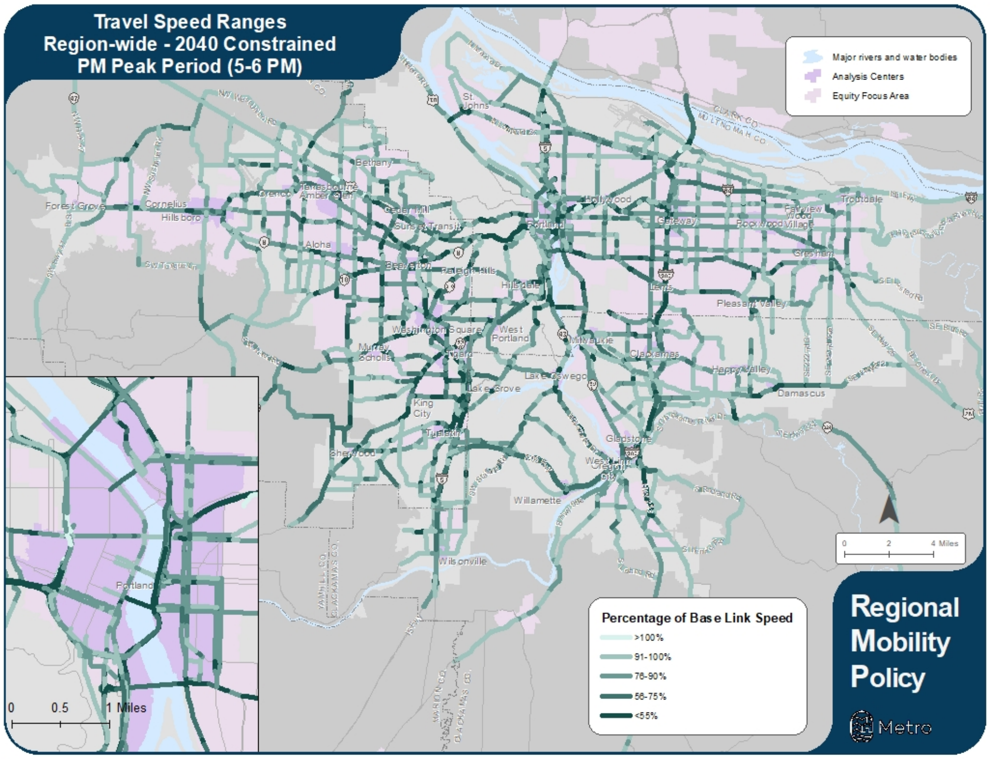
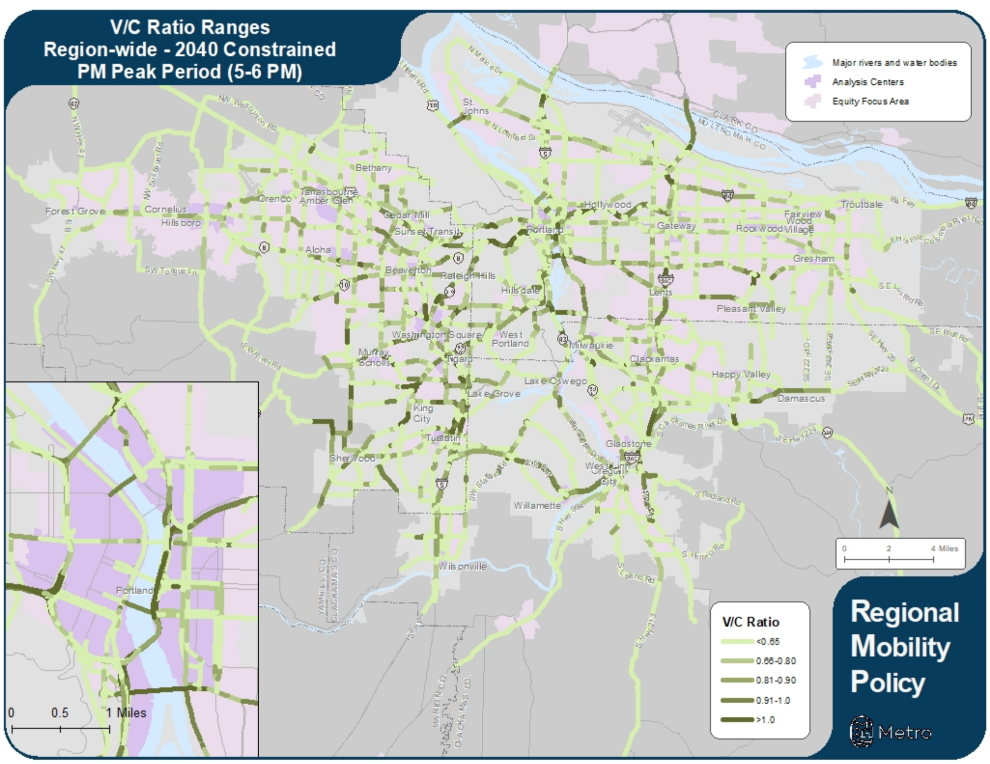


Figure 12a and b. Congestion Measure Ranges Comparison Region-wide – 2040 Constrained PM Peak Period





How sensitive are the model outputs to changes in land use?

Focused sensitivity testing on the congestion-based metrics was conducted for the TV Highway study area. The sensitivity testing scenarios used the 2040 model network as a base, with updated population and employment levels from 2015 and 2027 scenarios depending on the scenario. **Error! Reference source not found.** describes how model year variables were assigned to the sensitivity testing scenarios reviewed for congestion-based metrics.

Table 3: Congestion-based Sensitivity Testing Scenario Definitions

Scenario	Variables from model year			Impacted TAZs
	Households	Employment	Model Network	
Scenario 3 – South Hillsboro No growth	2015	2015	2040FC	1341, 1352, 1353, 1363, 1366, 1367
Scenario 4 – South Hillsboro Minimal growth	2027	2027	2040FC	1341, 1352, 1353, 1363, 1366, 1367
Scenario 5 – South Hillsboro Household-only growth	2040	2015	2040FC	1341, 1352, 1353, 1363, 1366, 1367
Scenario 6 – TV Highway Aloha growth	Increased by 50%	Increased by 50% (TAZ 1137 only)	2040FC	1336, 1337, 1338

Source: Metro Travel Demand Modeling staff, 2021.

Figures 13 through 16 compare the sensitivity testing scenario model travel speed output with the 2040 Constrained output. Based on this comparison, travel speed is not very sensitive to land use changes.

For Scenarios 3 through 5, which focus on land use adjustments within the large South Hillsboro development area, the travel speed changes were mostly seen on arterials instead of throughways. Arterials often have lower posted speeds (or base link speeds which were used for the sensitivity testing calculations) and will therefore see more of a percentage impact for a minor travel speed change like from 24 to 22 MPH. The travel speed changes are almost all in direct correlation to the land use change. In Scenario 3 for example, the scenario removed the household and employee growth that was added to the 2040 Constrained model, reducing trips to and from the South Hillsboro area. As expected, the travel speeds increase between the 2040 Constrained model output and the Scenario 3 output in places where changes occur. For Scenario 6, no significant travel speed changes occurred, suggesting that travel speed is not sensitive to smaller scale plan amendments. The adjusted TAZs are also located along TV Highway, where higher posted speeds (or base link speeds) do not show small changes in travel speed as a significant percentage change.

Figure 13. Sensitivity Testing Scenario 3 (Travel Speed Ranges) TV Highway – 2040 PM Peak

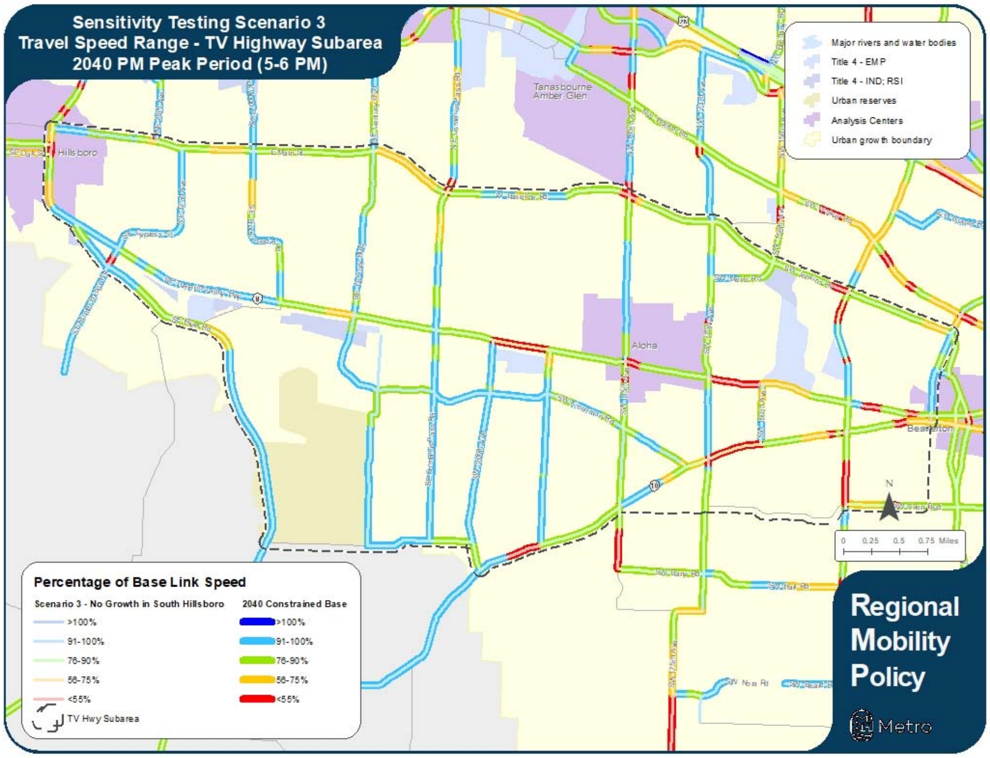


Figure 14. Sensitivity Testing Scenario 4 (Travel Speed Ranges) TV Highway – 2040 PM Peak

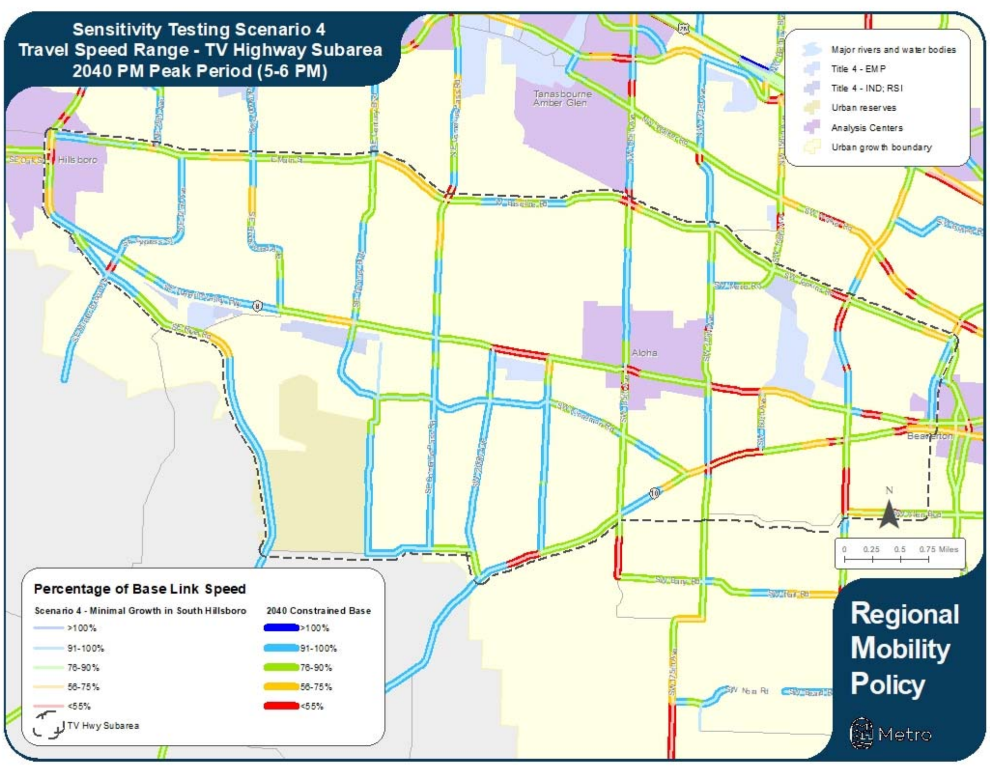


Figure 15. Sensitivity Testing Scenario 5 (Travel Speed Ranges) TV Highway – 2040 PM Peak

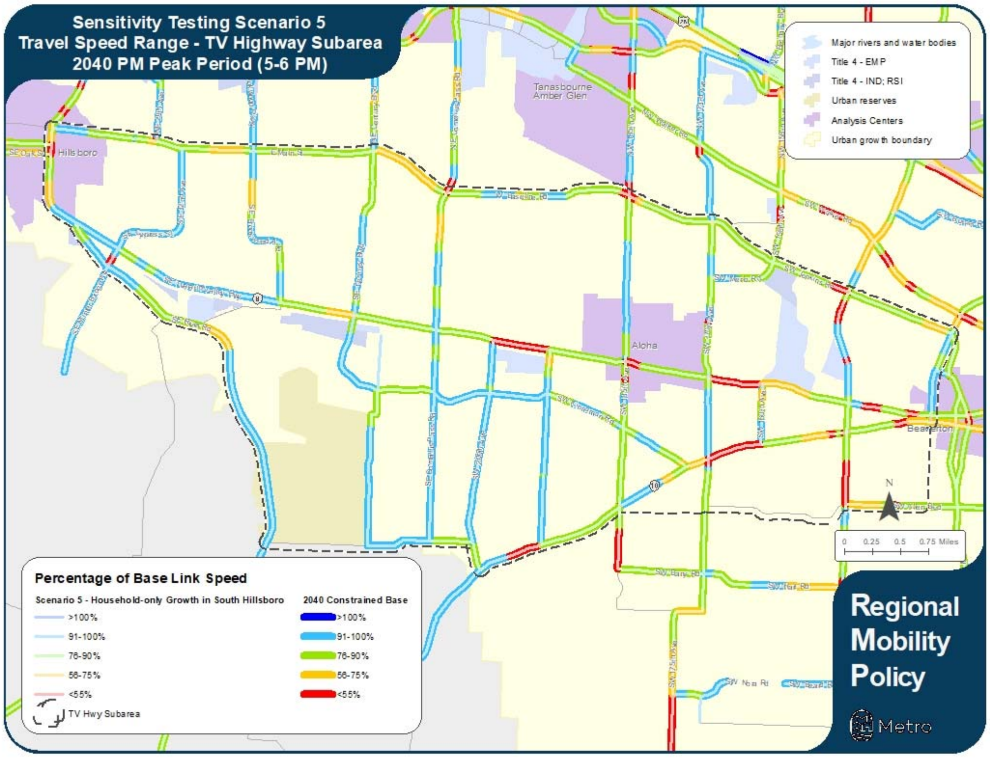
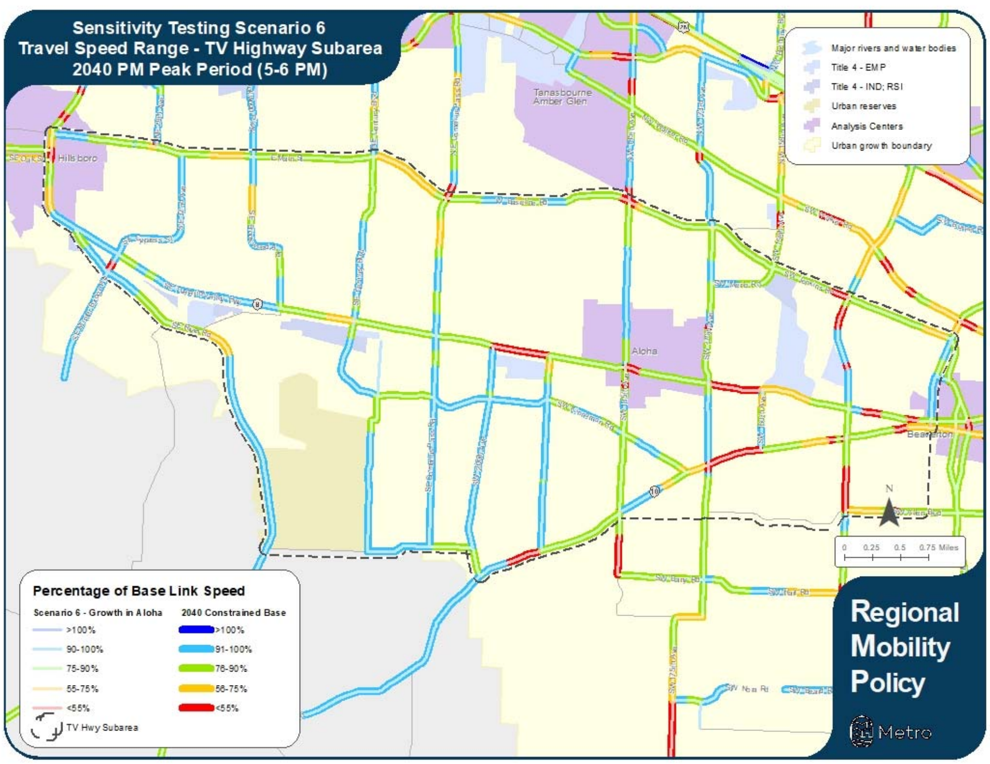


Figure 16. Sensitivity Testing Scenario 6 (Travel Speed Ranges) TV Highway – 2040 PM Peak



Policy Considerations

If travel speed is utilized in the mobility policy, major considerations include:

- What speed variable will be the denominator for determining a travel speed threshold? Options include posted speed, free flow speed, and the base link speed from the travel demand model.
    - For this analysis, the base link speed from the 2015 travel demand model was used because it was a readily available output that could be easily incorporated into GIS-based calculations. Base link speed is not a measured or designated speed; it is an input that is part of the travel demand model. It is often close to or equal to the posted speed, but it can vary from the posted speed if needed to yield accurate travel times in calibration.
    - Whichever speed variable is used, it is recommended to create a dataset where the model output and the speed variable data have the same link segmentation. This will simplify requests to Metro and/or the calculation process. Posted speed was not used for this analysis due to the effort requires to match the two datasets for use in the calculations.
- How would thresholds be decided?
    - 75% is currently used by ODOT for the Portland Region Traffic Performance Report (PRTPR) and Corridor Bottleneck Operations Study (CBOS)
    - 75% may not make sense on roadways that are controlled (versus uncontrolled roadways such as freeways). Roadways that have more traffic control, such as signals and roundabouts, will experience more delay and slower speeds. Thresholds or targets would need to take that into consideration. Potentially using a threshold based on measured speeds (like average travel speed for the link) would provide a realistic base for developing a threshold.
    - 75% may not make sense for roadways that have low posted speeds (or base link speeds). Minor variations of travel speed (such as a change in 2 MPH) would show large percentage changes.
- Guidance would need to be developed related to calibration and validation of Metro models in relation to speed if it is going to be used as a measure with a target. Currently, most of the speed related measures are used for relative comparisons between various alternatives, not as a measure against a target.
    - Metro modeling staff notes that there is some calibration related to travel times, which has a direct relationship to travel speeds. The base year link speeds are generally set to yield accurate travel times in calibration. Horizon year speeds may be adjusted when speed changes are known or expected in future year models.

