Washington County, Oregon

MULTI-MODAL PERFORMANCE MEASURES AND STANDARDS

June 2014

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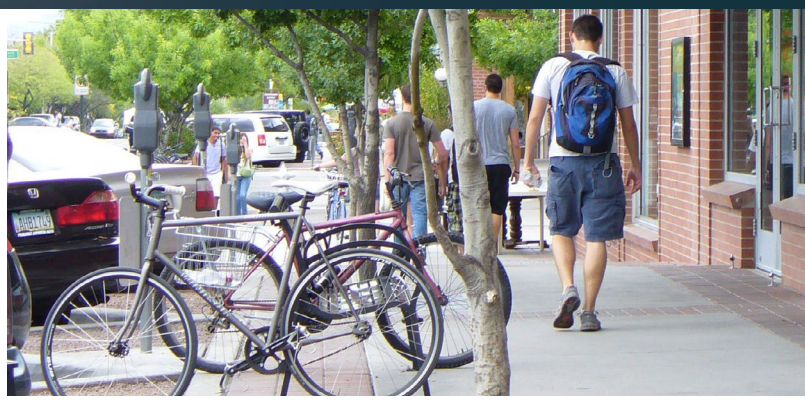

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TRANSPORTATION ENGINEERING/PLANNING

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Introduction

As the Portland Metro area has grown and developed, the region has embraced goals that favor increasing travel by non-auto modes and reducing single-occupant-vehicle travel. Yet, measuring non-auto travel quantitatively and applying those metrics has remained difficult. Transportation performance measures continue to be dominated by auto measures despite Transportation Planning Rule (TPR) and Oregon Highway Plan (OHP) provisions allowing for more diverse measures. Increasingly, jurisdictions are finding that maintaining a specific level of auto mobility may also be at odds with other objectives and that multi-modal measures based on a broader set of goals will better serve their communities.

Washington County has taken the lead in exploring methods to incorporate multi-modal performance measures and standards into all levels of the planning process that could better reflect the goals and aspirations of the community. With the intent that other Oregon jurisdictions can also learn from the work in Washington County, this report contains three sections:

Section 1 Context and Performance Measures

Section one summarizes much of the work completed in the early stages of the Washington County Multi-modal Performance Measures and Standards project, including the following:

- Oregon and Portland Metro policy framework allowing jurisdictions to adopt multi-modal measures;
- Existing ODOT and Metro standards that apply to the region; and,
- A description of the method used to compile and assess a comprehensive list of over 160 performance measures.

Section 2 Applying the Measures: Lessons Learned

Throughout the process of developing recommendations for Washington County, the project team tested a wide variety of performance measures and methods for application. Section two summarizes the lessons learned from this process and outlines several potential methodologies for applying multi-modal performance measures that may be applicable to other agencies or to Washington County at a future time.

Section 3 Recommendations for Washington County

Section three details the measures and application methods recommended for use in Washington County, given the County's existing policies, processes, and goals. Section three also provides detail on future steps the County needs to take in order to implement the measures.

Section 1 Policy Context and Performance Measures

STATE AND REGIONAL POLICY

Recent years have seen notable changes to Oregon's transportation planning and land use policies and requirements. These changes reflect statewide policy to support transportation solutions that encourage economic development, contribute to public health, offer multi-modal choices for all users, and reflect the uncertain fiscal realities and limited transportation funding.

State Policies

In response to recurring concerns from Oregon communities, the Oregon Transportation Commission (OTC) and the Land Conservation and Development Commission (LCDC) formed a joint subcommittee to evaluate and recommend revisions to the Transportation Planning Rule (TPR) and the OHP Highway Mobility Policy. In 2011, the State Legislature passed Senate Bill 795, setting a deadline of January 1, 2012 for the adoption of amendments to the plans in accordance with the joint subcommittee recommendations. The revisions aim to address stakeholder concerns that "economic development, transportation, and land use objectives should be balanced better" and that "transportation requirements can make it more difficult to increase development intensities, especially within urban centers, contrary to statewide planning goals and many community objectives."[1]

Oregon's Transportation Planning Rule (TPR)

The TPR Section -0060 applies when cities or counties are considering zone changes or plan amendments that would allow for additional development that would significantly impact or worsen the performance of planned transportation facilities, by generating levels of automobile traffic that cause the roadway to exceed motorized vehicle standards. If it is determined that there is a significant impact, jurisdictions are required to "ensure that allowed land uses are consistent with the identified function, capacity, and performance standards of the facility measured at the end of the planning period identified in the adopted Transportation System Plan."

Previously, compliance with the TPR would require that jurisdictions build, or require construction of, additional motor vehicle capacity, limit the level of development, or modify the motor vehicle performance standards. Recent amendments to the TPR offer flexibility that allows jurisdictions to "provide improvements that would benefit modes other than the significantly affected mode, improvements to facilities other than the significantly affected facility, or improvements at other locations." In doing so, the jurisdiction must also show evidence that "the system-wide benefits are sufficient to balance the significant effect" from the change.

These amendments also allow for the creation of Mixed-use Multi-modal Area (MMA) designations, in which jurisdictions do not need to consider motor vehicle congestion standards in zone changes or land use amendments. In addition the TPR amendment allow flexibility related to mitigation for significant

[1] Oregon Department of Transportation. Cover memo to the Oregon Transportation Commission regarding the OHP Policy 1F revisions. December 8, 2011

effects resulting from land use amendments or zone changes that support key economic development needs.

Oregon Highway Plan Policy 1F

The Oregon Highway Plan Policy 1F establishes mobility targets (as defined by motor vehicle volume-to-capacity ratios) for state facilities that vary by region, facility classification, and whether or not the roadway is located inside an urban growth boundary (UGB).

It allows for development of alternative mobility targets in areas where it is "infeasible or impractical to meet the mobility targets". The policy allows for the use of alternative mobility targets to "balance overall transportation system efficiency with multiple objectives of the area being addressed." It requires that targets "shall be clear and objective and shall provide standardized procedures to ensure consistent application of the selected measure. The alternative mobility target(s) shall be adopted by the Oregon Transportation Commission as an amendment to the OHP."

Regional Transportation Functional Plan

Metro's Regional Transportation Functional Plan (RTFP) is the document that directs how cities and counties are supposed to implement and be consistent with the goals and objectives stated in the Regional Transportation Plan (RTP). The RTFP requires Washington County to "include performance measures for safety, vehicle miles traveled per capita, freight reliability, congestion, and walking, bicycling and transit mode shares to evaluate and monitor performance of the TSP." The RTP sections 2.3.1 and 2.3.2 establish regional transportation performance targets.

Section 3.08.230, subsection B of the RTFP allows cities or counties to "adopt alternative targets or standards in place of the regional targets and standards..." provided these alternative targets or standards are not lower than regional targets and standards; do not require motor vehicle capacity beyond what is planned in the RTP; and will not increase the SOV travel to a degree inconsistent with the non-SOV targets. The RTFP also requires cities or counties to demonstrate that alternative mobility standards have been approved by the OTC if they are applied to state facilities.

State and Regional Policy Summary

As directed by the state legislature, recent policy amendments ensure that state highway mobility targets should be balanced with community objectives and support development intensities in multi-modal urban centers. The RTP establishes a policy framework that includes multiple performance targets and that requires local TSPs to do the same. Taken together, these policies provide Washington County with the flexibility to explore and potentially adopt performance measures that address multiple goals and evaluate multiple modes. Key elements of the policies include:

- As supported by TPR amendments, the County can provide multi-modal improvements with benefits to transportation system performance as a measure to offset significant impacts associated with zone changes and plan amendments.
- The County can work with ODOT to establish alternative mobility targets for state highways in areas where it is "infeasible or impractical to meet the OHP mobility targets."

- Per the RTFP requirements, the County must include performance measures for *safety, vehicle miles traveled per capita, freight reliability, congestion, and walking, bicycling and transit mode shares* to evaluate and monitor performance of the TSP, and must demonstrate that the TSP project list will achieve progress towards the RTP targets or alternative locally adopted targets.

EXISTING PERFORMANCE MEASURES AND STANDARDS

The existing performance measures and standards that currently guide transportation and land use in Washington County are comprised of elements from the Oregon Highway Plan, the Metro RTP and RTFP, and the adopted Washington County Transportation System Plan (TSP).

Oregon Highway Plan Targets

The Oregon Highway Plan includes separate targets for facilities within and outside the Portland Metro area. Washington County is made up of land within the Metro area and also rural lands outside the Metro boundary. Table 1 and 2 show which targets apply to each of these areas.

Table 1: OHP Volume to Capacity Ratio Targets within Portland Metropolitan Region

Location	Standard	
	PM 2-Hour Peak	
	1st Hour	2nd Hour
Regional centers Town centers Main streets Station communities	1.1	0.99
Corridors Industrial areas Intermodal facilities Employment areas Inner neighborhoods Outer neighborhoods	0.99	0.99
Principal Arterial Routes in Washington County I-5 OR 217 US 26 (west of Sylvan) US 30 OR 8 (Murray Boulevard to Brookwood Avenue) OR 47	0.99	0.99

Table 2: OHP Volume to Capacity Ratio Targets Outside the Portland Metropolitan Region

Highway Category	Outside UGB	
	Unincorporated Communities	Rural Lands
Interstate Highways	0.70	0.70
Statewide Expressways	0.70	0.70
Freight Route on a Statewide Highway	0.70	0.70
Statewide (not freight route)	0.75	0.70
Freight route on a Regional or District Highway	0.75	0.70
Expressway on a Regional or District Highway	0.75	0.70
Regional Highways	0.75	0.70
District/Local Interest Roads	0.80	0.75

Regional Transportation Functional Plan Targets and Standards

The Metro RTFP, the implementing ordinance for the Regional Transportation Plan (RTP), provides targets for mode share by land use type (Table 3) and operating standards for volume-to-capacity ratio for autos for areas within the Metro UGB (Table 4), which are the same as in the Oregon Highway Plan for the two-hour PM peak. The mode split target for Portland City Center is higher, but does not apply in Washington County and is not shown here. Similarly, Table 4 shows only the standards applicable to Washington County, to be used as deficiency thresholds in TSPs and operating standards in evaluating plan amendments. The mid-day one-hour peak standard is distinct from the OHP. In order to apply the mobility standards for Regional Centers, Town Centers, Corridors, Main Streets, and Station Communities, the County must first establish a boundary and adopt land use regulations to allow a certain mix and intensity of land uses in each of those areas, consistent with the Urban Growth Management Functional Plan Title 6 (Metro Code section 3.07.610 - 650). Metro's Regional Transportation Plan also provides performance targets that apply to jurisdictions' TSPs. These targets are shown in Appendix A.

Table 3: Metro RTFP Regional Modal Targets

2040 Design Type	Non-drive alone modal target
Regional centers Town centers Main streets Station communities Corridors Passenger intermodal facilities	45-55%
Industrial areas Freight intermodal facilities Employment areas Inner neighborhoods Outer neighborhoods	40-45%

Table 4: Interim Regional Mobility Policy: Deficiency Thresholds and Operating Standards from Metro RTFP

Location	Standard		
		PM 2-Hour Peak	
	Mid-Day One-Hour Peak	1st Hour	2nd Hour
Regional centers Town centers Main streets Station communities	0.99	1.1	0.99
Corridors Industrial areas Intermodal facilities Employment areas Inner neighborhoods Outer neighborhoods	0.90	0.99	0.99
Principal Arterial Routes in Washington County I-5 OR 217 US 26 (west of Sylvan) US 30 OR 8 (Murray Boulevard to Brookwood Avenue) OR 47	0.90	0.99	0.99

POTENTIAL MULTI-MODAL PERFORMANCE MEASURES

The project team reviewed an array of potential performance measures and standards included in published engineering manuals, rating systems, and literature from academic sources. Appendix B provides a performance measure assessment framework and extended list of measures from the literature review, including a brief description for each measure, the modes to which each measure is applicable, and an evaluation for each measure of its understandability, data accessibility, relevance to user experience, and usefulness for comparisons, as a benchmark, and as a standard. A summary description of each source document is included in Appendix C. Following a series of discussions with Washington County staff and the Technical Advisory Committee (TAC), the project team did a second tier of more in-depth assessment on a subset of measures selected for their potential to be applicable in Washington County. This section includes a description of each of these assessments.

VOLUME-TO-CAPACITY AS AN EXAMPLE

Answering some questions with respect to volume-to-capacity ratio as an example performance measure provides insight as to why additional measures are needed in certain situations:

What goal(s) are being measured?	**Mobility** *Volume-to-capacity measures the degree to which the capacity of a segment or intersection is utilized.*
What travel mode(s) are being measured?	**Automobiles** *While other vehicles and transportation system users can affect the v/c ratio, the measure generally applies only to autos.*
What scale of measurement is being used?	**Roadway segments** *Applicable to system planning, project planning* **Roadway intersections** *Applicable to project planning, development review*

Volume-to-capacity ratio addresses one system design goal (mobility) and also addresses one mode (autos). However, it is quantifiable and relatively easily measured.

Tier One Performance Measure Assessment Methods

For each measure, the assessment framework identifies which Washington County TSP goal or goals are addressed by the measure, which mode or modes can be measured, and how well the measure performs in terms of data cost and accessibility, understandability of measures, reflection of user experience, and application to different planning uses. Each of these is explained herein:

- **TSP Goals:** Each measure applies to at least one TSP goal, and most measures can apply to two or more TSP goals. *Through the testing process, jurisdictions would need to determine whether to emphasize measures that are cross-cutting, addressing multiple goals, or whether to use separate measures for each goal. Moving forward with the effort, it will be important to consider a mixture of measures that do not bias the outcomes.*

- **Modes:** In some cases, specific measures address all travel modes because they measure the system as a whole (e.g., connectivity). Other measures also address all modes, but must be

calculated separately for each mode (e.g., multi-modal level of service). Mode-specific measures only address one mode, and generally address specific characteristics of that mode (e.g. transit frequency or pedestrian crosswalk spacing).

Notably, some measures do not specifically address transportation modes, but directly address land use or economic activity. Measures of land use and/or economic activity often can provide insights about the performance or adequacy of the transportation system that cannot be measured using transportation-specific measures alone. In particular, land-use-related measures or standards may be the most effective way for local jurisdictions to promote improved transit service in the medium- to long-term.

- **Understandability of measures:** This criterion refers to the degree to which the measure is easily understood by members of the public and elected officials. Each measure is rated on a low-medium-high scale, where:

  = A measure that can be mostly understood intuitively from the name of the measure.

  = A measure that can be explained in non-technical terms to members of the public and/or policy-makers, but is not completely intuitive.

  = A measure that is difficult to explain to people not familiar with planning and engineering concepts.

- **Data cost and accessibility:** This criterion refers to the ease with which the measures can use data to be objective and quantitative measures. Each measure is rated on a 1-3 scale, where:

  = Necessary data is readily available or easy to collect; analysis is not complex

  = Data is possible to obtain but not easily available; or data analysis is complex

  = Data is difficult/impossible to obtain; or measures rely on models still in development

- **Reflective of user experiences:** This criterion refers to whether the measure is a direct reflection of a travelers' experience in using the transportation system. Each measure is rated on a 1-3 scale, where:

  = The measure is directly related to the experience of the user of the transportation system during a particular trip, such as transfer time between two transit vehicles.

  = The measure is indirectly related to the user experience during a particular trip, such as the level of roadway connectivity.

= The measure is not perceived by the user during a particular trip and may be a regional or system-wide measure, such as the total vehicle miles traveled (VMT) per capita.

- **Applicability:** This criterion rates how the well the performance measure can be applied in each of four different planning uses, and is rated on a scale of 1-3 for each use.
    - **Prioritization** – ranking different projects within a community according to which will enable more progress towards community goals.
    - **Comparison** – comparing different project or policy alternatives within the same area in order to select the preferred alternative.
    - **Long-term benchmark** – for use as a system- or area-wide measure that shows overall change or progress over time.
    - **Near-term standard** – for use as a standard, threshold, or target that must be mitigated to or moved in the direction of when making plan amendment or development decisions.

= The measure would be easily applied for the planning scenario.

= The measure could be applied, but may not be the most effective measure.

= The measure would be difficult to apply to the planning scenario.

Tier Two Performance Measure Assessment

After assessing each performance measure according to the criterion above, County staff and the TAC selected a subset of measures to carry forward for further assessment. The project team assessed each of these measures in more depth for the following qualities:

- How/whether each measure would apply to each level of planning need (TSP-level planning; project/corridor planning; plan amendment; and development review)
- Level of difficulty to apply the measure, given existing data and methodologies
- Whether the measure is quantitative and objective
- Whether the measure is able to forecast or predict for future conditions

The subset of measures evaluated in more detail is shown in Table 5 can be characterized in one of two ways: mode-specific transportation measures or accessibility/land use measures.

Table 5: Measures in Tier Two Assessment

Mode Specific Measures	Auto/ Freight	Bike	Ped	Transit	Land Use / Accessibility
Travel Time	■			■	
Travel Time Reliability	■			■	
Critical Movement Delay	■				
Crash Frequency and Severity	■	■	■		

Mode Specific Measures	Auto/ Freight	Bike	Ped	Transit	Land Use / Accessibility
Predicted Crash Frequency and Severity	■	■	■		
HCM Level-of-Service	■	■	■	■	
Percent arterial/collector build-out (system completeness)	■				
Bicycle Level of Traffic Stress		■			
Percent bicycle facility coverage/build-out (system completeness; could also incorporate standards for bicycle facility types/widths)		■			
Pedestrian Crossings Completeness			■		
Percent sidewalk coverage (system completeness; could also incorporate standards for pedestrian facility types/widths)			■		
Supply of transit service (system completeness)				■	
Land use /accessibility related measures	**Auto/ Freight**	**Bike**	**Ped**	**Transit**	**Land Use / Accessibility**
Accessibility to Destinations/Diverse Uses					■
Affordability					■
Auto Trips Generated	■				■
Land Use Mix/Balance					■
Non-residential intensity					■
Intersections per square mile (including multi-use paths and pedestrian connections)	■	■	■		■
Access to Transit				■	■
Mode Choice Availability					■

Definitions and more detailed assessments of each of these measures are included in Appendix D. One measure, bicycle level of traffic stress (LTS), has recently emerged as a planning-level alternative to the more data-intensive Multi-modal Level-of-Service (MMLOS). In general, LTS provides a planning level framework for assessing the level of comfort for cyclists, given a roadway's geometry, average speeds, and general auto volumes (order of magnitude). It is very useful in assessing network connectivity for bicyclists. MMLOS provides a methodology more sensitive to changes in widths of specific parts of facilities (buffers, lanes) and auto volumes. It is useful in comparing project alternatives within a specific study area to assess trade-offs between modes. Other key differences between the two measures are included below. Both measures are proposed for inclusion in the update to ODOT's Analysis Procedures Manual, and it is recommended that both measures be included for consideration in Project/Corridor Planning applications in Washington County to allow staff to select the measures most applicable to the specific context and level of data availability.

Comparing Bicycle Level of Service (MMLOS) and Bicycle Level of Traffic Stress

MMLOS

- Sensitive to vehicle volumes (can measure fractional changes in LOS due to changes in traffic volumes)
- Can be used with pedestrian, transit, and auto MMLOS to compare trade-offs between modes.
- Relatively data-intensive, so most applicable over smaller study areas.
- Does not include a methodology for looking specifically at protected bike lanes.
- MMLOS looks at volumes in the lane adjacent to bikes
    - Only considers volume in *outside* lane of 3 or 5 lane facility (in some cases, 5 lanes could have a better MMLOS than 3 lanes if the volumes were the same).

LTS

- Not sensitive to minor changes in traffic volumesMore conducive to a standard by bike network facility type than MMLOS
    - Best suited to network planning (TSP, bike plan, etc.)
- Could be incorporated into the definition of system completeness for the different classifications of bike routes.
- Results in a uniform low-stress rating for protected bike lanes.
- LTS looks at number of through lanes adjacent to the bike lane
    - Holding all else equal, 5 lanes is worse than 3 lanes.

Section 2 Applying the Measures: Lessons Learned

Throughout the process of developing recommendations for Washington County, the project team went through multiple iterations, testing measures in different scenarios, comparing results, and determining methods for applying measures to different planning applications. Ultimately, the recommendations for Washington County will not be applicable to every other jurisdiction – jurisdictions vary substantially on the conditions of their existing systems, their goals and priorities, and their current methods for measuring performance. This section, therefore, documents the key "lessons learned" from the project team process in order to help inform other agencies as they seek to shift from auto-centric to more multi-modal performance measures.

APPLICABILITY OF MEASURES

Key Lesson: Communities may need to select different measures for different planning applications.

Communities can use performance measures or standards in a variety of settings. Some measures work well across multiple settings, while others are only suitable in certain applications. Table 6 shows how the uses can be applied in different stages of planning. The performance measures assessment contained in Appendix B provides an initial evaluation of each performance measure and whether it can be applied to each of these uses. Few of the performance measures are easily applied across all applications.

Table 6 Performance Measure Uses and Applications

	Prioritization	Comparison	Long-term Benchmark	Near-team Standard or Threshold
Transportation System Planning / Subarea Plans / Multijurisdictional Corridor Planning	●		●	
Project / Corridor Planning		●		
Plan Amendments / Zone changes subject to TPR			●	●
Development Review		●		●

TSP, Subarea, and Multi-jurisdictional Corridor Studies

Key Lesson: Determine which measures will be used to track progress towards TSP goals and which will be used to help define or prioritize TSP projects.

Higher-level measures, such as total vehicle hours of delay, are useful for monitoring and tracking progress over time, but are not specific enough to help define or prioritize transportation projects. Others, such as sidewalk completeness, can be used to help develop and prioritize projects for inclusion in the Transportation System Plan.

Project / Corridor Planning

Key Lesson: Set clear needs, goals, and priorities; select measures to reflect the needs and goals; and then weight them according to priorities.

In project planning when comparing alternatives, as in a corridor study, clear priorities and goals must be defined in order to be able to assess the performance of alternatives. Inevitably, communities will need to make trade-offs in planning projects. Therefore, in doing a project planning process, first select measures that reflect the needs and goals of the project, then weight the measures according to the priorities of the project stakeholders. This process allows for selection of an alternative driven by community goals and priorities, based on a diverse set of measures.

Development Review and Plan Amendments

Key Lesson: Of the planning applications, incorporating multi-modal measures into the context of development review and plan amendments poses the greatest challenge to jurisdictions, given the need to demonstrate a nexus between the impact of the development and an improvement as a condition of approval. For auto-mobility oriented improvements, demonstrating the nexus is relatively easy, given the highly developed methodologies that are available and accepted for determining the number of auto trips generated by a proposed land use and for measuring auto mobility.

In the process of developing a recommended methodology for Washington County, the project team considered a variety of potential approaches.

Approach 1: Assess a fee in addition to the Transportation Development Tax (TDT) that would be used to fund non-auto mode improvements within the development area commiserate with their impact. The fee could be applied by district and be directly related to the non-auto needs and anticipated growth within that district or could be based on countywide needs and growth. Alternatively, the existing TDT could be increased to fund additional development-driven multi-modal project needs. While this approach would increase the funding available for improvements to non-auto improvements, there are drawbacks: first, the jurisdiction would still be responsible for the planning, design, and implementation of the improvements, which takes staff resources and potentially more time. Second, the development applicant would not necessarily benefit directly from the improvements funded by the fee if a district is too large or a countywide approach is taken.

Approach 2: Determine the development's multi-modal impacts and proportionate mitigation. This approach would use a process parallel to that currently used for auto-oriented improvements by most agencies. While the following steps do vary somewhat depending on the agency, they generally cover the process used in Oregon for development review and to comply with the Transportation Planning Rule in the case of plan amendments.

1. **Define system adequacy** – Define the minimum standard or threshold for each adopted performance measure.
2. **Assess the existing conditions of the system** – Determine if the standards for each performance measure are being met currently or the extent of the existing deficiency.

3. **Define the impact area –** Estimate the number of trips a development will generated by mode and their origin or destination to determine the extent of the impact area based on pre-defined definitions such as a percent change in trips or total number of additional trips.
4. **Determine the development impact –** Evaluate the impact of the development based on the multi-modal performance measures that a development will have or if minimum adequacy thresholds are met.
5. **Develop potential mitigation strategies –** Identify the improvements necessary to meet minimum adequacy thresholds or mitigate impacts of the development.
6. **Determine the impact of the mitigations –** Evaluate the resulting performance of the system.
7. **Determine proportionate share –** Determine the development's proportionate share of the cost of the improvement based on a benefit-cost ratio or based on their portion of the travel demand triggering the need for the improvement.

Approach 2 is proposed for Washington County. The remainder of this section outlines considerations and key lessons for each step.

Define system adequacy

Multi-modal measures for defining system adequacy can be divided into two general categories:

1. **Completeness of the system** – presence, absence or deficiencies of existing sidewalks, multi-use trails, bike lanes, cycle tracks, transit service, or roadways. System completeness measures are most applicable when a jurisdiction has systems that aren't fully developed or that are deficient. In this type of setting, measures such as "sidewalk coverage" or "bicycle facility coverage" will be effective in helping the jurisdiction move towards a developed multi-modal system. However, system completeness for the pedestrian mode may not effectively identify under-performing facilities in an urban area with full sidewalk coverage and complete crosswalks at all intersections. The standard for system completeness measures within the TSP could be 100% completeness but for development review could be 100% complete within a specific defined area of impact, or providing enhancements so that the system is left "no worse than before" considering both impacts and improvements.

> **System completeness** measures are most applicable when a jurisdiction has systems that aren't fully developed for the pedestrian mode, but may not be as effective for assessing deficiencies in an urban area with full sidewalk coverage and complete crosswalks at all intersections.

2. **Performance of the system** – how well the system serves each mode, e.g. delay for pedestrians, transit headways, level of traffic stress for bicycle facilities, multi-modal level-of-service (MMLOS), and average travel time. Measures currently used for auto mobility, such as level-of-service and volume-to-capacity ratio fall into the category of system performance measures. System

> **System performance** measures provide a way to compare the relative performance of transportation facilities. For incomplete systems, they are most appropriate when used in conjunction with system completeness measures.

performance measures can be used to define system adequacy for relatively complete networks where performance may vary across the system and measures can be used to identify ways to optimize the system or improve the system performance. System performance measures can also be used in conjunction with system completeness measures in transportation systems that are less complete.

Assess existing conditions

An existing conditions assessment must determine if the standards for each performance measure are being met currently or the extent of the existing deficiency. It provides a baseline on which to evaluate project impacts.

Define the impact area

Currently jurisdictions use a variety of ways to define impact areas of development or plan amendments for autos. Often this includes a conversation or negotiation between the jurisdiction and the applicant. In the case of autos, the impact area often emphasizes intersections. Intersections generally represent the capacity constraints and have higher numbers of crashes than segments, and mobility and safety are the two elements most commonly measured. In the multi-modal context, intersections are also critical elements of the system, but in the case of Washington County, where many segments lack multi-modal facilities, a study area focused only on intersections is not sufficient. The project team considered a number of potential methods, each of which is described below:

> In the multi-modal context, a study area focused only on intersections is not sufficient.

- **District-based system.** In a district-based system, jurisdictions would pre-define "districts" based on existing neighborhoods, commercial areas, transit station areas, or other method. Each district would represent the multi-modal "impact area" for any development or plan amendment within that district. Using this method would require jurisdictions to evaluate the transportation needs of each district, assuming maximum development.
- **Path along the network to "essential destinations," including transit stops.** This option allows jurisdictions to study the particular routes that are most likely to be used by people walking or biking to and from a new land use. In the case of Washington County, a threshold number of walking or biking trips for including a route in the study area needs to be identified. This process is similar to how Washington County currently uses a 10% increase in auto volume (by leg) approach to defining study intersections for autos.
- **Distance along the network.** This option would include facilities within a certain distance along the transportation network. Overall this option is less promising for defining a study area, because it is much more difficult to establish a nexus, in the case that there are no destinations along a particular route. Moreover, determining the distance from the development would likely need to vary based on the size of the development, but developing this distance and the thresholds for extending the distance is difficult and may be perceived as arbitrary.
- **A set radius from the development.** This option is a variation on distance along the network – it simply sets a predetermined radius and includes all transportation facilities within that

radius. This option also poses challenges for defining a study area, because it is much more difficult to establish a nexus, in the case that facilities may be included within the radius that aren't connected to the development or plan amendment site. Moreover, determining the size of the radius would likely need to vary based on the size of the development, but developing this radius and the thresholds for extending it is difficult and may be perceived as arbitrary.

Determine the development impact

Determining the impact of the development is a step that can be approached in a number of different ways. Because most jurisdictions are in the position of needing to increase the share of non-auto mode trips in order to reach their goals, determining impact needs to be carefully done to be sure there is not a disincentive to generating walking, biking, and transit trips. In addition, the method of determining the development impact must be informed by measures selected to define system adequacy, as described for the following methods:

> Methods for determining impact need to be carefully selected so as not inadvertently create a disincentive to generating walking, biking, and transit trips.

- **Use person trips generated by mode based on an "aspirational" mode split and measure the impact of those trips on the system.** This method is proposed for Washington County. A safety-related "impact" will occur when pedestrian or bicycle trips are added to a part of the system that is not yet complete (even if the pedestrian or bicycle trips are aspirational). This will allow the County to build a system to support its future mode split goals, instead of building for their existing mode split, which has a higher portion of auto trips.
- **Use auto trips generated as the starting point for impact, and then measure the impact of those auto trips on the system.** Using this definition requires adopting measures for other modes that are sensitive to changes in auto volumes. For example, pedestrian MMLOS is sensitive to auto volumes (and goes down and auto volumes rise.) Sidewalk Completeness, however, is not sensitive to auto volumes, and this measure would not change as a result of the impact.
- **Use total area developed as a measure of impact.** This is a simplified method that rewards density, which is proven to be a factor in creating a walkable environment. Using the area developed may be more applicable when the impact area is defined as a district, because it would then be possible to determine the proportional share attributable to a particular development. This method could also vary the "impact" depending on the land use context in the proposed development area.
- **Portion of theoretical "development capacity" of a particular district.** This method is a variation of using total land area. Instead the "development capacity" of a district could be calculated based on existing zoning and existing uses, and a development's impact could be determined by the total portion of this theoretical capacity within the district that it consumes.

