Seattle's Urban Village Transit Network

UVTN Monitoring Project

2007 Update

Prepared for the Seattle Department of Transportation

June 2008

Seattle's Urban Village Transit Network:

UVTN Monitoring Project

2007 Update

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June 2008

Prepared for the Seattle Department of Transportation, in partial fulfillment of the requirements of the University of Washington Geographic Information Systems Certificate Program

This report is an update of the UVTN Monitoring Project Final Report, prepared by Nelson\Nygaard Consulting Associates, February 2007.

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Background

The UVTN Monitoring Project measures the performance of Seattle's Urban Village Transit Network. The UVTN was established by the Seattle Department of Transportation (SDOT) in 2005 as a recommended network of transit corridors connecting the urban villages established in the City of Seattle's Comprehensive Plan.[1] The urban village strategy is intended to maintain and enhance the character of Seattle's neighborhoods as the city grows and changes. The city is expected to incorporate transportation improvements that support walking and use of public transportation in and between urban villages and urban centers.

In recent years, urban planners have begun to recognize the links between transportation policy and public health – most transit trips begin and end with walking, and the design of communities and transportation systems affects levels of physical activity.[2] Public opinion in the Puget Sound region supports active living as an organizing principle for interface of residential, commercial and employment land use,[3] and transit-oriented development can accomplish both land use planning and public health goals.

In order to manage transportation demand – i.e., encourage a shift in travel modes away from single-occupancy vehicle (SOV) trips, the goals of the 2005 Seattle Transit Plan include a balanced transportation system, incentives to use non-SOV modes, and accommodation of all new trips to downtown with non-SOV modes.[4] According to the "What's new?" 2008 update of the Comprehensive Plan, amendments to the transportation element promote strategies to reduce transportation demand within and between urban villages.

In fall 2004, SDOT outlined its vision for the UVTN: "to reinforce, on the level of policy, that certain bus service corridors are as permanent as any rail corridor, and can therefore also be the foundations of dense, transit-reliant communities."[5] UVTN corridors are along streets with a certain density of population and employment, within a quarter-mile walking distance of residents and/or workers, and on routes that carry the majority of Seattle's transit riders. The goal of the UVTN is to cohere as a network, so that it typically provides the most direct routing between any two points within it.

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[1] Seattle Department of Planning and Development. (2005; updated 2007). *Toward a Sustainable Seattle: City of Seattle Comprehensive Plan.* http://www.seattle.gov/dpd/Planning/Seattle_s_Comprehensive_Plan/ComprehensivePlan/default.asp

[2] Besser, L. M., & Dannenberg, A. L. (2005). Walking to public transit: steps to help meet physical activity recommendations. *American Journal of Preventive Medicine*, 29(4), 273-279.

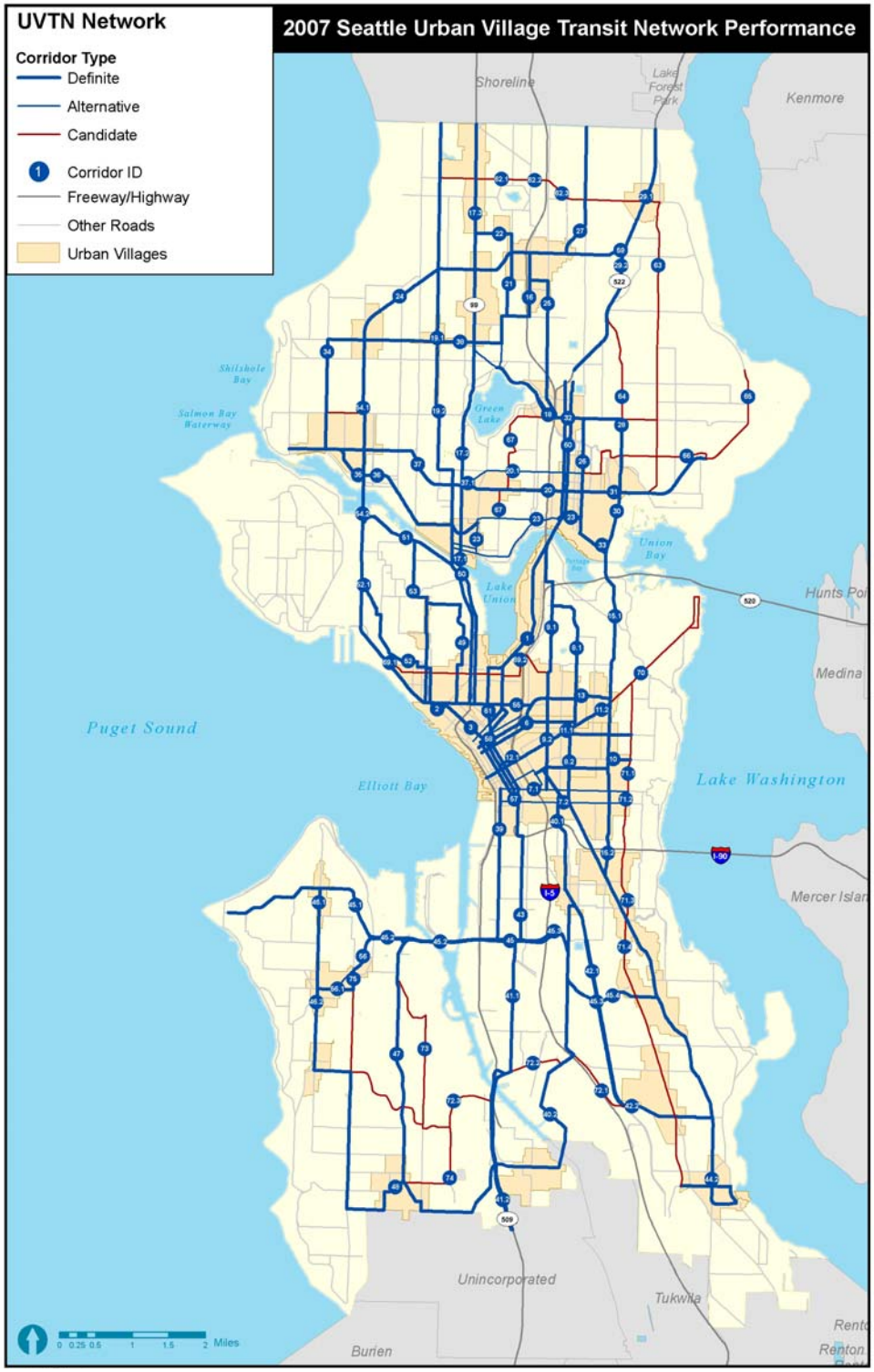
[3] Puget Sound Regional Council. (2004). *Issue paper on health: What's health got to do with growth management, economic development and transportation?* http://www.psrc.org/projects/vision/pubs/health.pdf