Should the DTA model be used for congestion-based metrics?

- Overall, the DTA model provides volumes that are more spread out on the system and likely more realistic for peak travel periods, decreasing volumes on throughways that are congested and adding volumes to parallel arterial routes. Similar to in-the-field conditions, the DTA theoretically never has a v/c ratio greater than 1.0, which would help with target and threshold setting. The RTDM will assign trips to a link even if it is well over capacity already, which is not possible on the ground.

- Although more realistic, Metro does not have a regional DTA. It would take a lot of time to actually develop and calibrate the DTA for each area.
- It is unclear if there is any feedback to Metroscope/land use and demographic allocation with the current DTA model. The entire region would need to be covered by a DTA model to get that type of feedback into the regional Metroscope and land use tools.
    - The region's agencies may have other tools like HERS, Fixit, RITIS, etc. that would be more useful for considering land use changes.

If v/c ratio is utilized in the mobility policy, major considerations include:

- The comparison of post-processed volumes from the RTDM model and the DTA model confirm that volumes from the RTDM are likely to be overestimates in congested areas and could result in overbuilt solutions that induce demand. Consideration should be given to specifying the use of DTA for intersection analysis for plan amendments where the targets are applied as standards to ODOT facilities. Alternatively, an adjustment could be made to the v/c targets or an adjustment could be made to the forecast traffic volumes when a DTA model is not available.

Are the measures useful and practical for system planning?:

Throughways: Travel speed and v/c ratio are both useful for planning on throughways. The two measures trend very similarly when looking at congestion but travel speed has some advantages over v/c ratio. Travel speed is already used by ODOT for reporting on the highway network and is more relatable to the public, allowing them to understand and more meaningfully weigh in on targets.

Queuing at ramp terminals continues to be a good planning measure for safety as well as mobility.

Arterials: Although v/c has been used traditionally, travel speed has some benefits over v/c including that it provides a holistic view of travel progression through a corridor. Posted speed limits can vary along a corridor based on the land use context and intended us of the facility so the target can reflect if it's operating as intended. .

Are the measures sensitive enough to use for plan amendments?

Travel speed is not very sensitive to land use changes and will not be useful for small scale plan amendments. Travel speed has similar disadvantages to v/c ratio when applying the target as a standard to plan amendments in that if the facility is already complete with regard to number of travel lanes, the standard may not be able to be met. The policy should consider not applying a congestion target when the facility is considered complete with regard to travel lanes.

Duration of Congestion (Hours)

Hours of congestion (HOC) is the number of hours within a time period, most often within a weekday, where a facility's congestion target (such as v/c ratio or acceptable speed) is exceeded or not met. HOC is a measure of recurring congestion versus travel time reliability measures which evaluate both recurring and non-recurring congestion.

HOC is a vehicle-focused measure that supports reliability and efficiency outcomes. Current uses of the interim regional mobility policy heavily relies on v/c ratio to determine where congestion is unacceptable, but as explored above, travel speed is another option that could be used and that is easily available from the regional models. The project team wanted to explore the following questions for these measures, as summarized in the following sections:

- Do different definitions of "congestion" identify different needs at the system level?
- How sensitive are the model outputs to changes in land use?

Do different definitions of "congestion" identify different needs at the system level?

There are several potential measures that could be used to determine "congested" hours for HOC. The project team explored two that are already being considered as part of the regional mobility policy update and that can be provided as or calculated from link-level output from the regional models: v/c ratio and travel speed.

Similar to the comparison in the previous section, the project team reviewed region-wide v/c ratio and travel speed output for the 2015 base year and 2040 constrained networks to determine HOC based on each measure. For v/c, the current interim regional mobility policy midday peak hour threshold was used to define "congested" links, which vary by roadway facility. Targets for the midday peak hour are either 0.99 or 0.90, varying by roadway facility. For travel speed, "congested" was defined as when a link travel speed is less than 75 percent of the base link speed. The base link speed is often similar to the posted speed limit but is not exactly equal to it for all model links. These v/c and travel speed thresholds were applied to each link for each hour of the day to determine the number of hours each link was "congested". It is worth noting that the analysis hours are all based on clock hours. So if a link is "congested" from 7:30-9:30AM, it will be reported as only being congested for one hour (8:00-9:00AM).

Figures 17 and 18 compare v/c-based and travel speed-based HOC by model link. v/c-based HOC output is represented by the thicker lines and travel speed-based by the thinner lines.

Figure 17. Hours of Congestion Measure Comparison Region-wide – 2015 Base Year

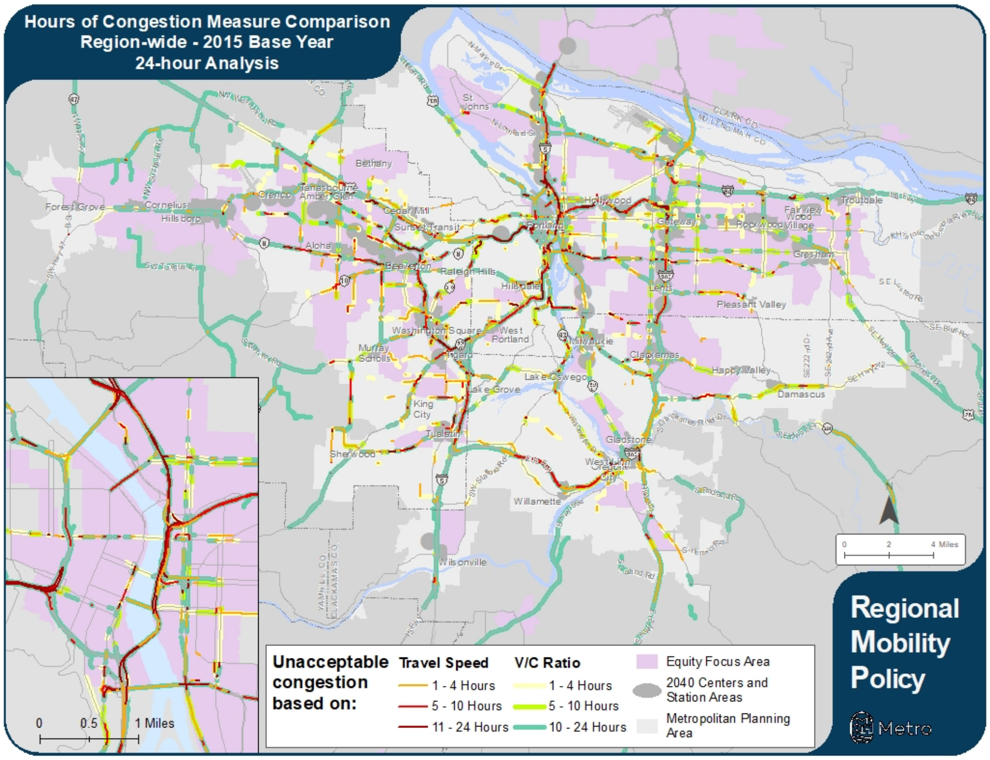
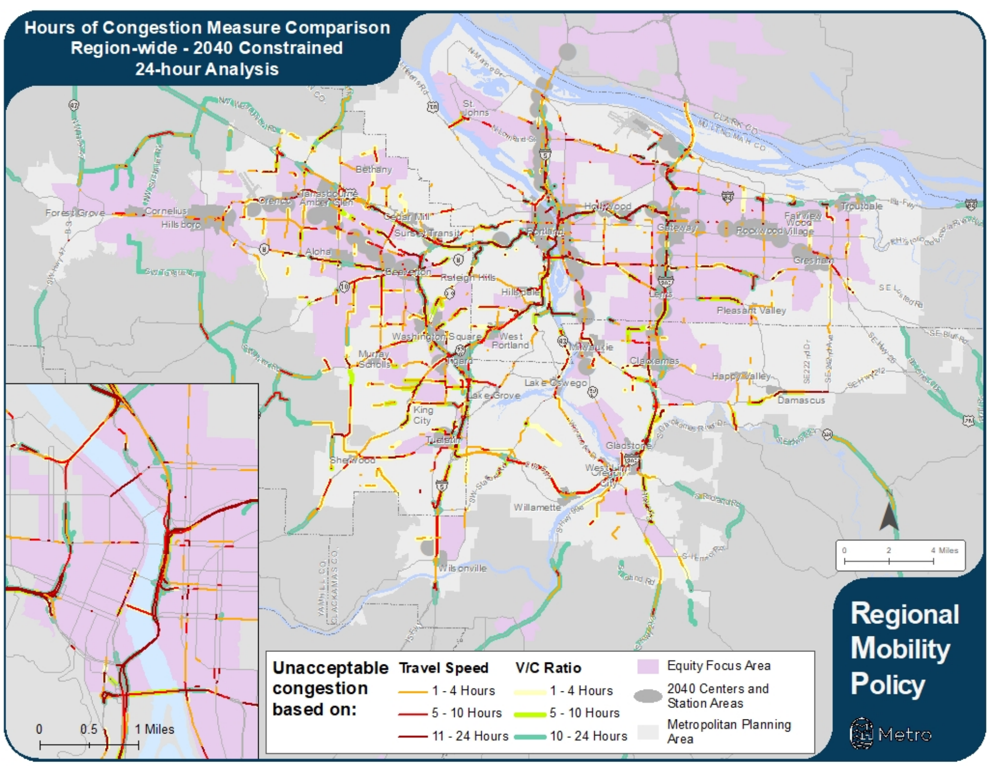


Figure 18. Hours of Congestion Measure Comparison Region-wide – 2040 Constrained



As shown in the figures, most links that have at least one hour of daily congestion based on either metric also experience congestion based on the other metric. In addition, the majority of the links that experience the highest HOCs are modeled to have sustained hours of congestion whether based on v/c or travel speed. The difference between number of hours of congestion reported between v/c and travel speed-based thresholds is not consistent throughout the region. In some areas, v/c-based HOC is higher, and the opposite is true for other areas.

When comparing the figures with the 2018 RTP, all roadways segments that are congested for the two analysis hours in the PM peak period are forecast with HOCs of 3 or more, no matter whether v/c- or travel speed-based. The HOC measure highlights more links that experience congestion, which tells a more holistic story of daily congestion impacts for the region and for throughways in particular.

How sensitive are the model outputs to changes in land use?

Focused sensitivity testing on the congestion-based metrics was conducted for the TV Highway study area. The sensitivity testing scenarios used the 2040 model network as a base, with updated population and employment levels from 2015 and 2027 scenarios depending on the scenario. Table 4 describes how model year variables were assigned to the sensitivity testing scenarios reviewed for congestion-based metrics.

Table 4: Congestion-based Sensitivity Testing Scenario Definitions

Scenario	Variables from model year			Impacted TAZs
	Households	Employment	Model Network	
Scenario 3 – South Hillsboro No growth	2015	2015	2040FC	1341, 1352, 1353, 1363, 1366, 1367
Scenario 4 – South Hillsboro Minimal growth	2027	2027	2040FC	1341, 1352, 1353, 1363, 1366, 1367
Scenario 5 – South Hillsboro Household-only growth	2040	2015	2040FC	1341, 1352, 1353, 1363, 1366, 1367
Scenario 6 – TV Highway Aloha growth	Increased by 50%	Increased by 50% (TAZ 1137 only)	2040FC	1336, 1337, 1338

Source: Metro Travel Demand Modeling staff, 2021.

Figures 19 through 26 compare the sensitivity testing scenario model HOC output with the 2040 Constrained output. Figures 19 through 22 show HOC based on travel speed, where “congested” was defined as when a link travel speed is less than 75 percent of the base link speed. Figures 23 through 26 show HOC based on v/c ratio. For v/c, the current interim regional mobility policy midday peak hour threshold was used to define “congested” links, which vary by roadway facility. Targets for the midday peak hour are either 0.99 or 0.90, varying by roadway facility.

HOC – Travel Speed Threshold

For Scenarios 3 through 5, which focus on land use adjustments within the large South Hillsboro development area, HOC changes were mostly seen on arterials instead of throughways. The HOC changes are all in correlation to the land use change. In Scenario 3 for example, the scenario removed the household and employee growth that was added to the 2040 Constrained model, reducing trips to and from the South Hillsboro area. As expected, the HOC decreases between the 2040 Constrained model output and the Scenario 3 output in places where changes occur. For Scenario 6, no significant HOC changes occurred, suggesting that using a travel speed threshold is not sensitive to smaller scale plan amendments.

HOC – V/C Ratio Threshold

For Scenarios 3 through 5, HOC changes were mostly seen on arterials instead of throughways, especially on TV Highway (major arterial per Metro classifications). The HOC changes are all in correlation to the land use change. In Scenario 3 for example, the scenario removed the household and employee growth that was added to the 2040 Constrained model, reducing trips to and from the South Hillsboro area. As expected, the HOC decreases between the 2040 Constrained model output and the Scenario 3 output in places where changes occur. For Scenario 6, no significant HOC changes occurred, suggesting that using a v/c ratio threshold is not sensitive to smaller scale plan amendments.

Figure 19. HOC Sensitivity Testing Scenario 3 (Travel Speed) TV Highway – 2040 PM Peak

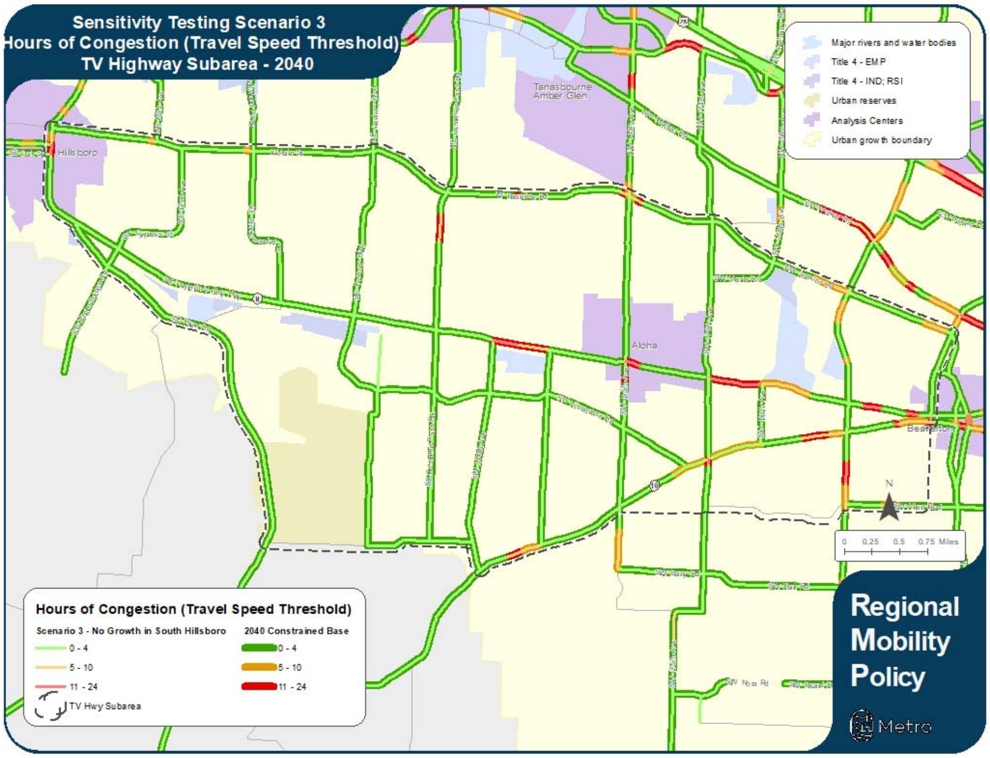


Figure 20. HOC Sensitivity Testing Scenario 4 (Travel Speed) TV Highway – 2040 PM Peak

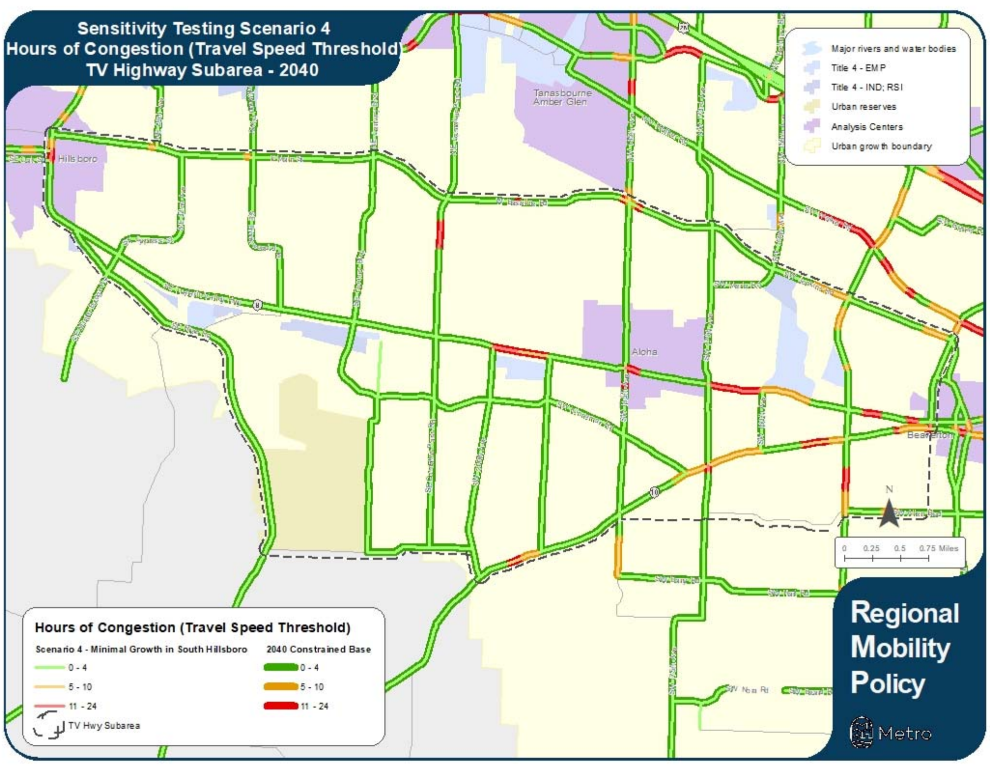


Figure 21. HOC Sensitivity Testing Scenario 5 (Travel Speed) TV Highway – 2040 PM Peak