- **Assign impact "points" that need to be mitigated to an applicant based on ITE Trip Gen rates or other methods for determining trips generated.** The impacts must be "offset" (or mitigated) by making improvements to the system. In this system, development or plan amendment applicants would still be responsible for meeting a minimum standard within the defined impact area for each performance measure. Improvements done to meet the minimum standard would provide credit towards the necessary offsetting impact "points", and applicants would be able to choose improvements to gain additional points needed. This system would provide development applicants with flexibility to choose improvements (beyond the performance measure minimum standard levels) that reflect their priorities in the area. For example, a developer of dense multifamily housing with a low parking ratio may choose to improve all the pedestrian crossings in the area, knowing that tenants may be more likely to make walking trips. However, this system of "points" would likely be monetized to account for the variation in costs between improvements depending on context and to provide a level of certainty to developers in terms of the total costs of mitigations. As such, it could be perceived as a trip based tax or fee.

> Methods that provide flexibility are likely to become monetized to account for the variation in costs between improvements depending on context. This could be perceived as a trip based tax or fee.

Develop Mitigation Strategies

Mitigation strategies depend principally on the measures that are chosen for system adequacy. System completeness measures will primarily require the addition or upgrading of facilities in order to improve the system. System performance measures, however, would result in different types of mitigations, for instance, changes that reduce delays for non-auto travelers seeking to cross a major arterial.

Currently, Washington County's process for determining mitigation strategies includes a benefit-cost calculation for hazardous locations and is defined in R&O 86-95, included in Appendix E. Development applicants are required to mitigate based on safety, measured in one of two ways: locations identified as hazard locations in the County's Safety Priority Index System (SPIS) or locations where development increases the volume-to-capacity ratio above 0.99.

Determine the impact of mitigations

When applying a multi-modal set of performance measures, mitigations to one mode may positively or negatively impact other modes. Assessing the impact of the mitigations will allow jurisdictions to evaluate more comprehensively which mitigation strategies best align with needs. For instance, currently, development review processes assess the performance of the system for autos and then develop mitigations in locations where the performance doesn't meet the standard. A common mitigation in these cases is to add turn lanes and/or widen roadways. While this type of mitigation allows auto-mobility performance measures to improve, it decreases the quality of the system for pedestrians by increasing the crossing distance and increasing pedestrian delay if the signal cycle is increased to accommodate separate left turn phases.

One option is to choose a multi-modal mitigations framework in which a set of performance measures are assessed in the existing conditions, assessed with the development or plan amendment, and then assessed with the mitigations. Each performance measure is assigned a weight, according to its importance in the given context. Ultimately, a mitigation strategy would need to cause an aggregate improvement across the measures, even though one measure may improve while another degrades. This framework is proposed in the TRIP97 project. More detail about this framework can be found at www.trip97.com. Alternatively, policy direction could be provided about which performance measures or modes have higher priority in different contexts such as in regional centers, town centers, residential areas, or employment areas.

> When applying a multi-modal set of performance measures, mitigations to one mode may positively or negatively impact other modes. A system of weighting the measures or developing policy guidance on priority based on context is necessary.

Determine proportional share

After agreeing on appropriate mitigations to the impact of the development or plan amendment, the final step is to determine the proportional share for the applicant. A method for determining proportional share will draw heavily on the performance measures selected to define system adequacy, the method of determining impact, and the impact area. Some examples of methods for determining proportional share are as follows:

- If an impact area is defined by a pre-determined district, proportional share could be determined by the share of development within the district represented by a particular application. This ratio would be applied to the full list of needed improvements identified within the district to meet performance standards.
- Determining proportional share for other impact area definitions could be determined by measuring the share of total trips along a segment or through an intersection that are attributable to the new development. In this case, jurisdictions could choose to use an aspirational mode split to calculate the base level of trips, so as to not compare aspirational walking trips from the development with actual walking trips on a facility (given that many facilities currently do not meet mode split targets.

Section 3 Washington County Recommended Measures and Implementation Framework

The project team took an iterative approach to developing recommendations for Washington County, including several rounds of assessment of different performance measures, multiple work sessions with Washington County staff, and testing of different methods and measures in sample development review settings. Based on the feedback received and a detailed evaluation of candidate measures, the project team developed an implementation framework, including recommended measures and a process for incorporating them into the planning processes. Recommended measures and implementation for each planning level is described in more detail herein. Washington County's existing measures are included in Appendix F.

TRANSPORTATION SYSTEM PLANNING, SUBAREA PLANNING, AND MULTI-JURISDICTIONAL PLANNING

At the transportation system plan (TSP) level, local jurisdictions identify 20-year multi-modal projects, programs and policies that are needed to support economic development, the comprehensive plan, and the community's vision. TSPs are often updated every 5 – 7 years to reflect evolving funding sources, land use changes and system needs. To assess the impacts of transportation investments and land development, TSPs help measure progress towards meeting community goals.

The County's previous TSPs have focused primarily on the street system and automobile performance. As part of their current TSP update, Washington County is focusing on programs, policies and projects that provide for a transportation system that is safe and efficient for all modes. The County's TSP Update includes a number of performance measures designed to track progress toward achieving a multi-modal system. These measures are shown in Table 7. In addition to the measures already included in the TSP update, the County can include additional measures as determined by the Multi-modal Performance Measures and Standards project. Table 7 also includes these additional measures and shows proposed long-term targets and steps necessary for implementation. These measures are also proposed to be used for TSP horizon year analyses such as sub-area plans or multi-jurisdictional long-term studies (such as plans for Metro's Regional Mobility Corridors such as TV Highway or Southwest Corridor).

The long-term targets are established to set a vision for the future, including complete systems for all modes, affordable transportation and housing for all, and zero traffic fatalities. However, each update of the Transportation System Plan should report progress towards each of these goals and set an attainable interim goal for the more near-term future.

Table 7: Proposed TSP-Level Measures

Measure	Standard	Implementation Needs
Mode Share*	• Drive Alone: 44% • Shared Ride: 24% • Walk: 19% • Bike: 3% • Transit: 10%	Washington County currently has one set of mode share goals for the entire urban area of the County. The goal could be further refined for each land use type (e.g., mode share for town centers versus residential neighborhoods versus industrial uses). Alternatively, refined mode share goals for certain areas could be developed and adopted as part of the Community Plans.
Sidewalk completeness*	All urban area collector and arterials include sidewalks that meet a minimum width and include appropriate ADA accommodations (i.e., 100% coverage standard[2]).	The number of roadway miles that meet the completeness standard could be measured and reported annual and compared to previous year's results. The reporting could be based on • % sidewalk coverage of full arterial/collector network (regardless if the width meets code requirements) • % of existing sidewalks that meet ADA standards • % sidewalk coverage of full arterial/collector network that is to standard (ADA and width)
Crossings completeness	Crossings complete (all legs) at intersections of collector/arterials and crossing opportunity present within reasonable distance[3] of all transit stops (collectors and arterials)	Reporting and improvement toward this standard can be based on: • % signalized intersections with complete crossings • % transit stops with crossings opportunity within reasonable distance This reporting could also be done for unsignalized intersections of collectors and arterials, depending on availability of data and county resources.
Bicycle facility completeness*	All arterial and collector streets include bicycle facilities consistent with TSP designation. Neighborhood greenways provide low-stress network connections for trips between essential destinations that require <25% diversion from the most direct route.	Reporting and improvement toward this standard could be based on: • % of arterial and collector miles that include bike facilities consistent with TSP designation • # of barriers to network connectivity (A methodology for evaluating this is described in *Low-stress Bicycling and Network Connectivity* (Mekuria, et al. 2012), one of the documents reviewed for Memorandum #1.)

[2] County Code currently allows sidewalk on one side or not at all under special circumstances. Requirements for exceptions should be reviewed.

[3] Having a crossing within 200 feet is desirable when citing new transit stops or relocating existing transit stops; however, reasonable distance to a crossing opportunity on an arterial or collector for an existing transit stops may be greater than 200 feet based on mid-block crossing spacing standards.

Measure	Standard	Implementation Needs
Intersection completeness	All collector and arterial intersections contain appropriate facilities for pedestrians and bicyclists.	Reporting can include the percentage of intersections with: • Complete striped crosswalks • Complete bicycle facilities up to stop bar • Signal timing that incorporates pedestrians and cyclists, not just motorists. • Detection and actuation • Lighting Appendix G provides a more complete recommended definition for intersection completeness – the County can choose to amend or add to this definition as appropriate.
Crash frequency*	Zero deaths	Reporting and progress toward this standard can include: • Total crashes by mode, total fatal and serious injury crashes by mode per capita or per VMT • Identification of intersections above Critical Crash Rate (SPIS locations)
Transit Accessibility*	All urban area County households have access to transit: - within ¼ mile; or - within ½ mile of high-frequency transit	Reporting and progress can be measured by % of urban area households that have: • network connections to transit within ¼ mile • ADA compliant walking connections to transit within ¼ mile ▪ network connections to frequent transit within ½ mile
Bicycle Level of Traffic Stress	Provision of a complete network of LTS 2 facilities in the urban area that require no more than 25% diversion from total trip distance	Reporting and progress can include: • Lane miles of roadways classified by LTS levels • Levels of diversion from most direct route
Travel time reliability – buffer index	Improvements to Buffer Index (to be determined based on baseline study)	Develop baseline travel time reliability on key arterial corridors, updated and reported annually. The initial baseline effort can be used to set a standard for the buffer index.
Accessibility to destinations / diverse uses	All urban area households have access to essential destinations within a 20-minute walk, bike, or transit trip.	Reporting and progress could include percentage of households with 20 minute essential destinations via: • walking • biking • transit In addition, the average number of "essential destinations" accessible to households within a 20 minute trip walking, biking, or riding transit could be reported.
Affordability	All urban and rural households pay 45% or less of their income on housing and transportation combined.	Reporting and progress could measure: • Average portion of household income spent on housing and transportation costs. • % of households spending 30% of income or less on housing • % of households spending 15% of income or less on transportation

Measure	Standard	Implementation Needs
Vehicle Hours of Delay (VHD)*	Reduce VHD per capita by 10% compared to 2005 (RTP goal).	None
Vehicle Miles Traveled (VMT)*	Reduce VMT per capita by 10% compared to 2005 (RTP goal).	None
Roadway miles with demand to capacity ratio deficiencies*	0.99 v/c in regional centers, town centers, main streets, and station communities during the peak hour 0.90 v/c in other urban and rural areas during the peak hour	None

*Measures currently in use or proposed in 2035 TSP update. This set of measures fulfills the requirements for TSP performance measures in Metro's RTFP.

PROJECT/CORRIDOR PLANNING

Performance measures used in project/corridor planning will vary based on the land uses served by the project/corridor, the types of users served by the project/corridor, the vision of the surrounding community, and the functional classification of the roadway or roadways within the study area. The size of the project or length of the corridor and the corresponding study area will dictate, to some degree, the measures that can be applied.

In lieu of establishing standards to apply to all project/corridor planning, a process that defines the appropriate standards for application can be applied at the onset of each study process. This process should evaluate:

1. Surrounding land uses needs
2. Primary users served by the project/corridor
3. Input from stakeholders to determine priorities and/or desired outcomes

Based on this evaluation, measures can be selected according to the users, priorities and desired outcomes in the vicinity of the project or corridor.

Table 8 summarizes examples of measures selected by the TAC that can be used in project/corridor planning. Appendix B includes a list of more than 160 measures, many of which are also applicable to project/corridor planning. At this planning level, it's most important that planners and engineers have the tools and measures available to assess progress towards meeting the multi-modal standards identified in the TSP.

Table 8: Corridor Planning Performance Measures

Measure	Standard	Implementation Needs
Sidewalk completeness	100% sidewalk coverage of urban area collector/arterial network that meets ADA and code width standards.	Policy guidance is needed to determine modal order of priority for different land use contexts for application in corridors with ROW constraints.
Crossings completeness	100% of corridor has crossings connecting essential destinations; four complete crossings at four-leg intersections; crossings present within reasonable distance[4] of all transit stops (collectors and arterials)[5]; crossings present at trail connections.	Clear guidance in TSP on desired crosswalk locations (between essential destinations) for different land use contexts.
Bicycle facility completeness	100% coverage of arterial/collector network with bicycle facilities meeting TSP designation along all collectors and arterials Complete connections to neighborhood greenways	Adoption of neighborhood greenways network.
Intersection completeness	Includes all elements of intersection completeness (see Appendix G), providing safe multi-modal access to all intersections New projects should meet 100% standard[4]	Agreement on intersection completeness definition, and policy guidance on modal order of priority at intersections.
Predicted Crash Rate	Lower predicted crash rate than existing condition	Data requirements to enable annual calculation and monitoring of predicted crash rates.
Pedestrian delay	Evaluate impacts of each alternative	Each of these measures should be considered in a corridor study; however, many of these comparative measures will be at odds with each other and will require decisions on trade-offs, especially on high-transit corridors and corridors with constrained ROW. Policy guidance is needed to determine modal order of priority for different land use contexts either at the project level (through vision and goals) or at the countywide or special area level).
Pedestrian crossing distance		
Pedestrian MMLOS		
Bicycle MMLOS		
Bicycle LTS		
Travel time		
Travel time reliability – buffer index		
Volume-to-capacity ratio		

[4] Having a crossing within 200 feet is desirable when citing new transit stops or relocating existing transit stops; however, reasonable distance to a crossing opportunity on an arterial or collector for an existing transit stops may be greater than 200 feet based on mid-block crossing spacing standards.

[5] May be exceptions to the crossings completeness standard based on policy guidance on modal priority.

PLAN AMENDMENTS AND DEVELOPMENT REVIEW

R&O 86-95 defines the transportation requirements associated with the County's existing review process. Per current requirements, the impact area for a development includes the site access points, all intersections within a certain distance of the property boundaries, based on roadway classification and any collector/arterial intersection to which the development adds 10% to entering vehicle volumes on any given approach leg. Within this impact area, two measures are currently used: crash frequency (as defined by the Washington County SPIS list) and volume-to-capacity ratio (as a proxy for safety). If the intersection appears on the SPIS list, the developer or party seeking a plan amendment must provide or contribute to countermeasures to improve the safety of an impacted the intersection, based on a benefit-cost analysis. If any of the site access points exceeds a v/c ratio of 0.99, mitigations are required to improve the v/c ratio based on potential safety issues for vehicles associated with overcapacity intersections such as rear-end crashes and red-light running.

The existing R&O 86-95 requires sidewalks for the site frontage and requires a connection to the nearest sidewalk. However, the requirements do not require further analysis of the transportation system for pedestrians, bicyclists, or transit riders, and therefore do not maximize the potential to improve safety of all users as new development occurs. The County can incorporate new performance measures into the development review process that seek to balance safety for all users and to provide options for where and how to contribute to improving the system, depending on the potential benefits and challenges posed by the existing constraints.

A proposed framework for modifying the development review process is presented in summary below and then outlined in detail in the following sections. An example of a hypothetical development application is included in order to demonstrate the process. Also noted are areas where issues still need to be resolved and/or the County will need to provide policy direction in order to move forward with the process of adopting new measures and incorporating them into the review process.

Developer or plan amendment applicant process

The proposed process for a developer or applicant to a plan amendment includes:

1. **Determine the development impact –** Estimate person-trips generated based the County's goals for mode split, and assign multi-modal trips to the transportation network for those trips to essential destinations.
2. **Determine impact area –** Intersections or facilities upon which a certain number of trips are added or there is a certain percentage increase in trips over existing (could vary by mode).
3. **Assess existing conditions for each mode –** Evaluate existing facilities and intersections against applicable performance standards. Identify any locations on existing SPIS list and a to-be-developed non-vehicle SPIS list.
4. **Determine improvements –** Identify improvements needed to mitigate impacts and complete a proportional share calculation.

Step 1: Determining Development Impact

In a multi-modal development review framework, trip generation by mode needs to be calculated to determine potential impacts rather than relying solely on the automobile trip generation rates contained in the standard reference *Trip Generation* (as published by ITE).

The County's Transportation Development Tax methodology assumes person trips are equal to 1.42 times the ITE trip generation rate. This methodology does not provide for disaggregation of person trips by mode and does not recognize likely differences in mode split in different land use contexts.

As part of the multi-modal framework process, the aspirational mode share targets by land use type could be used to estimate trip generation for non-vehicle modes. This will allow Washington County to identify and plan for the multi-modal facilities needed to meet mode share goals. Table 9 identifies the aspirational mode share targets, based on the Regional Transportation Plan goal of tripling non-SOV modes by 2035. The County could choose to adopt refined mode share goals by land use type, given the differing needs of industrial, residential, and mixed use areas. The regional non-SOV mode share targets vary by land use type.

Table 9 Washington County Mode Share Goals

Mode	Mode share goal
Drive Alone	44%
Shared Ride	24%
Walk	19%
Bike	3%
Transit	10%

Example Development Application: The example is a residential development consisting of 300 single family homes, portrayed in Figure 1.

Figure 1: Example Development Proposal: 300 Single Family Detached Homes

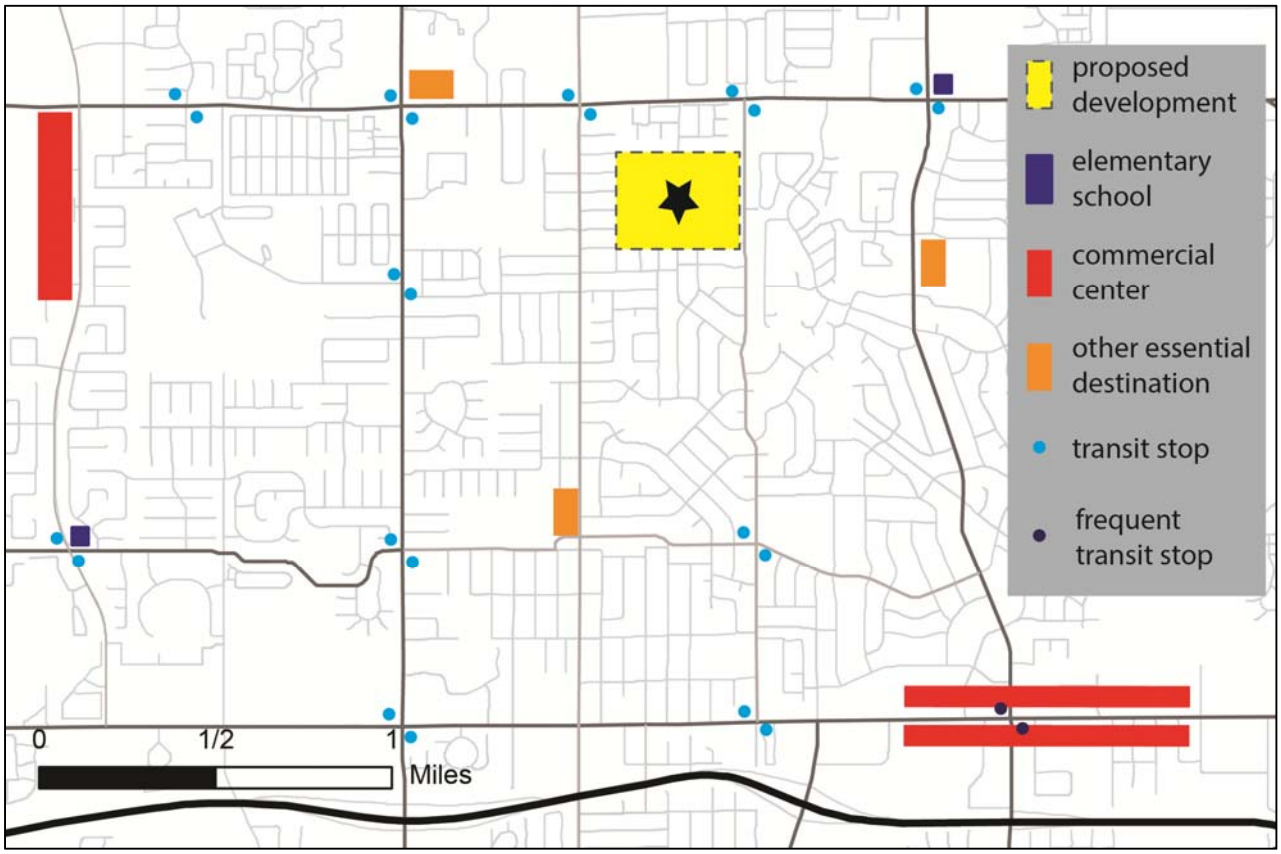

Table 10 shows the trip generation calculations that would be done under the recommended process for determining development impact:

Table 10: Example Multi-modal Trip Generation

300 Single Family Detached Homes			Calculation	Result: Daily Trips
Step 1: Calculate ITE Trip Generation Daily Vehicle Trips			=300*9.52	2,856
Step 2. Calculate Weekday Daily Person Trips			=2,856*1.42	4,056
Step 3. Apply Mode Share Goals	Drive Alone	44%	=44%*4,056	1,784
	Shared Ride	24%	=24%*4,056	973
	Walk	19%	=19%*4,056	771
	Bike	3%	=3%*4,056	122
	Transit	10%	=10%*4,056	406

Step 2: Determine Impact Area

An impact area includes those facilities that could experience an increase in trips attributable to a proposed development (or redevelopment). The County will continue to apply the existing R&O 86-95 process to determine vehicular impact area; this is defined by any intersection that experiences an increase of 10% or greater for volumes on any one leg are included in the impact area as well as those intersections within a certain distance of the property boundaries, based on roadway classification.

The multi-modal impact areas will be defined in a similar way as discussed below.

1. The trips are distributed and assigned to the modal networks as follows:
    - Pedestrian – trips distributed among key essential destinations[6] within a walking distance defined by the size of the development[7].
    - Bicycle – trips distributed among key essential destinations within a bicycling distance[8] defined by the size of the development.
    - Transit – trips assigned to network as pedestrian trips to nearby transit stops or frequent transit stops.
2. After performing the trip distribution, the impact area will include the following[9]:
    - Any segment or intersection that is assigned 20[10] or more added daily pedestrian trips will be included in the impact area.
    - Any segment or intersection that is assigned 10[8] or more added daily bicyclist trips will be included in the impact area.
    - The nearest transit stops (for both directions of travel) and adjacent crossings will be included in the impact area.

Example Development Application: Figure 2 shows an illustration of multi-modal trip distribution, using the same 300 single family detached example. The 771 total pedestrian trips would be distributed among three key destinations within walking distance (approximately ½ mile), a school and two others. The 406 transit trips are added and distributed as pedestrian trips to the three pairs of bus stops nearest the new development. The 122 bicycle trips are distributed to seven key destinations within approximately two miles.

Based on the 20- and 10- trip thresholds for pedestrian and bicycle trips, the study area for this development would be as shown in Figure 3. A more connected pedestrian and/or bicycle network would serve to distribute the trips over more potential routes, minimizing the impact area.

Washington County will need to determine an accepted method for trip distribution and assignment, answering the following questions:

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[6] The regional functional transportation plan defines essential destinations as hospitals, medical centers, grocery stores, schools, and social service centers with more than 200 monthly LIFT pick-ups.

[7] A maximum distance should be identified to limit the size of the impact area defined by step 2.

[8] If desired, the bicycle trips could be distributed based on the key "bicycle trip generators" from the Neighborhood Greenways study.

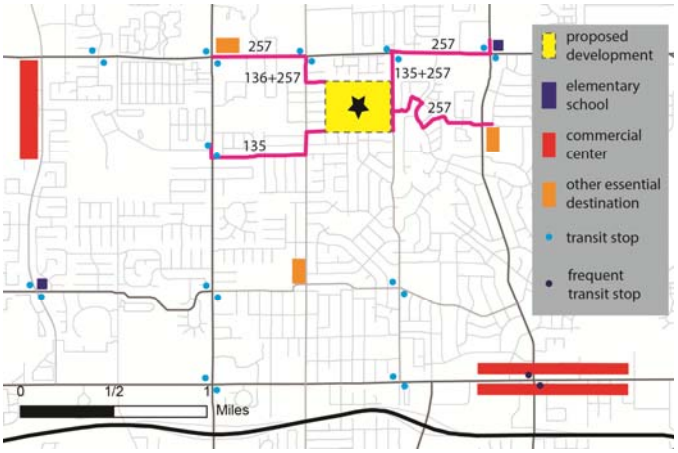
[9] Note: A policy decision is needed to determine the number of pedestrian or bicycle trips added to trigger addition to the impact area.

[10] The numbers included are baseline recommendations subject to policy discussion.

- Can informal pedestrian routes be considered in routing trips?
- Does the County wish to set guidance or a standard for out-of-direction travel?
- Should bicycle trips only be routed on the bike network designated in the TSP and Neighborhood Greenways project? Or should they also be routed on other local streets?

Figure 2: Pedestrian and bicycle routes to destinations

Pedestrian trip routes and walk to transit



Bicycle trip routes

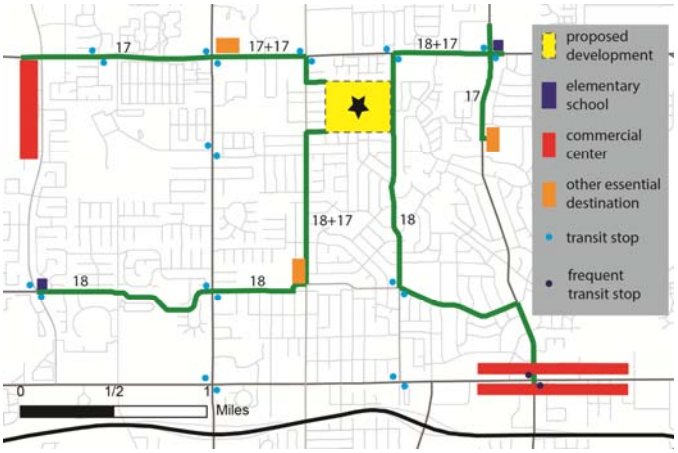
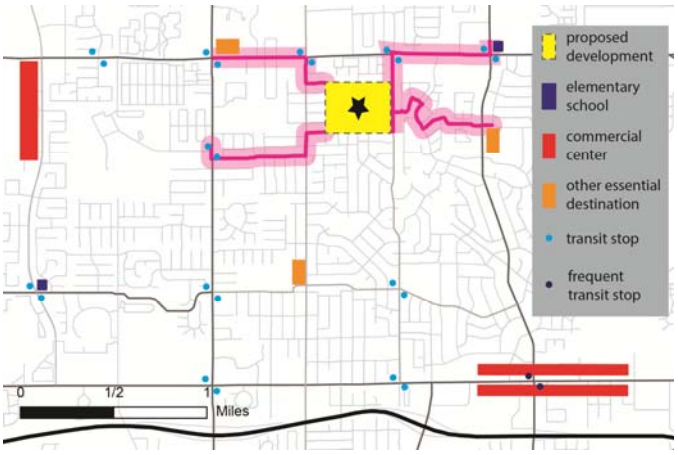
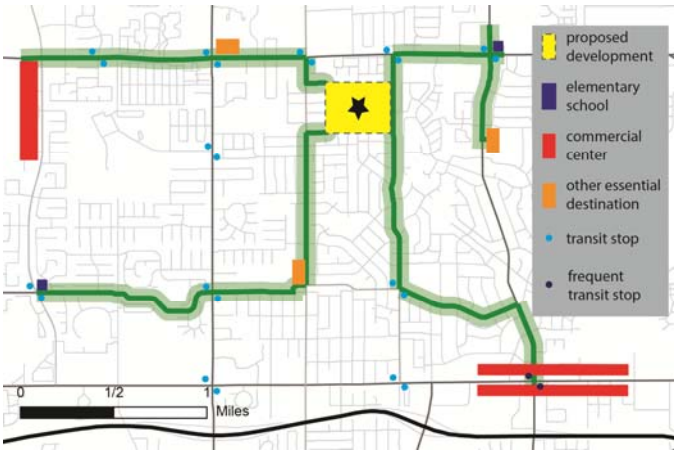


Figure 3: Pedestrian and bicycle study areas

Pedestrian and transit study area



Bicycle study area



Step 3: Assess Existing Conditions for Each Mode

Within the multi-modal framework, the type and level of mitigation measures will be based on an assessment of existing conditions or future baseline conditions for each travel mode. Recommended measures for assessing the system are included in Table 11.

Table 11: Plan Amendment and Development Review Measures

Measure	Standard	Implementation Needs
Sidewalk completeness	100% coverage of collector/arterial network in defined impact area that meets ADA and code width standards.	Develop method for determining proportional share of pedestrian improvements.
Crossings completeness	• Complete crossings at 100% of intersections in defined impact area • 100% of locations in defined impact area meeting TSP crossing spacing requirements, with appropriate crossings treatments per NCHRP 562 • Crossings present within 200 feet of all transit stops in defined impact area along collectors and arterials.	Develop method for determining proportional share of crossing improvements.
Bicycle facility completeness	100% coverage of arterial/collector network in defined impact area with bicycle facilities consistent with TSP designation	Develop method for determining proportional share of bicycle facility improvements.
Intersection completeness	All elements of intersection completeness (Appendix G), providing safe multi-modal access to all intersections in defined impact area	Develop method for determining proportional share of intersection modifications.
Crash Frequency	Implement safety countermeasures, including completing infrastructure for bicyclists and/or pedestrians, at impacted vehicle SPIS and non-vehicle SPIS sites in defined impact area	Develop non-vehicle SPIS list from the risk factors in the PBSIP.
Pedestrian delay	Evaluate impacts on pedestrian delay for any proposed intersection	Policy guidance is needed on whether or not to set a maximum increase in delay for pedestrians.
Pedestrian crossing distance	Evaluate impacts on pedestrian crossing distance for any proposed roadway modifications.	Policy guidance is needed on whether or not to set a maximum unbroken crossing distance for pedestrians
Travel time reliability – buffer index	TBD – as HCM methodologies are adopted, county may choose to adopt vehicle mobility measures such as travel time reliability to augment the existing process or replace v/c.	Develop travel time reliability baseline for county roads in order to identify areas of need, for use much like existing SPIS list is used in access reports to identify areas of needed safety improvements.
Volume-to-capacity ratio*	0.99 v/c during the peak hour for site accesses or intersections on the SPIS list in regional centers, town centers, main streets, and station communities 0.90 v/c during the peak hour hour for site accesses or intersections on the SPIS list in other urban and rural areas	None

* Measure already in use in the development review and plan amendment processes

As discussed above, the pedestrian and bicycle systems in Washington County are relatively immature and include many gaps and deficiencies. As such, measures to assess the pedestrian and bicycle modes largely focus on system completeness to enable the County to plan for and provide safe multi-modal access for users of all ages and abilities. System completeness for each mode is further defined in the County's TSP and may be refined in subsequent updates to the TSP.