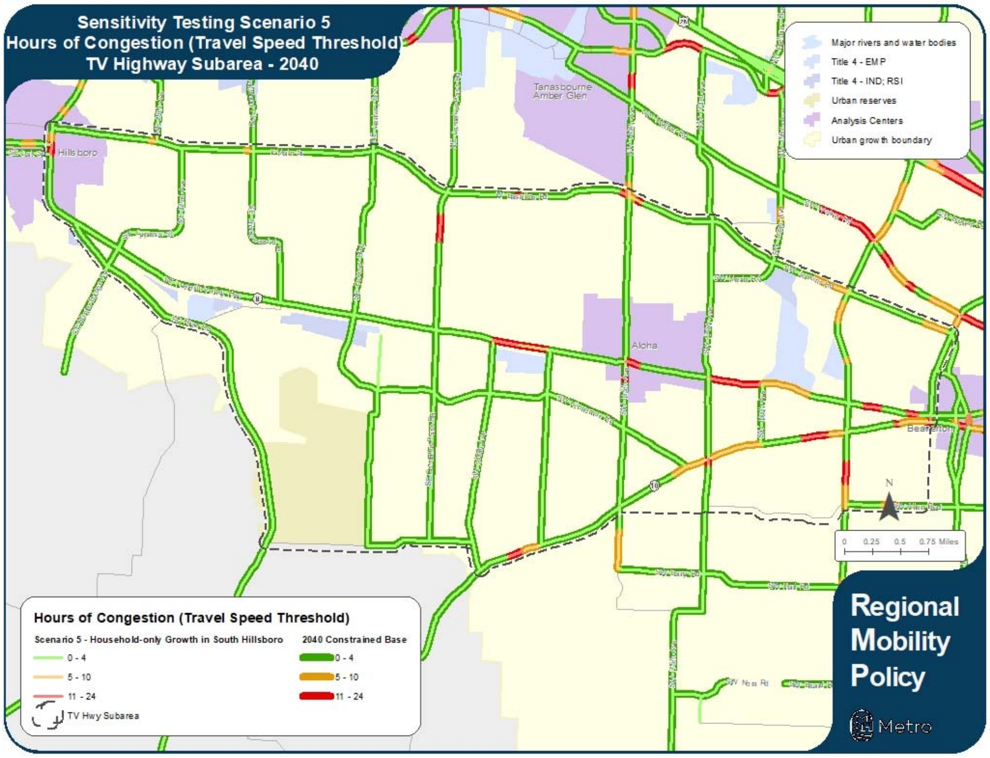


Figure 22. HOC Sensitivity Testing Scenario 6 (Travel Speed) TV Highway – 2040 PM Peak

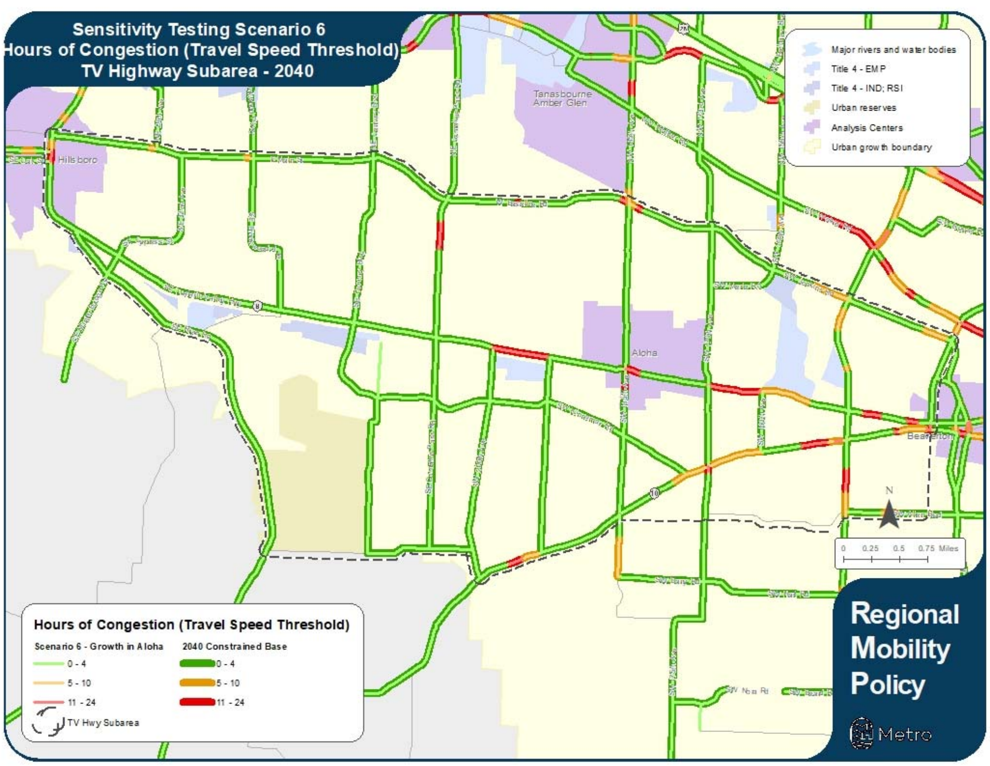


Figure 23. HOC Sensitivity Testing Scenario 3 (V/C Ratio) TV Highway – 2040 PM Peak

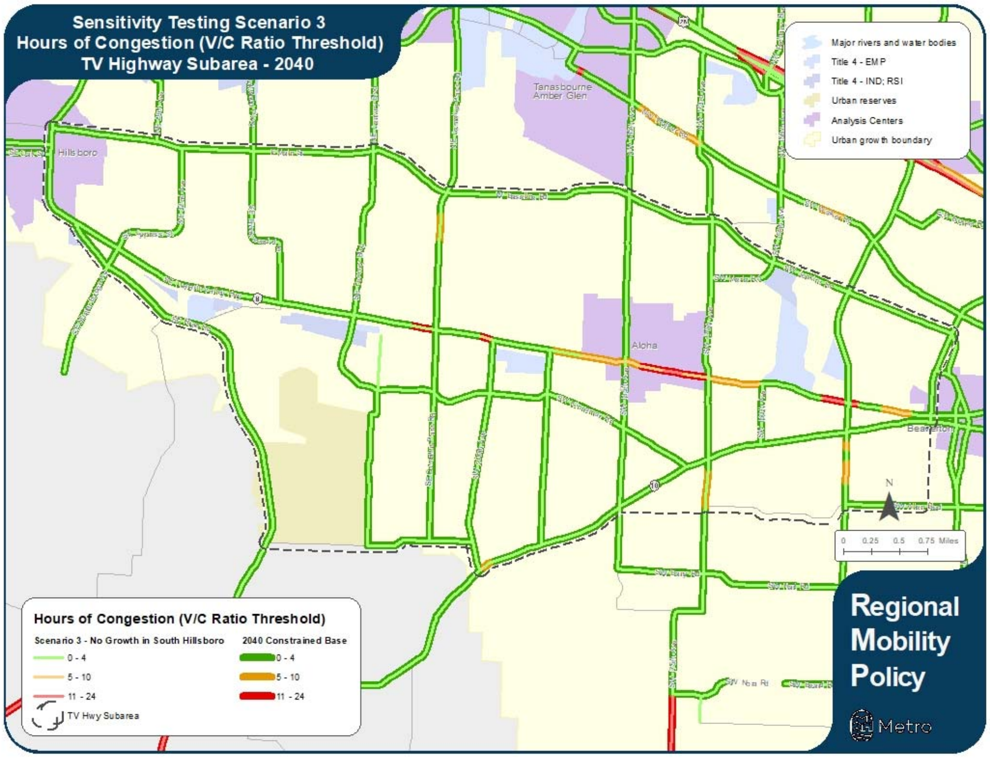


Figure 24. HOC Sensitivity Testing Scenario 4 (V/C Ratio) TV Highway – 2040 PM Peak

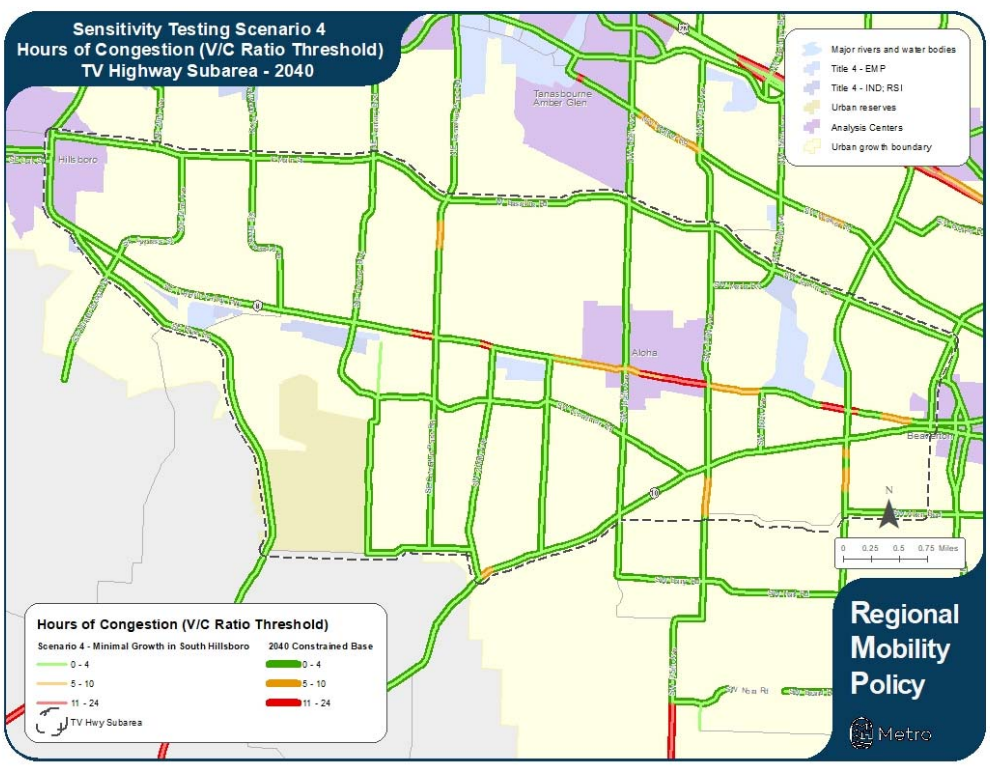


Figure 25. HOC Sensitivity Testing Scenario 5 (V/C Ratio) TV Highway – 2040 PM Peak

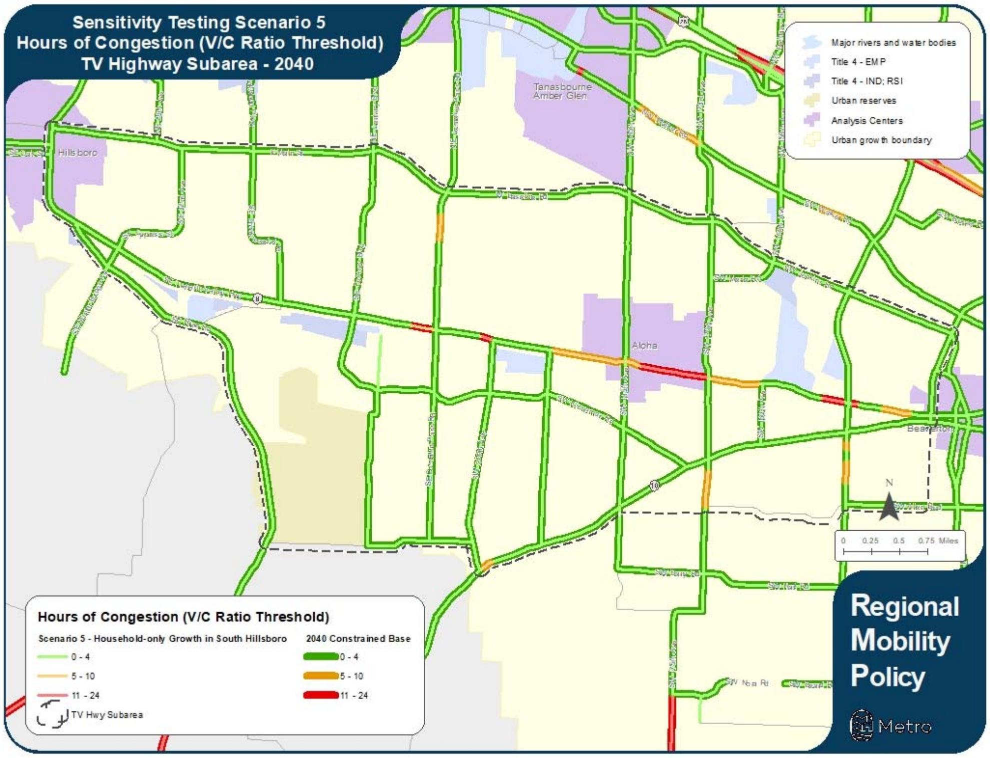
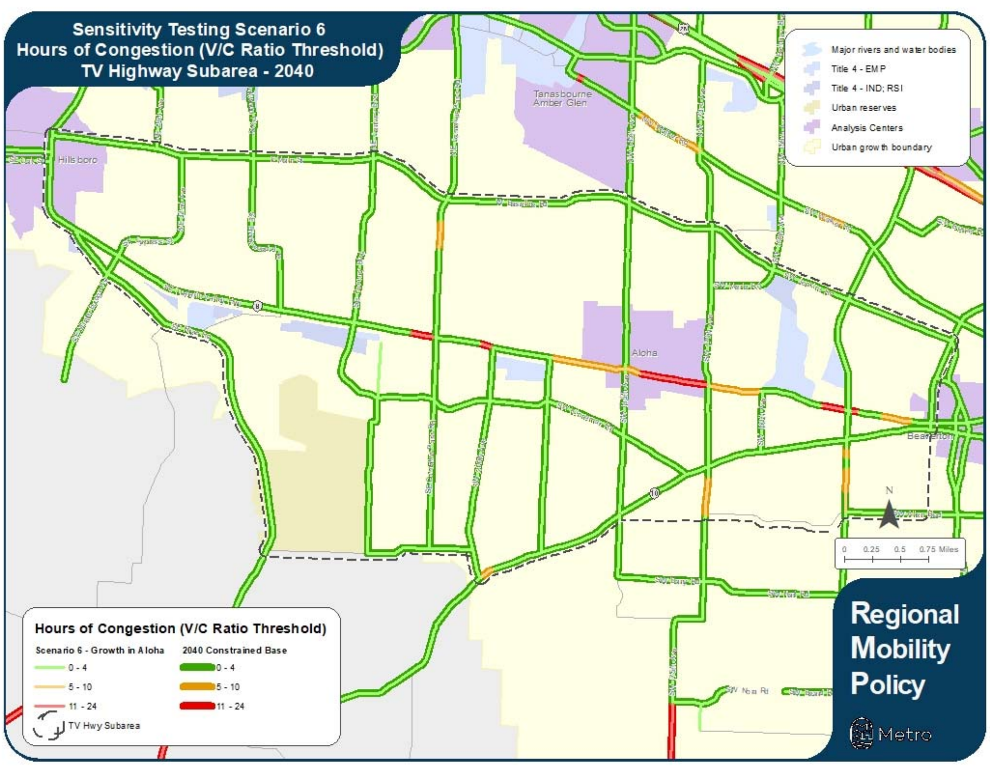


Figure 26. HOC Sensitivity Testing Scenario 6 (V/C Ratio) TV Highway – 2040 PM Peak



Policy Considerations

Considerations:

- The same v/c ratio and travel speed threshold determination questions apply for HOC because the definition of "congested" is required for all three metrics.

Are the measures useful and practical in planning?

Throughways: As a high-level 24-hour view, HOC is a useful measure on throughways to highlight current congestion and forecast locations in the future. HOC based on travel speed is already used by ODOT for reporting on the highway network in the PRTPR. There may be other simulation tools available to support future forecasting that more closely aligns with field operations.

Arterials: As a high-level 24-hour view, HOC is a useful measure on arterials to highlight current congestion and forecast locations in the future. Establishing thresholds for "congested" links on controlled roadways is a primary issue for replicable calculations.

Are the measures sensitive enough to use for plan amendments?

HOC, whether with a travel speed threshold or v/c ratio threshold, is not very sensitive to land use changes.

VMT/Capita and Access to Destinations/Opportunities

Vehicle miles traveled (VMT) is the number of vehicle miles traveled by motorists within a specified time period and study area. . Currently, most vehicles are powered by internal combustion engines; therefore, greenhouse gas emissions tend to rise and fall with VMT, although emissions/VMT tend to be lower in smooth-flowing traffic and higher in slow moving or stop-and-go traffic. The relationship between VMT and greenhouse gas emissions will weaken as electric vehicles become more common. **VMT/capita** compares this number to a specific population, such as total number of residents or employees within a defined area, to measure how much people drive to meet their obligations and daily needs.

Access to destinations/opportunity measures how many essential destinations (such as jobs, community services, and educational institutions) can be reached within a certain travel time or distance using different travel modes. This measure is typically evaluated for a specific site or study area but can also be calculated regionally. As defined in Metro's 2018 RTP, areas with high accessibility enable people "to reach desired goods, services, activities and destinations with relative ease, within a reasonable time, at a reasonable cost and with reasonable choices." Increased used of e-commerce, delivery services, and telecommuting over the past decade (and particularly since 2020) has enabled many people to meet their needs and to access opportunities without leaving home. Geographic measures of access, therefore, do not fully portray the resources available to residents.

What they measure

Both VMT/capita and Access to destinations/opportunity reflect how well the land use and transportation systems work together, and both respond to the same types of changes in those systems. Places with a mix of residential and commercial development and a transportation network that serves people walking, biking, and taking transit as well as driving tend to have low VMT/capita and high access to destinations/opportunity by multiple travel modes. Conversely, places where housing is far from jobs and services and where people must drive to meet their daily needs tend to have high VMT/capita and low Access to destinations/opportunity, especially for people using transit.

Although they reflect similar transportation and land use characteristics, the two measures focus on different aspects of mobility. VMT/capita indicates how *efficiently* people within a combined transportation and land use system can meet their needs, while Access to destinations/opportunity measures how *useful* that combined transportation and land use system is for specific types of trips and specific travel modes.

What they do not measure

Neither VMT/capita nor Access to destinations/opportunity evaluate how well the transportation system itself operates. They can inform long-range planning, but do not provide useful information for improving the operations of existing transportation systems.. These measures should be supplemented with metrics that indicate network performance (such as travel speed, V/C ratio, queuing, and duration of congestion) and/or with metrics that evaluate network completeness (such as LTS, pedestrian crossing index, and system completion).

Neither VMT/capita nor Access to destinations/opportunity perfectly measures the efficiency and usefulness of a combined land use and transportation system. Key deficiencies include:

- VMT/capita is affected by a range of demographic and economic factors beyond land use and transportation conditions. In general, VMT/capita is higher than average for large households and households with high incomes; it also tends to rise when gas prices fall.
- While VMT currently generates greenhouse gas emissions, this relationship will weaken as electric vehicles become more common, and relationship is also affected by the traffic conditions under which VMT occurs.
- Access to destinations/opportunity does not perfectly reflect the opportunities and resources available to residents, since it does not account for telecommuting, delivery services, and home entertainment that can be ordered online.