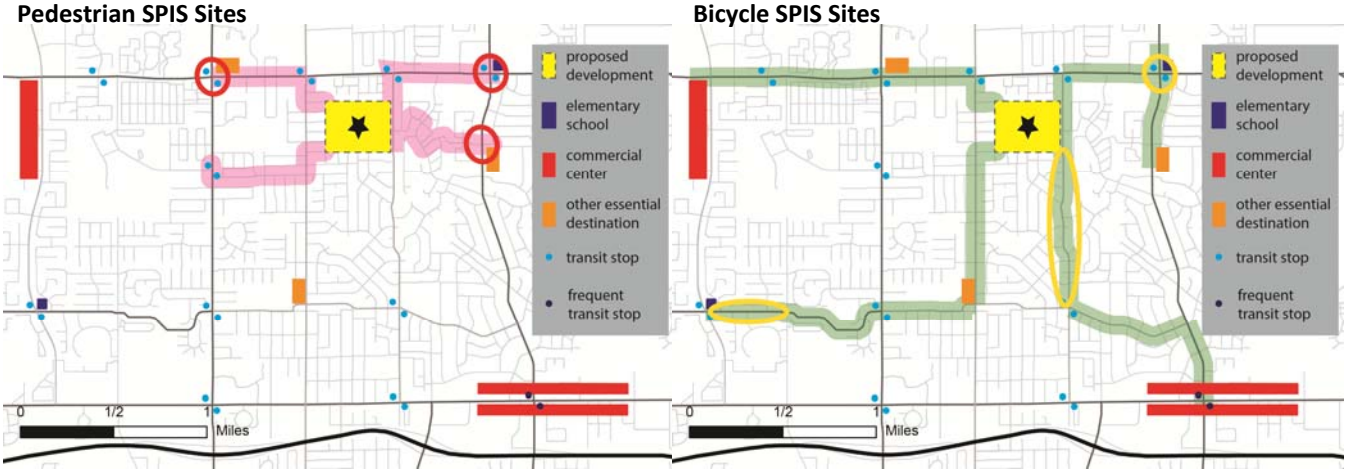
In addition to system completeness measures, the new framework will also require identification of hazardous sites that focus on all modes of travel. The existing methodology for identifying SPIS locations is heavily influenced by automobile crashes in congested locations. More attention to the number of bicycle and pedestrian crashes, as well as known risk factors, can be incorporated into this review to enable a truly multi-modal approach. This could be accomplished by Washington County through the development of a list of sites (a non-vehicle SPIS list) based on ODOT's recently released *Pedestrian and Bicycle Safety Implementation Plan* (PBSIP).

The PBSIP outlines a network screening approach to identify risk factors for pedestrian and bicycle travel. Washington County can use combinations of these risk factors to identify locations in the system where non-vehicular users are most at risk, independent of whether or not the locations have a documented crash history.

Working with county staff, development applicants, in their existing conditions assessment, would identify the SPIS and "non-vehicle SPIS" sites within the defined impact area. The existing conditions assessments at these locations should be inclusive of all modes. Appendix G provides a number of analysis considerations for multi-modal intersection completeness analysis.

Figure 4 shows the identification of theoretical pedestrian and bicycle SPIS sites in the development example.

Figure 4: Pedestrian and bicycle SPIS sites



Step 4: Determine Improvements

Currently, development applicants are required to provide:

- Vehicle accesses to sites that operate at a v/c of 0.99 or below (adding sufficient improvements to meet this standard if necessary);
- Half-street frontage improvements with complete multi-modal facilities;
- ROW easements for connections to adjacent properties;
- A proportional share of the cost of safety-related improvements that are warranted in accordance with the County's benefit/cost methodology at intersections appearing on the Washington County SPIS list.

Table 12 identifies the general level of improvements required at different levels of trip generation, consistent with existing County policy. These improvements are assessed as part of an Access Report completed by an applicant and/or through a Traffic Impact Statement (TIS) completed by County staff.

Table 12: Required Improvements per 86-95

Type of Improvement	Impact Level		
	< 14 daily vehicle trips	15- 40 daily vehicle trips	> 40 daily vehicle trips
Multi-modal Site Access	■	■	■
ROW Dedication	■	■	■
Frontage Improvement (or equivalent)		■	■
Safety Improvements at SPIS Locations			■

In implementing a multi-modal development review, Washington County wants to provide the framework for improving safety for all users of the transportation system. This can be accomplished by applying a proportional share framework to both vehicular and non-vehicular SPIS locations.

Similar to the existing R&O 86-95 requirements, the County will need to identify a benefit-cost methodology associated with a non-vehicular improvement recognizing that the PBSIP is not based on crash history but potential risk locations. The PBSIP enables a calculation of benefits depending on existing and/or total (with development) pedestrian or bicycle volumes.

Throughout the course of the project, the project team developed an alternate system of applying the measures in the context of plan amendments and development review that aligned with impact "points" approach described on page 20. Appendix H outlines this alternate system, which may be useful for other jurisdictions, but ultimately was not recommended for Washington County, due to the relative ease of applying the recommended system within the context of R&O 86-95.

MULTI-MODAL PERFORMANCE MEASURES SUMMARY

As noted in Section 2, each performance measure must be assessed based on how easy it is to apply, how easy it is to understand, the availability of data needed to asses it, and whether it is appropriate for the desired planning application. A number of measures have emerged as the ones that work best within the context of Washington County's existing infrastructure, its existing policies and processes, and those which are most appropriate for each application. Table 13 provides a summary of these measures and their applications.

Table 13: Summary of multi-modal measures and their application

Measure	TSP	Corridor Planning	Development Review and Plan Amendment
Mode Share	■		■
Sidewalk completeness	■	■	■
Crossings completeness	■	■	■
Bicycle facility completeness	■	■	■
Intersection completeness	■	■	■
Crash frequency	■		■
Predicted Crash Rate		■	
Pedestrian delay		■	■
Pedestrian crossing distance		■	■
Pedestrian MMLOS		■	
Bicycle MMLOS		■	
Transit Accessibility	■		
Bicycle Level of Traffic Stress	■	■	
Travel time reliability – buffer index	■	■	■
Accessibility to destinations / diverse uses	■		
Affordability	■		
Vehicle hours of delay per capita	■		
Vehicle miles traveled per capita	■		
Average Travel Time	■		
Demand to capacity ratio	■		

IMPLEMENTATION

Washington County is leading the way in developing a next-generation set of performance measures and standards for their transportation system, in accordance with state and regional policy requirements and local jurisdictional goals and values. To implement the proposed system, Washington County will need to take steps to build consensus and understanding among County staff and other agency, business, and public stakeholders; refine details of the process; and amend existing County documents. The next steps are arranged by planning application:

TSP, Subarea Plans, Multi-jurisdictional Corridor Planning

Washington County has recently undergone an effort to update their Transportation System Plan, currently in hearings for adoption. The updated TSP is already proposes using many of the measures recommended by this project (shown in Table 7). The additional recommended measures should be adopted as an amendment to the TSP. Once adopted, the County would be required to also use these measures for other long-range planning efforts such as Subarea Plans or Multi-jurisdictional Corridor Plans.

Project/Corridor Planning

A subset of multi-modal measures is recommended for broad use in project and corridor planning. In addition, Appendix B provides an even larger menu of options for measures that are applicable in project/corridor planning applications. Primary next steps for incorporating these measures are as follows:

- Familiarize County staff with performance measures that can be used in project/corridor planning and provide the resources for staff to learn about the measures and apply them in projects.
- Develop and provide clear policy guidance about modal prioritization for different areas. This could be done at the County level or on a project-by-project basis. However, it is critical to provide guidance to staff in weighing trade-offs inherent in the planning process when there is limited funding and right-of-way.

Development Review and Plan Amendment

The project team considered a number of different approaches to incorporating multi-modal performance measures into development review and recommends an approach that:

- Maintains the County's current focus on **safety** as the primary driver of mitigations for development review.
- Can be implemented within the framework of existing documents and policies.
- Defines system adequacy for non-auto modes using system completeness measures, deemed most appropriate for Washington County due to the existing incomplete state of the system.

In order to implement the recommended process, Washington County must take the following steps:

- Refine the thresholds in the recommended process (including crossings locations, number of pedestrian or bicycle trips/day to constitute inclusion in study area, etc.), based on County staff and stakeholder input.
- Develop a **bicycle and pedestrian SPIS list**, based on identified risk factors and existing high priority gaps, drawing on work already done:
    - ODOT's Pedestrian and Bicycle Safety Implementation Plan (identifies risk factors)
    - Washington County's Bicycle and Pedestrian Improvement Prioritization Project (identifies high priority gaps)
- Develop a process for assessing the benefit/cost ratio of pedestrian and bicycle improvements
- Develop a method for determining a development's proportional share of an improvement found to have a benefit/cost ratio of one or greater.
- Amend R&O 86-95: In R&O 86-95 Appendix B, Section D.2, the following changes are recommended:
    - Existing hazard locations should be updated to include locations from the bicycle and pedestrian SPIS list.
    - In R&O 86-95 Appendix B, Section D.2, the following changes are recommended:

    - D.2.1 – Existing Hazard Improvements should be amended to include potential improvements to mitigate hazard locations for pedestrians and bicyclists.
    - D.2.2.2 – Warranted Improvements should be amended to include improvements such as bike facilities, transit infrastructure, and crosswalks; and, the existing text of D.2.2.2, 3. should be amended to clarify its intended application, including essential destinations and defining a threshold level of aspirational pedestrian activity that would require mitigations instead of relying on the subjective "heavy pedestrian draw" definition.
  - In R&O 86-95 Appendix C, Access Report requirements, consider the following amendments:
    - Consider defining "traffic" as flows of people using any travel mode, and specify mode-specific traffic in instances where it occurs in reference to only one mode.
    - Under trip generation, add a section to explain the multi-modal trip generation method.
    - "Area to be Considered in the Report" should be amended to reflect the recommended method for determining study area, if desired.
    - Trip Distribution and Assignment should be amended to indicate that bicycle and pedestrian trips should be distributed to essential destinations.
    - Under Safety Considerations, add a discussion of pedestrian and bicycle risk factors and potential mitigations.
    - Add a section describing the completeness measures and analysis methods ultimately recommended for use.

Appendix A Regional Transportation Performance Targets

2.3.1 Performance targets

While goals and objectives are a vital component of the plan, equally important are quantifiable performance targets and indicators to track the region's progress. Investments that work together toward achieving a set of performance targets is critical for the region to be successful in realizing a truly integrated, multi-modal transportation system that achieves the goals and objectives of this plan.

Raising the bar from past RTPs, the plan includes a set of transportation performance targets, listed in **Table 2.3,** that support the outcomes-based framework and the plan's goals and objectives. The targets provided policy direction for developing the investment strategy recommended in Chapter 3. Table 2.3 includes findings on how well the plan performs in relation to the targets. The supporting data is found in Appendix 1.7.

Table 2.3
Regional Transportation Performance Targets

Target	Performance	Finding
	ECONOMY	
Safety –By 2035, reduce the number of pedestrian, bicyclist, and motor vehicle occupant fatalities plus serious injuries each by 50% compared to 2005.	Between 2003 - 2005: There were an estimated: 55 pedestrian fatalities and serious injuries 27 bike fatalities and serious injuries 392 motor vehicle fatalities and serious injuries	The region has established a baseline to track progress toward achieving the target over time.
Congestion – By 2035, reduce vehicle hours of delay (VHD) per person by 10 percent compared to 2005.	By 2035: VHD per person increases by 264% in 2 hour pm peak travel period VHD per person increases by 385% in the 1 hour mid-day travel period	The region does not meet the target. The data shows that VHD per person increases dramatically from 2005 based on the planned level and mix of investments.
Freight reliability – By 2035, reduce vehicle hours of delay truck trip by 10 percent compared to 2005.	By 2035: VHD per truck trip increases by 247% in 2 hour pm peak travel period VHD per truck trip increases by 358% in the 1 hour mid-day travel period	The region does not meet the target. The data shows that VHD per truck trip increases dramatically from 2005 based on the planned level and mix of investments.

Target	Performance	Finding
ENVIRONMENT		
Climate change – By 2035, reduce transportation-related carbon dioxide emissions by 40 percent below 1990 levels.	By 2035: Carbon dioxide emissions increase by 49% above 2005 levels	The State is developing a 1990 baseline and developing targets for light duty vehicles pursuant to House Bill 1059.The data shows that carbon dioxide increases from 2005 based on the planned level and mix of investments.
Active transportation – By 2035, triple walking, biking and transit mode share compared to 2005.	By 2035: Transit mode share increases by 4% compared to the 10% target Walking increases by 7% compared to the 19% target Biking increases by 1% compared to the 3% target	The region does not meet the target. However, the data shows that the region is making progress toward achieving the target.
Basic infrastructure – By 2035, increase by 50 percent the number of essential destinations[3] accessible within 30 minutes by trails, bicycling and public transit or within 15 minutes by sidewalks for all residents compared to 2005.	Data under development	The methodology for establishing a base line for this target is being developed.
Clean air – By 2035, ensure zero percent population exposure to at-risk levels of air pollution.	In 2035: Carbon monoxide is estimated at 836,484 lbs/day, 29% below the regional motor vehicle emissions budget for 2035 Hydrocarbons (VOC) is estimated at 17 tons/day, 58% below the regional motor vehicle emissions budget for 2035 Nitrogen oxide (NOX) is	The region meets the target for carbon monoxide and ozone (VOC and NOX) exposure from transportation sources. A regional standard for air toxics is under development.

[3] Consistent with the evaluation methodology used for the High Capacity Transit plan, essential destinations are defined as: hospitals and medical centers, major retial sites, grocery stores, elementary, middle and high schools, pharmacies, parks/open spaces, major social service centers (with more than 200 monthly LIFT pick-up counts), colleges and universities, employers with greater than 1,500 employees, sports and attraction sites and major government sites.

Target	Performance	Finding
	estimated at 16 tons/day, 73% below the regional motor vehicle emissions budget for 2035	
Travel – By 2035, reduce vehicle miles traveled per person by 10 percent compared to 2005.	In 2035: Vehicle miles traveled per person decline 4% below 2005 levels.	The region meets the target.
EQUITY		
Affordability – By 2035, reduce the average household combined cost of housing and transportation by 25 percent compared to 2000.	Data under development	Data for this target will be generated Spring 2010.
Access to daily needs – By 2035, increase by 50 percent the number of essential destinations accessible within 30 minutes by bicycling and public transit for low-income, minority, senior and disabled populations compared to 2005.	Data under development	The methodology for establishing a base line for this target is being developed.

The performance targets are numerical benchmarks to assess the region's progress in carrying out the RTP vision. These targets are drawn from federal and state legislation.

A broader set of performance targets that include land use as well as equity, economic and environmental measures will also be developed as part of the *Making the Greatest Place* effort in 2010. Monitoring of all the performance targets will provide accountability for achieving the goals of the plan. Decision-makers can use this information to adapt policies and investment strategies based on what is learned.

Appendix B Performance Measures and Assessment Framework

Multi-Modal Performance Measures and Standards - Assessment Framework

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
1	80th Percentile Travel Time Index	The 80th percentile travel time divided by the free flow travel time	Mobility	auto freight transit	Yellow	Yellow	Yellow	Yellow	Green	Red	Yellow	Yellow	Red	DTA model is capable of modeling this measure, but currently is in development	ODOT Alternative Mobility Measures
2	95th Percentile Travel Time	Travel time corresponding to the 95th highest out of 100	Mobility	auto freight transit bike	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Red	Yellow	Red	80th percentile is a more accurate measure. DTA model is capable of modeling this measure, but currently is in development	ODOT Alternative Mobility Measures
3	Accessibility to Destinations/Daily Needs	Percent of population living within 'X' miles or 'Y' minutes of defined destinations, by trip purpose and mode	Accessibility Economic Vitality	auto transit bike ped	Green	Yellow	Green	Red	Green	Yellow	Green	Yellow	Yellow	Good measure for assessing land use/development impacts.	ODOT Alternative Mobility Measures
4	Accessibility to Freight Network	Number of industry-specific jobs within 'X' miles or 'Y' truck travel time minutes of the regional freight network	Accessibility Connectivity Economic Vitality	freight	Yellow	Green	Red	Yellow	Red	Green	Red	Yellow	Green	Requies GIS based industry specific employment data	ODOT Mosaic
5	Accessibility to Freight Terminals	Number of industry-specific jobs (as proxy) within 'X' miles or 'Y' truck travel time minutes of port or intermodal facilities	Accessibility Economic Vitality	auto freight	Yellow	Green	Red	Yellow	Red	Green	Red	Yellow	Yellow	Requies GIS based industry specific employment data	ODOT Alternative Mobility Measures
6	Accessibility to Frequent Transit Service	Number or percent of homes and environmental justice communities within half mile of high capacity transit or quarter mile of frequent bus service	Active Transportation Accessibility	transit	Green	Green	Red	Green	Yellow	Yellow	Red	Yellow	Yellow	Requies GIS based housing and transit data.	ODOT Alternative Mobility Measures
7	Accessibility to Transit	Percent of population living within "X" miles or "Y" minutes that can access fixed-route transit	Active Transportation Accessibility	transit	Green	Green	Green	Red	Yellow	Green	Yellow	Yellow	Yellow	Requies GIS based housing and transit data.	ODOT Alternative Mobility Measures
8	Adjacent Sites with Connectivity	Locate the project on an infill site. OR Locate the project on an adjacent site (i.e., a site that is adjacent to previously developed land; see Definitions) where the connectivity of the site and adjacent land is at least 90 intersections/square mile as measured within a 1/2-mile distance of a continuous segment of the project boundary, equal to or greater than 25% of the project boundary, that is adjacent to previous development.	Connectivity	land use	Yellow	Green	Green	Yellow	Green	Green	Yellow	Green	Red	Existing external and internal intersections may be counted if they were not constructed or funded by the project developer within the past ten years. Locate and/or design the project such that a through- street and/or nonmotorized right-of-way intersects the project boundary at least every 600 feet on average, and at least every 800 feet, connecting it with an existing street and/or right of way outside the project; nonmotorized rights-of-way may count for no more than 20% of the total.	LEED-ND
9	Affordability	Average household combined cost of housing and transportation as a percent of total income. An affordable range for H+T as the combined costs consumes no more than 45% of income. Also can be measured with respect to transportation disadvantaged population to evaluate equity	Accessibility Livability Economic Vitality	auto transit	Yellow	Yellow	Green	Yellow	Green	Green	Red	Yellow	Green	The measure has limited applicability for assessing the adequcy of the transportation system in some settings such as plan amendments.	ODOT Alternative Mobility Measures, STARS
10	Agricultural land conservation	Locate the project on a site that is not within a state or locally designated agricultural preservation district, unless any changes made to the site conform to the requirements for development within the district (as used in this requirement, district does not equate to land-use zoning). AND Locate the project development footprint such that it does not disturb prime soils, unique soils, or soils of state significance as identified in a state Natural Resources Conservation Service soil survey. OR Locate the project on an infill site.	Natural Environment	land use	Yellow	Yellow	Red	Yellow	Yellow	Red	Yellow	Yellow	Red	Part of LEED "Smart Location and Linkage"	LEED-ND
11	Air Quality	Days exceeding national/state standards by region/air basin and statewide	Natural Environment Livability	auto freight transit	Green	Green	Yellow	Red	Red	Green	Red	Red	Yellow	A difficult measure to use and apply in a regional sub-area or on an individual project basis.	ODOT Alternative Mobility Measures
12	Auto Trips Generated	The number of net new automobile trips generated by a proposed development.	Mobility Livability	auto	Green	Green	Red	Red	Green	Red	Green	Yellow	Yellow		SFCTA
13	Average Incident Clearance Times	Average amount of time it takes to clear major incidents from the roadway.	Safety	auto freight transit	Green	Red	Yellow	Red	Red	Yellow	Red	Red	Red	Measures the success of efforts to relieve congestion due to incidents. Projects that substantially increase connectivity may decrease average clearance times.	FDOT Expanded Perf Measures

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
14	Average number of transfers	Number of transfers required, on average, for transit trips	Mobility	transit	🟢	🔴	🟢	🟡	🟡	🟢	🔴	🟡	🔴		FDOT Expanded Perf Measures
15	Average Speed	Average travel speed across a corridor	Safety Mobility	auto	🟢	🟡	🟡	🟢	🟢	🔴	🟡	🟡	🟡		FDOT Expanded Perf Measures
16	Average transit travel time; travel time reliability	Improve average transit travel time and travel time reliability between key origins and destinations for transportation-disadvantaged populations at least as much as the rest of the population.	Mobility Active Transportation	auto freight transit bike ped	🔴	🔴	🟡	🔴	🔴	🟡	🔴	🔴	🟡		STARS
17	Average Trip Length	Average length of trips within a given travel analysis zone or defined area.	Accessibility Livability	auto transit bike ped	🟢	🟢	🔴	🔴	🔴	🟢	🔴	🔴	🟡		FDOT Expanded Perf Measures
18	Average vehicle occupancy	Average occupancy rate of vehicles.	Coordination	auto	🟢	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴		FDOT Expanded Perf Measures
19	Bicycle access to destinations	Whether an existing bicycle network begins within 1/4 mile bicycling distance of the project and connects to 10 diverse uses within 3 miles	Active Transportation Accessibility	bike	🟡	🟡	🟡	🟡	🟡	🔴	🟡	🟡	🟡	Part of LEED "Smart Location and Linkage"	LEED-ND
20	Bicycle access to schools/employments	For residential projects, whether an existing bicycle network begins within 1/4 mile bicycling distance of the project and connects to school or employment center within 3 miles	Active Transportation Accessibility	bike	🟡	🟡	🟡	🟡	🟡	🔴	🟡	🟡	🟡	Part of LEED "Smart Location and Linkage"	LEED-ND
21	Bicycle Level of Traffic Stress	Rating of 1-4 that measures the traffic stress experienced by cyclists on a route, based on bicycle facility type and design, traffic speeds, presence of parking, and street width and lane configurations.	Safety Active Transportation Accessibility	bike	🟢	🟢	🟢	🟢	🟢	🔴	🟢	🟢	🟢	Could be used as a standard with each roadway class given an allowable LTS. Does not require traffic volume data	Low Stress Bicycling and Network Connectivity
22	Bicycle Network	Existing bicycle network of at least 5 continuous miles within 1/4-mile bicycling distance of project	Active Transportation Connectivity	bike	🟢	🟢	🟡	🔴	🔴	🟡	🟢	🟡	🟡		LEED-ND
23	Bicycle storage	Standards for multi-unit residential, retail, and non-residential other than retail	Active Transportation	bike	🟡	🟡	🟢	🟡	🟡	🔴	🟢	🟡	🔴	Part of LEED "Smart Location and Linkage"	LEED-ND
24	Bike Storage Facility Utilization	V/C of bike lockers or other facilities	Active Transportation	bike	🟡	🔴	🟡	🟢	🔴	🔴	🔴	🔴	🔴		ODOT Alternative Mobility Measures
25	Bike/ Pedestrian Route Directness	Ratio of shortest path route distance to straight line distance for two selected points.	Active Transportation Accessibility Connectivity	bike ped	🟡	🟢	🟢	🟡	🟢	🔴	🔴	🟡	🟢	Requires GIS network	ODOT Alternative Mobility Measures
26	Buffer Index	Percent of extra travel time travelers add to expected travel time to ensure on-time arrival X percent of time	Mobility Accessibility	auto freight transit bike	🟡	🔴	🟡	🔴	🔴	🟢	🔴	🔴	🟡	RTP Measure	ODOT Alternative Mobility Measures
27	Capital Costs	One-time, non-recurring expenditures associated with a transportation action	Funding	auto transit bike ped	🟢	🟢	🔴	🟡	🟢	🔴	🟡	🟡	🔴		ODOT Mosaic
28	Change in Employment Density	Measures impact on non-residential land use in response to changes in transportation system.	Economic Vitality	land use	🟢	🟡	🔴	🔴	🔴	🟢	🔴	🔴	🔴	Difficult to accurately forecast densities in the future. May need to be a more qualitative estimate.	ODOT Mosaic
29	Change in Population Density	Measures impact on residential land use in response to changes in transportation system.	Economic Vitality	land use	🟢	🟡	🔴	🔴	🔴	🟢	🔴	🔴	🔴	Difficult to accurately forecast densities in the future. May need to be a more qualitative estimate.	ODOT Mosaic

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
30	Changes in employment by industry and wage category	Calculates the change in employment and wages attributable to particular investments or actions	Economic Vitality	land use	🔴	🔴	🔴	🟡	🟢	🔴	🔴	🟡	🔴	Uses NAICS codes and IMPLAN data, which is integrated into MOSAIC tool. Users input current employment, construction costs, timelines, expected revenues, and congestion conditions. Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
31	Changes in productivity from increased connectivity	Measures economic effects resulting from increased connectivity, such as agglomeration economies, increased competition, and labor supply	Economic Vitality	Economic	🔴	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🔴	Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
32	Changes in total value of exports and imports	Estimates the total change in value of imports and exports based on annual growth, transportation costs, and transportation cost elasticities	Economic Vitality	Economic	🔴	🟡	🔴	🟢	🟡	🟢	🔴	🟡	🔴	Uses NAICS export and import data, which is integrated into MOSAIC tool. Users input annual growht, transportation costs, and elasticities. May be useful in prioritizing large regional transportation investments.	ODOT Mosaic
33	Changes in transportation costs by industry	Looks at the impacts of a transportation investment on the transportation costs for each industry sector, including "on-the-clock" travel	Economic Vitality	Economic	🟡	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴	Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
34	Clean Air	Percent of population with exposure to at-risk levels of air pollution within a specified time period, also can be evaluated for transportation-disadvantaged populations	Natural Environment Livability	auto freight transit	🟡	🔴	🟡	🔴	🔴	🟢	🔴	🔴	🟡	Limited applicability in a plan amendment or TSP setting.	ODOT Alternative Mobility Measures, STARS
35	Congested Traffic (percent)	Ratio of congested VMT to total VMT	Mobility	auto freight transit	🟡	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴		ODOT Alternative Mobility Measures
36	Congestion	Identifies number of network miles and locations that exceed the interim regional mobility policy for congestion in the mid-day and pm peak.	Mobility	auto freight	🟡	🟢	🟡	🔴	🔴	🟢	🔴	🔴	🔴	RTP Measure.	ODOT Alternative Mobility Measures
37	Congestion Duration (Hours of Congestion)	The number of hours that a facility is operating below a specificed density or speed.	Mobility	auto freight transit	🟢	🔴	🟢	🟢	🟢	🟢	🔴	🟢	🔴	Potential tool for identifying project priority at the TSP level. Dynamic assignment model may be able to address this.	ODOT Alternative Mobility Measures, MOSAIC, FDOT Expanded Perf Measures
38	Congestion Extent	The length of a segment, by direction, that experiences speeds below a certain threshold.	Mobility	auto freight transit	🟡	🔴	🟡	🟢	🟢	🟢	🔴	🟢	🔴	Potential tool for identifying project priority at the TSP level. Dynamic assignment model may be able to address this.	ODOT Alternative Mobility Measures
39	Connectivity: Intersections per linear-mile	Ratio of intersections to linear-miles for a given area.	Connectivity	auto freight transit bike ped	🟡	🟢	🟡	🟡	🟡	🟢	🟡	🟡	🔴	This measure could be difficult to apply in certain types of plan amendments such as zone changes.	ODOT Alternative Mobility Measures
40	Connectivity: Intersections per square mile (SLL)	Number of publicly accessible intersections per square mile, including any combination of streets, dedicated alleys, transit rights-of-way, and nonmotorized rights-of-way.	Connectivity	auto freight transit bike ped	🟢	🟢	🟡	🟡	🟡	🟢	🟡	🟡	🔴	If one must both enter and exit an area through the same intersection, such an intersectio and any beyond it are not counted; intersections leading only to cul-de-sac are also not counted. The land area calculation excludes water bodies, parks larger than 1/2 acre, public facility campuses, airports, rail years, slopes over 15% and areas nonbuildable under law.	LEED-ND
41	Connectivity: Link to node ratio	Ratio of nodes to links in a given area, where a node is an intersection, cul-de-sac or dead end, and a link is the roadway connecting nodes.	Connectivity	auto freight transit bike ped	🔴	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🔴		FDOT Expanded Perf Measures
42	Connectivity: Network locations without dead ends	Percentage of nodes (intersections, cul-de-sacs, or nodes) in the network that are not dead ends or cul-de-sacs.	Accessibility Connectivity	auto freight transit bike ped	🟡	🟢	🟡	🟡	🟡	🟢	🟡	🟡	🟡		Washington County TSP
43	Connectivity: Road Density	Centerline miles of road network per square mile	Accessibility Connectivity	auto freight transit	🟡	🟢	🔴	🔴	🟡	🟢	🟡	🟡	🟡	Provides an aggregated way to measure compactness, connectedness, and accessibility within one measure.	FDOT Expanded Perf Measures

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
44	Cost of Delay to Economy	Cost of delay on regional freight network in mid-day and PM peak	Economic Vitality	auto freight	Yellow	Red	Red	Red	Red	Green	Red	Red	Red	RTP measure. Values of time are derived by using person cost figures from Cost of Congestion to the Economy of the Portland Region Study with 2004 figures converted to 2007 dollars using Bureau of Labor Statistics consumer price index inflation calculator.	ODOT Alternative Mobility Measures
45	Crash Frequency	Number of crashes occuring at a site, facility, or network in a one year period, Can be broken down by type or severity.	Safety	auto freight transit bike ped	Green	Green	Yellow	Yellow	Red	Green	Yellow	Yellow	Red	Does not require traffic volume data. Average crash frequencies in and of themselves do not indicate whether or not a location needs safety improvements. This metric is the least desirable when determing safety performance.	ODOT Alternative Mobility Measures, HSM, MOSIAC
46	Crash Rates	Total crashes per million vehicle miles of travel (VMT) or total entering AADT. Can be broken down by severity.	Safety	auto freight transit bike ped	Green	Green	Yellow	Green	Red	Green	Yellow	Yellow	Red	Requires traffic volume data and crash data. Crash rates in and of themselves do not indicate whether or not a location needs safety improvements.	ODOT Alternative Mobility Measures, HSM
47	Critical Movement Delay	A measure of delay at an intersection for the critical movement	Mobility	auto freight	Red	Green	Green	Yellow	Green	Yellow	Green	Green	Red		HCM 2010
48	Critical Rate	Establishes a threshold to which to compare each site's crash rate. Sites with crash rates above the threshold are flagged for further investigation. Can be broken down by severity.	Safety	auto freight transit bike ped	Yellow	Green	Yellow	Green	Red	Red	Green	Yellow	Red	Requires traffic volume and crash data. The primary benefit of using critical rate over crash rate is it establishes a threshold thereby identifying the sites to focus safety improvements.	ODOT Alternative Mobility Measures, HSM
49	Crosswalk spacing	Distance between marked crosswalks, designed in accordance with NCHRP 562	Active Transportation Accessibility Connectivity	ped	Green	Green	Green	Red	Green	Yellow	Green	Yellow	Green		FDOT Expanded Perf Measures
50	Delay on Regional Freight Network	Evaluates traffic delay for freight movement in the one-hour mid-day travel period and in the two-hour pm rush hour.	Mobility Economic Vitality	freight	Green	Green	Green	Yellow	Green	Yellow	Red	Yellow	Yellow		ODOT Alternative Mobility Measures
51	Demand to Capacity Ratio	Ratio of the forecast future demand of a segment or intersection to its capacity.	Mobility	auto freight	Yellow	Green	Red	Green	Yellow	Red	Red	Yellow	Red		Washington County TSP
52	Designated High-Priority Locations	Locate the project in one of the following high-priority redevelopment areas: EPA National Priorities List, Federal Empowerment Zone, Federal Enterprise Community, Federal Renewal Community, Department of Justice Weed and Seed Strategy Community, Department of the Treasury Community Development Financial Institutions Fund Qualified Low-Income Community (a subset of the New Markets Tax Credit Program), or the U.S. Department of Housing and Urban Development's Qualified Census Tract (QCT) or Difficult Development Area (DDA).	Coordination	land use	Yellow	Yellow	Red	Yellow	Red	Red	Red	Red	Red	Part of LEED "Smart Location and Linkage"	LEED-ND
53	Destination Travel Times	Evaluates mid-day and pm peak motor vehicle travel time between 20 regional origin-destination pairs.	Mobility	auto	Green	Green	Yellow	Yellow	Yellow	Green	Red	Yellow	Red	RTP Measure. Good regional measure, but could have its limitations when applied at a local level.	ODOT Alternative Mobility Measures
54	Destination Travel Times	Evaluates mid-day and pm peak transit travel time between 18 origins and destinations across the region.	Mobility	transit	Green	Green	Yellow	Yellow	Yellow	Green	Red	Yellow	Red	RTP Measure. Good regional measure, but could have its limitations when applied at a local level.	ODOT Alternative Mobility Measures
55	Driveway Density	Average number of driveways or accesses per unit	Active Transportation Accessibility Maintenance	bike ped	Green	Yellow	Green	Red	Yellow	Yellow	Green	Yellow	Green		FDOT Expanded Perf Measures
56	Emergency Management Systems	Measure of estimated travel times on major routes serving hospital and trauma centers.	Safety Mobility	auto freight transit bike ped	Green	Yellow	Green	Red	Green	Green	Red	Yellow	Yellow	Uses data from the National EMS Information System (NEMSIS) to identify response times to hospitals and trauma centers in different geographies. Then uses travel demand model to estimate change in travel times.	ODOT Mosaic
57	Equivalent Property Damage Only Average Crash Frequency with EB Adjustment	The expected crash frequency is calculated for each site. Crashes are multipled by a monetary value based on their severity. Sites are ranked by crash cost.	Safety	auto freight transit bike ped	Red	Red	Yellow	Green	Green	Red	Yellow	Yellow	Red	Requires safety performance functions specific to study roadways. ODOT does not currently have these functions. Feasible, if safety performance functions become available.	ODOT Alternative Mobility Measures, HSM

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58	Excess Expected Average Crash Frequency with Empirical Bayes Adjustment	The observed crash frequency for each siteis compared to the site's expected crash frequency. Sites are ranked based on the difference or "excess" between the two.	Safety	auto freight transit bike ped	🔴	🔴	🟡	🟢	🟢	🔴	🟡	🟡	🔴	Requires safety performance functions specific to study roadways. ODOT does not currently have these functions. Feasible, if safety performance functions become available.	ODOT Alternative Mobility Measures, HSM
59	Excess Predicted Average Crash Frequency Using Method of Moments	A method of comparing a site's crash frequency to other similar sites and identifying locations with the most potential to improve.	Safety	auto freight transit bike ped	🔴	🔴	🟡	🟢	🟢	🔴	🟡	🟡	🔴	Requires safety performance functions specific to study roadways. ODOT does not currently have these functions. Feasible, if safety performance functions become available.	ODOT Alternative Mobility Measures, HSM
60	Excess Predicted Average Crash Frequency Using Safety Performance Functions	The observed crash frequency for each site is compared to a predicted crash frequency. Sites are ranked based on the difference or "excess" between the observed and predicted crashes.	Safety	auto freight transit bike ped	🔴	🔴	🟡	🟢	🟢	🔴	🟡	🟡	🔴	Requires safety performance functions specific to study roadways. ODOT does not currently have these functions. Feasible, if safety performance functions become available.	ODOT Alternative Mobility Measures, HSM
61	Excess Proportions of Specific Crash Types	Measures whether certain crash types are overrepresented at a specific site.	Safety	auto freight transit bike ped	🟢	🟢	🟡	🟢	🔴	🔴	🟡	🟡	🔴	Requires traffic volume and crash data. Can be used to evaluate safety for specific users such as pedestrian and bicyclists therefore it is a unqiue way to identify locations for pedestrian and biycle improvements.	ODOT Alternative Mobility Measures, HSM
62	Expected Average Crash Frequency with Empirical Bayes Adjustment	The predicted crash frequency for each site is weighted by the site's observed crash frequency. Sites are ranked by their resulting expected crash frequency.	Safety	auto freight transit bike ped	🔴	🔴	🔴	🟢	🟡	🔴	🟡	🟡	🔴	Requires safety performance functions specific to study roadways. ODOT does not currently have these functions. Feasible, if safety performance functions become available.	ODOT Alternative Mobility Measures, HSM
63	Failure/On-Time Measures	Percent of trips with travel times less than 1.1 x Median Travel time or 1.25 x Median Travel time	Mobility	auto freight transit bike	🟡	🔴	🟡	🟢	🟢	🟡	🔴	🟡	🔴	DTA model is capable of modeling this measure, but currently is in development	ODOT Alternative Mobility Measures
64	Freeway Lane Miles with ITS	Extent of system with ITS technologies	Mobility Maintenance	auto freight	🟢	🟢	🔴	🔴	🔴	🟢	🔴	🔴	🟡	Highway specific measure with limited application for plan amendments or application to non-freeway facilities.	ODOT Alternative Mobility Measures
65	Fuel Consumption per VMT or PMT	Fuel consumption per VMT or PMT	Natural Environment	auto freight transit	🟢	🟢	🔴	🔴	🔴	🟢	🔴	🔴	🔴	MOBLE 6 and/or MOVES model is capable of assessing this measure.	ODOT Alternative Mobility Measures
66	Highway Runoff	Change in pollutant loads due to change in highway capacity based on VMT or new lane miles	Natural Environment	auto freight	🟡	🟡	🔴	🔴	🟡	🔴	🟡	🔴	🔴	Limited applicability in a plan amendment or TSP setting.	ODOT Alternative Mobility Measures
67	Hours of Service	Number of hours during the day that transit service is provided.	Active Transportation	transit	🟢	🟢	🟡	🟡	🟡	🔴	🟡	🟡	🔴		FDOT Expanded Perf Measures
68	House and jobs proximity	Include a nonresidential component equaling at least 30% of the project's total building square footage (exclusive of parking structures), and locate on an infill site whose geographic center (or boundary if the project exceeds 500 acres) is within 1/2-mile walk distance of an existing rail transit, ferry, or tram stop and within 1/2-mile walk distance of existing dwelling units whose number is equal to or greater than 50% of the number of new full-time-equivalent jobs created as part of the project	Accessibility Economic Vitality	land use	🟡	🟡	🔴	🟡	🟡	🔴	🟡	🟡	🟡	Part of LEED "Smart Location and Linkage"	LEED-ND
69	Infill Sites	Locate a new project on a site served water and wastewater and adjacent to 75% previously developed land.	Accessibility Natural Environment Economic Vitality	land use	🟢	🟢	🔴	🟡	🟢	🔴	🟢	🟡	🟢	LEED-ND has specific definitions addressing the percent of adjacent land developed, and how that number is caluclated. This measure is not transportation-specific, but is related to the transportation goals. Part of LEED "Smart Location and Linkage"	LEED-ND
70	Jobs Housing Balance	Number of employees divided by the number of residences in an area.	Accessibility	land use	🟢	🟢	🔴	🔴	🔴	🟢	🟡	🟡	🔴	This measure represents the potential for reducing VMT by balancing jobs and housing within a given area, potentially increasing the portion of trips internal to that area.	FDOT Expanded Perf Measures

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71	Labor Force Accessibility	Number of residents within reach of region's employers (based on a change in average travel time to major employment centers as a result of project)	Accessibility Economic Vitality	auto transit bike ped land use	🟢	🟡	🟡	🟡	🟡	🟢	🔴	🟡	🟡	Requires extensive data on employment, street network, and transit network.	ODOT Alternative Mobility Measures
72	Land Consumption	Percentage of land consumed by a development scenario (compared to the amount of land conserved).	Natural Environment	land use	🟢	🟡	🔴	🔴	🟢	🟡	🟡	🟡	🔴		FDOT Expanded Perf Measures
73	Land Use Mix/Balance	The portion of land allocated to different uses of multi-family, retail/service, office, entertainment, institutional, industrial, and single-family.	Active Transportation Accessibility Livability	land use	🟢	🟢	🟡	🟡	🔴	🟢	🟡	🟡	🟢		ODOT Alternative Mobility Measures. FDOT Expanded Perf Measures
74	Level of Service (LOS)	A quantitative stratification that represent a traveler's perceptions of quality of service by a facility.	Mobility	auto freight	🟢	🟢	🟢	🟢	🟢	🔴	🟢	🟢	🔴		ODOT Alternative Mobility Measures, HCM 2010
75	Level of Service of Safety (LOSS)	The observed crash frequency for each site is compared to a predicted crash frequency. Letter grades are assigned to each site based on the difference between the two.	Safety	auto freight transit bike ped	🔴	🔴	🟡	🟢	🟢	🔴	🟢	🟢	🔴	Requires safety performance functions specific to study roadways. ODOT does not currently have these functions. Feasible, if safety performance functions become available.	ODOT Alternative Mobility Measures, HSM
76	Lifecycle Costs	Capital costs + O&M costs + financial costs	Funding	auto transit freight bike ped	🟢	🔴	🔴	🟡	🟢	🔴	🔴	🟡	🔴		ODOT Mosaic
77	Lives saved due to active transportation	Calculates change in mortality due to increased physical activity from increases in walking or cycling for transportation	Active Transportation Livability	ped bike	🟡	🟡	🔴	🔴	🔴	🟢	🔴	🔴	🟡	Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
78	Local Traffic Diversion	Amount of traffic diverted to local parallel facilities.	Mobility Livability	auto	🟡	🟡	🟡	🔴	🟢	🔴	🟡	🟡	🟡		FDOT Expanded Perf Measures
79	Miles of bicycle facilities	Measures the number of miles of multi-use paths and bike boulevards; bicycle lanes.	Active Transportation Accessibility Connectivity	bike	🟢	🟢	🟡	🔴	🟡	🟢	🔴	🟡	🟢	Multi-use paths and bike boulevards are counted separately from bicycle lanes, since MUPs and bike boulevards have been shown in Portland-based studies to attract more bicyclists	ODOT Mosaic
80	Misery Index	The average of the highest 5 percent of travel times divided by the free-flow travel time	Mobility	auto freight transit bike	🟡	🔴	🟡	🟢	🟢	🟡	🔴	🟡	🔴	DTA model is capable of modeling this measure, but currently is in development	ODOT Alternative Mobility Measures
81	Mode choice availability	Number of modes that can be used to access destinations (specify thresholds for distance walking and biking)	Mobility Accessibility	auto transit bike ped	🟡	🟡	🟡	🟢	🟢	🟡	🟡	🟢	🟡		FDOT Expanded Perf Measures
82	Mode Share	Percentage of trips made via each mode, also calculated in aggregate (SOV vs non-SOV mode share)	Mobility Accessibility Natural Environment	auto transit bike ped	🟢	🟡	🔴	🔴	🟡	🟢	🟡	🟡	🟢	RTP measures non-drive alone mode share	ODOT Alternative Mobility Measures, ODOT Mosaic, FDOT, STARS
83	MPO Location with Low VMT	Locate a new project in a TAZ that has 90% or less of the average for the MPTO.	Natural Environment	auto freight	🔴	🟡	🟡	🟡	🔴	🟡	🔴	🔴	🔴	Part of LEED "Smart Location and Linkage"	LEED-ND
84	Multi-Modal Level of Service (LOS)	A quantitative stratification that represent a traveler's perceptions of quality of service by a facility.	Mobility	transit bike ped	🟢	🟡	🟢	🟢	🟢	🔴	🟢	🟢	🔴	More data intensive than LOS for autos	ODOT Alternative Mobility Measures, HCM 2010
85	Multiple Route Choices	Number of route choices between origins and destinations.	Accessibility Connectivity	auto freight transit bike ped	🟢	🟡	🟡	🟢	🟡	🟡	🔴	🟡	🟡		FDOT Expanded Perf Measures, ITDP

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86	Natural, Cultural, Built, and Resources at Risk	Measures the impacts of a transportation project on threatened or endangered species or their habitat by quantifying the number of acres of habitat impacted.	Natural Environment	land use	🟢	🟢	🟡	🟢	🔴	🔴	🟢	🟡	🔴		ODOT Mosaic
87	Nearby Neighborhood Assets	Project boundary within 1/4 mile walk distance of five diverse uses, or project center within 1/2 mile walk of seven diverse uses.	Accessibility	ped land use	🟢	🟡	🟢	🟡	🟢	🔴	🟡	🟡	🔴	Part of LEED "Smart Location and Linkage"	LEED-ND
88	Noise Impacts	Measure noise impacts in 50 feet increments from the centerline of a highway	Livability Funding	auto freight transit	🟢	🔴	🟡	🔴	🟡	🔴	🟡	🔴	🟡	Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
89	Non-Recurring Delay	Vehicle hours of delay in excess of recurring delay for a given time of day, day of week, and type of day	Mobility	auto freight transit	🔴	🔴	🟢	🟢	🔴	🟡	🔴	🟡	🔴	Data collection efforts would be costly as it would require repeated travel time measurements over a long time span. Difficult to break delay in to its recurring and non-recurring components.	ODOT Alternative Mobility Measures, MOSAIC
90	Non-residential Intensity	Measure non-residential uses, and is usually measured in employees per acre or floor area ratio (building square footage to the square footage of the parcel or developed area)	Economic Vitality	land use [transit]	🟢	🟢	🔴	🟢	🟡	🟢	🟡	🟢	🔴	Can provide guidance on where multimodal transportation investments may be the most impactful, especially tranit.	FDOT Expanded Perf Measures
91	Number of jobs associated with a plan or project	This measure looks at the short-run impacts of construction spending on a particular project.	Economic Vitality	land use	🟢	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴	Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
92	Number of residents displaced by a transportation project		Funding Coordination	land use	🟢	🟡	🟡	🟡	🟡	🔴	🔴	🔴	🟡		STARS
93	Number of violations of weight restrictions	Number of violations of weight restrictions	Mobility Maintenance	freight	🟢	🟢	🔴	🟡	🔴	🟡	🔴	🔴	🟡		FDOT Expanded Perf Measures
94	Off/On Street Parking V/C	V/C of parking facilities within specified area	Accessibility	auto	🟢	🔴	🟢	🔴	🔴	🟡	🟡	🔴	🔴	This measure has limited application in assessing the adequacy of TSPs or plan amendments, but is useful as an indicator for a change in parking supply, standards, pricing, or policies.	ODOT Alternative Mobility Measures
95	Off-peak transit availability		Active Transportation Accessibility	transit	🟢	🟡	🟢	🟡	🟡	🟢	🔴	🟡	🟡		FDOT Expanded Perf Measures
96	On-Time Arrivals	Percent of trips that reach a given destination over a designated facility within a specified travel time.	Mobility	auto freight transit bike	🟢	🔴	🟡	🟢	🟢	🟡	🔴	🟡	🔴	DTA model may be capable of modeling this measure.	ODOT Alternative Mobility Measures
97	Overweight permits	Number of overweight permits granted	Maintenance	freight	🟢	🟢	🔴	🔴	🔴	🟡	🔴	🔴	🔴		FDOT Expanded Perf Measures
98	Passengers per transit vehicle mile		Active Transportation Funding	transit	🟡	🟢	🔴	🟢	🔴	🟡	🔴	🟡	🟡		FDOT Expanded Perf Measures
99	Pedestrian Crossings Completeness	Percentage of intersections with complete, accessible crosswalks in all directions	Accessibility Active Transportation Connectivity	ped	🟢	🟢	🟢	🔴	🔴	🟢	🟢	🟡	🟢	In addition to being a requirement for new or upgraded intersections, new developments could be required to contribute towards complete crossings in a certain area around the intersection.	ITDP, ODOT Mosaic (modified)
100	Percent bicycle trips connected	The percentage of trips in the regional trip table that can be made without exceeding a specified level of stress and without an excessive detour	Active Transportation Accessibility Connectivity	bike	🟡	🟡	🟡	🟢	🔴	🟢	🔴	🟡	🟢		Low Stress Bicycling and Network Connectivity
101	Percent Effective Network	Percent of a network in a particular area that provides a through path for travel, i.e. excludes cul-de-sacs and dead ends.	Connectivity	auto freight transit bike ped	🟡	🟢	🟡	🟡	🔴	🟡	🟢	🟡	🔴	Can be used as a measure of connectivity of the roadway system over a large area, and could be used as a minimum standard for large new developments.	FDOT Expanded Perf Measures

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102	Percent Miles Bicycle Accommodation	The portion of roadway miles that accommodate bicyclists with lanes, multi-use paths, or on low-speed residential shared streets.	Active Transportation Accessibility	bike	🟢	🟢	🔴	🔴	🟡	🟢	🟢	🟡	🟡		FDOT Expanded Perf Measures
103	Percent nodes connected	Percentage of nodes that are connected to one another without exceeding a specified level of stress and without an excessive detour	Active Transportation Connectivity	bike	🟡	🟢	🔴	🟡	🔴	🟢	🔴	🟡	🟡		Low Stress Bicycling and Network Connectivity
104	Percent of Residential Areas within a mile of an elementary school	An indicator of access to schools, measures the portion of households that are within one mile.	Accessibility	land use bike ped	🟢	🟢	🟢	🔴	🔴	🟡	🔴	🔴	🔴		FDOT Expanded Perf Measures
105	Percent of Transportation Projects that Impact High Value Habitat Areas	Evaluates impact of transportation investments on Goal 5 high value habitat areas.	Natural Environment	auto freight transit bike ped	🟢	🟢	🔴	🟡	🟢	🟡	🔴	🟡	🔴	RTP Measure	ODOT Alternative Mobility Measures
106	Person Hours of Travel (PHT)	Person hours of travel within a specified area and time period	Mobility	auto transit	🟡	🟡	🟡	🔴	🔴	🟢	🔴	🔴	🔴	Identifying the size of the specified areas to measure may be difficult to interpret.	ODOT Alternative Mobility Measures
107	Person Throughput	Total number of people traveling along a corridor.	Mobility	auto transit bike ped	🟢	🔴	🔴	🟢	🟢	🟡	🟡	🟢	🔴	Data intensive; Requires additional data and model refinement before bike movements can be modeled; Metro model not currently capable of assessing pedestrian movements.	ODOT Alternative Mobility Measures
108	Person Travel Time	Travel time for any passenger modes to traverse a segment.	Mobility	auto transit	🟢	🔴	🟢	🔴	🟢	🔴	🔴	🔴	🔴	Not a multimodal measure. Travel times are estimated for each mode then combined in a weighted average. It results in a more expensive and complicated evaluation process as it requires several levels of travel speeds by different modes. Extensive analysis procedures would need to be developed.	ODOT Alternative Mobility Measures
109	Physically Permeable Frontage	Number of shops and pedestrian building entrances per block frontage (by length)	Active Transportation Livability	ped land use	🟢	🟡	🟢	🔴	🟡	🔴	🟢	🟡	🟡		FDOT Expanded Perf Measures
110	Planning Time Index	95th percentile travel time divided by the free flow travel time	Mobility	auto freight transit	🟡	🔴	🟢	🟢	🟡	🔴	🔴	🟡	🔴	DTA model is capable of modeling this measure, but currently is in development	ODOT Alternative Mobility Measures
111	Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day	Measure of portion of people and jobs with quality transit coverage (30 vehicles per day may include different bus lines)	Accessibility Economic Vitality	transit	🟡	🟢	🟡	🟡	🔴	🟢	🔴	🟡	🟡		ODOT Mosaic
112	Population and/or Employment Density	People, households, or workers over district area. Measured in people or jobs per acre or dwelling unit per acre.	Active Transportation Accessibility	land use	🟢	🟢	🟡	🟢	🔴	🟢	🟡	🟡	🟡	This is a measure of building and/or people density. Density measures can help prioritize and maximize investments in active transportation infrastructure and transit service.	ODOT Alternative Mobility Measures, FDOT Expanded Perf Measures
113	Population within 45 minutes of work and home	Specific measure of travel time between home and work. The threshold can be adjusted.	Accessibility	auto transit bike ped	🟢	🟡	🟢	🔴	🔴	🟢	🔴	🔴	🔴		ODOT Mosaic
114	Project location type	Awards points based on whether the site is infill, previously developed, adjacent to other developed sites.	Accessibility Natural Environment Economic Vitality	land use	🟢	🟢	🟢	🔴	🟡	🔴	🟢	🟡	🟢	Part of LEED "Smart Location and Linkage"	LEED-ND
115	Projected Transit Ridership	Person-trips and person-miles forecast to be made on transit	Active Transportation	transit	🟡	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴		FDOT Expanded Perf Measures

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116	Quality of the Travel Environment	Measures the "journey ambiance" by accounting for presence of physical bicycle and pedestrian-oriented elements.	Active Transportation Livability	ped bike	Yellow	Red	Green	Green	Red	Red	Green	Yellow	Yellow	Measures presence of elements that are valued in the environment, including ped-scale lighting, crowing, curb level, pavement evenness, and directional signage for pedestrians; cycle-track or lane, width of lane, parking facilities, and changing/shower facilities. Calculates the value based on the length of the elements and the number of users. Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
117	Queues	Proportion of time when queues spill beyond a certain threshold.	Mobility	auto freight transit	Green	Red	Yellow	Yellow	Green	Green	Yellow	Green	Red	Dynamic assignment model may be able to address this.	ODOT Alternative Mobility Measures
118	Recurring Delay	Vehicle hours of delay that are repeatable for a point in time below a threshold.	Mobility	auto freight transit	Yellow	Red	Green	Red	Red	Green	Yellow	Yellow	Red	Data collection efforts would be costly as it would require repeated travel time measurements over a long time span. Difficult to break delay in to its recurring and non-recurring components.	ODOT Alternative Mobility Measures, MOSAIC
119	Reduced incidence of disease due to active transportation	Calculates change in morbidity due to increased physical activity from increases in walking or cycling for transportation	Active Transportation Livability	ped bike	Yellow	Red	Red	Red	Red	Green	Red	Red	Yellow	Calculated in MOSAIC spreadsheet tool.	ODOT Mosaic
120	Relative Land Value Change	Measures change in land value in the Oregon Statewide Model attributable to transportation system changes.	Economic Vitality	land use	Yellow	Red	Red	Yellow	Red	Yellow	Red	Red	Red	Calculated in MOSAIC spreadsheet tool, using Statewide model. This method is not applicable to smaller scale projects, such as bicycle or pedestrian improvements.	ODOT Mosaic
121	Relative Severity Index	Monetary crash costs are assigned to each crash type (i.e., a relative severity index). The number of crashes per crash type are multiplied by the associated costs. Sites are ranked based on their total crash costs.	Safety	auto freight transit bike ped	Yellow	Red	Yellow	Green	Green	Red	Green	Green	Red	Requires an established Relative Severity Index (ODOT does not currently maintain an RSI). Feasible, if data becomes available.	ODOT Alternative Mobility Measures, HSM
122	Residents Impacted by Noise	Number of residential units exposed to transportation generated noise exceeding standards, can also be applied to test for disproportionate impacts to transportation disadvantaged populations.	Livability	auto freight transit	Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red	Red	Limited applicability in a plan amendment or TSP setting.	ODOT Alternative Mobility Measures, STARS
123	Resiliency of the Network	Measures the expected damage to key lifeline routes in the case of a natural event or emergency.	Safety Maintenance	auto freight transit bike ped	Yellow	Green	Yellow	Green	Yellow	Green	Red	Yellow	Yellow	Requires GIS-coded listing of lifeline routes, current condition of lifeline routes, location of hospitals and emergency centers, and assessment of damage that would occur with a natural event. May be able to draw data from the Oregon Health Authority, the Emergency Management System program in the Transprotation Safety Division of ODOT, and law enforement agencies in the region.	ODOT Mosaic
124	Retail Activity	Sales Per Foot of Street Frontage	Economic Vitality	Economic	Yellow	Red	Red	Red	Red	Green	Red	Red	Red		FDOT Expanded Perf Measures
125	Ride Quality	highway lane-miles with good to excellent ride quality	Maintenance	auto freight transit	Yellow	Red	Green	Yellow	Red	Green	Red	Yellow	Red	More of a pavement quality measure. Only measures existing pavement qualities and would have a limited application in assessing non-infrastructure changes such as land use amendments.	ODOT Alternative Mobility Measures
126	Seat Capacity	The combination of available seats in a corridor in vehicles (SOV and HOV) and transit.	Mobility	auto transit	Yellow	Green	Red	Yellow	Green	Red	Yellow	Yellow	Red	This measure combines roadway capacity, average number of people per vehicle, and transit seats available based on the capacity of the transit vehicle and the frequency of service during the peak. If bicycle facilities are present, additional seats can be added to the measures.	FDOT Expanded Perf Measures
127	Shade and Shelter	The portion of pedestrian space (sidewalks and/or trails) with shade or shelter	Active Transportation Livability	ped	Green	Yellow	Green	Yellow	Green	Red	Green	Yellow	Yellow		FDOT Expanded Perf Measures

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
128	Share of funding that is new or recycled	Measure of the portion of funding that comes from "new" or "recycled" sources.	Funding	auto transit freight bike ped	🔴	🔴	🔴	🟡	🟢	🔴	🔴	🟡	🔴	"New" is private sector or fresh public funds (e.g. new tax). "Recycled" are funds committed by other agencies that aren't "new".	ODOT Mosaic
129	Sidewalk Coverage	Sidewalk coverage is measured by sidewalk miles/gross acre or sidewalk miles/centerline miles	Active Transportation Accessibility Connectivity	ped	🟢	🟢	🟢	🟡	🟢	🟡	🟢	🟢	🟢		ITDP, ODOT Mosaic
130	Skew Statistic	The ratio of (90th percentile travel time minus the median) divided by (the median minus the 10th percentile).	Mobility	auto freight transit bike	🔴	🔴	🔴	🟢	🟢	🟡	🔴	🟡	🔴	DTA model is capable of modeling this measure, but currently is in development	ODOT Alternative Mobility Measures
131	Spatial enclosure	Ratio of building height to street width. Can be an indicator of how walkable a street is, with 3:1 or higher seen in urban cores; 1:3 or lower seen in suburban settings.	Active Transportation Livability	ped	🟡	🟡	🟢	🟡	🟢	🔴	🟢	🟡	🟡	Building height is ground to eaves, street width is measured from building façade to building façade, not ROW width.	FDOT Expanded Perf Measures
132	Speed Consistency	A measure of variation in fuel consumption between key origins and destinations based on speed braking and acceleration.	Natural Environment	auto freight	🟡	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴		STARS
133	Speed suitability	Difference between posted speed limit and operational speed.	Safety Livability	auto freight transit bike ped	🟡	🟡	🟡	🟢	🔴	🔴	🟡	🟡	🟡	Measures whether traffic speeds are compatible with land use context and safety for all modes.	STARS FDOT Expanded Perf Measures
134	Square Feet of Paths/Sidewalks, Bike Lanes, and Roadways	Total square feet or acres dedicated to sidewalks, bike facilities, travel lanes, and parking. Can be a expressed as a ratio for comparison. Can also be measured by width in a cross section	Active Transportation Maintenance	auto bike ped	🟡	🔴	🔴	🔴	🟢	🔴	🟢	🟡	🟡	Ratios could be set as a standard in order to allocate space by mode.	FDOT Expanded Perf Measures
135	Street connectivity	Design and/or locate the project such that a through-street and/or nonmotorized right-of-way intersects or terminates at the project boundary at least every 400 feet or at existing abutting street intervals and intersections, whichever is the shorter distance. Include a pedestrian or bicycle through-connection in at least 90% of any new	Connectivity	auto freight transit bike ped	🟡	🔴	🟡	🟡	🟡	🔴	🔴	🔴	🔴	Part of LEED "Neighborhood Pattern and Design"	LEED-ND
136	Street Layout	Small blocks, grid system preferrable to long, winding streets, cul-de-sacs and dead-ends. Can be measured by average block length	Active Transportation Connectivity	auto transit bike ped	🟢	🟡	🟡	🔴	🔴	🔴	🟢	🔴	🟡		ODOT Alternative Mobility Measures
137	System Completeness	Percent of planned bike facilities that are built	Active Transportation Accessibility Connectivity	bike	🟢	🟢	🟡	🟢	🔴	🟢	🟢	🟢	🟢	Simple to calculate. Provides a good measuring tool for assessing progress of the transportation plan/capital improvement plan.	ODOT Alternative Mobility Measures
138	System Completeness	Percent of planned pedestrian facilities that are built	Active Transportation Accessibility Connectivity	ped	🟢	🟢	🟡	🟢	🔴	🟢	🟢	🟢	🟢	Simple to calculate. Provides a good measuring tool for assessing progress of the transportation plan/capital improvement plan.	ODOT Alternative Mobility Measures
139	System Completeness	Percent of planned arterials that are built	Accessibility Connectivity	auto	🟢	🟢	🟡	🟢	🔴	🟢	🟢	🟢	🟡	Simple to calculate. Provides a good measuring tool for assessing progress of the transportation plan/capital improvement plan.	ODOT Alternative Mobility Measures
140	System Preservation	Condition of highway/streets	Maintenance	auto	🟡	🟡	🟡	🟢	🔴	🟢	🟢	🟢	🔴	A snapshot measure. Only measures existing highway/street conditions and would have a limited application in assessing non-infrastructure changes such as land use amendments.	ODOT Alternative Mobility Measures
141	Tons of Pollutants Generated	Tons of transportation related air pollutants. Can be broken down into criterion air contaminants, mobile source air toxics, non-mobile source air toxics, and lifecycle CO2 emissions.	Natural Environment	auto freight transit	🟢	🟢	🔴	🔴	🔴	🟢	🔴	🔴	🔴	RTP Measure. MOBLE 6 and/or MOVES model is capable of assessing this measure.	ODOT Alternative Mobility Measures, MOSAIC