How they are measured

Access to destinations/opportunity

Access to destinations/opportunity is often used to compare how well the transportation system serves people using different modes (e.g., transit users vs. auto users) and people living in different locations (e.g., comparing what can be accessed from the center of a Census tract in an Equity Focus Area vs. what can be accessed from the center of a Census tract in a higher-income neighborhood). Defining key destinations and opportunities is essential to evaluating access meaningfully. Access to jobs is one component of access to opportunity, which can also include access to destinations that provide education and training. Community destinations are typically understood as places where people can access key services and meet their daily needs.

To provide consistent results for existing and forecasted conditions, Metro spatial analysts recommend combining spatial data on destinations with travel times calculated using Metro's travel model. At the regional level, this approach was used in Metro's 2018 RTP to evaluate access to low and middle-wage jobs (jobs with annual wages of $65,000 or less) using different travel modes under both existing and forecasted conditions.

Metro's travel model includes forecasts for jobs and population growth averaged at the Transportation Analysis Zone (TAZ) level, roughly equivalent in size to a Census Tract. Plan amendments typically evaluate changes within an area equivalent to a few TAZs; therefore, the model is less useful at evaluating access for plan amendments and other sub-regional geographies. Access to destinations/opportunity for existing conditions can be evaluated with greater precision by combining GIS data on destinations with travel times calculated using transit performance and vehicle speed data to reflect the effects of traffic congestion. Metro's travel model does not provide forecasted destination, transit performance, or vehicle speed data at comparable levels of precision, making Access evaluations under forecasted conditions less precise and difficult to compare to existing conditions.

VMT/capita

Measures of VMT/capita start with measures of VMT. Both current and future VMT are evaluated using Metro's regional travel model, which models and forecasts travel within the four-county Portland metropolitan area. The model is validated against observed travel, employment, and population for a 2015 base year; travel in future years (2027 and 2040) is forecasted using regional assumptions about jobs and population growth, along with planned changes in transportation infrastructure, services, and policy. The model differentiates between passenger and freight travel and generates trips based on household size and the number and type of jobs within the metropolitan area.

VMT metrics evaluated include:

- All (passenger) VMT: All vehicle travel by passenger and commercial vehicles, assigned to the network within a specific geographic boundary. Vehicle volume on each network link is multiplied by link distance.
- Home-Based VMT: All passenger vehicle travel that begins or ends at the traveler's home; includes trips to and from work, shopping, school, recreation, etc.; does not include vehicle travel associated with deliveries or in-home services.
- Commute VMT: All passenger vehicle travel between the traveler's home and work; does not include trips that stop at an intermediate location between home and work (e.g., trips to work that include a school drop off).

VMT/capita is a measure of VMT divided by a defined population, such as the number of households, residents, or employees within the study area. VMT/capita metrics fall under two broad categories:

- *Ratio metrics*, such as VMT/capita as developed for the 2018 RTP Update, in which all passenger VMT is divided by the total population of residents or employees in the area under study, and
- *Rate metrics*, such as commute VMT/employee or home-based VMT/capita, in which passenger VMT generated by specific types of trips to or from an area is divided by the population residents and employees who generate it.

Metro currently evaluates two VMT ratio metrics in its Regional Transportation Plan:

- VMT/capita (all passenger VMT divided by all residents), and

- VMT/employee (all passenger VMT divided by all employees).

These metrics capture non-commute and non-home-based passenger travel, such as trips between workplaces and shopping or recreation destinations.

While VMT rate metrics capture a wide spectrum of passenger vehicle travel, they do not closely tie VMT to the land uses that generate it. To assess how smaller-scale land use and transportation decisions affect VMT, these case studies evaluate VMT ratio metrics, including:

- Home-based VMT/capita, which divides VMT generated by trips that start or end at home by the number of people living in the study area;
- All VMT/capita, which divides VMT generated by passenger trips that start in a study area by the number of people living in that study area;
- Commute VMT/employee, which divides VMT generated by trips between home and work by the number of jobs in the study area; and
- All VMT/employee, which divides VMT generated by passenger trips that end in a study area by the number of jobs in that study area.

Reflecting the assumptions built into the Metro regional travel model, these case studies assume that Metro's 2018 Regional Transportation Plan will be implemented with projected revenue sources (the 2040 fiscally constrained scenario).

Ease of application

The two performance measures are substantially different in how easy they are to apply. VMT/capita is evaluated and forecasted using Metro's regional travel demand model alone.

Questions addressed

The project team explored the following questions for these measures, as summarized in the following sections:

- Can Access to destinations/opportunity be confidently evaluated for existing and future conditions?
- Which VMT/capita metrics are most useful for different land use contexts?
- How sensitive are model calculations of VMT/capita to changes in land use?

Can Access to destinations/opportunity be confidently evaluated for existing and future conditions?

Access to destinations/opportunity can be estimated with great accuracy and precision for existing conditions and with much less accuracy and precision for future (forecasted) conditions. To provide consistent results for existing and forecasted conditions, Metro spatial analysts recommend combining spatial data on destinations with travel times calculated using Metro's travel model.

Consultants reviewed the 2018 RTP's technical appendixes and spoke with Metro modelers to better understand their experience of evaluating Access to destinations/opportunity for the RTP using the

Metro travel demand model. This review identified the following challenges with evaluating Access to destinations/opportunity under both existing and future conditions:

- Spatial data on destinations of all types is available for existing conditions but not for forecasted conditions. Metro's travel model includes forecasts for jobs and population growth but does not forecast changes in the locations of community destinations. Analysts must either make assumptions about the future locations of community destinations or assume that they will not change over the next 10-20 years.
- Spatial data is available at greater levels of resolution for existing conditions than for forecasted definitions. Under existing conditions, the street addresses of jobs and community destinations can be used to evaluate access. Under future (forecasted) conditions, jobs and populations are averaged at the Transportation Analysis Zone (TAZ) level. Plan amendments frequently evaluate land use and transportation changes within just a few TAZs; as a result, forecasted measures of access are less meaningful at the plan amendment scale.
- Travel times by different modes can be estimated with great accuracy for existing conditions but not for forecasted conditions, due to how the model estimates transit travel time and its relatively coarse assessment of traffic congestion.
- The 2018 RTP found that the travel demand model was not a robust tool to evaluating walking and bicycling modes, due to the model's scale of analysis and assumptions about travel behavior. Therefore, while Access to destinations/opportunity can be accurately evaluated for walking and bicycling under existing conditions, it cannot be accurately evaluated under forecasted conditions.

What VMT/Capita output is most useful for different land use contexts?

The following case studies evaluate VMT/capita metrics applied to the Metro Regional Transportation Plan, the Colwood Industrial District, downtown areas in Portland and Oregon City, and the development of the South Hillsboro neighborhood. VMT/capita metrics for land use sub-areas are compared to regional and citywide averages as well as to the Oregon Transportation Planning Rule requirement that new plans do not increase VMT/capita by more than 5% and target of reducing VMT/capita by 5% or more.

Metro 2018 Regional Transportation Plan Update

The 2018 Regional Transportation Plan Update (2018 RTP) is the Metro region's 25-year plan to accommodate population and jobs growth by investing in transportation infrastructure and programming. The 2018 RTP envisions the future of transportation in the Metro region as an integrated, multi-modal system where people are increasingly able to meet their needs by using transit, carpooling, bicycling, and walking. To that end, the 2018 RTP sets a target that VMT/capita will be 10% lower in 2040 than in 2015.

The 2018 RTP evaluated VMT/capita (all passenger VMT divided by all residents) and VMT/employee (all passenger VMT divided by all employees) at the regional scale for three scenarios:

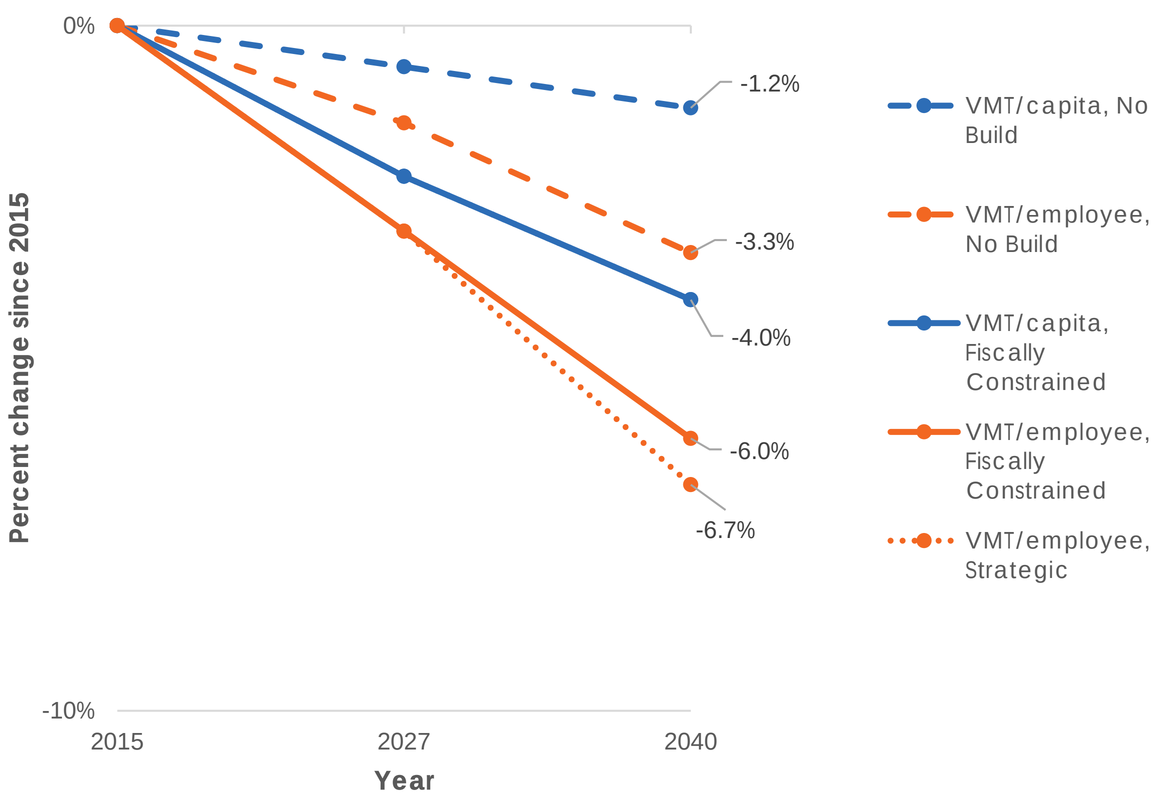
- No Build, which assumes that only projects with fully committed funding as of 2018 would be constructed;

- Fiscally Constrained, which assumes that transportation funding will continue according to current projections; and
- Strategic, which assumes that additional transportation funding will become available, allowing greater investment in infrastructure and programming.

The 2018 RTP estimates that, from 2015 to 2040, the region's population will grow by about 1/3 (36%) and employment will grow slightly more (39%). As a result, total VMT will grow even though average VMT per person will decline. As shown in Exhibit 2, all scenarios would see decreases in average VMT/capita and average VMT/employee, although the investments made under the Fiscally Constrained scenario would reduce these substantially more compared to the No Build scenario. The Strategic scenario would reduce VMT/employee slightly more than the Fiscally Constrained scenario (6.7% vs. 6.0%); it would not provide a substantial reduction in VMT/capita compared to the Fiscally Constrained scenario (4.0% vs. 4.0%). None of the scenarios, including the Strategic scenario, would achieve the 10% VMT/capita reduction target identified in the 2018 RTP.

(Note that Exhibit 2 shows VMT/capita ratio metrics, not the rate metrics that will be evaluated throughout the rest of this memorandum.)

Exhibit 2. Change in average passenger VMT within Metro Planning Area, 2015-2040*



* Note: Exhibit 2 shows VMT ratio metrics as calculated for the 2018 RTP's performance targets.

Change from 2015 to 2040 was also evaluated for the VMT rate metrics (home-based VMT/capita and commute VMT/employees). Exhibit 3 shows how the 2018 RTP performs when VMT rate metrics are applied under the Fiscally Constrained scenario. Home-based VMT/capita declines about the same amount as the VMT/capita metric shown in Exhibit 2 (4.2% vs. 4.0%); Commute VMT/employee declines about 1/3 more (8.1% vs. 6.0%). This reflects that many of the long-term investments identified under the Fiscally Constrained scenario would expand transit capacity to centers and along corridors that are projected to have substantial jobs and housing growth, improving how well the region's transit system serves commute trips.

For Metro's Equity Focus Areas (EFAs), which have higher than average concentrations of people of color, people with low incomes, and/or people with limited English proficiency, results are similar. As shown in Exhibit 4, the EFAs show a somewhat smaller reduction in Commute VMT/employee than the region overall, but a somewhat larger reduction in Home-based VMT/capita. When measured using Home-based VMT/capita, neither the Equity Focus Areas nor the region as a whole achieve the 10% VMT/capita reduction target.

Exhibit 3. Metro Region Change in VMT/capita, 2015-2040

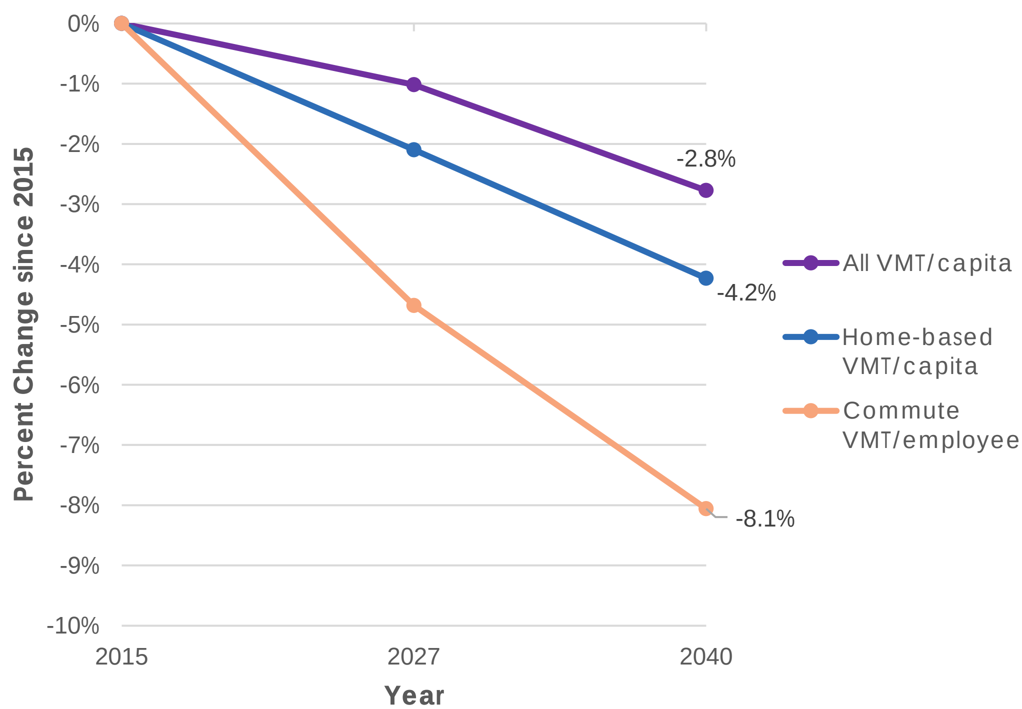
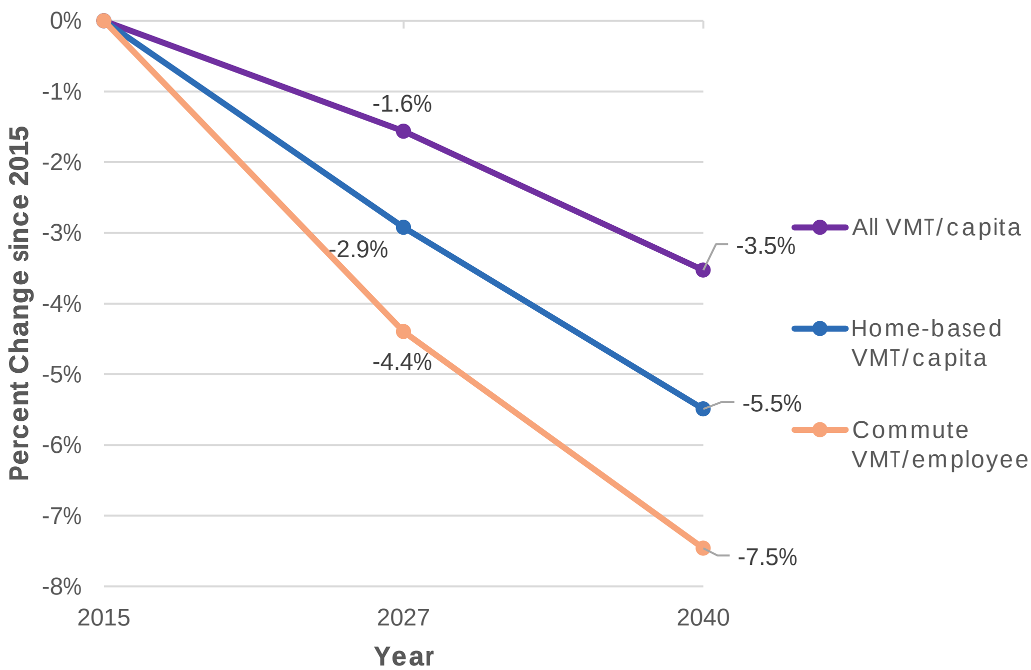


Exhibit 4. Metro Region Change in VMT/capita, 2015-2040 - Equity Focus Areas



Colwood Plan Amendment

The Colwood Plan Amendment (Portland, OR) was adopted in 2013 as a legislative amendment to Portland's Comprehensive Plan, enabling the redevelopment of the Colwood Golf Course as industrial land. The industrial use would add approximately 1,100 jobs to the area, just over 50% more than already existed at the time of the amendment. A Transportation Impact Analysis study for the plan amendment identified auto capacity expansion projects at three nearby intersections to mitigate traffic congestion and comply with Oregon's Transportation Planning Rule.

Industrial jobs are generally located far from housing, other commercial land uses, and transit, and industrial workers may need to travel outside of peak commute hours, when transit is infrequent or not provided at all. As a result, industrial areas typically generate more Commute VMT/employee than the average employment center. As shown in Table 5, jobs in Colwood would generate more commute VMT/employee in 2040 than the average in the Metro region. However, Colwood would see a slight reduction in VMT/employee from 2015 to 2040 (1.2% vs. 8.1% for the region as a whole), while seeing a greater proportional growth in jobs (53% vs. 43% for the region as a whole). Colwood therefore would conform to the Oregon Transportation Planning Rule requirement that that new plans not increase VMT/capita by more than 5%.

Table 5. Colwood Commute VMT/employee

Area	Commute VMT/ Employee, 2040 Fiscally Constrained Scenario	Change in Commute VMT/Employee, 2015-2040	Jobs Growth, 2015-2040
Colwood	12.0	-1.2%	53%
Metro Region	9.5	-8.1%	43%

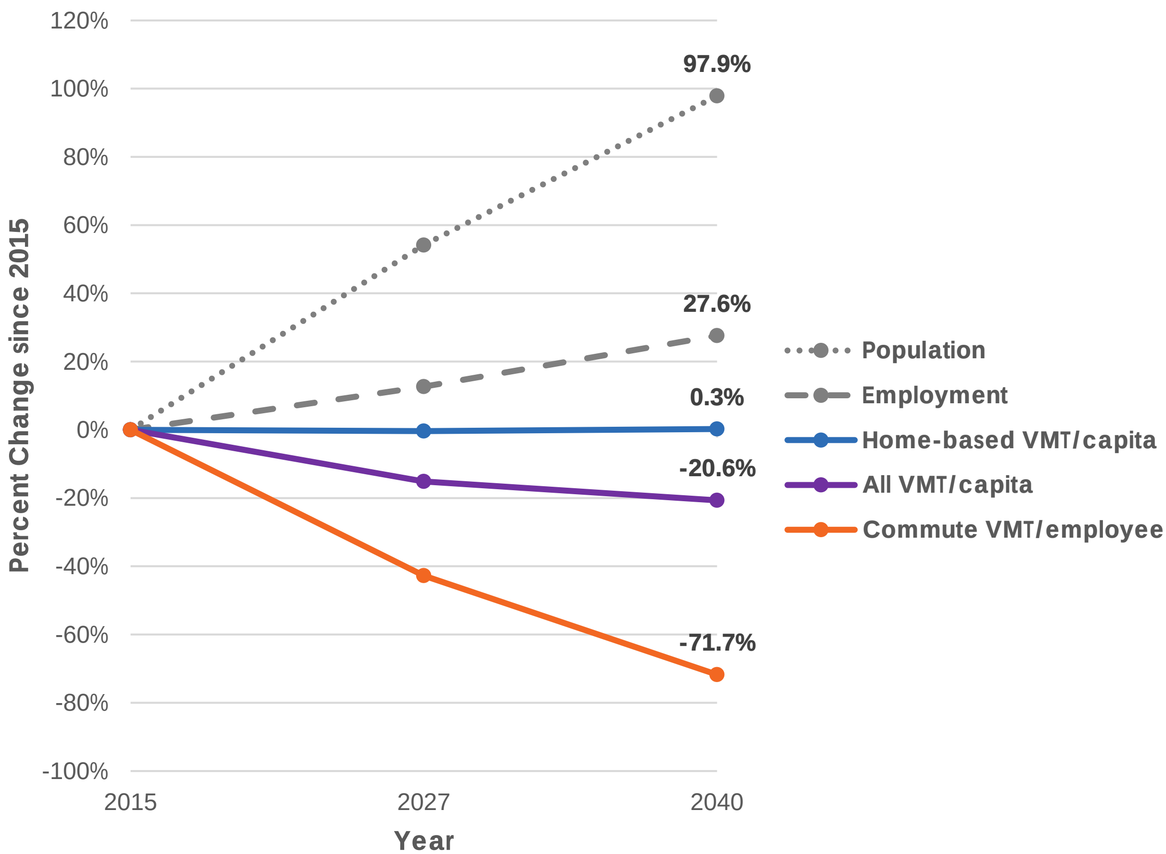
Home-based VMT/capita was not evaluated for Colwood due to the small number of households in the area (fewer than 100 from 2015 to 2040).

Central City Multimodal Mixed-Use Area

The Central City Multimodal Mixed-Use Area (MMA) was established in Portland, OR to permit the continued growth of Portland's city core while complying with Oregon's Transportation Planning Rule. The MMA designation exempts dense neighborhoods that feature well-connected streets, transit service, and a mix of multifamily housing, office, and retail land uses from TPR performance standards related to vehicle congestion. The City of Portland secured grant funding from the state and conducted a feasibility study to demonstrate that the Portland Central City qualified as an MMA.

As shown in Exhibit 5**,** the Central City MMA would see its population double and its jobs grow by about ¼ between 2015 and 2040. Home-based VMT/capita would rise only slightly (less than 1%) in an area where residents already generate less VMT than the average Metro region resident (4.2 Home-based VMT/capita in the MMA vs. 11.0 in the region overall, as of 2015). Over the same period, Commute VMT/employee would drop by over 70 percent, reflecting planned investments in transit access to central Portland from throughout the Metro region.

Exhibit 5. Change in VMT/capita, Portland Central City MMA, 2015-2040

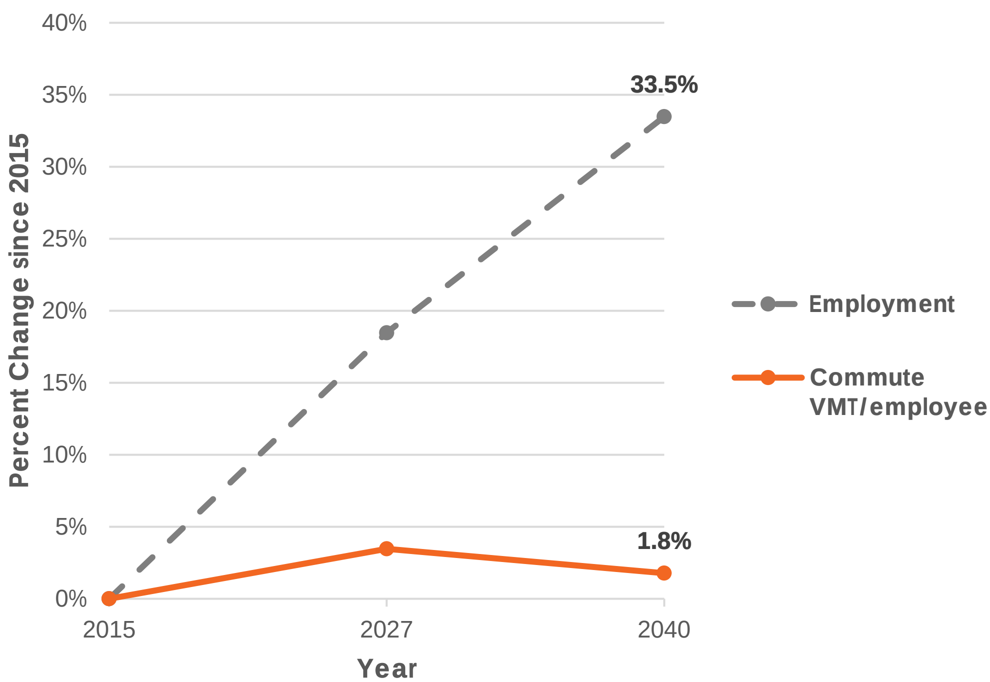


Oregon City Mixed-Use Multimodal Area

In 2014, Oregon City secured an MMA designation to allow for future growth in its downtown area. Downtown Oregon City is bordered by the Willamette River, a decommissioned paper mill on the site of the Willamette Falls, and a high bluff that separates downtown from much of the City's residential neighborhoods. This geography and otherwise limited access by transit and road creates auto congestion that exceeds current OHP and RMP standards.

As shown in Exhibit 6, growth in downtown Oregon City and the redevelopment of the paper mill site are projected to increase employment by 1/3 from 2015 to 2040 while increasing Commute VMT/employee by no more than 2%. Commute VMT/employee is projected to increase by more than 2% in Oregon City overall during the same time period; the relatively low increase in the Oregon City MMA may reflect its walkable, well-connected street grid and mix of office, retail, and services. The increase to Commute VMT/employee conforms to the Oregon Transportation Planning Rule requirement that new plans not increase VMT/capita by more than 5%.

Exhibit 6. Employment vs. Commute VMT/employee growth, Oregon City MMA



South Hillsboro Community Plan

The South Hillsboro Community Plan (Hillsboro, OR) was adopted as a legislative plan amendment that enabled the development of Reed's Crossing, a master-planned, 463-acre neighborhood in South Hillsboro. The new neighborhood would add as many as 4,000 housing units along with several hundred thousand square feet of retail and commercial space, along with supportive schools, parks, and community spaces, constructed in four phases between 2017 and 2031. Between 2015 and 2040, Metro estimates that the area would add 22,300 residents, or about 90 times the 2015 population, and nearly 1,300 jobs, or about 11 times the jobs present in 2015.

While most of the land area would be dedicated to detached single-family housing, the neighborhood would feature pedestrian-oriented design and a mixed-use town center, two features that tend to encourage walking and bicycling and to enable transit use. Developing a mix of uses in an area with low-density agricultural and industrial jobs could also enable people who work in the area to live near their jobs. These elements would tend to result in lower VMT per capita for people living and working in the neighborhood even as overall VMT in the area would rise with the addition of jobs and residents.

Despite these design elements, single-family residential neighborhoods tend to generate more VMT/capita than denser mixed use neighborhoods, especially those served by transit. As shown in Exhibit 7, people living in South Hillsboro would generate more VMT, on average, than residents of the City of Hillsboro and the overall Metro Region. This likely reflects South Hillsboro's limited transit access and predominantly residential character. However, people *working* in South Hillsboro would generate less VMT, on average, than their peers in Hillsboro and the region. As shown in Exhibit 8, commute VMT/employee in South Hillsboro would decline substantially even as all commute VMT and all VMT generated by travel to the area increases.

Exhibit 7. South Hillsboro home-based VMT/capita and commute VMT/employee (vs. City of Hillsboro and Metro Region), 2040 Fiscally Constrained Forecast

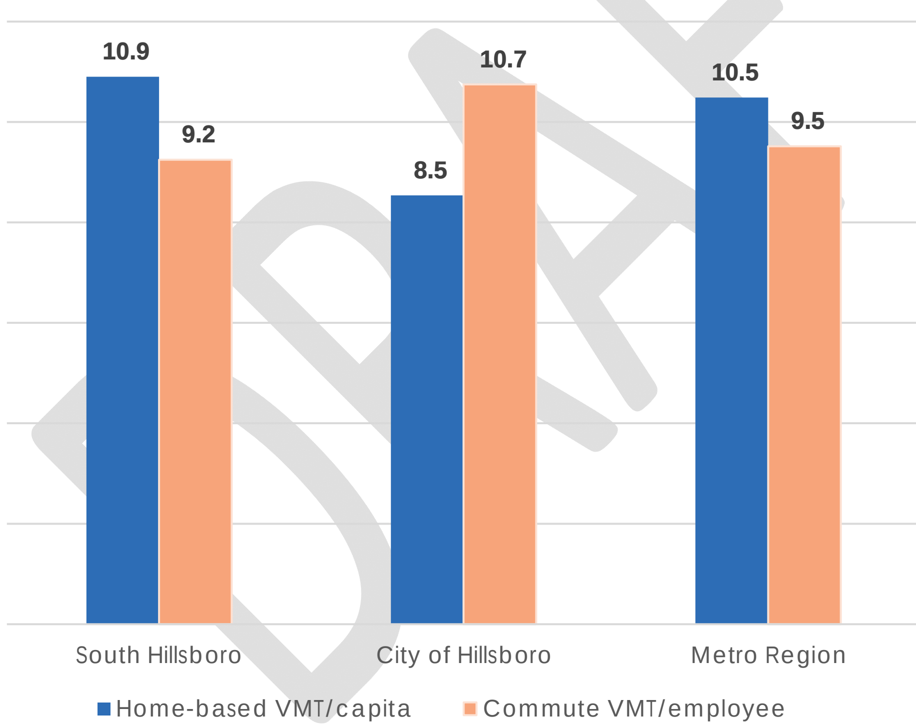
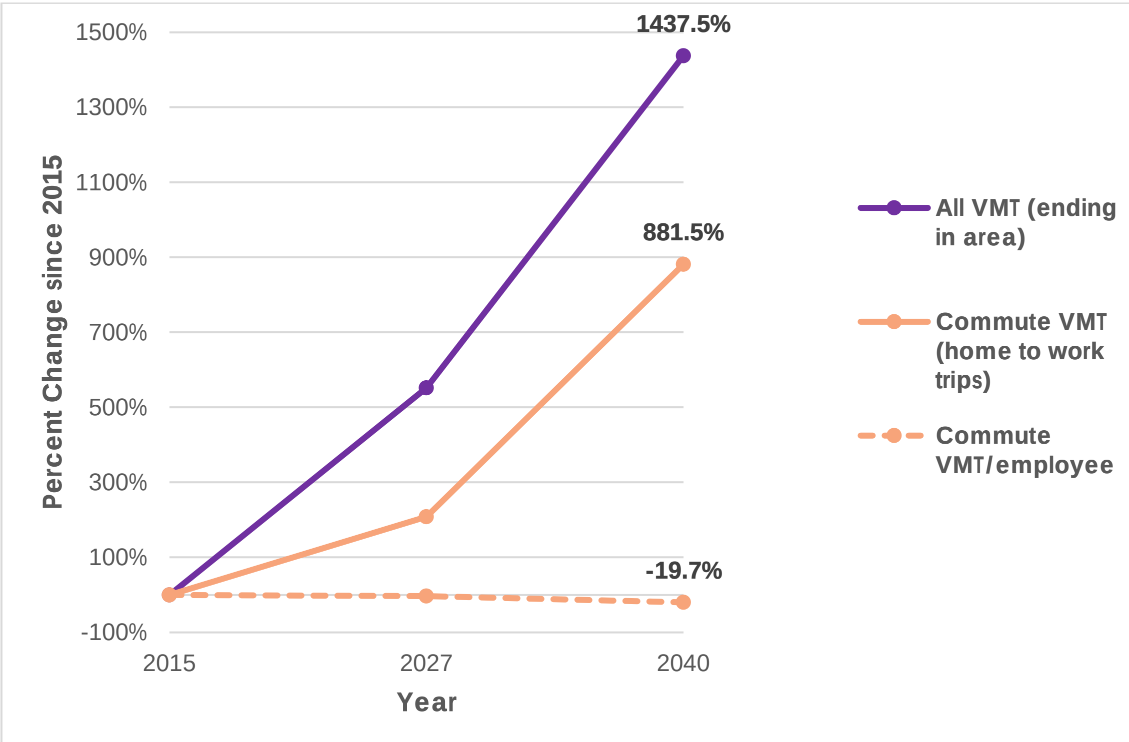


Exhibit 8. South Hillsboro, Change in Commute VMT/employee, 2015-2040



How sensitive are the model outputs to changes in land use?

Focused sensitivity testing on the home-based VMT/capita and commute VMT/employee metrics was conducted for the Colwood and South Hillsboro study areas. To ensure that the transportation investments and policy changes modeled in the 2040 Fiscally Constrained scenario would reliably reduce VMT/capita under different growth scenarios, study areas in the 2040 model network were updated with population and employment levels from 2015 and 2027 scenarios. Table 6 describes how model year variables were assigned to the sensitivity testing scenarios discussed below.

Table 6: Sensitivity Testing Scenario Definitions

Scenario	Variables from model year		
	Population	**Employment**	**Model Network**
2015	2015	2015	2015
No growth	2015	2015	2040
2027 FC	2027	2027	2027
Minimal growth	2027	2027	2040
2040 FC	2040	2040	2040
Household-only growth	2040	2015	2040

Source: Metro Travel Demand Modeling staff, 2021.

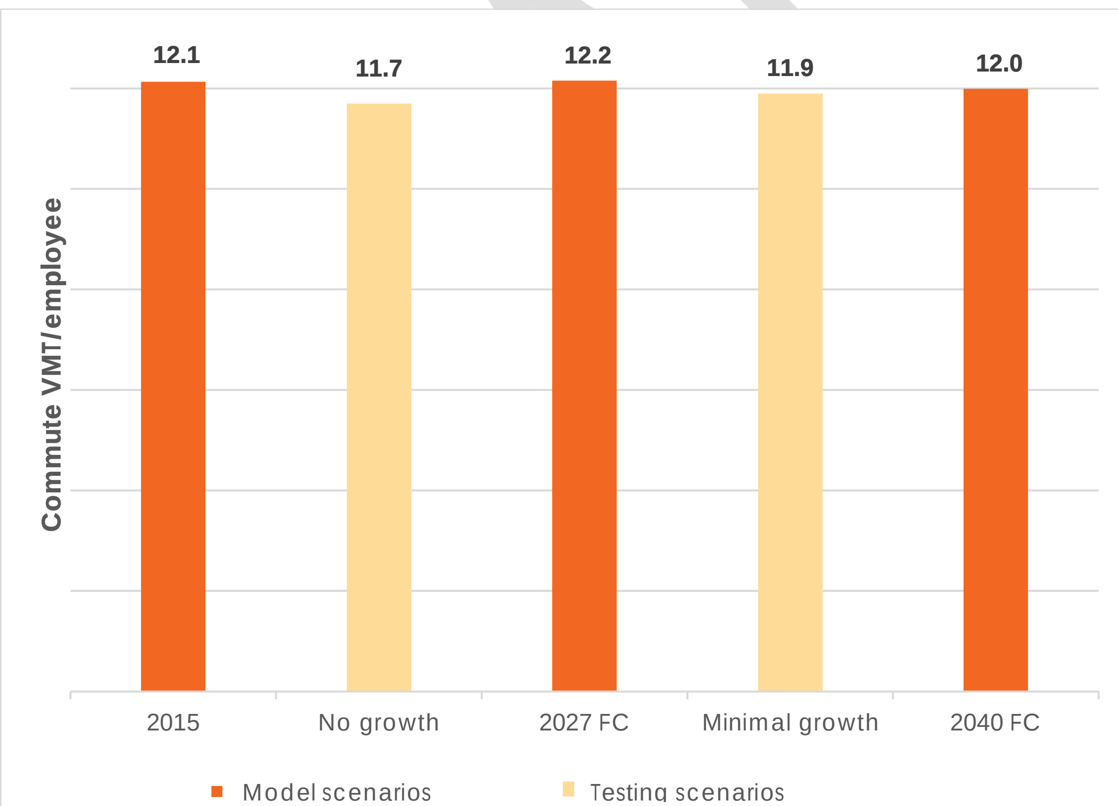
These scenarios were evaluated for Commute VMT/employee and for Home-based VMT/resident. The assessment found that while the model produces reliable and meaningful VMT/capita results at the neighborhood level, it cannot reliably produce VMT/capita metrics for very small populations of residents or employees.