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
142	Total Freeway lane-Miles	Total freeway lane miles	Mobility Maintenance	auto freight	🟢	🟢	🔴	🔴	🔴	🟡	🔴	🔴	🟡	Highway specific measure with limited application in assessing non-infrastructure changes such as land use amendments.	ODOT Alternative Mobility Measures
143	Total Revenues	Positive or negative revenues from transportation project, program, or action, both long term and short term	Funding	auto transit freight bike ped	🟡	🔴	🔴	🟡	🟢	🔴	🔴	🟡	🔴	Includes costs, farebox revenues, tolls, tax increment as a result of the project, value capture, etc	ODOT Mosaic
144	Transfer time	Average amount of time it takes to make a transfer between transit routes	Mobility	transit	🟢	🔴	🟢	🟡	🟢	🟡	🔴	🟡	🔴		FDOT Expanded Perf Measures
145	Transit Access	Percentage of dwelling units and non-residential building entrances within 1/4 mile walk distance of bus or streetcar stops OR within 1/2 mile walk of BRT, rail, or ferry terminals, and the service at those stops meets a minimum level.	Active Transportation Accessibility	transit	🟢	🟢	🔴	🔴	🟡	🟢	🟡	🟡	🟡	Requies GIS based housing and transit data. Part of LEED "Smart Location and Linkage"	LEED-ND
146	Transit Frequency	Headways on a particular route, or average headways across an area.	Mobility Active Transportation	transit	🟢	🟡	🟢	🟢	🟢	🔴	🔴	🟡	🟡		ODOT Alternative Mobility Measures
147	Transit Productivity	Transit boarding rides per revenue hour.	Mobility Active Transportation Funding	transit	🟡	🟡	🔴	🟢	🟡	🟢	🔴	🟡	🟢	RTP Measure. This is a transit owner/operator measure of productivity but doesn't define quality for the rider.	ODOT Alternative Mobility Measures
148	Transit Reliability	Percent of on-time arrival for fixed route transit (within 0-5 minutes of scheduled time)	Mobility Active Transportation	transit	🟢	🟡	🟢	🟢	🔴	🟡	🔴	🟡	🟡		FDOT Expanded Perf Measures
149	Transit Service Density	Measure of route miles/acre served. (Miles of a particular route times the number of times it is served in a day divided by the acreage within one/quarter mile of the stops)	Active Transportation Accessibility	transit	🟡	🟡	🟡	🔴	🟢	🔴	🟡	🟡	🟡		FDOT Expanded Perf Measures
150	Transit Station Parking V/C	V/C of bus and rail park-and-ride lots and bicycle parking facilities	Active Transportation Accessibility	auto bike	🟢	🔴	🟢	🟡	🟡	🔴	🔴	🔴	🟡	This measure has limited application in assessing the adequacy of TSPs or plan amendments, but is useful as an indicator for a change in parking supply, standards, pricing, or policies.	ODOT Alternative Mobility Measures
151	Transit Supply	Miles of transit service x Service frequency x hours of operation	Active Transportation	transit	🟢	🟡	🟡	🔴	🔴	🟢	🟡	🟡	🔴	A snapshot measure. Only measures existing transit supply and would have limited application in assessing non-infrastructure changes such as land use amendments.	ODOT Alternative Mobility Measures
152	Transportation Accessibility Index	Calculates an index value representing the average cost of accessing a travel "market-basket" from a given travel analysis zone	Accessibility Economic Vitality	auto transit bike ped	🟡	🔴	🔴	🟡	🔴	🟢	🟡	🟡	🟡	Requires defining the travel market basket and relies on the regional travel demand model to calculate trip costs.	ODOT Mosaic
153	Travel Time	Travel time required to traverse a segment.	#REF!	auto freight transit bike ped	🟢	🟢	🟢	🔴	🟢	🟡	🟡	🟡	🔴		ODOT Alternative Mobility Measures, ODOT Mosaic, FDOT Expanded Perf Measures
154	Travel Time Ratio	Ratio of the time it takes to make a given trip via transit compared to private auto.	Mobility Active Transportation	auto transit	🟢	🟡	🟡	🟡	🟢	🔴	🔴	🟡	🟡		FDOT Expanded Perf Measures
155	User Costs	Out-of-pocket costs to the user associated with travel, including vehicle ownership, maintenance, parking, gas, and tolls/fares	Accessibility Economic Vitality	auto transit bike	🟢	🟡	🟢	🔴	🟡	🟢	🔴	🟡	🟡	Mosaic includes default cost values, which can be augmented form other more specific data sources	ODOT Mosaic
156	Vehicle Hours of Delay (VHD)	Vehicle hours of delay per trip, per truck trip for freight, during 2-hour p.m. peak period	Mobility	auto freight	🟢	🟡	🟢	🟡	🟡	🟢	🔴	🟡	🔴		ODOT Alternative Mobility Measures, FDOT Expanded Perf Measures

ID Number	Measure	Description of Measure	Goals Addressed	Modes	Understandability	Data Cost/ Accessibility	Reflective of User Experience	Useful for prioritization?	Useful for comparisons?	Useful as a benchmark measure	Useful as threshold or standard?	Usefulness Average for All Levels	Number of Goals Addressed	Notes	Source
157	Vehicle Hours Traveled (VHT)	Vehicle hours traveled within a specified area and time period.	Mobility	auto freight	🟢	🟢	🔴	🔴	🔴	🟢	🟡	🟡	🔴	Identifying the size of the specified areas to measure may be difficult to interpret.	ODOT Alternative Mobility Measures, FDOT Expanded Perf Measures
158	Vehicle Miles Traveled (VMT) / VMT per capita	Vehicle miles traveled within a specified area and time period. Also VMT per capita.	Mobility Natural Environment	auto freight	🟢	🟢	🔴	🔴	🔴	🟢	🟡	🟡	🟡	Current RTP measure. System-wide evaluation of average weekday (AWD) total and per person vehicle miles traveled (VMT). Identifying the size of the specified areas to measure may be difficult to interpret.	ODOT Alternative Mobility Measures, STARS, MOSAIC, FDOT Expanded Perf Measures
159	Visually Active Frontage		Active Transportation Livability	ped land use	🟡	🟡	🟢	🔴	🟡	🔴	🟢	🟡	🟡		FDOT Expanded Perf Measures
160	Volume to Capacity (v/c)	Ratio of the volume to a segment's or intersection's capacity	Mobility	auto freight	🟢	🟢	🔴	🟢	🟢	🔴	🟢	🟢	🔴	The v/c measure is clear, objective, and precise. However, it is narrow and not multi-modal, so it can't be used by itself.	ODOT Alternative Mobility Measures, FDOT Expanded Perf Measures
161	Waiting Time	Out-of-vehicle waiting by transit passengers, including transfer time.	Mobility	transit	🟡	🔴	🟢	🔴	🔴	🟡	🔴	🔴	🔴	Waiting time is more of a function of the level of transit service. Transit service is reactive to land use, demand, etc., so this would be a difficult measure to apply to TSPs and plan amendment settings.	ODOT Alternative Mobility Measures
162	Walkable streets	Continuous sidewalks or equivalent all-weather provisions for walking are provided along both sides of 90% of streets or frontage within the project, including the project side of streets bordering the project. New sidewalks, whether adjacent to streets or not, must be at least 8 feet wide on retail or mixed-use blocks and at least 4 feet wide on all other blocks. Equivalent provisions for walking include woonerfs and all-weather-surface footpaths. Alleys, driveways, and reconstructed existing sidewalks are excluded from these calculations.	Active Transportation Connectivity	ped	🟢	🟡	🟡	🟡	🟡	🔴	🟢	🟡	🟡	Part of LEED "Neighborhood Pattern and Design"	LEED-ND
163	Work Accessibility	Calculates accessibility between travel analysis zones based on the number of jobs and the cost of traveling between them using a given mode	Accessibility Economic Vitality	auto transit	🟡	🟡	🔴	🟡	🔴	🟢	🔴	🟡	🟡	Requires extensive data on employment, street network, and transit network.	ODOT Alternative Mobility Measures, FDOT Expanded Perf Measures

Appendix C Literature Review

1. Alternative Performance Measures Final Report

ODOT initiated the Alternative Mobility Performance Standards study to evaluate and review potential new performance measures that could be used in addition to or as an alternative to v/c standards. The final **report** (*Accessibility Performance Measures Final Report*) identifies transportation policy categories lacking metrics for determining system adequacy, including Mobility, Accessibility, Economic Vitality, Environment, Balanced Transportation System, System Preservation, and Safety & Security. The report categories transportation performance measures in two classes with sub-groups as follows:

Transportation Performance

- Mobility – measures that address all modes of travel in terms of speed, travel time, vehicular and person throughput, etc.
- Reliability – measures that address the variability in expected travel time versus actual travel time experienced.
- Accessibility – measures that address the ease of travel or ability to reach destinations by all modes.
- Safety – measures that address the identification of deficiencies or improving the safety of the public sector transportation infrastructure investment.

Other Impacts of Transportation

- Infrastructure – measures that address the supply, quality, and preservation of the public sector transportation investment.
- Energy/Environment – measures that address the impact to or conservation of the natural environment.
- Equity – measures that address the affordability or accessibility of the public sector transportation investment.

Eight screening criteria are used to determine the feasibility of applying each, including:

- Cost of Measurement – Can the data needed to assess the measure be collected and analyzed cost effectively?
- Understandability – Is the measure understandable for decision makers and/or other practitioners?
- Consistency – Can the measure be applied consistently across jurisdictions and other user groups?
- Sensitivity to Design/Operations – Can the measure be used to make decisions regarding design and operational improvement strategies?
- Predict Future Conditions – Can the measure be used for predicting future conditions (modeled) or can it be calculated using GIS?
- Economic Development – Can the measure assess growth in economic activity?
- Applicability to Land Use Policy – Is the measure sensitive to Metro's or a local jurisdiction's land use goals such as the type, density, and transit oriented nature?
- Applicability to Plan Evaluation – Can the measure be used to gauge the practicality of:
    - Transportation System Plans/Corridor Plans?
    - Land Use Plan Amendments (subject to TPR -0060)?

The recommended measures are shown below in Tables C1 and C2.

TABLE C1 *ALTERNATIVE PERFORMANCE MEASURES FINAL REPORT* RECOMMENDED PERFORMANCE MEASURES BY TRAVEL MODE

Policy Category	*Performance Measure Application by Travel Modes*				
	Auto	***Freight***	***Transit***	***Bike***	***Pedestrian***
Mobility	*V/C*	*V/C*	-	-	-
	MMLOS	*MMLOS*	*MMLOS*	*MMLOS*	*MMLOS*
	-	-	*Non-Drive Alone Mode Share*	*Non-Drive Alone Mode Share*	*Non-Drive Alone Mode Share*
	Origin-Destination Travel Time	*Origin-Destination Travel Time*	*Origin-Destination Travel Time*	*Travel Time*	*Travel Time*
	VMT	*VMT*	-	-	-
	-	*Delay on Regional Freight Network*	-	-	-
Reliability	*80th Percentile Travel Time Index*	*80th Percentile Travel Time Index*	*80th Percentile Travel Time Index*	-	-
Accessibility	*Access to Destinations*	-	*Access to Destinations*	*Access to Destinations*	*Access to Destinations*
	-	-	*Accessibility to Transit*	-	-
	-	-	-	*Accessibility to Bike Facilities*	*Accessibility to Bike Facilities*
Safety	*Critical Rate*	-	-	-	-
	Excess Proportions of Specific Crash Types	*Excess Proportions of Specific Crash Types*	*Excess Proportions of Specific Crash Types*	*Excess Proportions of Specific Crash Types*	*Excess Proportions of Specific Crash Types*
Infrastructure	*System Completeness*	-	-	*System Completeness*	*System Completeness*
	Intersection Density	-	*Intersection Density*	*Intersection Density*	*Intersection Density*
Energy/Environment	*Tons of Pollutants Generated*	-	*Tons of Pollutants Generated*	-	-
Equity	-	-	*Accessibility to Frequent Transit Service*	-	-

TABLE C2 *ALTERNATIVE PERFORMANCE MEASURES FINAL REPORT* RECOMMENDED PERFORMANCE MEASURES BY APPLICATION

Category	Measure	Planning Applications	
		TSP / Corridor Plans	Plan Amendments
Mobility	MMLOS	X	-
	Non Drive-Alone Mode Share	X	[1]
	Origin-Destination Travel Time	X	[1]
	VMT	X	[1]
	Delay on Regional Freight Network	X	-
Reliability	80th Percentile Travel Time Index	X	[1]
Accessibility	Access to Destinations	X	X
	Accessibility to Transit	X	X
	Accessibility to Bike Facilities	X	X
Safety	Critical Rate	X	X
	Excess Proportions of Specific Crash Types	X	X
Infrastructure	System Completeness	X	X
	Intersection Density	X	X
Energy/Environment	Tons of Pollutants Generated	X	-
Equity	Accessibility to Frequent Transit Service	X	X

[1]Limited application. Could be applied in some large-scale plan amendment settings

Performance measures drawn from each of these categories are included in Appendix B of this report.

2. Sustainable Transportation and Access Rating System (STARS)

STARS (Sustainable Transportation Analysis and Rating System), developed by the North American Sustainable Transportation Council (STC) and the City of Portland's Bureau of Transportation, is an integrated set of sustainability tools for transportation plans, projects, and programs. STARS provides a framework for application in corridors, Transportation System Plans and Regional Transportation Plans, and establishing Safety, Health, and Equity Credits. Jurisdictions or agencies can apply to work with the STARS system in order to gain STARS certification for transportation plans.

The STARs system provides **a rating method** that takes into account the full life cycle of transportation plans, projects, and programs, including construction and life-time operations, given that a project will continue to impact a community beyond the construction phase. This "upstream" approach, emphasizing the earlier

planning stages, distinguishes STARS from other rating systems that are centered on design and construction phases. STARS focuses on seven categories:

- Integrated process
- Access and Mobility
- Safety, Health, and Equity
- Climate and Energy
- Ecological Function
- Cost Effectiveness
- Economic Benefit

STARS requires users to set and achieve clearly stated goals and objectives, many of which are quantitative in nature. STARS applicants are asked to evaluate strategies to help them achieve their goals—goals that have been set through an "Integrated Process" with a diverse stakeholder group. In cases where data may be limited, STARS allows for a more prescriptive process, such as a list of recommended improvements. In general, STARS encourages a mix of transportation and land use strategies to meet the needs of residents and businesses emphasizing access to goods, services, and information in addition to mobility. This focus allows for transportation solutions that may otherwise be overlooked when only vehicle mobility is considered.

The potential performance measures identified for Washington County from STARS are drawn primarily from STARS-Plan and the Safety, Health, and Equity Credits. The system's Access and Mobility credits are still under development.

3. LEED Neighborhood Design

The U.S. Green Building Council (USGBC), the Congress for New Urbanism (CNU), and the Natural Resources Defense Council (NRDC) developed Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND), **a rating system** for neighborhood planning and development. LEED-ND builds on the USGBC's Leadership in Energy and Environmental Design (LEED) system, a system of certifying that a particular development meets high standards for environmental sustainability. The LEED-ND system seeks to establish a national standard for assessing and rewarding environmentally superior neighborhood planning and development practices, integrating the principles of smart growth, New Urbanism, and green building. Neighborhood development teams can apply for LEED-ND certification as they move through the stages of neighborhood development. Most often, LEED-ND is applied to new or redeveloping neighborhoods.

LEED ND places emphasis on site selection, design, and construction elements of neighborhoods, which bring buildings and infrastructure together and relate the neighborhood to the surrounding landscape. LEED-ND has three primary credit categories: Smart Location and Linkage, Neighborhood Pattern and Design, and Green Infrastructure and Buildings. The credit categories, in combination, provide an approach to neighborhood planning that reduces the impacts on water resources, air quality and natural resource consumption, including reducing demand for automobile travel and associated greenhouse gas emissions. Smart Location and Linkage emphasizes site selection elements, awarding points for infill sites and locations that avoid impacting crucial environmental resources. Neighborhood Pattern and Design awards points for compact mixed-use development; a walkable, highly connect street network; and transit service and other transportation demand

management strategies that reduce reliance on automobiles. Green Infrastructure and Buildings focuses on energy-efficient buildings, infrastructure, and other green building principles; waste and wastewater management; and district heating and cooling.

LEED ND also awards regional bonus credits to acknowledge the importance of local conditions in determining best environmental design and construction practices as well as social and health practices.

The allocation of points among credits is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories. The impacts are defined as the environmental or human effect of the design, construction, operation, and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, toxins and carcinogens, air and water pollutants, and indoor environmental conditions. The system uses a combination of approaches, such as energy modeling, life-cycle assessment, and transportation analysis to quantify each type of impact.

The potential performance measures identified for Washington County from LEED-ND primarily include the transportation-related performances measures.

4. 2010 Highway Capacity Manual Multi-Modal Level of Service

The Highway Capacity Manual is published by the Transportation Research Board and provides guidance and procedures to transportation planners and engineers on evaluating the capacity and performance of different types of transportation facilities.

The most recent edition, the 2010 Highway Capacity Manual, introduced a major shift from measuring capacity and delay to assessing user experience in the methodology for evaluating adequacy of systems for pedestrians, bicyclists, and transit. The 2010 HCM Multi-Modal Level of Service (MMLOS) measure evaluates level-of-service for each mode separately and does not calculate a combined LOS. The LOS grade is designed to reflect the quality of the experience for each user, and can be calculated for a roadway link, segment, facility, or intersection.

For pedestrian LOS, the MMLOS methodology includes the following factors, where a “+” indicates a positive factor (increasing the level of service) and a “-” indicates a negative factor (decreasing the level of service):

:

- Link:
    - Sidewalk presence and clear width (+)
    - Vehicle volume and speed in the outside travel lane (-)
    - Bicycle lane, shoulder, and outside vehicle lane widths (+)
    - Buffer presence and width (+)
    - On-street parking utilization (+)
- Intersection
    - Permitted left turn, right-turn-on-red volumes (-)
    - Cross-street motor vehicle volumes and speeds (-)
    - Crossing length (-)
    - Average pedestrian delay (-)
    - Right turn channelizing island presence (+)

- Segment
    - Considers link and intersection LOS.
    - Street crossing difficulty
        - Delay diverting to signalized crossing
        - Delay crossing street at legal unsignalized location
- A facility is analyzed using the length-weighted average of segment LOS.

For bicyclist LOS, the MMLOS methodology includes the following factors:

- Link:
    - Vehicle volume and speed in the outside travel lane (-)
    - Heavy vehicle percentage (-)
    - Pavement condition (+)
    - Bicycle lane presence (+)
    - Bicycle lane, shoulder, and outside vehicle lane widths (+)
    - On-street parking utilization (-)
- Intersection
    - Cross-street width (-)
    - Width of lanes (+)
        - Outside through vehicle lane
        - Bicycle lane
    - Motor vehicle traffic in the outside lane (-)
- Segments
    - Bicycle link LOS
    - Bicycle intersection LOS
    - Number of access points on right side (-)
- A facility is analyzed using the length-weighted average of segment LOS.

For transit passenger LOS, the MMLOS methodology includes the following factors:

- Segment:
    - Access to transit (pedestrian link LOS) (+)
    - Wait for transit (frequency) (-)
    - Riding transit (perceived travel time rate)
        - Excess wait time due to late bus/train arrival (-)
        - Actual bus travel speed (+)
        - Bus stop amenities (+)
        - On-board crowding (-)

Multi-modal Level of Service is one of the performance measures that is included in Appendix B for consideration in Washington County.

5. Low Stress Bicycling and Network Connectivity

This document outlines a method for measuring the level of stress for cyclists and the overall connectivity of the low-stress network. The authors (Maaza Mekuria, Peter Furth, and Hilary Nixon of the Mineta Transportation Institute) propose a classification system based on the level of traffic stress (LTS) experienced by cyclists traveling along a segment, crossing a segment, or passing through an intersection. ODOT has proposed

incorporating the Bicycle Level of Stress methodology into Chapter 14 – Multimodal Analysis in Version 2 of the Analysis Procedures Manual (APM).

Level of Traffic Stress

Four categories of potential cyclists and the percent of the overall populace included in each are defined as:

- Strong and Fearless (<1%)
- Enthused and Confident (7%)
- Interested but Concerned (60%)
- No way no how (33%)

The LTS methodology proposes using four classifications: LTS 1 – suitable for children; LTS 2 – tolerated by most adults; LTS 3 – tolerated by "enthused and confident" cyclists; and LTS 4 – only tolerated by "strong and fearless" riders.

The LTS of a given segment is based on, where a "+" indicates a positive factor (decreasing the level of traffic stress) and a "-" indicates a negative factor (increasing the level of traffic stress):

- The degree of physical separation of the bicycle facility on a street (+)
- Width of the bicycle facility (+)
- The number of vehicle through lanes (-)
- Vehicle speed limit (or prevailing speed) (-)
- Frequency of bike lane blockage (-)

The LTS of unsignalized crossings is based on:

- Presence of a median refuge (+)
- Speed limit of street being crossed (-)
- Number of travel lanes being crossed (-)

The LTS of an intersection approach is based on:

- The presence of a right turn lane (-)
- Length of the right turn lane (-)
- Curb radius of the right turn lane (-)
- The geometry of the bike lane in relation to the right turn lane

Connected Low-Stress Network

In addition to the classification for individual segments, crossings, and intersections, the report proposes a methodology for achieving a well-connected low stress *network*. It suggests that to achieve a comfortable and connected bicycle network, jurisdictions should plan for routes not exceeding LTS 2 at any point on the route and not requiring cyclist to divert more than 25% from the shortest path (0.33 miles for short trips).

In this methodology, the authors disaggregate traffic analysis zones into census blocks in order to better represent bicycle travel scale, and then estimate travel demand and trips between blocks. To measure the connectivity of the bicycle network, the authors measure the "percent trips connected" via a route with LTS 1 or LTS 2 between each of the census blocks. They also propose an alternate connectivity measure of "percent

nodes connected," which is much easier to calculate but does not represent the difference in demand between nodes.

Bicycle LTS is one of the performance measures that is included in Appendix B for consideration in Washington County.

6. Expanded Transportation Performance Measure to Supplement Level of Service (LOS) for Growth Management and Transportation Impact Analysis

This report summarizes more than 200 performance measures referenced in current literature and identifies a framework and evaluation criteria that can be used by agencies to select performance measures. The evaluation criteria from the report are shown in Table C3.

TABLE C3 UNIVERSITY OF FLORIDA TRANSPORTATION RESEARCH CENTER - PERFORMANCE MEASURE EVALUATION CRITERIA

Performance Measure Characteristics	Description
Measure Classification	- ***Measured (M)*** performance measures can be directly measured in the field, but they may also be estimated using calibrated models or approved calculation procedures especially for future conditions. - ***Estimated (E)*** measures are generally data extrapolations generated from a limited data set. - ***Index (I)*** measures are collections of multiple individual measures that are aggregated and calibrated to provide a broad assessment of the quality of a system from multiple points of view. - ***Model-generated (G)*** measures are estimates that are extrapolated from detailed system-wide models of land use and transportation systems. Many of these model-generated measures have correlates in smaller-scale, measured variables, but take into account system level changes that could impact specific operations in specific locations.
Scale	Level of scale at which a indicator is typically applied: ***Project (P), Network (N), Local/Jurisdictional (L), or Region (R)***
Target mode	Target modes for which an indicator measures influence: ***Auto (A), Transit (T), Bicycle (B), Walking (W), or Multimodal (M)***

The report also examines case studies of communities in Florida that have moved towards multi-modal systems and finds that land use mix and pedestrian environment measures were favored in case study communities, and the communities strongly prioritized multi-modal choice over congestion management.

Appendix B incorporates many of the applicable performance measures from this compilation, with a focus on those able to rate transportation system performance with respect to Washington County's goals.

7. Highway Safety Manual

AASHTO published the first Highway Safety Manual in 2010, providing a method for quantitative and objective safety predictions on rural two-lane roads, rural multi-lane highways, urban and suburban arterials, and intersections. The HSM provides tools for considering safety when making decisions about roadway design and operation, evaluating of alternatives, and prioritizing locations for safety-related investments. Many of the methods included in the HSM account for regression to the mean and can result in more effectively identifying improvements to achieve a quantifiable reduction in crash frequency or severity.

The HSM offers a predictive method to estimate crash frequency and severity. This method also seeks to minimize the influence of randomness of crash occurrence by using safety performance functions (SPFs) to predict the average number of crashes per year, and weight those with the observed number of crashes to calculate the "expected" number of crashes.

The HSM compiled research from a vast array of high-quality sources to establish crash modification factors (CMFs), which show the expected change in the number of crashes attributable to specific geometric or operational treatments.

The HSM outlines and provides examples of the following applications:

- Identifying sites with the most potential for crash frequency or severity reduction;
- Identifying factors contributing to crashes and associated potential countermeasures to address these issues;
- Conducting economic appraisals of potential improvements and prioritizing projects;
- Evaluating the crash reduction benefits of implemented treatments; and
- Estimating potential effects on crash frequency and severity of planning, design, operations, and policy decisions.

Many of the performance measures in Appendix B related to Washington County's safety goal come from measures found in the Highway Safety Manual.

8. MOSAIC: Value and Cost Informed Planning

Mosaic (www.oregonmosaic.org) is a planning tool, developed by the Oregon Department of Transportation, designed to offer an "efficient, transparent way to evaluate the social, environmental, and economic costs and benefits of transportation programs and investments." Mosaic provides six steps to help users compare transportation options:

1. **Identify Bundles of Actions:** In this step, the user groups investments (projects, policies, or programs) into "bundles," and identifies the cost and time-frame for each component.
2. **Establish the Framework:** The Mosaic framework includes nine categories for transportation system performance, based on the goals of the Oregon Transportation Plan. Each category has a set of measurable indicators that provide the basis for rating each alternative. Table C4 shows the nine categories and the general and specific indicators within each category. Mosaic users select categories and indicators that meet the needs of their application of the tool.
3. **Weight Indicators:** In step three, Mosaic users consult with stakeholders to weight categories or non-monetary indicators, according to the values of the stakeholder community.
4. **Populate the Tool:** Mosaic includes an excel spreadsheet tool available for download that users populate with data for each of the categories and provides detailed instructions for completing this step.
5. **Interpret the Results:** The spreadsheet tool provides a set of outputs that allow the user to compare costs and benefits (monetized and non-monetized) of each bundle of actions. These outputs are designed to allow the users to understand tradeoffs among the bundles.
6. **Use the Results to Make Decisions:** Decision-makers can use results to help inform decisions through a benefit-cost analysis (BCA) or multi-objective decision analysis (MODA) framework, two tools that Mosaic combines.

TABLE C4 MOSAIC CATEGORIES AND INDICATORS

Category	General Indicator	Specific Indicator
MOBILITY	Travel Time	Travel Time
		Hours of Congestion
	Quality of Service	Reliability – Recurring congestion
		Reliability –Non-recurring congestion
	Out of Pocket Costs	User Costs
	Travel Characteristics	Mode Split
		VMT / Capita
ACCESSIBILITY	Proximity	Transportation Cost Index
		Population within X minutes between work and home
	Connectivity/Ease of Connections	Location of industrial jobs in relation to the regional freight network
	Modal Availability	Population and employment within ¼ mile of a transit stop served by at least 30 vehicles per day
		Amount of multi-use paths and bike boulevards
		Sidewalk coverage
ECONOMIC VITALITY	Economic Impacts of Spending for Construction	Number of jobs associated with plan or bundle of actions, and associated income metrics
	Economic Impacts of more Efficient Transportation Services	Changes in transportation costs by industry (business travel and freight)
		Changes in employment by industry, and associated income metrics
	Structural Economic Effects of Transportation System Improvements	Changes in productivity from increased connectivity (agglomeration effects)
		Changes in the total value of exports and imports
ENVIRONMENTAL STEWARDSHIP	Air	Criteria Air Contaminants
		Mobile Source Air Toxics
		Non-Mobile Source Air Toxics
	GHG	Life-cycle CO2e
	Resources at Risk	Natural, built, and cultural resources at risk
FUNDING THE TRANSPORTATION SYSTEM / FINANCE	Capital Costs	Capital Costs
	Lifecycle Costs	Other Lifecycle Costs
	Operating Revenues	Total Revenue
	Leveraging Funds from Private Sector and Other Agencies	Share of lifecycle funds that are “new” or “recycled”
	Net Impact on State and Local Fiscal Balance and Debt	Net impact of program on State and Local fiscal balance

Category	General Indicator	Specific Indicator
SAFETY & SECURITY	System Safety	Fatal, Injury A, and Injury B Crashes
	System Security	Emergency Management Systems (EMS) Response Times
		Resiliency of the Network
LAND USE & GROWTH MANAGEMENT	Population and employment density	Population and employment change and distribution
	Land Value	Relative land value change compared to base case or no action
QUALITY OF LIFE & LIVABILITY	Physical Activity	Lives saved due to active transportation
		Reduced incidence of diseases due to active transportation
	Journey Ambience	Quality of the travel environment
	Noise	Noise Impacts
EQUITY	Equity Analysis of Accessibility	Transportation Cost Index, in different geographic areas (e.g., urban vs. rural) and/or for different population groups
	Equity Analysis of Environmental Stewardship	Distribution of PM and PM Diesel emissions across population groups
	Equity Analysis of Quality of Life	Reduced incidence of disease due to active transportation
	Equity Analysis of Safety	Distribution of accident rates (fatalities and injuries) across population groups

Specific indicators from all nine categories of Mosaic were included in the list of performance measures in Appendix B.

Appendix D Detailed Measures Assessment

MULTI-MODAL PERFORMANCE MEASURES DETAILED ASSESSMENT

County staff and the TAC selected a subset of measures (including mode-specific and accessibility/land use measures) to carry forward for further assessment. The project team assessed each of these measures in more depth for the following qualities:

- How/whether each measure would apply to each level of planning need (TSP-level planning; project/corridor planning; plan amendment; and development review)
- Level of difficulty to apply the measure, given existing data and methodologies
- Whether the measure is quantitative and objective
- Whether the measure is able to forecast or predict for future conditions

This appendix includes a more detailed assessment for each measure on each of these qualities. The information included in the appendix was presented at a County staff workshop.