Strength: Predictable results for neighborhood-level analysis

Evaluating Commute VMT/capita under the sensitivity testing scenarios and the model scenarios demonstrates that the transportation improvements and policy changes assumed under the 2040 Fiscally Constrained (2040 FC) scenario would reduce the need to drive even at lower levels of employment.

Within the Colwood study area, the scenarios evaluated using the 2040 FC model network (No growth, Minimal growth, and 2040 FC) showed slightly lower Commute VMT/employee than the scenarios evaluated using the 2015 and 2027 FC networks. As shown in Exhibit 9, Commute VMT/capita is lowest in the No growth scenario, in which 2015 levels of employment in the study area are applied within the 2040 FC model network. Adding employment to the study area (under the Minimal growth and 2040 FC scenarios) results in a slight increase in VMT/capita, possibly due to the model assumptions that increased employment would draw workers from more distant neighborhoods. Overall, however, the transportation investments and related policy changes under the 2040 FC scenario would have only a small effect on Commute VMT/employee within the plan amendment study area.

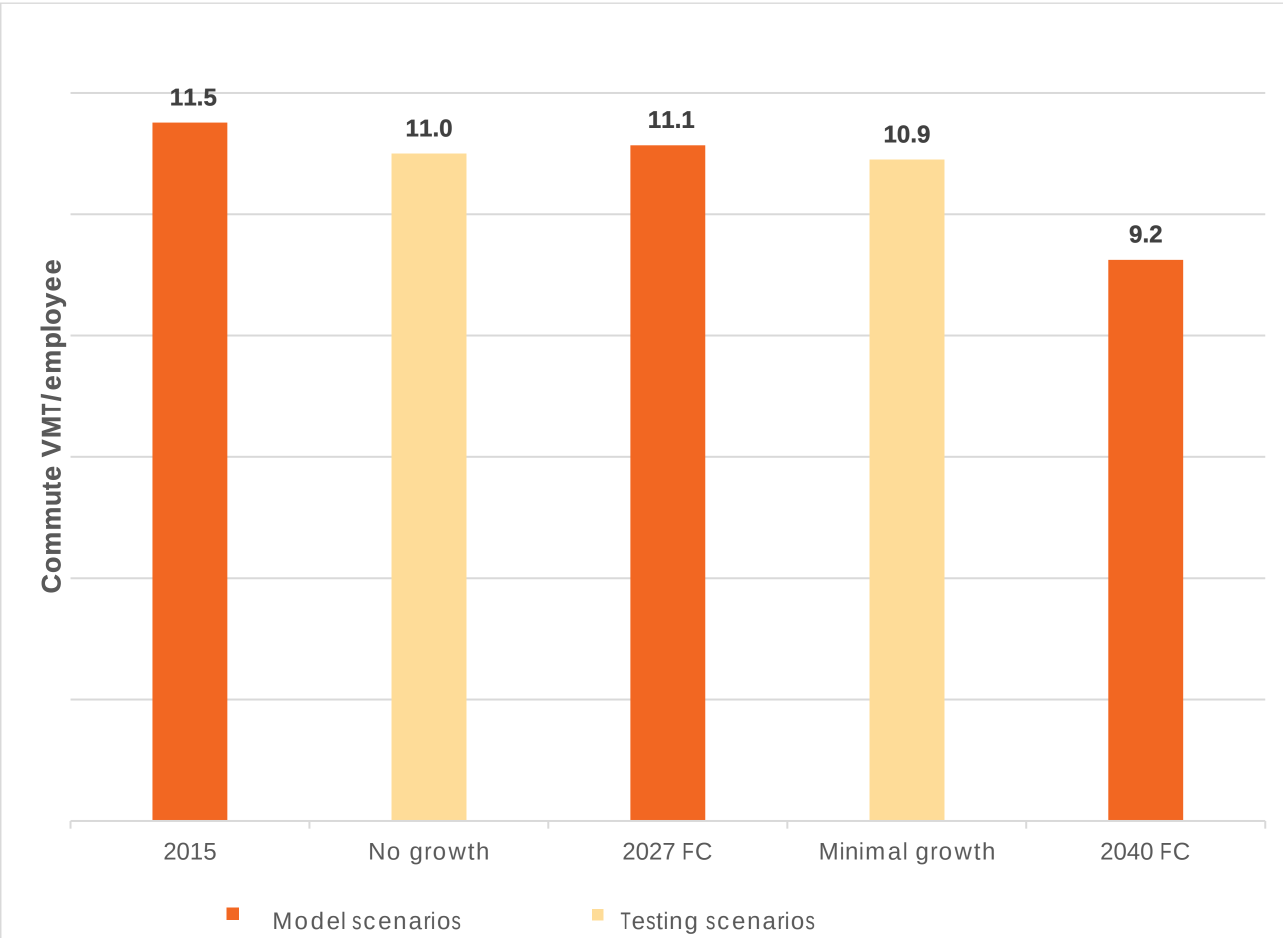
Exhibit 9. Colwood, Commute VMT/employee under multiple scenarios



Evaluating the same scenarios in the South Hillsboro study area shows a greater reduction in VMT/capita, possibly due to land use changes within the study area. As shown in Exhibit 10, Commute VMT/employee is consistently lower under the scenarios evaluated using the 2040 FC model network (No growth, Minimal growth, and 2040 FC) than under the scenarios evaluated using the 2015 and

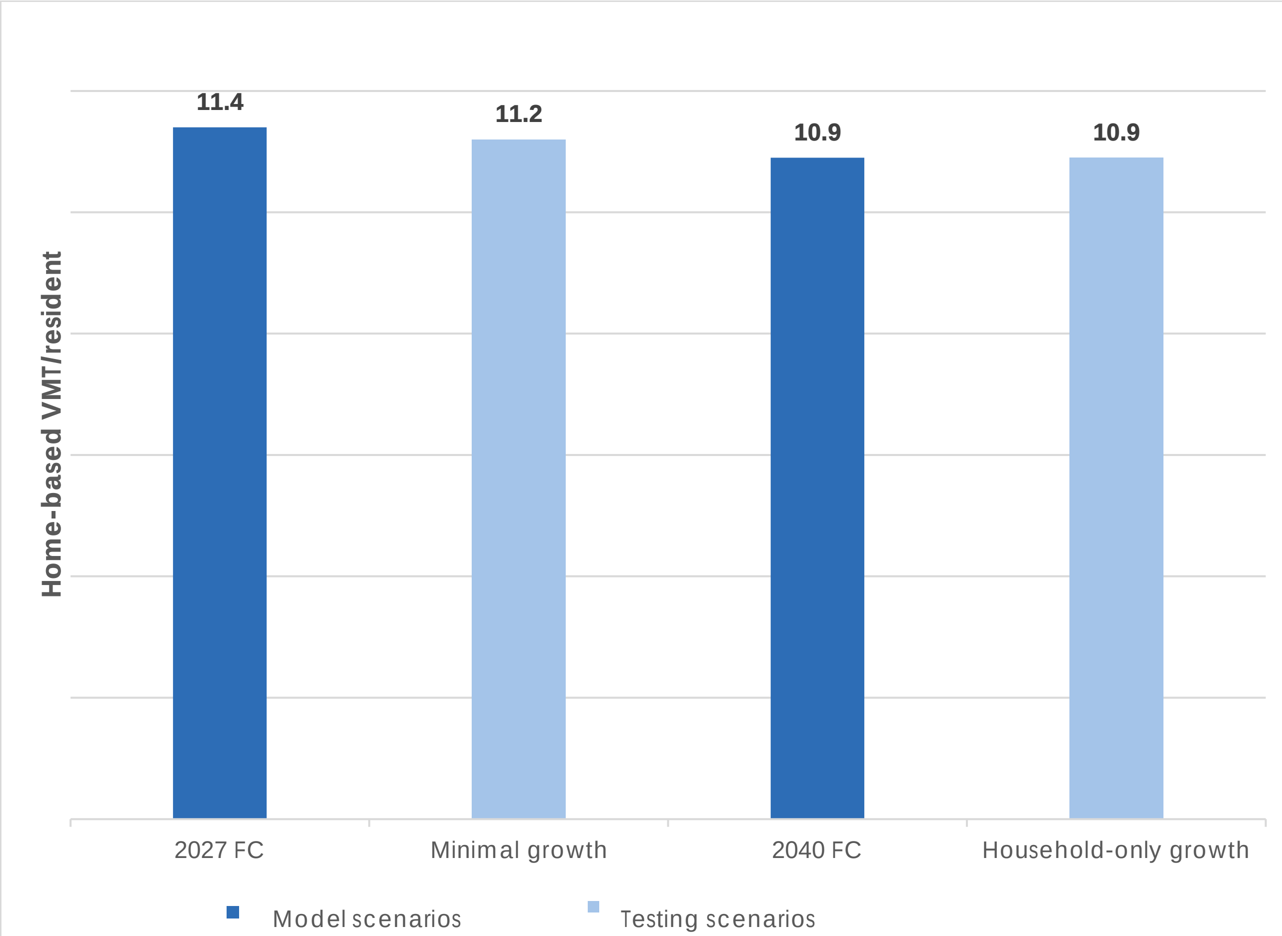
2027 FC networks. Commute VMT/employee is 15% lower (1.7 VMT/employee) under the 2040 FC scenario than under the Minimal growth scenario. This difference could result from model assumptions that the addition of residents within the study area would allow more workers to live close to their jobs, thereby reducing the distances they must drive when commuting.

Exhibit 10. South Hillsboro, Commute VMT/employee under multiple scenarios



A second analysis was conducted for South Hillsboro to assess how Home-based VMT/capita responds to growth in housing without corresponding growth in employment. Exhibit 11 shows Home-based VMT/capita under the 2027 FC, Minimal growth, 2040 FC, and Household-only growth scenarios. (Since there are very few households in the 2015 model, the 2015 and No-growth scenarios could not be reliably evaluated.) Consistent with results from the Commute VMT/employee analysis, Home-based VMT/resident is consistently lower under the scenarios evaluated using the 2040 FC model network (Minimal growth, 2040 FC, and Household-only growth) than under the scenarios evaluated using 2027 FC network. Removing 2015-2040 FC employment growth (under the Household-only growth scenario) has no effect on Home-based VMT/resident. Under the 2040 FC scenario, population in the study area would grow by about 22,000 residents and about 1,200 employees; under the Household-only growth scenario, the same number of residents, but no employees, would be added to the study area. Comparing the results in Exhibit 10 to the results in Exhibit 11, it appears that Commute VMT is more sensitive to changes in local jobs/housing balance than Home-based VMT.

Exhibit 11. South Hillsboro, Home-based VMT/capita under multiple scenarios



Limitation: Evaluating isolated and/or new land uses

The Colwood and South Hillsboro case studies indicates that the Metro regional travel model has a limited ability to evaluate conditions for isolated and new land uses.

In South Hillsboro, an entirely new neighborhood located in an area that was previously undeveloped, the regional travel model was not able to evaluate how home-based VMT/capita changed from 2015 to 2040 simply because the area had fewer than 100 households in 2015, and therefore home-based VMT/capita could not be estimated with confidence. (Comparing home-based VMT/capita in 2040 in South Hillsboro, the City of Hillsboro, and the Metro Region, however, suggests that the model does reflect how density, neighborhood design, and transit access affect the measure.) A VMT/capita policy should provide guidance for evaluating new growth that would substantially change the intensity and nature of existing land uses.

In Colwood, a primarily industrial area, the model could evaluate employee commute VMT/capita with confidence. However, the low number of households in the area (fewer than 100 between 2015 and 2040) meant that the model was not able to confidently evaluate home-based VMT/capita. This does not necessarily mean that results are inaccurate, since home-based VMT would make up only a small share of the total VMT generated in the area. However, it shows that a VMT/capita policy must be written to ensure that analysis is relevant to the area in question and reflects the capacities of the regional travel model.

Limitation: VMT varies in response to variables that the model does not control for

[insert discussion of demographics/residential selection effect issues and job types issues raised in Brian Dunn's comments*; also note increase in VMT with increase in income*

What did we learn?

Whether measured using a ratio metric (VMT/capita and VMT/employee) or a rate metric (Home-based VMT/capita and Commute VMT/employee), VMT/capita is projected to decline from 2015 to 2040 in the Metro region and in several plan areas. Where VMT/capita is projected to increase, those increases are small (less than 5%) and in conformance with TPR guidance that cities should limit VMT/capita growth to 5% or less. The variation between VMT/capita results can be attributed to both transportation investments and increased mixing of land uses.

The sensitivity testing conducted in the Colwood and South Hillsboro plan amendment study areas indicate that VMT/capita metrics are reliably responsive to modeled land use changes.. In-depth sensitivity testing to evaluate how different infrastructure packages would affect these metrics has not been completed. The 2018 RTP evaluated VMT/capita and VMT/employee for multiple scenarios; however, the small differences between the Fiscally Constrained and Strategic scenarios indicates that VMT/capita is either not particularly sensitive to infrastructure changes alone or that the Strategic infrastructure package includes elements that would both reduce and increase VMT/capita.

Policy Considerations

Both VMT/capita and Access to destinations/opportunity reflect the efficiency and usefulness of the combined transportation and land use system,. Of the two, VMT/capita can be evaluated in congruent ways for both existing and future conditions, and can be evaluated for multiple scales, from plan amendments to regional evaluations. Therefore, we recommend the following approach:

- **Apply VMT/capita as a primary system performance measure**, alongside performance measures that evaluate both system operations and system completeness. VMT/capita can be applied in the following ways:
  - *Identifying system needs and system adequacy in system planning:* For TSPs and large sub-area plans, forecasted VMT/capita can be compared to the existing condition to determine if land use changes or improvements to multimodal access are needed or would help to reduce VMT/capita.
  - Evaluating the transportation/mobility impacts of land use decisions in plan amendments: For TSPs and large sub-area plans, forecasted VMT/capita can be compared to the existing condition to determine if the plan amendment would result in a reduction in VMT/capita or an increase, which could be a negative impact that requires mitigation or changes to the plan.
  - Evaluating mitigations when a threshold of significance is exceeded: For system planning and sub-area planning, Metro's travel demand model can be used to evaluate the VMT/capita differences between plan alternatives with different levels of land use density and diversity. However, the model
- **Support the use of Access to destinations/opportunity as a planning tool,** especially when:
  - Planning networks for specific travel modes to ensure that they meet community needs;

- o Evaluating alternative land use and transportation scenarios in a comprehensive plan; and
- o Measuring overall system usefulness for different populations within the Metro region.

LTS and Pedestrian Crossing Index

Level of traffic stress (LTS) classifies points and segments on routes into different categories of stress ranging from 1 (low stress) to 4 (high stress) based on factors that correlate to the comfort and safety of the bicyclist or pedestrian using that facility.

Pedestrian crossing index is the percent of a corridor or roadway segment meeting the pedestrian crossing target spacing.

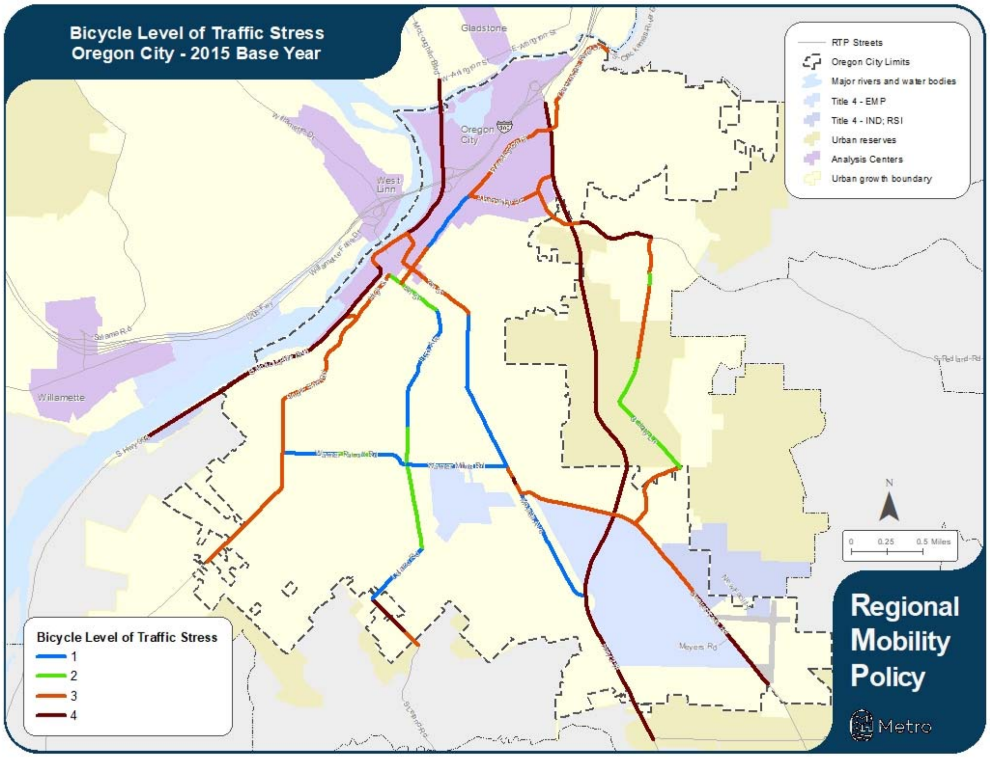
LTS and pedestrian crossing index are multimodal measures that supports equity, access, safety, and options outcomes. Pedestrian crossing index also supports efficiency outcomes. The project team wanted to explore the following questions for these measures, as summarized in the following sections:

- Would a different system have been planned if LTS was the target?
- How useful is the current pedestrian crossing dataset?
- Can the same process used by ODOT be used at a regional/local level?

Would a different system have been planned if LTS was the target?

LTS analyses most often use a target of 2, which will encourage most of the potential bike-riding population to consider riding. A BLTS 2 target can be difficult to meet, especially on high-speed roadways. Most local system planning does not attempt to meet a BLTS 2 on all non-freeway throughways and arterials because it is cost-prohibitive, often looking to complete the system instead of creating a fully low-stress system. For example, the Oregon City TSP does not include a project for the section of OR 213 from Meyers Road to the southern city limits because it already has bike lanes. But this segment, as shown in Figure 27, does not have a BLTS 2 rating due to the number of lanes and high speed. In fact, there is no BLTS 2 rating achievable for a speed equal to or greater than 40 mph when there is no adjacent parking. If a BLTS target of 2 was used, the Oregon City TSP would have included a much different system (reducing travel lanes or requiring right-of-way for parallel off-street facilities) or have not met the target at many locations with restrictions such as travel speed or available roadway width to include buffers. In addition, many cities prioritize filling gaps in their system over updating existing facilities that may not meet the ideal conditions.

Figure 27. Bicycle Level of Traffic Street Oregon City – 2015 Base Year



How useful is the current pedestrian crossing dataset?