ASSESSMENT KEY

Colored circles were used to visually represent the degree to which each measure fulfilled the "Ease of Application" criteria, with the following meaning:

= Yes, with minimal reservations

= Potentially, some barriers and/or difficulties.

= No, the measure does not fulfill the criteria.

MODE SPECIFIC MEASURES

AVERAGE TRAVEL TIME

Definition:

Average travel time is a relatable measure to the public and a good indicator of the system or individual corridor performance.

Table 1: Applicability to Each Planning Scenario

Applicability to each planning scenario		
TSP	HIGH	Can set goals for average travel time reductions (or non-increase) on key O-D routes during peak or mid-day time periods.
Corridor Planning	HIGH	Average travel time can be used to compare the impacts of alternatives. Travel time will favor alternatives that prioritize mobility on the mainline of the corridor.
Plan Amendment	MED	Can be measured and used to calibrate a model to evaluate the impacts of a plan amendment – it may be difficult to forecast the sensitivity to volume changes.
Development Review	MED	Can be measured and used to calibrate a model to evaluate the impacts of a development. Jurisdiction would need to establish travel time corridors for assessment in development review.

Table 2: Ease of Application

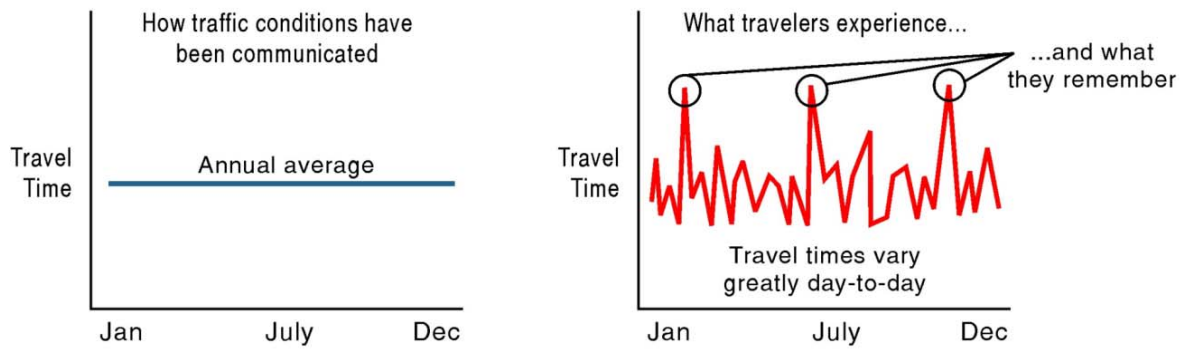
Ease of Application		
Easy to apply?	●	Relatively easy to determine existing conditions using Bluetooth data collection, INRIX data, or travel time runs. Fairly easy to calibrate to Synchro or SimTraffic to assess impacts of changes.
Quantitative? Objective?	●	Yes
Able to forecast/predict?	●	Yes – Average travel time can be forecast using future volumes from model outputs or development impact. Travel demand models can forecast at the TSP level.

TRAVEL TIME AND TRAVEL TIME RELIABILITY

Definition:

Travel time has been the traditional mobility measure for a corridor but it is not a complete descriptor of the traveler's experience.

Figure 1: Traffic Conditions Communication



Definition:

Travel time reliability measures the variability in the expected travel time vs. the actual travel time experienced due to demand fluctuations, traffic control devices, traffic incidents, weather, work zones, and physical capacity.

Measuring Travel Time Reliability:

- **Buffer Index** – compares the 95th percentile travel time to the average travel time. For example, 45% means the 95th percentile travel time is 45% longer than the average travel time
- **Planning Time Index** – also compares the 95th percentile travel time to the average travel time. For example, 2.25 means the 95th percentile travel time is 2.25 times as long as when conditions are free-flowing.
- **Travel time variance**
  - Unit dimensions are the same as for travel time, which makes it more easily monetizable
  - As a measure of the distributional "spread" of travel times, travel time variance is sensitive to actions that reduce the overall variability of travel time

Applicability to each planning scenario		
TSP	HIGH	Can set goals for travel time reliability (using buffer index or planning time index) at the TSP level.
Corridor Planning	HIGH	Can evaluate travel time reliability to compare alternatives (using buffer index or planning time index) at the corridor level.
Plan Amendment	MED	Travel time reliability may not be sensitive to minor volumes changes at the 20-year planning horizon.
Development Review	MED	Can be determined in existing conditions using INRIX or Bluetooth data. Analysis methods currently may be too costly to predict the impacts of a development for development review.

Ease of Application		
Easy to apply?		Can be assessed on an arterial or corridor level using spreadsheet tool or Dynamic Traffic Assignment (DTA) modeling. Metro is in the process of developing a travel time model.
Quantitative? Objective?		Yes
Able to forecast/predict?		Yes – travel time reliability can be forecast using future volumes from model outputs or development impact.

HCM LEVEL OF SERVICE (LOS)

Definition:

A quantitative stratification on an A through F scale that represents a traveler's perceptions of quality of service by a facility. For autos, level of service is based on the average delay. For signalized intersections, LOS reflects average delay for entering vehicles, whereas at unsignalized intersections, intersection LOS is the LOS of the worst approach.

Applicability to each planning scenario		
TSP	HIGH	LOS can be applied at the TSP level as a goal, and can be useful to assess future auto system performance at a high level.
Corridor Planning	HIGH	LOS can be easily applied to evaluate alternatives in a corridor study. However, it may not reflect through-travel on the corridor, especially at unsignalized intersections.
Plan Amendment	HIGH	LOS can be easily applied to evaluate impacts at the 20-year planning horizon, but may change based on intersection changes, such as signal retiming. Also, given the thresholds for the different levels, LOS may change a whole letter grade as a result of 0.1 sec change in delay.
Development Review	HIGH	LOS can be easily applied to evaluate impacts before and after development. However, given the thresholds for the different levels-of-service, LOS may change a whole letter grade as a result of 0.1 sec change in delay if it is at the edge of the threshold. Similarly, it may NOT change with 8 additional seconds of delay.

Ease of Application		
Easy to apply?	●	LOS can be easily determined using the HCM methodology and implemented in a number of readily available software packages, including Synchro, HCS, and Vistro.
Quantitative? Objective?	●	Deterministic measure that can be calculated based on geometric intersection configurations, signal timing, traffic volumes, and local conditions (such as flow rate).
Able to forecast/predict?	●	Yes –LOS can be assessed for future conditions, given traffic volumes forecast and intersection changes. However, it may not be as useful for long-term forecasts.

CRITICAL MOVEMENT DELAY

Definition:

A measure of delay at an intersection for the critical movement.

Applicability to each planning scenario		
TSP	LOW	Difficult to apply as a measure at the TSP level, given that it focuses on one movement of an intersection during the peak hour. However, critical movement *analysis* can be used at the TSP level to determine a planning level capacity assessment for intersections.
Corridor Planning	HIGH	Critical movement delay can be easily applied to evaluate alternatives in a corridor study. However, it is a narrowly focused measure and may not capture mobility through the corridor. For example, at unsignalized intersections, the critical movement will measure delay to the stop-controlled cross streets.
Plan Amendment	MED	Difficult to apply in 20-year analysis, especially at a signalized intersection, for instance, where signal timing is likely to change.
Development Review	HIGH	Easily applicable in development review where an analysis takes into account existing conditions and near-term impacts of development.

Ease of Application		
Easy to apply?	●	Critical movement delay can be easily determined using the HCM methodology and implemented in a number of readily available software packages, including Synchro, HCS, and Vistro.
Quantitative? Objective?	●	Deterministic measure that can be calculated based on geometric intersection configurations, signal timing, traffic volumes, and local conditions (such as flow rate).
Able to forecast/predict?	●	Yes – Critical movement delay can be assessed for future conditions, given traffic volumes forecast and intersection changes. However, it may not be as useful for long-term forecasts.

CRASH FREQUENCY OR CRASH RATE

Crash Frequency:

The number of crashes occurring at a site, facility, or network in a one year period. Can be differentiated by severity.

Crash Rate:

The rate of crashes occurring at an intersection or on a segment, often measured in crashes per million entering vehicles or crashes per million VMT.

Applicability to each planning scenario		
TSP	HIGH	Crash frequency can be used as a long-range goal, for example "Achieve 50% reduction in crashes," but is not predictive. It is also useful as a method to help identify high priority areas for improvement.
Corridor Planning	MED	Crash frequency cannot help compare alternatives, although it can identify priority intersections / segments for improvements.
Plan Amendment	LOW	Crash frequency can identify areas of needed improvement, but it cannot assess the future adequacy of the system.
Development Review	HIGH	Crash frequency can identify areas of needed improvement, but it cannot measure effectiveness of mitigations; predicted crash frequency can help with this.

Ease of Application		
Easy to apply?		Crash frequencies are easy to determine based on state crash data reported by ODOT. The crash data also includes severity and information about the crash parties, such as motorists, bicyclists, or pedestrians. Crash rates are more difficult to apply because they require volumes. Volumes for non-auto modes are particularly difficult to obtain for larger scales, and therefore crash rate is not usually a multimodal measure.
Quantitative? Objective?		Crash frequency is quantitative and objective.
Able to forecast/predict?		*Predicted crash rate* can forecast/predict.

PREDICTED CRASH FREQUENCY

Definition:

This measure uses a safety performance function (SPF) to calculate the predicted crash frequency of an intersection or segment based on its geometry, volumes, and other local characteristics. This measure allows testing of mitigations by incorporating crash modification factors (CMFs).

Applicability to each planning scenario		
TSP	HIGH	Predicted crash frequency can be used at a system-level to identify areas with high crash reduction potential.
Corridor Planning	HIGH	Predicted crash frequency can be used at a corridor level to identify areas with high crash reduction potential and assess the potential effectiveness of mitigations or different alternatives.
Plan Amendment	HIGH	Predicted crash frequency can be used to identify the impacts of plan amendments due to changes in traffic volumes or roadway geometry and can help assess the potential effectiveness of mitigations.
Development Review	HIGH	Predicted crash frequency can be used to identify the impacts of development due to changes in traffic volumes or roadway geometry and can help assess the potential effectiveness of mitigations.

Ease of Application		
Easy to apply?		Predicted crash frequency can be calculated easily, but relies on the availability of locally calibrated and approved safety performance functions. Crash modification factors are available in the Highway Safety Manual.
Quantitative? Objective?		Predicted crash frequency is quantitative and objective, but the HSM currently does not have a full set of CMFs related to multimodal mitigations and data does not yet provide the ability to evaluate safety trade-offs between auto and multimodal mitigations.
Able to forecast/predict?		Yes

SYSTEM COMPLETENESS

Definition:

Percent of planned facilities that are constructed. May consider whether facilities are built to current standards.

Applicability to each planning scenario		
TSP	HIGH	The TSP should outline what constitutes a complete system for each mode, with the goal of reaching 100% system completeness. This measure does not necessarily help with prioritization, however, given the lack of a scale.
Corridor Planning	HIGH	A corridor plan can assess the system completeness for each mode as a baseline and evaluate how far corridor alternatives go towards achieving complete systems.
Plan Amendment	HIGH	In evaluating plan amendments, system completeness can be evaluated in existing conditions and for 20-year forecast conditions for the impact area.
Development Review	HIGH	In development review, system completeness can be evaluated in existing conditions and for build conditions for the impact area.

Ease of Application		
Easy to apply?		Relatively easy to apply in a limited study area; easy at any level if complete data is available. In a limited study area, system completeness can be assessed through an audit of the existing and planned facilities. At the TSP level, a comprehensive data gathering effort may be necessary, depending on existing data availability.
Quantitative? Objective?		Can be quantitative, may not be objective – in order to be objective, there need to be agreed-upon definitions of a complete system and acceptable facility design and state of repair for different land use contexts. For instance, analysts need clarity on how to assess a non-ADA compliant sidewalk or a multi-use path in poor condition.
Able to forecast/predict?		Does not specifically forecast, but can be used to see how far/whether a plan will go towards system completeness

BICYCLE LEVEL OF TRAFFIC STRESS

Definition:

Bicycle Level of Traffic Stress is a stratified rating system designed to describe the traffic-based stress on bicyclists on a particular route or network, where 1 is low-stress and 5 is not appropriate for bicycles. The assessment is based on the following attributes:

- **Link**
  - Physical separation of bike facility (+)
  - Presence of on-street parking (-)
  - Number of through vehicle lanes (-)
  - Bike lane presence and width (+)
  - Speed limit (-)
  - On-street parking utilization (–)
  - Bike lane blockage (-)
  - Presence of Street Centerline (-)
- **Intersection**
  - Right turn lane configuration details
- **Crossing**
  - Speed limit of street being crossed (-)
  - Number of through vehicle lanes (-)
  - Presence of median refuge (at least 6 feet wide) (+)

Applicability to each planning scenario		
TSP	HIGH	LTS 2 is generally used as the target that appeals to the majority of potential bicyclists, and at the TSP level, an LTS network analysis can assess the bicycle route network and identify gaps between LTS 2 facilities.
Corridor Planning	HIGH	LTS can be used in corridor planning to assess the performance of different alternatives and the presence of a low-stress route through and across the corridor.
Plan Amendment	HIGH	LTS could be used to assess the adequacy of the system in evaluating a plan amendment and its potential transportation investments to address the system adequacy for bikes or cars. Some investments that would improve v/c for autos may also increase stress levels for bicycles.
Development Review	MED	LTS can be used at the development review level, although it does not measure volumes, and therefore would not assess a new development's impact on the LTS of a particular route unless used to assess infrastructure or physical changes. Using LTS in conjunction with other measures for autos and pedestrians to assess infrastructure investments would be applicable to development review.

Ease of Application		
Easy to apply?		Relatively easy to apply. LTS does not require auto volumes, and most of the required data can be gathered through a simple assessment of existing conditions or even aerial photography of the site. After gathering the data, an analyst can assess a facility based on a series of tables that assign LTS based on the route's attributes (from previous slide).
Quantitative? Objective?		There is some potential for variance in LTS analysis depending on the analyst's interpretation and data-gathering methods. ODOT is in the process of incorporating LTS into the Analysis Procedures Manual and the methods are still under refinement – ultimately, this may bring more uniformity to the analysis.
Able to forecast/predict?		Can be used to evaluate the LTS of future planned facilities or routes.

HCM URBAN STREETS MULTIMODAL LEVEL OF SERVICE (MMLOS)

Definition:

This Highway Capacity Manual methodology calculates level-of-service for transportation facilities from a user-experience perspective. The MMLOS method does not provide an overall LOS for a facility, but calculates a separate LOS for each mode in order to help illustrate trade-offs and allow for mode-specific assessment.

Applicability to each planning scenario		
TSP	LOW-MED	MMLOS would be difficult to apply at the TSP level because of the levels of data required, although if applied, it could identify gaps in the network for each mode.
Corridor Planning	HIGH	MMLOS is useful for corridor planning, especially for use in comparing how well alternatives serve different modes.
Plan Amendment	MED	MMLOS can be used to assess the adequacy of the system in evaluating a plan amendment and its potential transportation investments. MMLOS is data-intensive, however, when looking at a large study area.
Development Review	MED	MMLOS could be used for development review, in cases where an impact area is more limited. However, it would present a more difficult analysis than is currently used for development review analysis.

HCM URBAN STREETS MMLOS: BICYCLE FACTORS

Definition:

This Highway Capacity Manual methodology calculates level-of-service specifically for bicyclists from a user-experience perspective. It does not currently include a methodology for cycletracks. The HCM has a separate capacity-based methodology for multi-use paths. The bicycle LOS methodology uses the following factors for links and intersections:

- **Link**
  - Vehicle volume and speed in outside travel lane (–)
  - Heavy vehicle percentage (–)
  - Pavement condition (+)
  - Bicycle lane presence (+)
  - Bicycle lane, shoulder, and outside vehicle lane widths (+)

- On-street parking utilization (–)
- Number of access points on right side (–)

- **Intersection**
  - Cross-street width (–)

HCM URBAN STREETS MMLOS: PEDESTRIAN FACTORS

Definition:

This Highway Capacity Manual methodology calculates level-of-service specifically for pedestrians from a user perspective. The HCM has a separate capacity-based methodology for multi-use paths. MMLOS for pedestrians uses the following factors for links and intersections:

- **Link**
  - Sidewalk presence and clear width (+)
  - Vehicle volume and speed in outside travel lane (–)
  - Bicycle lane, shoulder, and outside vehicle lane widths (+)
  - Buffer presence and width (+)
  - On-street parking utilization (+)

- **Intersection**
  - Permitted left turn, right-turn-on-red volumes (–)
  - Cross-street motor vehicle volumes and speeds (–)
  - Crossing length (–)
  - Average pedestrian delay (–)
  - Right-turn channelizing island presence (+)

HCM URBAN STREETS MMLOS: TRANSIT FACTORS

Definition:

This Highway Capacity Manual methodology calculates level-of-service specifically for pedestrians from a user perspective. The HCM has a separate capacity-based methodology for multi-use paths. MMLOS for pedestrians uses the following factors for links and intersections:

- **Segment**
  - Access to transit (pedestrian link LOS) (+)
  - Wait for transit (frequency) (-)
  - Riding transit (perceived travel time rate)
    - Excess wait time due to late bus/train arrival (-)
    - Actual bus travel speed (+)
    - Bus stop amenities (+)
    - On-board crowding (-)

HCM URBAN STREETS MMLOS

Ease of Application		
Easy to apply?		Tools are available to help calculate MMLOS (Complete Streets LOS and HCS 2010), but it is more difficult to apply than auto-LOS due to the additional data inputs required. Existing tools like Synchro 7 and Vistro do NOT calculate MMLOS.
Quantitative? Objective?		Is quantitative and objective, but may result in different assessments than LTS due to heavy weight of vehicle volumes in calculation and other different factors.
Able to forecast/predict?		Yes, can be used to assess the impact of changes in infrastructure or volumes in the future.

Both HCM's MMLOS and Bicycle LTS use a particular set of factors to evaluate the user experience. Neither has a fully comprehensive set of factors that impact the user experience and therefore may not fully account for a user experience. (For example, steep grades are difficult for bicyclists, and pedestrian experience is impacted by the urban form fronting the street.)

PEDESTRIAN CROSSINGS COMPLETENESS

Definition:

Pedestrian Crossings Completeness is the percentage of intersections with complete, accessible crosswalks in all directions. This measure could also include a threshold for crossing spacing distance (in areas where intersections are far apart).

Applicability to each planning scenario		
TSP	HIGH	The TSP could establish a goal for 100% crossings completeness or for crossings completeness at a particular spacing distance. An inventory of intersections in the system can easily measure progress towards this goal. This measure does not necessarily help with prioritization, however, given the lack of a scale.
Corridor Planning	HIGH	A corridor plan can assess the existing pedestrian crossings completeness in the corridor as a baseline and evaluate how far corridor alternatives go towards achieving the TSP goal.
Plan Amendment	HIGH	In a plan amendment review, pedestrian crossings completeness can be evaluated in existing conditions and for 20-year forecast conditions for the impact area.
Development Review	HIGH	In development review, pedestrian crossings completeness can be evaluated in existing conditions and for build conditions for the impact area.

Ease of Application		
Easy to apply?	●	Easy to apply. This measure requires information about the existing physical conditions at intersections in the study area and can be assessed through an audit of the facilities. However, the jurisdiction will need to decide on how or whether to differentiate crossings that are striped but non-accessible from crossings with no treatment.
Quantitative? Objective?	●	Is quantitative and objective, however, analysts would need to understand up-to-date ADA standards to assess completeness.
Able to forecast/predict?	●	Does not specifically forecast, but can be used to see how far/whether a plan will go towards crossings completeness.

LAND USE / ACCESSIBILITY MEASURES

ACCESSIBILITY TO DESTINATIONS/DIVERSE USES

Definition:

Accessibility to destinations/diverse uses can be defined as having access within 'X' miles or 'Y' minutes to defined destinations or a certain combination of diverse uses. Can be by mode or trip purpose as well and may or may not account for presence of actual facilities.

Applicability to each planning scenario		
TSP	HIGH	At the TSP level, accessibility to destinations/diverse uses can be measured as the percent of population living within a set distance to key needs, such as schools, employment, grocery stores, or medical facilities.
Corridor Planning	LOW	Unless land use alternatives are integrated into the corridor planning process, this measure may not be as useful for corridor planning.
Plan Amendment	HIGH	In a plan amendment review, the existing and planned (forecast) accessibility of a particular site could be used to determine impacts of a zone change.
Development Review	HIGH	In a development review, the existing and planned accessibility of a particular site could be used to assess impacts of a development.

Ease of Application		
Easy to apply?		Moderate level of effort to apply, after database creation. Would require an initial investment in creating a GIS database of building/land use data and roadway, pedestrian, and bicycle networks. The network analyst tool in GIS allows an analyst to easily measure distance by mode to destinations.
Quantitative? Objective?		It is quantitative and measurable, but may be variable based on definitions of destinations and diverse uses.
Able to forecast/predict?		Able to forecast based on future land use planning, however, land use plans may not reflect actual market potential.

MODE CHOICE AVAILABILITY

Definition:

Number of modes that can be used to access destinations (specify thresholds for distance walking, transit, and biking)

Applicability to each planning scenario		
TSP	HIGH	A TSP could set a goal for the percent of households with at least 2, 3, or 4 mode choices for getting to destinations.
Corridor Planning	LOW	This measure could assess the number of modes available in a corridor, but may not provide differentiation between alternatives – quality of service measures may be more significant.
Plan Amendment	MED	This measure could assess the number of modes available in an impact area, but quality of service measures may be more significant. Increasing mode choice availability could be a mitigation for plan amendment impacts.
Development Review	MED	In a development review, mode choice availability could serve as a way to help determine the impact of a development. For instance, if a site is accessible by all modes, auto impacts are likely to be lower.

Ease of Application		
Easy to apply?		Moderate level of effort to apply, after database creation. Would require an initial investment in creating a GIS database of building/land use data and roadway, pedestrian, and bicycle networks. The network analyst tool in GIS allows an analyst to easily measure distance by mode to destinations. A simpler application at the development review level could simply assess whether access to all modal facilities exists within a given radius of the site.
Quantitative? Objective?		May have different or non-intuitive results depending on analyst and the threshold and facility types included in the analysis.
Able to forecast/predict?		Able to forecast based on future land use and transportation planning, but there is inherent uncertainty in future systems.

AFFORDABILITY

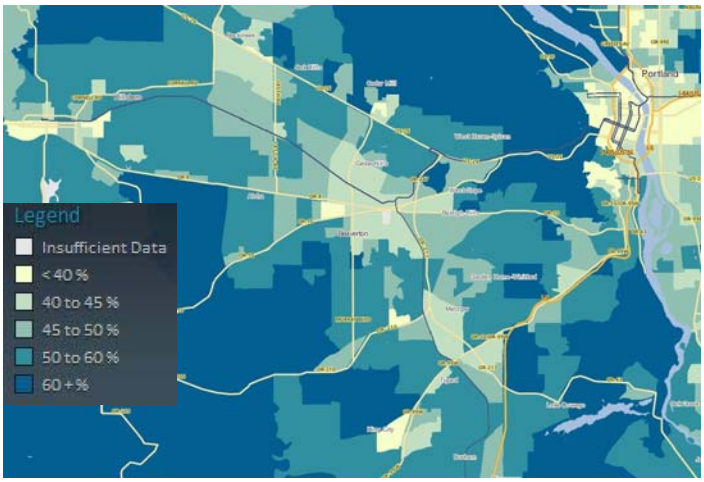
Definition:

Average household combined cost of housing and transportation as a percent of total income. An affordable range for H+T as the combined costs consumes no more than 45% of income.

Applicability to each planning scenario		
TSP	HIGH	A TSP could set a goal for average combined H+T costs for the whole jurisdiction.
Corridor Planning	LOW	Not easily applied in corridor planning.
Plan Amendment	LOW	Affordability would be difficult to project on a 20-year time frame.
Development Review	LOW	Affordability could be a good measure for jurisdictions to use in deciding where to plan for and incentivize residential development, but it is not likely to be a defensible measure in development review.

One available sketch-planning model to assess affordability is the H+T Affordability Index from the Center for Neighborhood Technology. It uses the factors at below in the model :

- **Environmental**
  - Residential Density
  - Gross Household Density
  - Employment Access Index
  - Transit Connectivity Index
  - Transit Access Shed
  - Average Block Size
  - Intersection Density
- **Household**
  - Median household income
  - Average household size
  - Commuters per household
- **Housing**
  - Average monthly housing costs
  - Percent owner-occupied
  - Percent renter-occupied



AUTO TRIPS GENERATED

Definition:

An estimate of the number of trips generated by a proposed development or potential development. ITE provides standard rates, but in using auto trips generated as a measure, it is more effective to use a localized methodology or a model that accounts for additional factors such as urban form, accessibility, and transit and parking availability.

Applicability to each planning scenario		
TSP	LOW	A TSP could set a goal for net new auto trips generated, but it may be difficult to track compared to other measures.
Corridor Planning	LOW	Not easily applied for comparing alternatives and projects in corridor planning.
Plan Amendment	HIGH	Can be estimated for the maximum allowable development under the proposed zoning, and could be used as the impact for which plan amendments are required to mitigate – though they could mitigate by improving other modes.
Development Review	HIGH	Can be estimated for the proposed development, and could be used as the impact for which developments are required to mitigate.

Ease of Application		
Easy to apply?		Can be easy to apply, depending on methodology. Existing transportation impact studies estimate trip generation as the first step in the study.
Quantitative? Objective?		May be difficult to estimate for uncommon land uses.
Able to forecast/predict?		Auto trips generated is generally estimated prior to the actual development for use in development review or plan amendments, so it is a forecast value.

LAND USE MIX/BALANCE

Definition:

The portion of land allocated to different uses of multi-family, retail/service, office, entertainment, institutional, industrial, and single-family.

Applicability to each planning scenario		
TSP	MED	A TSP measures overall balance of land use, but assesses it at a large scale. A certain balance could be part of the goals in a TSP or Comprehensive Plan. Land use mix could be useful for route selection in system-wide transit planning.
Corridor Planning	LOW/ MED	Unless land use alternatives are integrated into the corridor planning process, this measure may not be as useful for corridor planning, although it could be useful for route selection in transit planning if several different routes are under consideration within a corridor.
Plan Amendment	MED	The impacts of a plan amendment could be determined in part by whether it is located in a project area with a strong land use mix.
Development Review	MED	The impacts of a development could be determined in part by whether it is located in a project area with a strong land use mix.

Ease of Application		
Easy to apply?		Relatively easy to assess with parcel data and GIS, but more difficult to set levels of uses for desired land use mix.
Quantitative? Objective?		Some uses are difficult to categorize, and inconsistencies can occur depending on analyst methodology and data quality – whether to include public sector uses, ROW area, only building square footage, etc.
Able to forecast/predict?		Able to forecast based on future land use planning, however, land use plans may not reflect actual market potential.

NON-RESIDENTIAL INTENSITY

Definition:

The intensity (or density) of land use, excluding residential. Residential density can also be calculated. Can be measured based on floor area ratio, employees per acre or other methods.

Table 3: Applicability to Each Planning Scenario

Applicability to each planning scenario		
TSP	LOW/ MED	Non-residential intensity is a land use measure and would more likely be used in a comprehensive plan or zoning code as a standard. A TSP could use the measure to identify areas of priority for multimodal investments.
Corridor Planning	LOW/ MED	Unless land use alternatives are integrated into the corridor planning process, this measure may not be as useful for corridor planning, although it could be useful for route selection in transit planning if several different routes are under consideration within a corridor.
Plan Amendment	HIGH	Non-residential intensity (or residential density) could be used to define an impact area for a plan amendment. For example, an impact area would be geographically smaller in a high-intensity location, and larger in a low-intensity area.
Development Review	HIGH	Non-residential intensity (or residential density) could be used to define an impact area for a plan amendment. For example, an impact area would be geographically smaller in a high-intensity location, and larger in a low-intensity area.

Ease of Application		
Easy to apply?		Easy to apply depending on available data. One method is to use parcel data in GIS and calculate the number of non-residential square feet / acre.
Quantitative? Objective?		Yes, but can vary depending on what is measured (jobs/acre; net square feet/acre; gross square feet/acre; sales revenue/acre)
Able to forecast/predict?		No

INTERSECTIONS PER SQUARE MILE

Definition:

Number of publicly accessible intersections per square mile, including any combination of streets, dedicated alleys, transit rights-of-way, and nonmotorized rights-of-way. Intersections per square mile is a way to measure connectivity.

Ease of Application		
Easy to apply?		Easy to apply in GIS, if a complete transportation network layer is available, including non-motorized paths. The network also needs to have single lines for roads (instead of two lines to account for bi-directional travel) in order to avoid over counting.
Quantitative? Objective?		Yes, but must be clear what types of ped/bike connections are included.
Able to forecast/predict?		Intersections per square mile can be calculated for a future plan.

ACCESSIBILITY TO TRANSIT

Definition:

Percent of population living within "X" miles or "Y" minutes that can access fixed-route or high-frequency transit. Could also be defined for a specific site – whether that site is within a certain distance or time of fixed-route or high-frequency transit

Applicability to each planning scenario		
TSP	HIGH	Accessibility to transit can be used as a goal in the TSP, and can be measured over time.
Corridor Planning	LOW/ MED	This measure could be useful for route selection in transit planning if several different routes are under consideration within a corridor.
Plan Amendment	HIGH	Access to transit from a particular location could help determine the impacts of a plan amendment.
Development Review	HIGH	Access to transit from a particular location could help determine the impacts of a development on that site.

Ease of Application		
Easy to apply?		Accessibility to transit is fairly easy to measure in GIS if a GIS road and nonmotorized network is available.
Quantitative? Objective?		Yes, but must be clear what type of transit service is included in the measure.
Able to forecast/predict?		Can estimate in the future given plans for new transit investments and new residential development, but land use plans may not reflect actual market potential.

Appendix E Resolution & Order 86-95

Abridged Version

DETERMINING TRAFFIC SAFETY IMPROVEMENTS UNDER THE TRAFFIC IMPACT FEE ORDINANCE

PROCESS DOCUMENTATION

WASHINGTON COUNTY
DEPARTMENT OF LAND USE
AND TRANSPORTATION

ENGINEERING/SURVEYING DIVISION

AS ADOPTED BY
RESOLUTION AND ORDER NO. 86-95
JULY 22, 1986

DETERMINING TRAFFIC SAFETY IMPROVEMENTS UNDER THE TRAFFIC IMPACT FEE ORDINANCE

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RECOMMENDATION

The Department recommends that the Board establish Alternative B as the level of traffic safety to be utilized in determining necessary traffic safety improvements that will be required as a condition of development, Alternative B is recommended for the following reasons:

1. Alternative A by itself does not include many locations that are considered to be operating at an unacceptable level of safety.

2. Alternative D was developed to be used as a starting point for determining hazard locations and is the benchmark for comparing the effects of the other alternatives, and includes many intersections that are considered to be operating at an acceptable level of safety.

3. The cutoff point for locations to be included in Alternative B (as opposed to Alternative C) appears to be the point of diminishing returns within the range of alternatives considered; i.e., implementation of Alternative C would reduce the number of expected injuries by less than 10% but would increase the number of locations by over 32%. Implementation of Alternative B will require improvements at locations that are considered to be operating at an unacceptable level of safety; where cost effective solutions are expected to improve the locations to an acceptable level of safety.

INTRODUCTION

This report is a compilation of the various procedures that have been developed to process development applications under the Traffic Impact Fee Ordinance, the core of which is the criteria for traffic safety improvements. In the following narrative, the development and application of the criteria are put into context with the overall process of determining traffic related impacts associated with development and implementation of appropriate improvements.

For an overview of the process and to quickly find in this paper the information that is of interest to the reader, refer to Figure 1, Process Outline, page 4.

The objectives of this report are:

1. Document the procedures process developed by the Department to process development applications, determining safety and capacity deficiencies and identifying necessary improvements.

2. Document the process used to determine the criteria for traffic safety improvements, particularly the Safety Priority Index System (SPIS) analysis.

This report will serve as a source reference for staff involved with processing development applications, and will facilitate future updates of the SPIS analysis. It is also intended for external use, for those interested with the development review process or the technical analysis associated with the developed criteria. A listing of existing hazard locations is included in Appendix E.

BACKGROUND

On October 22, 1985 the County adopted the Traffic Fee Ordinance No. 310. The TIF ordinance significantly changed the method in which developments assure for adequate levels of arterial and major collector road service, and shifted the responsibility of determining needed capacity deficiencies from the applicant through the submission of a Traffic Analysis to staff, and requires staff to make a determination of when and where traffic safety improvements (as defined in the ordinance) are required as a condition of development.

Exhibit "C" of the "Washington County Growth Management Policy" (Task Force, July 24, 1984), (Department of Land Use and Transportation, January 15, 1985) states: "The task force recognized that at times distinctions between safety and convenience issues would be difficult to resolve. The task force was advised, however, that engineering standards exist that may be used as objective indicators of what constitute(s) safety concerns. It is the opinion of the task force that further investigation should be made by staff and County Counsel as to the workability of the safety/convenience distinction and the details of a reimbursement system based in part upon it."

It is the need for a distinction between safety and convenience issues that initiated the development of the criteria documented herein.

The basic approach assumed in determining necessary traffic safety improvements is that 1) there currently exist hazardous locations that present an unacceptable risk to the traveling public's safety, and that increasing accident exposure by significant increases in traffic resulting from development is unacceptable without mitigation measures, and 2) significant increases in traffic resulting from development can create hazard locations that currently do not exist and mitigating measures are necessary to protect the traveling public.

For the former (1), a comprehensive analysis of accident data for county road intersections was conducted. The determination of what constitutes an unacceptable risk to the traveling public will require a policy decision. This decision will require the selection of one of the four developed SPIS alternatives (Appendix A).

For the latter (2), necessary improvements are determined through the application of accepted traffic engineering procedures, standards, and practices, combined with the determination of unacceptable risk described above (Appendix B).

ASSUMPTIONS FOR THE CREATION OF CRITERIA FOR TRAFFIC SAFETY IMPROVEMENTS

This report is a continuation of previous effects pertaining to the establishment and implementation of the TIF ordinance, "Washington County Growth Management Policy" (Task Force, July 24, 1984), "A Fee-Based Traffic Impact System" (Task Force, July 31, 1985), and "Analysis and Methodology for the Creation of a Fee-Based Traffic Impact System", (DLUT, January 15, 1985). The following assumptions guided the procedures and criteria described herein:

1. Applicants are not required to identify, analyze, or evaluate capacity deficiencies which occur as a result of their development.

2. The Department of Land Use and Transportation ,Engineering Section, will identify, analyze, and monitor needed capacity improvements which occur due to increased traffic resulting from development, necessary for a systematic monitoring and evaluation of the performance of the County transportation system and to aid in prioritization of TIF and other capital improvement projects.

3. A consistent, defendable method for determining necessary traffic safety improvements is needed for: 1) determining improvements necessary for the traveling public's safety, 2) consistency in conditioning developments, and 3) establishing jurisdictional immunity in potential lawsuits concerning the operational safety of the County transportation system.

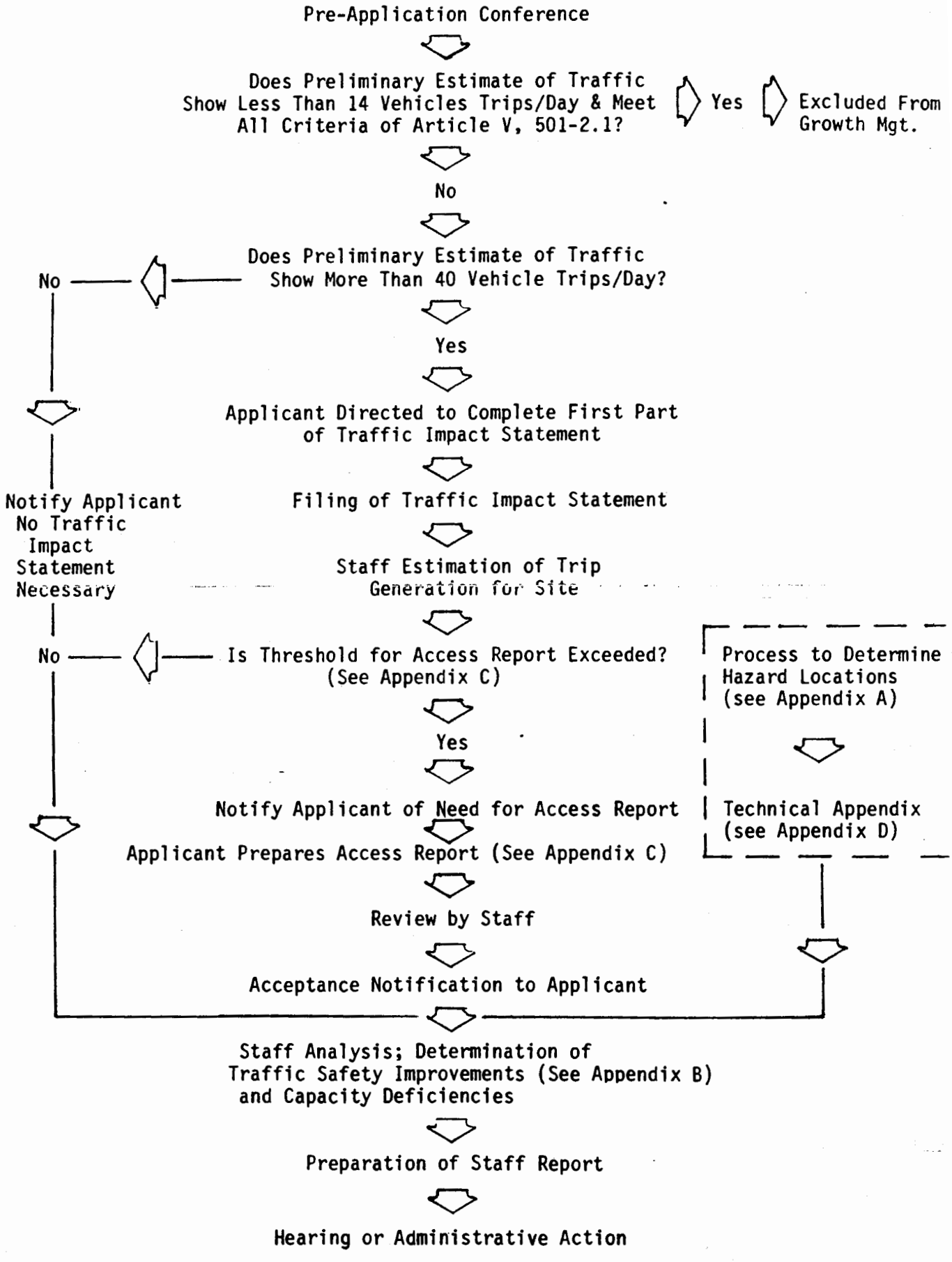
Board approval of the assumptions as stated above will provide staff with a clear directive in applying the procedures that are described in this report.

PROCESS OUTLINE

A general overview of the procedures developed to process development applications is depicted in Figure 1. Procedures developed to process developments under the Traffic Impact Fee Ordinance are noted in the outline and referenced to the appropriate appendix.

FIGURE 1

PROCESS OUTLINE



APPENDIX B

CRITERIA FOR TRAFFIC SAFETY IMPROVEMENTS

This appendix contains the recommended criteria for traffic safety improvements. The SPIS value of the recommended Alternative B is used to determine existing hazard locations.

One of the features of the criteria is in limiting the level of improvement for existing hazard locations, Section C. The cost values used in this section are from ODOT and represent a net monetary loss to society resulting from accidents, and are a standard for estimating the cost effectiveness of safety improvements. The desirable aspects of this feature is that it provides predictability to developers as to the upper limit of their potential improvement costs and limits county discretion in specifying the level of improvements. An undesirable aspect is that it will complicate administration of the criteria.

Figure 1B displays the criteria in a summarized tree structure.

The following criteria will be used to determine when Traffic Safety Improvements, as defined in the Traffic Impact Fee Ordinance #310, will be required as a condition of development. When warranted or specified, all improvements shall conform to County standards. The SPIS value (Section A.2) and the values used in the benefit-cost analysis (Section C.1) will be updated annually.

A. Definitions

1. Added Traffic: Traffic generated by developments, or phases of developments, which have been issued a building permit, or in the case of subdivisions have received final development approval, but are not yet occupied.

2. Existing Hazard Locations: Locations identified by a SPIS value greater than or equal to 32.24, where there is an existing accident history that currently presents an unacceptable risk to the traveling public's safety.

3. Existing Traffic: Traffic volumes measured within the previous 12 months of the development application.

4. Frontage: That portion of a site which abuts a public road.

5. Impact Area: The impact area for developments will be those road links where site generated traffic equals or exceeds 10% of existing average daily traffic but including at a minimum those access roads lying adjacent to and between the development and the nearest major collector or arterial road. Links within the developments impact area are considered to have a significant increase in traffic.

6. Link: A section of roadway which includes the intersection at both ends. The end points of a road link will be at an equally or higher classed roadway.

7. Predicted Hazard Locations: Locations identified in the County Transportation Plan as a Geometric or Traffic Safety Concern, or locations where safety improvements are warranted due to increased traffic resulting from development.

8. Total Traffic: The sum of existing, added, and site generated traffic.

9. Traffic Safety Improvements: Those street improvements including traffic control devices, necessary to protect the travelling public as determined by the Director (Traffic Impact Fee Ordinance #310).

10% impact area

B. Objective of Traffic Safety Improvements

B.1 For existing hazard locations:

To mitigate the adverse effects of increased traffic resulting from development on existing hazard locations which currently present a significant risk to the traveling public's safety, and where significant increases in additional traffic is unacceptable without improvements.

B.2 For predicted hazard locations:

To prevent future hazards locations by installing improvements where the increased traffic resulting from developments warrant the improvements, and where the existing, pre-development conditions did not warrant the improvements.

C. Level of Improvement

C.1 For existing hazard locations:

Existing hazard locations are identified through an analysis of the previous three years accident data, and have been determined to present an unacceptable risk to the traveling public's safety. Improvements will be required to correct the existing deficiencies. In no case will improvements be required where the benefit-cost ratio of the improvement is less than one (1) as determined by the following formula:

$$B/C = \frac{\text{(Annual Benefits)} * \text{(Series Present Worth Factor (20 yrs @ 10\%)}}{\text{Estimated Improvement Cost}}$$

$$\text{Where Annual Benefits} = \frac{\text{Total Accident Cost}}{3}$$

And where
Total Accident Costs = (Number of Reported PDO* Accidents) * 2 *$1,190 +

(Total Number of Injuries) * $9,300 +

(Total Number of Fatalities) * $220,000

The total accident costs will be calculated based on the previous three years accident data, on file and available at the Department of Land Use and Transportation.

C.2 For predicted hazard locations:

* Property damage only.

C.2.1 For warranted improvements:

The level and cost of improvement will be that level and cost as specified in Section D, Criteria.

C.2.2 For hazard locations identified in the County Transportation Plan:

The level of improvement will be determined by accepted engineering standards and practices and will be determined based on the impact and benefit of the proposed development.

D. Criteria

Locations will be analyzed to determine if they are existing hazard locations (improvements required under D.1.1 and D.2.1), predicted hazard locations (improvements required under D.1.2 and D.2.2) or other locations that warrant improvements under D.1.2.2 and D.2.2.2. If a location is determined to be an existing and predicted hazard location, both criteria shall apply.

D.1 Frontage Improvements

D.1.1 Existing Hazard Improvements

Existing hazards will be improved as specified in Section C.1 when site generated traffic equals or exceeds 10% of existing traffic.

D.1.2 Predicted Hazard Improvements

D.1.2.1 Hazard locations identified in the County Transportation Plan:

Hazard locations as defined in section A and identified in the County Transportation Plan will be improved as specified in Section C.2.2 when site generated traffic equals or exceeds 10% of existing traffic.

D.1.2.2 Warranted Improvements

Regardless as to whether there is a 10% impact on the frontage road, and regardless of whether situated at a predicted or existing hazard location, the following criteria shall be applied.

1. Frontage road access points that meet any of the signal warrants specified in the "Manual on Uniform Traffic Control Devices" (MUTCD), U.S. Department of Transportation Federal Highway Administration (FHWA), 1978 will be signalized. Level of improvement will provide Level of Service "D" or better at all times with the exception of a twenty (20) minute period in any peak hour when Level of Service "E" will be tolerated as determined using procedures established by the "1985 Highway Capacity Manual", Special Report 209 Transportation Research Board. Total traffic will be considered in establishing Level of Service.

2. Left Turn Refuge Lanes will be installed on frontage roads at the access points when warranted by "A Policy on Geometric Design of Highways and Streets", American Association of State Highway and Transportation Officials (AASHTO), 1984.

3. Sidewalks will be installed along the sites frontage, placed at ultimate location and grade, unless an exception is approved in accordance with the standard of the Community Development Code (CDC) Section 501-5.4.

4. Intersection sight distance at frontage road access point(s) must meet County standards.

5. Intersections that are adjacent to the site and serve as the primary route for traffic to the site will be adequately illuminated with street lighting in accordance with "An Informational Guide for Street Lighting", AASHTO, 1984. Such intersections that are hazardous due to inadequate sight distance will be improved.

6. Frontage road access points will be adequately illuminated with street lighting in accordance with "An Informational Guide for Street Lighting", AASHTO, 1984.

D.2. Impact Area Improvements

D.2.1 Existing Hazard Improvements

1. Unsignalized intersections that currently meet signal warrants (existing traffic) and are identified as an existing hazard location will require improvements and signalization. Level of improvement will provide Level of Service "D" or better at all times with the exception of a twenty (20) minute period in any peak hour when Level of Service "E" will be tolerated as determined using procedures established by the 1985 Highway Capacity Manual and as specified in Section C.1. Total traffic will be considered in establishing Level of Service.

2. Signalized intersections that are identified as a hazard location will require improvements as specified in Section C.1.

3. Unsignalized intersections that do not meet signal warrants considering total traffic but are an existing hazard location will require improvements as specified in Section C.1.

D.2.2 Predicted Hazard Improvements

D.2.2.1 Hazard locations identified in the County Transportation Plan

Hazard locations as defined in section A and identified in the County Transportation Plan will be improved as specified in Section C.2.2.

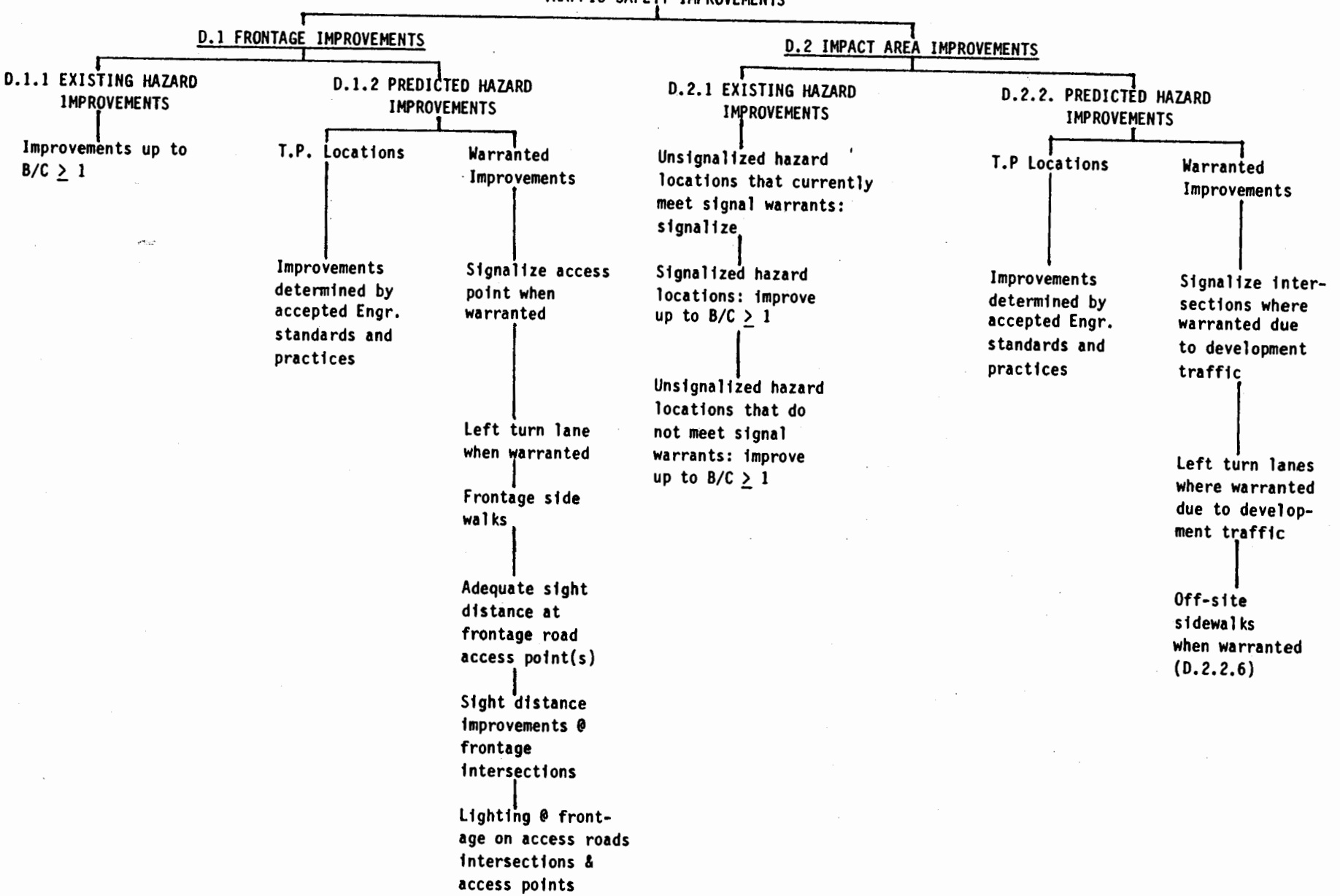
D.2.2.2 Warranted Improvements

1. Unsignalized intersections that currently do not meet signal warrants but will meet signal warrants considering total traffic will require improvements and signalization. Level of improvement will provide Level of Service "D" or better at all times with the exception of a twenty (20) minute period in any peak hour when Level of Service "E" will be tolerated as determined using procedures established by the 1985 Highway Capacity Manual. Total traffic will be considered in establishing Level of Service.

2. Left-turn refuge lanes at intersections within the impact area will be required if existing volumes do not warrant the improvement but the improvement is warranted by AASHTO considering total traffic.

3. Off-site sidewalks which are needed to allow safe pedestrian travel from the development to an existing network of sidewalks or to a area of heavy pedestrian draw, such as a neighborhood commercial development, will be required.

FIGURE 1B
TRAFFIC SAFETY IMPROVEMENTS



APPENDIX C

APPENDIX C

ACCESS REPORT REQUIREMENT

The requirements for access reports, a traffic analysis that is the responsibility of the applicant for some developments, is documented in this appendix. The requirements are included in this paper as they are interrelated with the criteria for traffic safety improvements and associated internal procedures.

The requirements replace the "Traffic Impact Evaluation Procedures" Resolution and Order 83-219, in specifying the requirements for traffic analysis that is the responsibility of the applicant, for developments within the unincorporated areas of the county.

The required analysis is much less stringent then specified in Resolution and Order 83-219, limiting the need, scope, and detail of the analysis. An access report is required only when the development has a considerable increase in traffic compared to the existing traffic at the frontage road. When required, the report need only consider safety at the developments access point and trip generation and assignment to the major collector and arterial road system. Evaluation of capacity is intentionally omitted.

The requirements for access reports have been finalized and administered since May 28, 1986. The requirements are distributed to applicants at the pre-application conference or after the traffic Impact Statement has been completed, when it has ben determined that the threshold for a report is met.

REQUIREMENTS FOR ACCESS REPORTS
FOR DEVELOPMENTS WITHIN THE
UNINCORPORATED AREAS OF WASHINGTON COUNTY
May, 1986

A traffic analysis to be titled "Access Report" is required prior to County acceptance of Development Applications when trip generation (Average Weekday Trips) and existing Average Daily Traffic (ADT) of the frontage county road at the point of access of that road fall within the ranges given below (vpd: vehicles per day).

Existing ADT of County Road at Point of Access	Trip Generation of Development
0 - 3000 vpd	2000 vpd or more
3001 - 6000 vpd	1000 vpd or more
Greater than 6001 vpd	500 vpd or more

ACCESS REPORT REQUIREMENTS

Objective

The objective of the Report is to analyze and evaluate access safety, feasibility, operation and performance, considering the movement of site generated traffic in relation to the existing conditions; traffic flow, access points, and intersections within the influence area. Alternate methods of mitigating identified deficiencies will be established and final recommendations made for improvements necessary for safe and efficient traffic flow. The Access Report will be prepared and certified by a Traffic or Civil Engineer registered in the State of Oregon.

Trip Generation

Estimates of trip generation must be made for peak hour traffic, for design purposes, as opposed to estimates of Average Weekday Traffic used in the calculation of the Traffic Impact Fee. Selection of the design hour used in the analysis will be justified but will include, as a minimum, AM and PM peak hour. Trip generation estimates will be based on the most recent issue of the ITE Trip Generation, An Informational Report. Where trip generation rates are not available in the ITE report, or justification can be made for the use of different rates, approval of the rate(s) must be obtained from the Director prior to use.

Area to be Considered in the Report

At a minimum, the analysis will consider all road segments, access points, and intersections within the influence area, defined as the sites frontage and the distance "d" extending out from the sites property line with d equaling 1000 feet for major arterials, 600 feet for minor arterials, 100 feet for major collectors, and 50 feet for minor collectors. Verification of compliance to the access spacing standards (CDC 501-5.3) is required. Any variance to the access spacing standards must be identified and justified, including evidence showing that other methods to gain access which does not require a variance are not feasible.

Trip Distribution and Assignment

Traffic generated from the development will be logically distributed and assigned at the frontage road access point(s) and at the point(s) where site generated traffic accesses the county major collector and arterial road system, based on Metro's zoned figures, supplied by staff, or analysis of local traffic patterns based on collected data.

Traffic Volumes to be Used in Analysis

The frontage road access point(s) will be analyzed and evaluated considering "total" traffic, the sum of existing, "added", and site generated traffic. Added traffic is defined as traffic generated by developments, or phases of developments, which have been issued a building permit, or in the case of subdivisions have received final development approval, but are not yet occupied. Added traffic volumes will be supplied by staff. Existing traffic must have been measured within the previous twelve months.

Safety Considerations

The frontage road access point(s) will be evaluated for safety considering existing traffic movements, intersections, and other driveways within the influence area. Potential safety problems resulting from conflicting turning movements with other driveways and intersections within the influence area, and internal traffic circulation, must be addressed.

Any safety or geometric concern, identified in the County Transportation Plan, which is adjacent to the sites frontage will be addressed. Potential solutions will be identified and evaluated, and specific recommendations made to alleviate the safety or geometric concern.

A determination of the need for traffic signals will be made at the frontage road access point(s), based on warrants in the Manual on Uniform Traffic Control Devices. If a traffic signal is warranted, recommendations will be made as to the type of traffic signal control and signal phasing. If storage lanes for right or left turns are required, recommendations will include the amount of storage needed.

Availability of adequate sight distance must be addressed at the proposed frontage road access point(s) for both the existing road configuration and the ultimate road configuration, based on improvements identified in the County Transportation Plan. Entering sight distance will ensure that a driver (eye 3.5 feet above the access road or driveway approach and 10 feet from the extended curb line or edge of pavement of the through street) has a minimum sight distance equal to ten (10) times the speed of the through street, continuously available in either direction, for an object 4.25 feet above the road. The posted speed of the through street (or basic speed rule, if unposted), or the 85th percentile speed (whichever is greater), will be used to establish the distance which must be available.

Acceleration lanes, deceleration lanes, turning lanes, and channelization will be considered, evaluated and recommended when determined necessary by accepted standards and practices.

Access Report Format

In general, the Access Report will devote a section to each of the topics discussed above. Documentation will include: 1) A description of development, intended use, ITE use code and complete documentation of trip generation calculations; 2) Traffic flow diagrams displaying traffic distribution, traffic assignment, existing, added and total traffic; 3) Vicinity map and influence area map displaying the existing road system including road names, functional classification, existing pavement and shoulder width, striping and channelization, and all existing driveways and intersections within the influence area; 4) Turning movements at access point(s) and intersections within the influence area; and 5) Technical appendices and other material necessary to convey a complete understanding to staff of the technical adequacy of the report.

Treatment of State Facilities

Any access onto a State highway facility requires approval from the Oregon State Department of Transportation (ODOT). Traffic analysis must meet ODOT's requirements for a Traffic Impact Analysis and County requirements for a Access Report.

Appendix F Existing Washington County Performance Measures and Standards

Washington County Performance Measures and Standards

Washington County has currently has standards related to transportation system performance with respect to mobility, safety, and connectivity within the County's TSP and Community Development Code. As part of the TSP update, Washington County also has proposed system performance measures in alignment with the requirements of the RTP and RTFP.

TSP System Performance Measures

The TSP update developed system performance measures in order to benchmark the performance of the system and track progress towards regional goals and targets. Table F1 describes these proposed measures.

TABLE F1: WASHINGTON COUNTY TSP SYSTEM PERFORMANCE MEASURES

Performance Measure	Regional Goals & Targets Addressed
Mix of System Users Measures	
Mode Share The overall share of trips made by walk, bike, transit, drive-alone, and shared ride vehicle modes. Measured for the urbanized area and regional centers, town centers, and station communities (where available)	• Active transportation -triple walking, biking and transit mode share compared to 2005. • Regional modal targets -40-45% or 45-55% non-drive alone trips by 2040 • Mode share may also serve as an indicator of progress towards vibrant communities, equity, clean air and climate change targets.
Walking and Biking Measures (System Completeness, Accessibility, Travel Time)	
Sidewalk Coverage The percentage of arterial and collector streets that include pedestrian facilities.	• Basic infrastructure –increase the number of essential destinations accessible within 30 minutes by trails, bicycling and public transit or within 15 minutes by sidewalks for all residents by 50% compared to 2005. • Access to daily needs –increase the number of essential destinations accessible within 30 minutes by bicycling and public transit for low-income, minority, senior and disabled populations by 50% compared to 2005.
Bikeway Coverage The percentage of arterial and collector streets that include bicycle facilities.	
Transit Service Coverage Frequent service routes on arterial and collector streets.	
Accessibility to Destinations Measure of access to destinations TBD	
Average Travel Time Average travel time per trip for all travel modes.	• Mobility and transportation system efficiency
Driving Measures (Congestion, Trip Length, Reliability)	
Vehicle Hours of Delay per capita Vehicle hours of delay (VHD) per person	• Congestion –reduce vehicle hours of delay (VHD) per person by 10 percent compared to 2005. • Freight reliability –reduce vehicle hours of delay per truck trip by 10 percent compared to 2005.
Vehicle Miles Traveled per capita Vehicle miles of travel (VMT) per person	• Travel –reduce vehicle miles traveled per person by 10 percent compared to 2005. • VMT commonly serves as an indicator of goals such as clean air and climate change
Demand to Capacity Ratio Deficiencies Roadway miles with demand to capacity ratio deficiencies identified. Measured for all roads and truck routes.	• Mobility –regional targets for demand to capacity ratio thresholds have been identified (i.e., how close a roadway is to being "full"). The targets vary depending on location and time of day.

The TSP is also applying the performance measures shown in Table F2, for evaluation of Study Areas.

Table F2: Washington County TSP Study Area Measures

Performance Measure	How Metric Will Be Applied
Street Connectivity How well the roadway network is connected within a given sub-area	This metric compares the current street and pathway system within the study area to a more uniform grid pattern. Metric will improve with the establishment of additional connections, extensions and / or parallel routes.
Travel Time & Reliability Study Area-specific travel time and variability	The metric will improve with better system management to reduce travel times and make them more stable under variable traffic demands.
Crash Reduction Study Area-specific estimate of crash reduction percentage	This metric estimates the value of corridor level strategies to reducing vehicle crashes. The metric will improve with changes that reduce the likelihood and severity of conflicts between system users, and improves user information and trip decision-making.

Mobility Standards

Washington County's Transportation System Plan assesses mobility performance by measuring the volume-to-capacity ratio for autos. The existing interim standard is 0.99 v/c during the peak hour for intersections in regional centers, town centers, main streets, and station communities. In other urban areas and rural areas, it is 0.90 during the peak hour. The County's interim motor vehicle performance measures are shown in Table F3. The motor vehicle performance measures, while noted as "interim", are intended to remain the standard until a new or revised standard is adopted. The RTP regional mobility policy retains the same "interim" framework.