ODOT currently has a good dataset that will be used to calculate the percent of state priority corridors meeting target crossing spacing for the annual Key Performance Measures report. Although the dataset is usable, additional updates are recommended, including the street that is crossed for each location. Metro does not currently have a full pedestrian crossing dataset, but there is an Open Street Maps (OSM) dataset that can be accessed. Metro GIS staff completed an initial review of this open-source dataset for relative accuracy and consistency across the region. It was a quick evaluation of a random sample of 400 points. Metro shared the following insights based on this review:

- Of the 400 points evaluated, 92% were in the right location, however only 24% had an attribute for the 'type' of crossing. Only 2.2% of the points were mid-block (not located at an intersection).
- The locations of mid-block crossings for trails were accurately identified when part of the dataset.
- While the 'type' was not consistent, the locations were accurate. There's a limit to the analysis completed without the "type" of crossing so there would certainly be a significant effort requires to augment the dataset with that attribute.
- There has not been an evaluation of the completeness of the layer. Does it capture all of the crossings for the entire region, or are there are areas that are missing? This would need to be reviewed and addressed before the dataset is used in any analysis.

- Adding crossing data into RLIS is a project that needs to be added to Metro's work program, scoped, and prioritized. The level of effort is difficult to determine without the determination of completeness..

Based on input from Metro staff, the OSM dataset is a useful first step toward creating a full pedestrian crossing dataset for the region. But it will take significant effort to update the data to be usable for regionwide and subarea analyses, including determining completeness of the dataset and updating or creating attributes. Attributes that are necessary or desirable include:

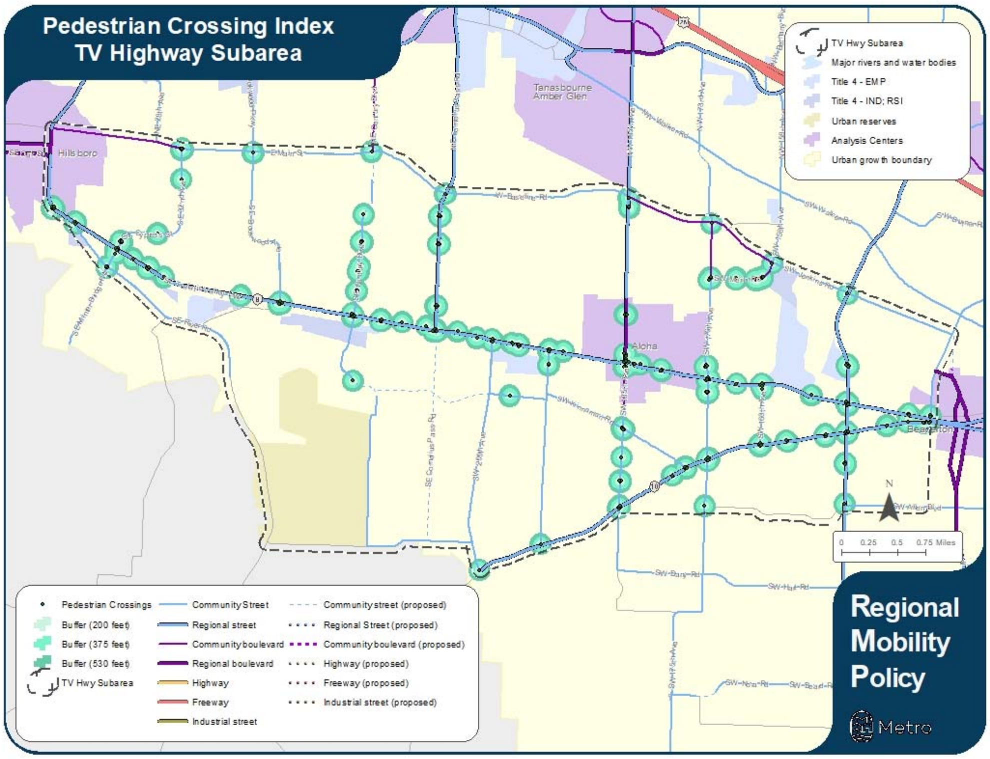
- Roadway ID for the street that is crossed
- Milepoint of the crossing on the roadway that is crossed, ideally based on Metro's linear referencing method (LRM) system
    - If the dataset is already being updated, adding this level of information will simply automation of the measure calculation and remove assumptions that would be included if the location is based on a different referencing system.
- Roadway classification that is linked to target setting (i.e. if the Metro regional design classification is used for setting crossing spacing targets, then it should be included in the dataset to support measure calculation)
    - If roadway ID is included in the dataset, an automated calculation tool may be able to reference a different dataset for roadway classification instead of including it in the crossing dataset itself. Metro GIS staff to support decisions on measure automation and potential use of several datasets.
- Type of crossing (marked, signalized, enhanced)
    - This is not strictly necessary for calculating the measure but would be helpful for other planning uses or to calculate spacing between different types of crossings (i.e. what is the crossing spacing for enhanced crossings?). It is worth including if an effort is moved forward to update and add to the crossing dataset..

Can the same process used by ODOT be used at a regional/local level?

The project team attempted the process that ODOT recently adopted to calculate pedestrian crossing index for their facilities statewide. Because the ODOT scripts are set for a system that has identified its study corridors, a more manual calculation was completed. If pedestrian crossing index is moved forward, a script similar to ODOT's could be created to streamline the process. Without the pedestrian crossing dataset establishing the street being crossed, all reported crossings were included in the buffer area, which will overestimate the available crossings. If pedestrian crossing index is moved forward, additional effort will be needed to update the OSM dataset to include the street crossed.

Even with the more manual procedure, the overall process can be used on any roadway segment that has a pedestrian crossing dataset. The other important data needed is the target spacing. For this case study test, Metro's Designing Livable Streets and Trails Guide was referenced to establish a spacing target. Within the TV Highway subarea, there are regional and community boulevards and regional and community streets. For these design street classifications, crossings are recommended every 200 to 530 feet. As shown in Figure 28, there are many segments of TV Highway within the case study sub area that do not meet the preferred pedestrian spacing. Between SE 10th Avenue and SW Cedar Hills Boulevard, approximately 3.9 miles of TV Highway does not have pedestrian crossings, based on the available dataset and an average target spacing of 375 feet. That segment of the corridor is approximately 8.2 miles long and therefore has a pedestrian crossing index of 52% (4.3 miles with pedestrian crossing meeting a target spacing of 375 feet).

Figure 28. Pedestrian Crossing Index – TV Highway Subarea



Policy Considerations

Achieving an LTS 2 on all arterials is too cost-prohibitive to be set as a standard. Some locations will not meet an LTS 2 unless speed limits or land use context change. Some locations already have facilities that would need to be reconstructed to meet an LTS 2 standard. For many cities in the region, the focus is first on creating a complete system, and LTS would create a very high standard that would not be feasible on many facilities. Standard bike lanes on a typical arterial achieves an LTS 3 which is not attractive to the “interested but concerned” potential bicyclists that applying LTS is intended to achieve.

A city is more likely to be able to create a low-stress network for a select few arterials and collectors in coordination with the local streets that help connect key destinations. This more focused approach would create options for active modes while considering the financial impacts of the planned system.

If pedestrian crossing index will be moved forward, Metro will need to put the crossing dataset in the RLIS work program.

In planning modal networks and identifying transportation projects that enhance the comfort and safety of the multi-modal network for all users, the following could be considered:

- Define the complete walking and biking networks that maximize access to destinations with low-stress routes and address disparities in EFAs.

- Identify locations where lack of safe crossings is limiting access to destinations for people walking, biking and riding transit. Set spacing targets for each facility based on the changing land use context.
- Identify high priority locations for additional or enhanced crossings that connect low-stress walking and biking routes and provide access to transit or that are in high-crash locations.

System Completion

System completion is the percent of planned facilities that are built within a specified network or on a specified corridor/roadway segment.

System completion is a multimodal measure that supports equity, access, efficiency, safety, and options outcomes. The project team wanted to explore the following questions for this measure, as summarized in the following sections:

- How can system completion be applied to system planning?
- How can system completion be applied to plan amendments for developed and undeveloped areas?

How can system completion be applied to system planning?

For system planning, system completion may be incorporated in two ways.

- **Establishing the planned system:** An outcome of system planning is creating a vision for the transportation system, most often split by mode or service. These planned networks become the base for the system completion calculation. Once there is a planned regional or local network established through system planning, future plan amendments, developments, and projects can determine whether they are helping further the completion of the planned system.
- **Comparing alternatives:** Once the overall planned system is envisioned, many agencies find that it is unlikely to acquire the funding to fill all the gaps in the system. Determining the system completion of a fiscally constrained system can show the need for additional funding for completing the multi-modal networks.

Regional System Planning

There are many examples of system completion being established or used in Metro region-wide planning projects. The 2010 Metro TSMO Strategic Plan is an example for establishing a planned system. Exhibit 12 shows the existing and planned fiber optic network for transportation data communications. Another TSMO example is shown in Exhibit 13, which highlights planned and built TSMO corridor strategies.

When the plan is established, the denominator for a system completion analysis is set. The target is then to increase the system completion for the relevant systems. TSMO infrastructure/services may not be a relevant system for every RTP throughway and arterial, similar to how constructing sidewalks may not be relevant on the freeway system.

Exhibit 12. Existing and Planned Regional Fiber Communication Infrastructure

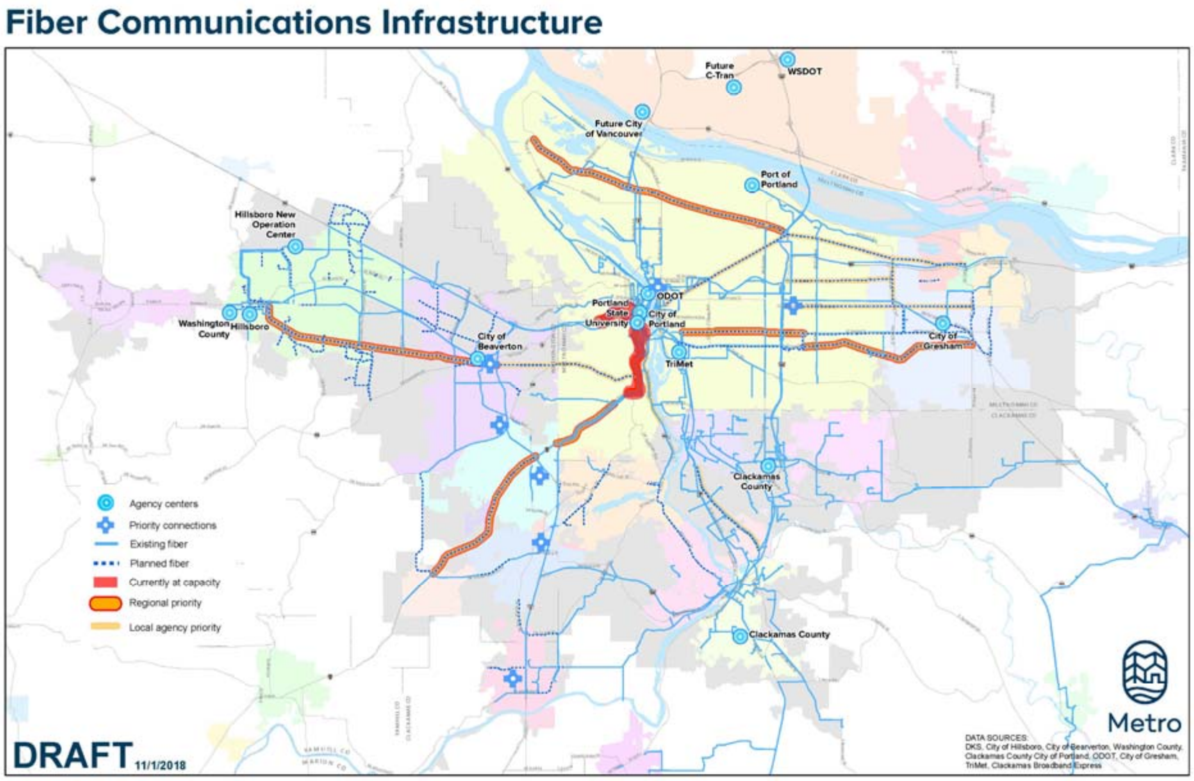
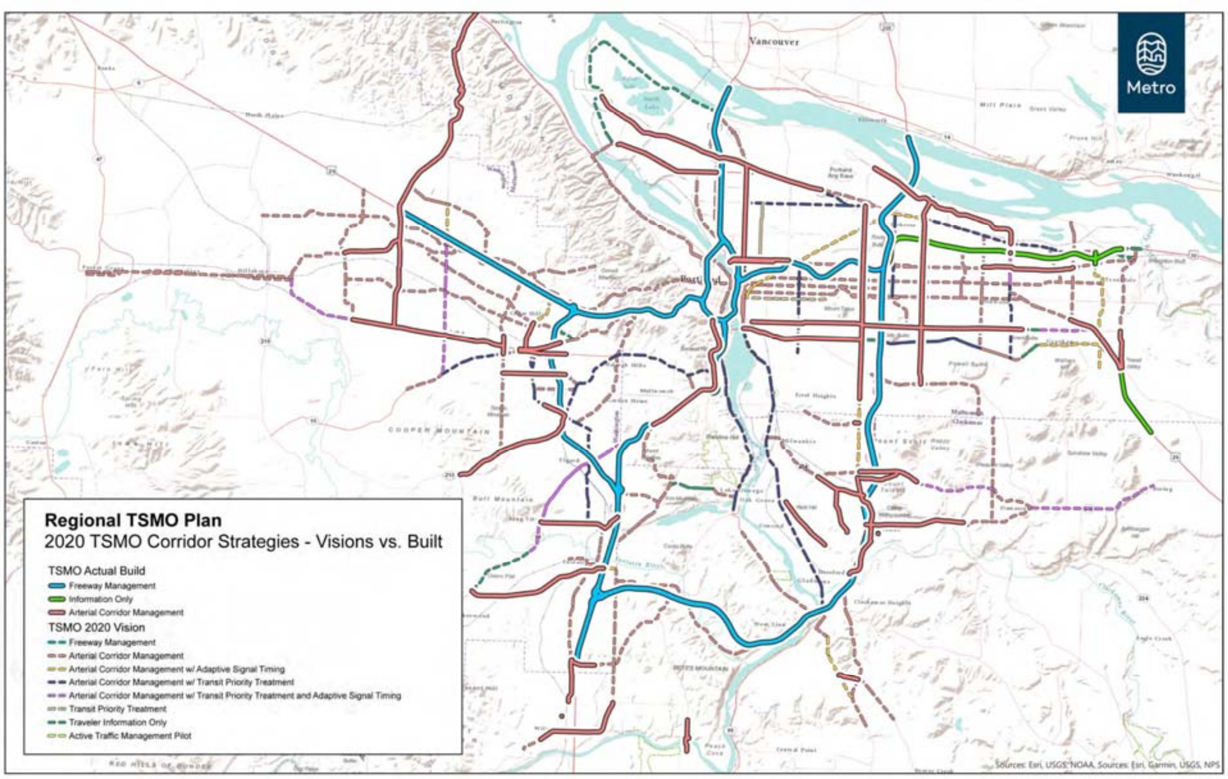


Exhibit 13. Existing and Planned Regional Fiber Communication Infrastructure



Metro's 2018 RTP is also a good example of system completion when conducting regional system planning. For the transit network, the 2018 RTP used a geospatial analysis to determine how much of the planned regional pedestrian, bike, and trail networks are completed within a walking distance to transit. Walking distance to transit was defined as:

- Within ½-mile from light rail stops
- Within 1/3-mile from streetcar stops, and
- Within ¼-mile from bus stops for existing and planned stops.

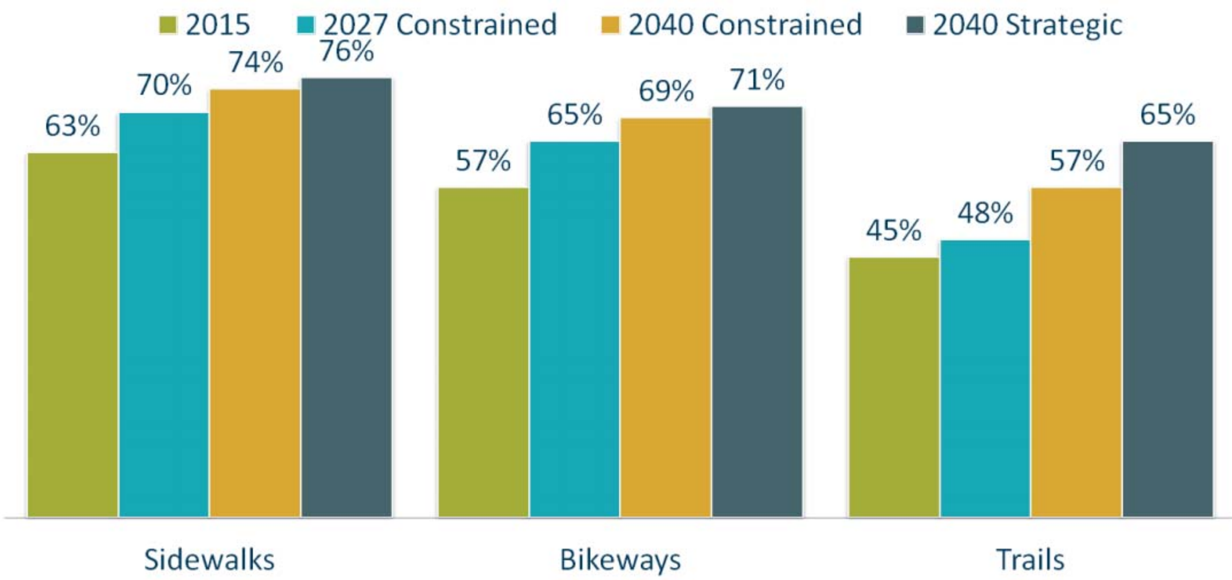
System completeness is a system evaluation measure in Chapter 7 of the 2018 RTP and was used to compare several system alternatives, including two 2040 systems with different funding assumptions. A target was set of one hundred percent completion of the Regional Pedestrian and Bicycle Networks, including within walking distance to transit, by 2040. As shown in Exhibit 14, the 2040 constrained scenario does not reach this target, although greater progress is made to compete the networks near transit compared to region-wide completion. As shown in Table 7, system completeness can very easily look at EFAs because it is a geospatial analysis. For all completeness values except trail completeness in the 2018 RTP, equity focus areas are forecast to see a larger percent completeness compared to the overall network.

Table 7. Sidewalk, Bikeway, and Trail Completeness Near Transit, Region-wide and within Equity Focus Areas

Completeness Measures	2015 Base	2040 No Build	2040 Constrained
Percent of sidewalks completed near transit	63%	63%	74%
Percent of sidewalks completed near transit within equity focus areas	73%	73%	83%
Percent of bikeways completed near transit	57%	57%	69%
Percent of bikeways completed near transit within equity focus areas	59%	59%	72%
Percent trails completed near transit	45%	45%	57%
Percent trails completed near transit within equity focus areas	44%	44%	56%

Source: Data extracted from 2018 RTP Table 7.16

Exhibit 14. Sidewalk, Bikeway, and Trail Completeness Near Transit



Source: 2018 RTP Figure 7.11

Local System Planning

Similar to regional system planning, local system plans (such as TSPs) can establish the planned system to then be used as part of analyzing system completion of future plan amendments or projects. When the plan is established, the denominator for a system completion analysis is set. The target is then to increase the system completion for the relevant systems. Every street should be planned for all modes, with some exceptions based on context and classifications. As an example, Exhibits 15 and 16 show the existing and planned pedestrian system for the Oregon City TSP. In addition to setting the planned pedestrian system for the future, these figures can be used to determine system completion and planned system completion of the RTP pedestrian system. For example, South End Road is an RTP regional pedestrian corridor but the segment from S 2nd Street to Barker Avenue does not have sidewalks and is not planned for a pedestrian project in the Oregon City TSP. This segment is very narrow with steep grade on either sides of the roadway, which is likely part of the reasoning that pedestrian facilities were not included in the TSP.

Exhibit 15. Oregon City TSP – Existing Pedestrian Facilities

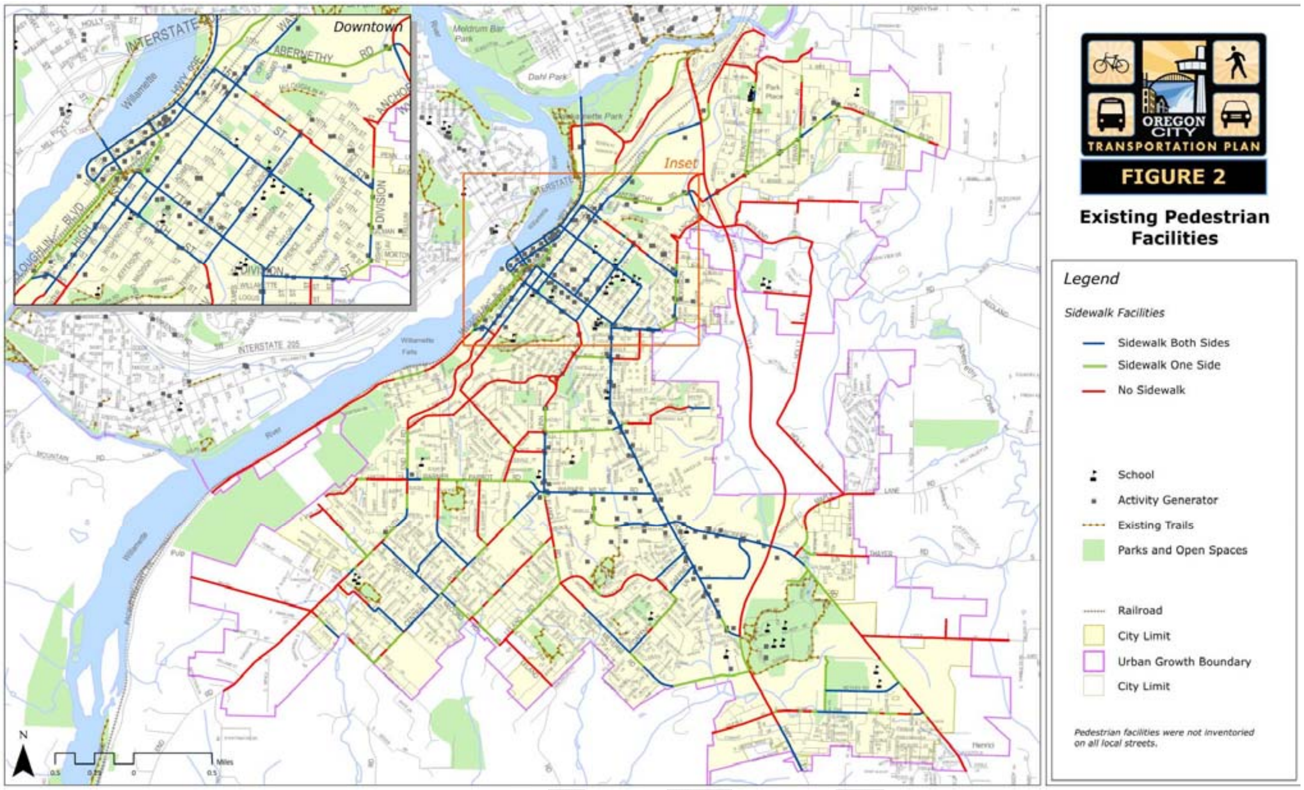
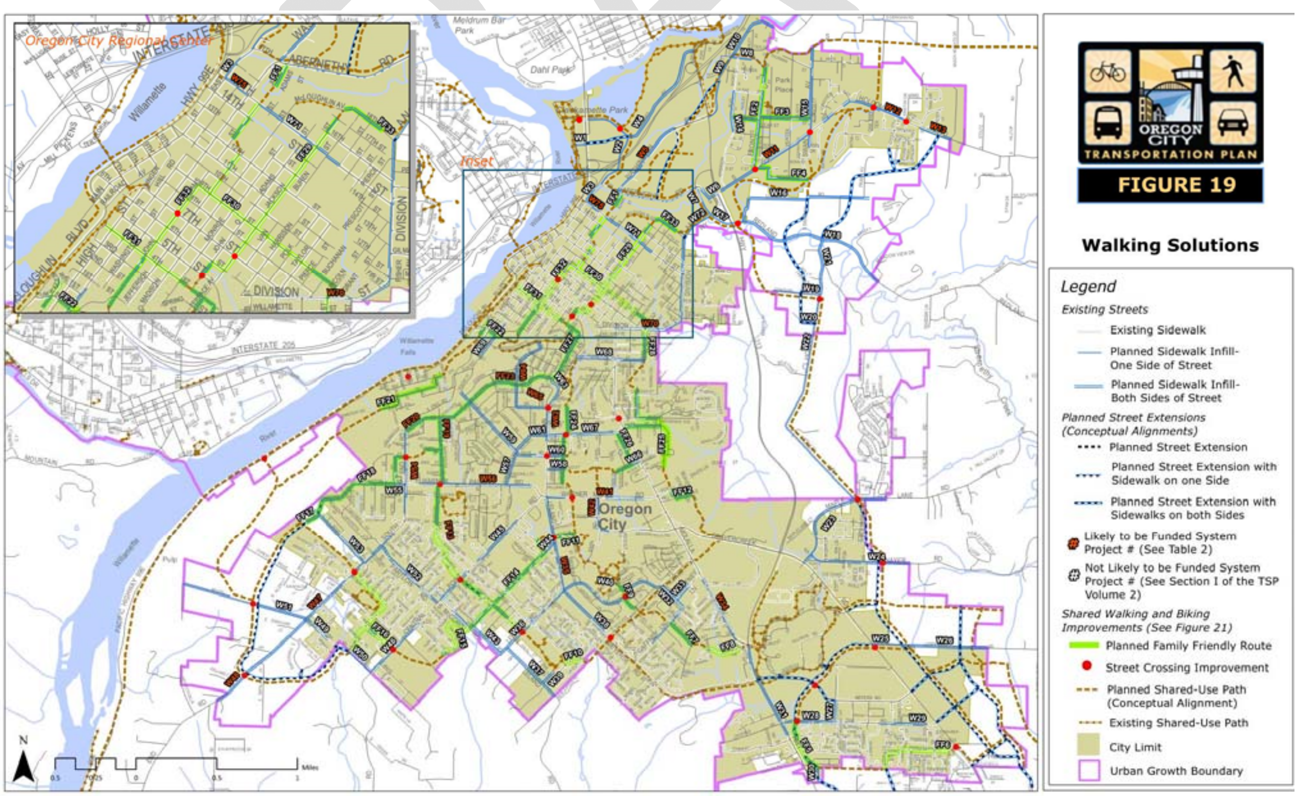


Exhibit 16. Oregon City TSP – Walking Solutions



How can system completion be applied to plan amendments for developed and undeveloped areas?

The definition of complete will vary based on the modal functional classification and design classification and can be refined by facility in system plans. Identify the desired network and projects that will result in better access to more destinations via each mode. The planned networks should ensure that each mode is an accessible option throughout the plan area.

- Where congestion measure targets cannot be met due to financial or right-of-way constraints or land use or multi-modal context (would increase VMT/capita), identify the number of through lanes and turn lanes or merge lanes (if applicable) that will be considered the maximum cross-section within the planning horizon and identify strategies such as demand management, congestion pricing, complete non-auto modal networks, and land use strategies to ensure access and mobility in the area.
- Where land use changes will increase the VMT/capita, the assessment should focus on whether the amendment changes what the definition of the complete system in the area should include. The localized impacts of increased VMT to the study area should largely be addressed during the development review process and applying the local jurisdictions development standards rather than during the plan amendment.

Once a planned system is set, a plan amendment can either show progress in system completion for relevant facility types or establish a change in the planned system due to new roadways or facilities. For those plan amendments that are building new facilities, modifications for the planned system will be established to allow for future monitoring.

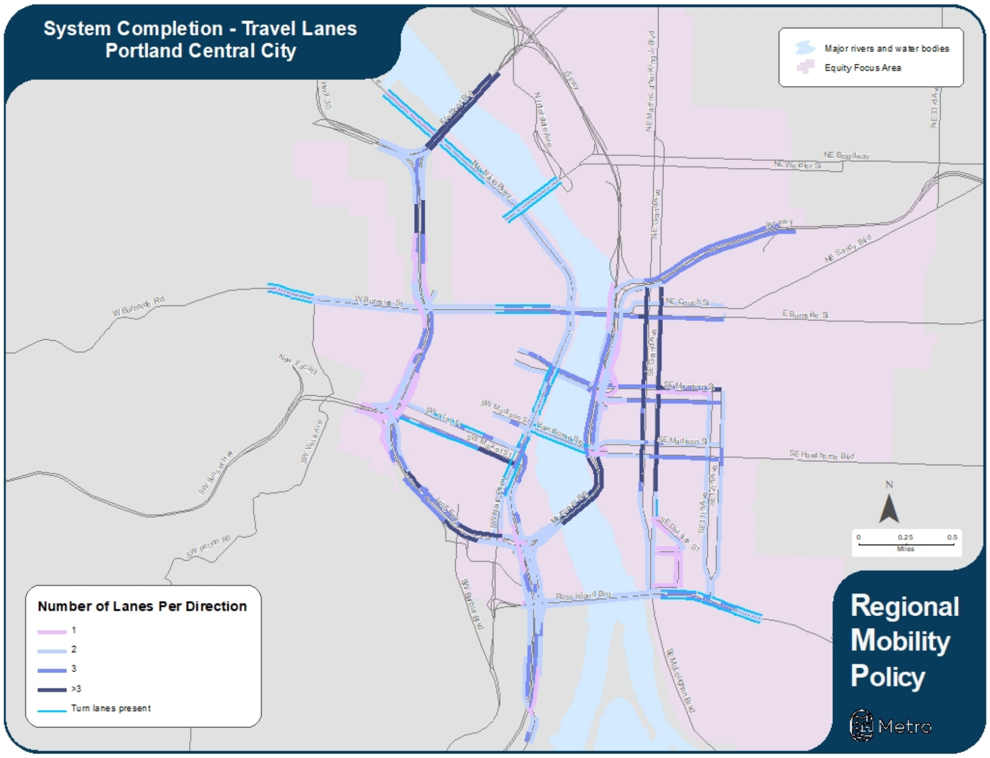
Developed Areas

The Portland Central City MMA is an example of a developed area within the Metro region. In this area, a complete system for walking, biking and accessing transit shall be prioritized over meeting congestion targets (such as in the central city, regional centers, station communities, corridors, town centers, and main streets) if the number of through lanes meet or exceed those in the regional design policy. For the Portland Central City, the following regional design classifications (and the related through lane range) are present:

- Freeways and highways – six lanes plus auxiliary lanes in some places
- Regional and community boulevards – two to four lanes with turn lanes for minor arterials and up to four lanes with turn lanes for major arterials
- Regional and community streets – two to four lanes with turn lanes for minor arterials and up to four lanes with turn lanes for major arterials

As shown in Figure 29, the majority of the roadways in this subarea are already built out based on these definitions. For example, Burnside Street is a regional boulevard and major arterial. With these designations, Burnside Street is planned for and already built with up to four lanes with turn lanes. With this in mind, a plan amendment that incorporates this segment of Burnside Street would need to explore other system completion options (like transit, bike, or pedestrian networks) to maintain mobility.

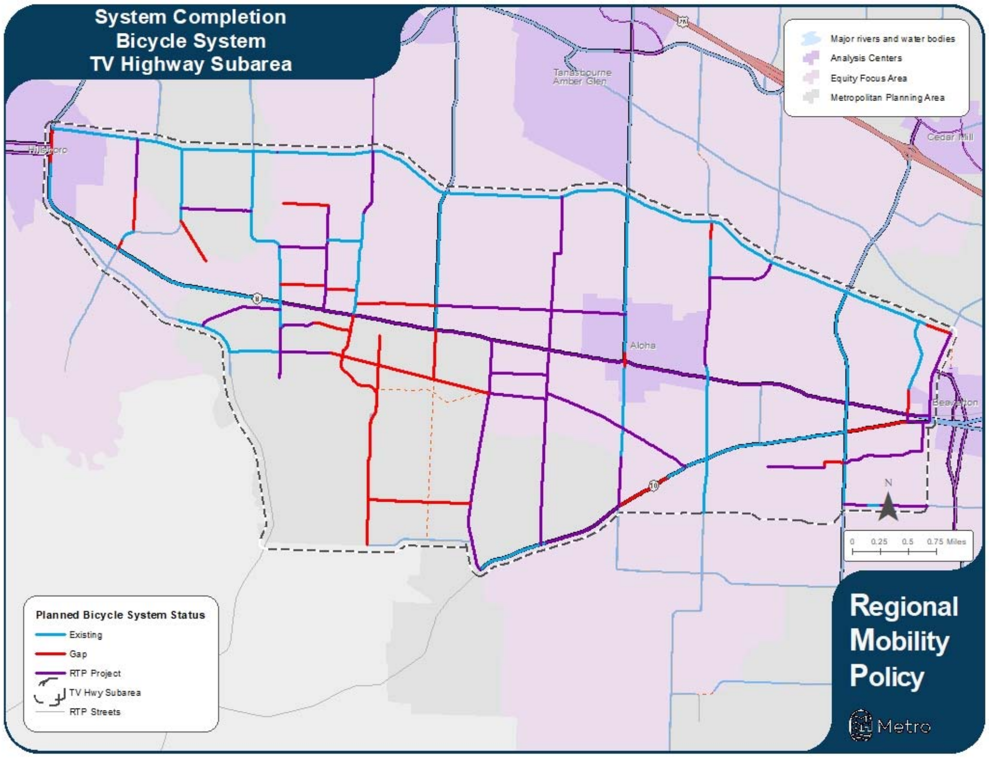
Figure 29. System Completion Portland Central City – Travel Lanes



Undeveloped Areas

South Hillsboro is an example subarea that was planned in an undeveloped location. For plan amendments in these types of locations, the amendment should consider if it changes what the definition of the complete system in the area should include. As shown in Figure 30, two new major connections are planned through the South Hillsboro plan amendment, connecting SE Davis Road and SW Rosedale Road and connecting SW River Road and SW 229th Avenue. Prior to this plan amendment, a bicycle system completion of 83% was planned for this subarea through existing infrastructure and RTP projects ((141,168 feet of existing infrastructure + 150,949 feet of planned RTP projects) / 352,289 total feet of roadway in the subarea). If the new roadway segments (13,268 feet) are included as gaps in the planned system, the new planned system completion is 80%. If the new roadway segments are included as planned projects, the new planned system completion is 84%.

Figure 30. System Completion TV Highway Subarea – Bicycle System



Policy Considerations

Considerations:

- Developed areas within the Metro area have established roadway patterns and meeting motor vehicle connectivity objectives will largely be achieved through concept planning and implementation for urbanizing areas. In contrast, gaps in pedestrian and bicycle systems are prevalent around the region. In many areas, the absence of bikeways and pedestrian facilities is a vestige of past planning and funding that prioritized vehicular mobility, as well as a lack of recognition regarding the need and desire for ways other than the auto to reach key destinations. Land uses have also changed as the region has grown, with established centers accommodating a greater intensity of uses and absorbing the new residents and jobs coming to this area. Opportunities for completing systems, and the pedestrian and bicycle networks in particular, not only improve the conditions for travelers, but also provide ways to support changing land use and travel preferences. Walking and biking become more attractive as the distance between home and destinations shorten; transit can be more cost-effective and frequent the more potential riders (residents and employees) there are in the vicinity of a transit stop.
- System completion is a measure that is used differently for different applications (i.e. system planning versus plan amendments). These differences are discussed above, and it will be important to emphasize the need for system planning to establish the planned system to set the denominator for system completion analysis.

    - Will the RTP become the planned system for throughways and arterials within the Metro region or will the local agency TSPs be the planned system used for completeness analysis?
- Metro and local agencies will set the planned system through planning modal and service networks. There are many networks that can be established and will need to be specifically called out in the mobility policy if system completion is included. Some or all of the following could be included:
    - Pedestrian, which could include planned crossings based on pedestrian crossing index
    - Bicycle, which could include a low-stress network based on bicycle LTS
    - Transit
    - Vehicle, which could build off of RTP policies in chapter 3 such as street connectivity/spacing and maximum number of through lanes
    - TSMO
    - TDM
- The planned TSMO system will likely be established through Metro's ongoing TSMO Strategy project. For example, there is a proposed performance measure for percent of signals on identified routes that have communications.
- The policy language should be very clear about which measures and associated targets apply to throughways (regardless of land use context) versus arterials (based on land use context).
- Every RTP street should be planned for all modes, with some exceptions based on context and classifications. The TSP process would determine what complete looks like for each street. For example, there will be locations where meeting a congestion target should not be done at expense of walking and biking facilities in any area or vice versa.

Are the measures useful and practical in planning?

System completion can be applied to any roadway (throughways and arterials) or transportation facilities or services. When the plan is established, the denominator for a system completion analysis is set. The target is then to increase the system completion for the relevant systems. The vital aspect during the planning process is determining which networks (pedestrian, bicycle, TSMO, etc.) are relevant to each facility or subarea.

Are the measures sensitive enough to use for plan amendments?

System completion is useful for transportation system plan amendments as long as there is a planned system already in place. Once a planned system is set, a plan amendment can either show progress in system completion for relevant facility types or establish a change in the planned system due to new roadways or facilities. For those plan amendments that are building new facilities, modifications for the planned system will be established to allow for future monitoring. Comprehensive plan amendments do not inherently impact system completeness but could be assessed to see if the financially constrained system is adequate to accommodate the change.