Table F3: Interim Washington County Motor Vehicle Standards

Maximum Volume to Capacity (V/C) Ratio Standards				
Location[2]	**AM/PM Peak Two-hour Period**			
	Target[1] Performance Measures[3]		**Acceptable[1] Performance Measures[3]**	
	First Hour[4]	Second Hour[4]	First Hour[4]	Second Hour[4]
Regional Centers Town Centers Main Streets Station Communities	0.99 (E)	0.9 (D)	0.99 (E)	0.99 (E)
Other Urban Areas	0.9 (D)	0.9 (D)	0.99 (E)	0.9 (D)
Rural Areas	0.9 (D)	0.9 (D)	0.9 (D)	0.9 (D)

[1] For development review purposes, these performance standards will be used in assessing safety improvements. For plan amendment purposes, if a plan amendment is predicted to exceed the acceptable performance standard, the performance on applicable facilities will not be allowed to deteriorate further, and mitigation may be necessary. For project development purposes, these performance standards will be used to evaluate conditions beyond the transportation plan's planning horizon, as appropriate.

[2] For location reference see 2040 Growth Concept Design Types Map.

[3] Vehicle performance shall be determined by using volume to capacity ratios. Volume to Capacity equivalencies to Level of Service (LOS) are as follows: LOS C = V/C of 0.8 or lower; LOS D = V/C of 0.81 to 0.9; LOS E = V/C of 0.91 to 0.99.

[4] First Hour is defined as the highest hour of the day. Second hour is defined as the hour following the first hour.

System Adequacy Standards

Article V of the Community Development Code establishes public facilities and services that are necessary at a minimum level to accommodate development. The framework in article V places public facilities and services into 3 categories for development: critical, essential, and desirable. An adequate level of access is identified as a critical service. An adequate level of arterial and collector roadways and street lighting is identified as an essential service. Pedestrian walkways, off-street trails and other park or recreation facilities are identified as desirable services.

Safety Standards

Resolution and Order No. 86-95 establishes the methodology to be used for determining traffic safety improvements and gives Washington County staff the authority to require safety improvements as a condition of development based on an analysis of the intersection crash data using the Safety Priority Index System.

Connectivity Standards

Sections 408-5 and 408-6 of the Community Development Code identify standards for street connectivity and pedestrian and bicycle accessways for new development within Washington County, including block length, block perimeter, connection to stub streets, accessway spacing, and accessway connections.

North Bethany Subarea Standards

Section 501-12 of the Community Development Code identifies standards for development within the North Bethany Subarea. The North Bethany Subarea standards are in addition to the other requirements of article V. The North Bethany Subarea provisions include requirements for interim bicycle and pedestrian connections. These requirements are described below in an excerpt from the Washington County Community Development Code. The North Bethany Subarea standards are included for reference, and depict an implementation tool that has been developed for an unincorporated, rural area within Washington County.

The North Bethany Subarea standards are intended to accomplish a greater number of the desirable attributes within the North Bethany Subarea as the rural land is developed with urban uses. North Bethany Subarea standards would necessarily need revision prior to implementation within an existing urbanized area.

501 PUBLIC FACILITY AND SERVICE REQUIREMENTS

501-12 Standards for Development Within the North Bethany Subarea Plan Area

501-12.2 In addition to the provision identified in Section 501-12.1, except for exempt development, an application for development approval within the North Bethany Subarea Plan shall be denied unless the applicant demonstrates that:

E. To provide an interim bicycle network, paved surfaces of existing access roads lying adjacent to and between the applicant's proposed development and the nearest a) existing Arterial or Collector, or b) existing Neighborhood Route that is built to county standard and connects to a Collector or Arterial, shall be a minimum of 28 feet. Through a Type III process, the Review Authority may approve a modification to, or waiver of, this bicycle improvement requirement based on a determination that this requirement is impracticable for one of the following reasons:

(1) The applicant could not obtain necessary easements or additional right-of-way at a reasonable cost where sufficient right-of-way to accommodate the interim bicycle improvements is unavailable; or

(2) Topographical, natural resource or other physical circumstances make it impracticable to construct the interim bicycle improvements.

(3) For the purposes of Subsection E., Portland Community College shall not be required to use its powers of eminent domain to acquire property or easements to provide for the interim bicycle network.

F. To provide an interim pedestrian network in areas where ultimate facilities have not been constructed, the following shall be required. In addition to the sidewalk requirements of Section 502 and accessway requirements of Section 408, a direct, safe and continuous pedestrian connection shall be required to be provided to the following pedestrian-oriented uses that are existing or have received final land use approval and required public improvements have been assured: schools, parks, recreation centers, commercial uses, and the nearest transit stops that do not abut the development site's frontage, on both sides of a street with transit service.

Interim pedestrian connections shall be provided in the quantities outlined below and shall be constructed in accordance with County Engineer approval:

(1) For development applications that generate less than 500 Average Daily Trips (ADT), one connection shall be required to a pedestrian-oriented use within one-quarter (1/4) mile of the development site if the existing connection is deficient. If two or more pedestrian-oriented uses (as defined above) are within one-quarter (1/4) mile, the connection shall be to the use that is likely to generate the most pedestrian travel. The length of the interim connection is not required to exceed 1450 feet. In some

cases, the subject development may be required to construct off-site pedestrian improvements and acquire easements as appropriate to construct such improvements. Easements may be temporary if the underdeveloped land that has the easement on it will likely redevelop and include a more permanent pedestrian connection that serves the same purpose.

(2) For development applications that generate 500 Average Daily Trips (ADT) or more, connections shall be required to no more than two (2) pedestrian-oriented uses within one-quarter (1/4) mile of the development site if the existing connections are deficient. If two or more pedestrian-oriented uses (as defined above) are within one-quarter (1/4) mile, the connections shall be to the two uses that are likely to generate the most pedestrian travel. The sum of the length of the interim connections are not required to exceed 2900 feet. In some cases, the subject development may be required to construct off-site pedestrian improvements and acquire easements as appropriate to construct such improvements. Easements may be temporary if the underdeveloped land that has the easement on it will likely redevelop and include a more permanent pedestrian connection that serves the same purpose. If more than one of the same use is within one-quarter (1/4) mile, only one connection is required to that particular use.

(3) For pedestrian connections required by Sections (1) and (2) above, street crossing improvements on Arterials and Collectors are not required unless determined necessary by the County Engineer to address a safety issue.

(4) For developments that already have direct, safe and continuous connections to the two nearest sets of transit stops that are located either on-site, along the frontage, or off-site, no additional connections are required.

(5) Through a Type II process, for developments that need an easement or additional right-of-way to provide a particular connection, the Review Authority may waive or modify the particular connection requirement if:

(a) The applicant provides a signed letter from the off-site property owner that states that the particular easement or right-of-way is not for sale and is not available; or,

(b) The off-site property owner does not respond to the applicant's inquiry to purchase an easement or right-of-way. The applicant shall submit a sworn, notarized statement describing the applicant's unsuccessful efforts to obtain the easement. Copies of written correspondence to the off-site property owner shall be included with the statement.

(6) Through a Type III process, the Review Authority may approve a modification to, or waiver of, these pedestrian improvement requirements based on a determination that this requirement is impracticable for one of the following reasons:

(a) The applicant could not obtain necessary easements or additional right-of-way at a reasonable cost where sufficient right-of-way to accommodate the interim pedestrian improvements is unavailable; or

(b) Topographical, natural resource or other physical circumstances make it impracticable to construct the interim pedestrian improvements.

(7) For the purposes of Subsection F., Portland Community College shall not be required to use its powers of eminent domain to acquire property or easements to provide for the interim pedestrian network.

G. For purpose of Section 501-12.2C. (1), (2) and (3)(b) and Section 501-12.2 D, acquisition of land shall be deemed assured if the applicant provides a deed or an executed and recorded purchase and sale agreement, land sale contract or similar arrangement and written documentation that all contingencies identified therein have been resolved to the satisfaction of the service provide, or a restrictive covenant enforceable by and acceptable to the county and the service provider. An irrevocable option in favor of and on terms acceptable to the service provider may be deemed acceptable provided that, at a minimum, the purchase price, or the mechanism for establishing the price and all other significant terms are specified. The Review Authority may impose a condition requiring that the transaction transferring the delineated land to the service provider be completed prior to issuance of building permits if the Review Authority concludes that such a condition is reasonably necessary to ensure that the transaction will, in fact, be completed.

H. For the purposes of Section 501-12.2 E. and F., an applicant may elect to use the following process to assure the provision of interim bicycle and pedestrian improvements prior to preliminary approval:

(1) The development application shall include a statement that the applicant intends to construct the required improvement(s) in conjunction with on-site public streets;

(2) Prior to final approval of the development application, assure the construction of the required improvement(s); and

(3) Prior to the occupancy of any building in the development, the required improvement(s) shall be constructed.

Appendix G Multi-modal Intersection Analysis

Intersection Analysis

System completeness for intersection safety evaluations should include the following elements:

- **Complete crossings**
  - Pedestrians: All legs of an intersection should include a marked crosswalk, with the exception of highway ramps and other cases where sidewalks are not provided. Washington County also has the option to make a policy decision to limit the unbroken crossing distance for pedestrians (e.g. if greater than five lanes, a median refuge is required).
  - Bicyclists: All legs of an intersection should include a bike facility continuing up to the stop bar.
- **Signal timing**
  - Pedestrians: All pedestrian signal phases should be timed to allow for a minimum of 5 seconds of walk time, and sufficient flash-don't-walk time for a pedestrian to complete the full crossing of the intersection walking at 3.5 feet/second. The formula for minimum walk+FDW time is as follows:

    walk+FDW = 5 sec + W/3.5, where W = crossing distance in feet.

  - Pedestrians: Leading pedestrian intervals (consider legislation to allow bikes to use leading pedestrian intervals)
  - Pedestrians: Left-turn phasing should separate left turning vehicles from pedestrian crossing movements. Flashing yellow arrow phase only when there is no pedestrian actuation.
  - Pedestrians and Bicyclists: Overall cycle length should balance vehicle mobility with pedestrian and bicycle mobility. Longer signal lengths may increase the efficiency of an intersection near capacity for autos, but will also increase delay for pedestrians and may result in poor signal compliance.
  - Bicyclists: All approach signal phases, with the exception of highway ramps, should provide sufficient green + yellow + red clearance time for the bicyclist to clear the last conflicting travel lane, traveling at 14.7 feet/second. The signal phase should also include a 6 second start-up time for bicyclists and assume a 6-foot long bicycle. The formula is as follows:

    G+Y+Rclear = 6 + (W+6)/14.7, where W = crossing distance in feet.

- **Detection / Actuation**
  - Pedestrians: At actuated signals, provide accessible pedestrian push buttons, countdown displays, and audible signals for all crossings.
  - Bicyclists: Provide bicycle detection at all actuated signals.
- **Lighting**
  - All modes: Provide complete intersection lighting that illuminates all crossings.

    - Pedestrian: Provide pedestrian-scale lighting to illuminate the sidewalk at the corners of the intersections.
- **Channelized Turns**
    - Channelized turns should be designed without an acceleration lane.
    - Should have clear yield signage and high-visibility crossing of the channelized lane.

The above measures can have a minor negative impact on vehicle operations. Often when intersections are "improved" for vehicles, there are negative operational impacts to pedestrians related to increased delay as well as increased crossing distance (a safety related measure). This framework will allow for a more comprehensive analysis of intersections and evaulation of the impacts of different modifications on all modes.

Appendix H Alternate Development Review Process

Plan Amendments and Development Review – Alternate Process

In development review, the existing review process is based primarily on safety for motorists, per R&O 86-95. Figure X shows the steps in the existing Washington County development review process. Currently, the impact area for a development includes intersections to which the development adds 10% to entering vehicle volumes on one leg. Within this impact area, two measures are currently used: crash frequency (which puts an intersection on the Washington County SPIS list) and volume-to-capacity ratio. If the intersection appears on the SPIS list, the development or party seeking the plan amendment is required to provide or contribute to countermeasures to improve the safety of the intersection. If an intersection in the 10% impact area exceeds a v/c ratio of 0.99, the development or party seeking the plan amendment is required to provide mitigations to improve the v/c ratio at the intersection based on potential safety issues for vehicles associated with overcapacity intersections such as rear-end crashes and red-light running.

The existing measures alone do not consider the performance of the transportation system for pedestrians, bicyclists, or transit riders, and therefore do not maximize the potential to improve the systems for the safety of all users as new development occurs. The proposed framework seeks to balance safety and system performance for all users and give developers the flexibility to make choices about where and how to contribute to improving the system. The proposed framework is as follows:

Step 1: Determine Development Impact

The impact of the development is determined by the number of additional trips generated by the development or redevelopment compared to the existing trips generated by the site. Until a person trip methodology is established by Washington County, this determination can be made using ITE's *Trip Generation* manual and/or local trip generation studies. Table H1 identifies five levels of development intensity based on additional daily trips generated, identifies an associated Impact Level to be used in subsequent steps, and a calculation for determining the level of impact that will need to be mitigated (Offsetting Impact Points).

Table H1: Development Impact - Additional Trips

Additional Trips Generated by Development[1]	Impact Level	Offsetting Impact Points Required
<40 daily trips	A	1
40-200 daily trips	B	# trips / 50 (1-4)
200-500 daily trips	C	# trips / 50 (4-10)
500-1000 daily trips	D	# trips / 50 (10-20)
>1000 daily trips	E	# trips / 50 (>20)

[1] Based on ITE trips without modification to mode split. A person trip methodology would be preferable. Establishment of a person trip methodology will trigger an update of the daily trip ranges for each level of impact.

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Reductions to the ITE trip generation estimates of vehicle trips for higher mode splits than reflected in the ITE methodology should be considered when determining the 10% vehicle impact area; however, reductions should not be considered for the purposes of identifying the development's total impact in Table H1 as the impacts are assumed to be to all modes and can be offset with mitigations to any mode.

Table H2 identifies the level of improvements required from each impact level. Consistent with existing County policy, developments in Impact Level 1 (less than 40 daily trips), are only required to provide adequate site access and dedicate right-of-way for future frontage improvements. Impact Level 2 developments (up to 200 daily trips) are additionally required to construct their own frontage improvements. Impact Level 3 and above also are required to consider off-site impacts.

Table H2: Required Improvements

Type of Improvement	Impact Level		
	A	B	C, D, E
Multi-modal Site Access	■	■	■
ROW Dedication	■	■	■
Frontage Improvement (or equivalent)		■	■
Additional Improvements			■

Step 2: Assess existing conditions for each mode

After determining the impact level, development applicants need to assess the existing conditions for each travel mode. Tables H4 through H7 identify the required study areas by mode and by impact level. Vehicle performance measures will continue to focus on safety as well as performance and operations. For the vehicle mode, crash frequency (i.e. SPIS locations) will continue as a primary measure of identifying existing safety conditions. Volume-to-capacity ratio will also continue as a measure of existing intersection operations. As Washington County advances its baseline assessment and tools become more readily available, travel time reliability will be incorporated into the conditions assessment for the vehicle mode.

Compared to the vehicle system, the pedestrian and bicycle systems are relatively immature and include many gaps and deficiencies; therefore, measures to assess the pedestrian and bicycle modes will largely focus on system completeness as a more complete system is a necessity to improve both operations and safety. System completeness for each mode is further defined in the TSP.

Safety evaluations at intersections should be inclusive of all modes and therefore should include evaluation of system completeness for all modes in addition to crash frequency and crash trend analysis.

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Intersection Analysis

System completeness for intersection safety evaluations should include the following elements:

- **Complete crossings**
  - Pedestrians: All legs of an intersection should include a marked crosswalk, with the exception of highway ramps and other cases where sidewalks are not provided.
  - Bicyclists: All legs of an intersection should include a bike facility continuing up to the stop bar.
- **Signal timing**
  - Pedestrians: All pedestrian signal phases should be timed to allow for a minimum of 5 seconds of walk time, and sufficient flash-don't-walk time for a pedestrian to complete the full crossing of the intersection walking at 3.5 feet/second. The formula for minimum walk+FDW time is as follows:

    walk+FDW = 5 sec + W/3.5, where W = crossing distance in feet.

  - Pedestrians: Leading pedestrian intervals (consider legislation to allow bikes to use leading pedestrian intervals)
  - Pedestrians: Left-turn phasing should separate left turning vehicles from pedestrian crossing movements. Flashing yellow arrow phase only when there is no pedestrian actuation.
  - Pedestrians and Bicyclists: Overall cycle length should balance vehicle mobility with pedestrian and bicycle mobility. Longer signal lengths may increase the efficiency of an intersection near capacity for autos, but will also increase delay for pedestrians and may result in poor signal compliance.
  - Bicyclists: All approach signal phases, with the exception of highway ramps, should provide sufficient green + yellow + red clearance time for the bicyclist to clear the last conflicting travel lane, traveling at 14.7 feet/second. The signal phase should also include a 6 second start-up time for bicyclists and assume a 6-foot long bicycle. The formula is as follows:

    G+Y+Rclear = 6 + (W+6)/14.7, where W = crossing distance in feet.

- **Detection / Actuation**
  - Pedestrians: At actuated signals, provide accessible pedestrian push buttons, countdown displays, and audible signals for all crossings.
  - Bicyclists: Provide bicycle detection at all actuated signals.
- **Lighting**

To be continued….(see pedbikesafe.org and attached signalized intersection improvements)

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The above measures can have a minor negative impact on vehicle operations. Often when intersections are "improved" for vehicles, there are negative operational impacts to pedestrians related to increased delay as well as increased crossing distance (a safety related measure). Performance measures at intersections for pedestrians can also include operational measures such as intersection delay as well as crossing time or distance. ***Discussion**: Do we want to account for these negative impacts to pedestrians when evaluating intersection mitigations and if so, how?*

In assessing existing conditions, development applicants will determine whether the stop-gap thresholds for each mode are met. Stop-gap thresholds are included in Table .

Step 3: Determine required improvements

The impact area category determines the study area for each mode for meeting stop-gap requirements.

Table H3: Impact Area for Stop-gap Requirements

	Impact Area by Development Impact Level				
	A	B	C	D	E
Pedestrian	Frontage	Frontage	250 ft from property	¼ mile from property	½ mile from property
Bicycle	Frontage	Frontage	250 ft from property	¼ mile from property	½ mile from property
Vehicle	Site Access	Site Access	+10% volume intersections	+10% volume intersections	+10% volume intersections

Step 4: Determine improvements for offsetting impact points

Development must provide improvements sufficient to offset all of their impact points (based on their total number of points in Table 1). They can offset their impact with improvements to meet the minimum standards or stop-gap thresholds (i.e. frontage improvements, etc.); however, if the minimum standards or stop-gap thresholds are already met, other improvements much be done to offset their impact. Tables H4 through H7 outline the improvements that developers can make to offset their points for each mode. After the stop-gap measures have been met, developers have the flexibility to offset the remainder of their points in a variety of ways.

***Question:** Do we need to monetize the points for points beyond the frontage, access, and stop-gap improvements? If we do, this becomes similar to a TIF, if we don't, the lowest cost options will be selected rather than most beneficial.*

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Table H4: Pedestrian Offset Table

Pedestrians	Size of Development Impact				
	A	B	C	D	E
Study Area Size	Frontage	Frontage	250 ft from property	¼ mile from property	½ mile property
Performance Measure: System Completeness[1] *(These are the aspirational definitions of system completeness, not the level each development would need to achieve).*		- Level 1; and crossing completeness	- Level 2; and - Sidewalks present along all collector and arterial routes to essential destinations within 250 ft. and connectivity to adjacent development	- Level 3; and - Intersections meeting standards for pedestrian access. - Crossings of collectors and arterials available (spacing standards vary according to roadway type).	- Level 4; within a ½ mile radius of the development
Improvements or mitigations (Offsetting Impact Points)	- Dedicate ROW and access easements: **1 point**	- Dedicate ROW and access easements: **1 point** - Construct sidewalk frontage **3 points** - Complete crossings (Value: 2 points) - Pedestrian crossings at transit stops. (Value: 2 points)	- Construct sidewalk frontage (Value: 3 points) - Construct sidewalks where connections are missing on routes to essential destinations or adjacent properties (Value: X points) - Complete crossings (Value: 2 points) -Provide connections to adjacent development (Value: 2 points) - Pedestrian crossings at transit stops. (Value: 2 points)	- Construct sidewalk frontage (Value: 3 points) - Construct sidewalks where connections are missing on routes to essential destinations (Value: X points) - Complete crossings (Value: 2 points) - Install pedestrian upgrades at intersections (Value: 2 points) - Pedestrian crossings at transit stops. (Value: 2 Point) - Transit stop amenities completed. (Value: 1 Point)	- Construct sidewalk frontage (Value: 3 points) - Construct sidewalks where connections are missing on routes to essential destinations (Value: X points) - Complete crossings (Value: 2 points) - Install pedestrian upgrades at intersections (Value: 2 points) - Pedestrian crossings at stops. (Value: 2 points) - Transit stop amenities completed. (Value 1 point)
[1]Each level of system completeness builds on the level before it.					

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Table H5: Bicycle Offset Table

Bikes	Size of Development Impact				
	A	B	C	D	E
Study Area Size	Frontage	Frontage	250 ft from property	¼ mile from property	½ mile from property
Performance Measure: System Completeness[1] *(These are the aspirational definitions of system completeness, not the level each development would need to achieve).*	- Bicycle facility built to the TSP definition of the route adjacent to the site.	- Level 1; and - Bicycle facilities built to the TSP definition of the routes within a 250 ft radius.	- Level 2; and - Bicycle facilities built to the TSP definition of the routes along all collector and arterial routes to essential destinations within ½ mile. - Intersections meeting standards for bicycle access.	- Level 3; and - Intersections meeting standards for pedestrian access.	- Level 4; within a ½ mile radius of the development
Improvements or mitigations (Offsetting Impact Points)	- Dedicate ROW (Value: 1 points)	- Dedicate ROW (Value: 1 points) - Construct bicycle facility frontage (Value: 3 points)	- Construct bicycle facility frontage (Value: 3 points) - Construct bicycle facility connections on routes to essential destinations. (Value: 4 points)	- Construct bicycle facility frontage (Value: 3 points) - Construct bicycle facility connections on routes to essential destinations. (Value: 4 points) - Install bicycle upgrades at intersections (Value: 2 points)	- Construct bicycle facility frontage (Value: 3 points) - Construct bicycle facility connections on routes to essential destinations. (Value: 4 points) - Install bicycle upgrades at intersections. (Value: 2 points)
[1]Each level of system completeness builds on the level before it.					

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Table H6: Auto Offset Table

Vehicles	Size of Development Impact				
	A	B	C	D	E
Study Area Size	Site Access	Site Access	10% Volume Impact Area	10% Volume Impact Area	10% Volume Impact Area
Performance Measures and Standards					
Safety	Site accesses operate safely and adequately designed	Site accesses operate safely and adequately designed	Study intersections operate safely for all modes (crash rate for autos, intersection completeness for bike/ped)	Study intersections operate safely for all modes (crash rate for autos, intersection completeness for bike/ped)	Study intersections operate safely for all modes (crash rate for autos, intersection completeness for bike/ped)
Improvements or mitigations	*Need to develop point value for different types of improvements that contribute to enhanced safety at study intersections (all modes), vehicle operations at study intersection, corridor travel time/travel time reliability (this could apply to improvements at non-study intersections but upstream or downstream along corridors in the 10% impact area)*				
[1]Each level of system completeness builds on the level before it.					

Table H7: Transit Offset Table

Transit (bonus points)	Size of Development Impact				
	A	B	C	D	E
Study Area Size	Frontage	250 ft	¼ mile	¼ mile	½ mile
Performance Measure:	System Adequacy by Impact Level				
System Completeness[1] *(These are the aspirational definitions of system completeness, not the level each development would need to achieve).*	-	- Access to transit stops with service in 2 or more directions.	- Access to "frequent" transit stops with service in 2 or more directions.	- Access to "frequent" transit stops with service in 2 or more directions.	- Access to "frequent" transit stops with direct (non-transfer) connections to essential destinations.
Bonus Points (points allowed for existing conditions or improvements)		- Access to transit stops with service in 2 or more directions (Value: 1 point)	- Access to "frequent" transit stops with service in 2 or more directions. (Value: 2 point)	- Access to "frequent" transit stops with service in 2 or more directions. (Value: 2 points)	- Access to "frequent" transit stops with direct (non-transfer) connections to essential destinations. (Value: 4 points)
[1]Each level of system completeness builds on the level before it.					

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Step 5: Determine maximum value of improvements after stop-gap (weighting)

If we monetize - The Impact points will be tied to improvement dollars spent (with increases tied to inflation). Each improvement associated with one offset point should not cost more than the offset point maximum value or it will be worth additional offset points. This will ensure that developments do not pay disproportionately more than their share to complete an improvement. This also allows for weighting of improvements to occur by mode by land use type area. For example, in Town Centers, the cost associated with an offset point could cost less for bicycle or pedestrian improvements, thus, creating incentive to favor improvement to these modes.

Table H8: Offset Point Values

Land Use Type	Offset Point Maximum Value			
	Pedestrian	Bicycle	Vehicle	Transit Improvement
Town Center/ Main Street, Station Communities (Mixed Use Area)	$0.75	$0.90	$1	$0.75
Residential Neighborhood	$1	$1	$1	$1
Non-residential	$1	$1	$1	$1

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Measure	Transportation System Plan		Corridor Plan		Plan Amendment or Development Review	
	Applicable?	Standard or "how to apply"	Applicable?	Standard or "how to apply"	Applicable?	Standard or "how to apply"
Sidewalk completeness	■	Standard: 100% coverage of collector/arterial network that meets ADA and code width standards. Baseline numbers should be developed and reported annually. Could report completeness in each of three ways: • % sidewalk coverage of full arterial/collector network • % of existing sidewalks that meet ADA standards • % sidewalk coverage of full arterial/collector network that is to standard (ADA and width)	■	Standard: 100% coverage of collector/arterial network that meets ADA and code width standards. New projects should meet 100% standard (may be exceptions)	■	Impact Offset points given for progress towards 100% coverage of collector/arterial network that meets ADA and code width standards. Stopgap: Within impact area, complete sidewalk routes to essential destinations with < 25% out-of-direction travel.
Crossings completeness	■	Standard: 100% of locations meeting TSP crossing spacing requirements; four complete crossings at all four-leg intersections; crossings present within X feet of all transit stops (collectors and arterials) Baseline numbers should be developed and reported annually. Could report: • % signalized intersections with complete crossings • % transit stops with crossings within X feet • % of arterial / collector segments with crossings meeting minimum spacing requirements.	■	Standard: 100% of locations meeting TSP crossing spacing requirements; four complete crossings at all four-leg intersections; crossings present within X feet of all transit stops (collectors and arterials) New projects should meet 100% standard (may be exceptions)	■	Offset points given for adding crossings to make progress towards standard. Stopgap: Within impact area, complete crossings at arterial/collector intersections; crossings present within X feet of transit stops
Bicycle facility completeness	■	Standard: 100% coverage of arterial/collector network with bicycle facilities consistent with TSP designation; neighborhood greenways make low-stress network connections such that trips between essential destinations require <25% diversion from the most direct route. Baseline numbers should be developed and reported annually. Could report: • % of network with facilities consistent with TSP designation • Barriers to network connectivity	■	Standard: 100% coverage of arterial/collector network with bicycle facilities meeting TSP designation along all collectors and arterials; complete connections to neighborhood greenways	■	Offset points given for improving off-site bicycle facility completeness (to TSP designation) Stopgap: Within impact area, bike routes to essential destinations with < 25% out-of-direction travel;
Intersection completeness	?		■	Standard: Includes all elements of intersection completeness (see section X), providing safe multi-modal access to all intersections New projects should meet 100% standard (may be exceptions)	■	Offset points given for adding elements of intersection completeness (see Step 2), providing safe multi-modal access to all intersections Stopgap: Within impact area, signal timing accommodates pedestrian and bicyclists.
Crash frequency	■	Standard: Zero deaths (does County have a stated safety goal?) Baseline numbers should be reported annually. Could include: • Total crashes, total fatal and serious injury crashes and per capita or VMT • Identification of intersections above Critical Crash Rate (SPIS locations)			■	Stopgap: Proportionate share of safety improvements at impacted SPIS sites
Predicted Crash Rate			■	Standard: Lower predicted crash rate than existing by X% or to baseline number.	■	Standard: All Intersection modifications to result in lower predicted crash rate than existing.

Pedestrian delay			■	Evaluate impacts on pedestrian delay for different alternatives (not a standard - should this be a standard or just required consideration?)		Evaluate impacts on pedestrian delay for intersection modifications (not a standard - should this be a standard or just required consideration?)
Pedestrian crossing distance			■	Evaluate only? Or set standard or stopgap such as Maximum unbroken crossing distance?	■	Evaluate only? Or set standard or stopgap such as Maximum unbroken crossing distance for intersection modifications?
Transit Service Supply					■	Offset points given for locations with frequent transit service within ½ mile; points for X level of transit service supply.
Transit Accessibility	■	Standard: 100% of households have access to transit within ½ mile Baseline should be developed and reported annually in each of three ways: • % of households with network connections to transit within ½ mile • % of households with ADA compliant walking connections to transit within ½ mile • % of households with network connections to frequent transit within ½ mile				
Bicycle Level of Traffic Stress	■	Standard: Complete network of LTS 2 facilities requiring no more than 25% diversion from total trip distance Baseline should be developed and reported annually. Could report: • LTS levels of existing roadways • Levels of diversion from most direct route	■			
Travel time reliability – buffer index	■	Standard: Buffer index (to be determined) Develop baseline travel time reliability on key arterial corridors, updated and reported annually. The initial baseline effort can be used to set a standard for the buffer index.	■	Standard: Improved reliability The buffer index can be used to evaluate travel time reliability impacts of different alternatives	■	Standard: None Impact Points for making improvements to improve buffer index on poorly performing arterials
Accessibility to destinations / diverse uses	■	Standard: 100% of households have access to essential destinations within 20-minute walk, bike, or transit trip. Baseline should be developed and reported annually. Could report: • % of households with access to essential destinations by walking • % of households with access to essential destinations by biking • % of households with access to essential destinations by riding transit • Average number of "essential destinations" accessible to households within a 20 minute trip walking, biking, or riding transit.				

Affordability	■	Standard: 100% of households pay 45% or less of their income on housing and transportation combined. Baseline should be developed and reported annually. Could report: • Average portion of household income spent on housing and transportation costs. • % of households spending 30% of income or less on housing • % of households spending 15% of income or less on transportation				
Land use mix / balance	■	(?)				
Intersections per square mile	■	300 (?)				