[4] Seattle Department of Transportation. (2005). Seattle Transit Plan: To Get Seattle Moving. http://www.seattle.gov/transportation/transitnetwork.htm

[5] Nelson\Nygaard Consulting Associates, & Seattle Department of Transportation. (September 2004). *Seattle Transit Network Development Plan: Final Draft.* http://www.seattle.gov/transportation/docs/transitplan_SEATTLEuvtn%20FINAL%20DRAFT.pdf

The map below shows the UVTN and how it connects Seattle's urban villages.

Figure 1: UVTN Network



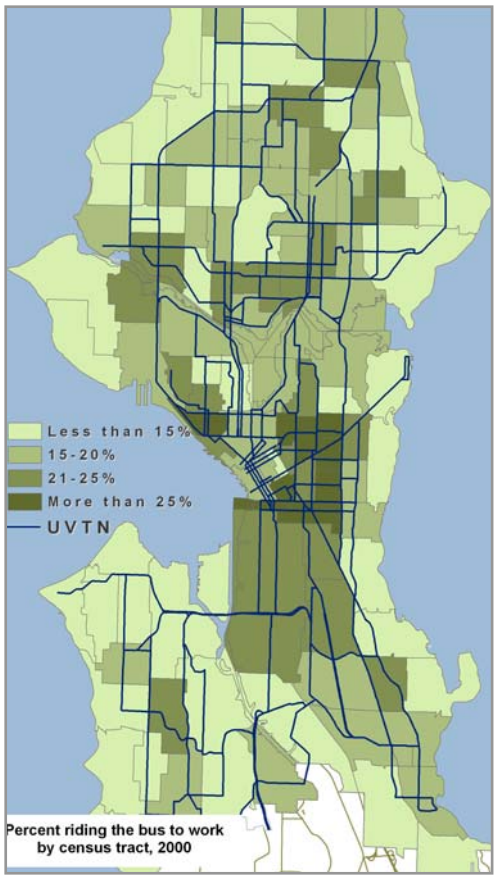
One of the goals of the Seattle Transit Plan and the Comprehensive Plan is to increase the percentage of work trips made by non-SOV modes of transportation. Table 2 shows the proportion of work trips by Seattle residents in selected urban centers using these alternative modes in 2000, with the city's goals for 2010 and 2020.

Table 1: Percent of Work Trips Using Non-SOV Modes

Urban Center	2000	Goal 2010	Goal 2020
Downtown	56%	62%	70%
First Hill/Capitol Hill	31%	37%	50%
Uptown/Queen Anne	33%	37%	50%
South Lake Union	30%	37%	50%
University District	56%	62%	70%
Northgate	26%	30%	40%
Seattle	**39%**	**42%**	**45%**

Figure 2 displays the percentage of workers using transit to get to work, by census tract. It is evident that the UVTN is established in areas of current and potential high ridership.

Figure 2. Percent of Seattle Workers Riding Transit to Work



Quality of Service Measures

The goal of the UVTN is to provide service at least every 15 minutes – in both directions – 18 hours a day, seven days a week. To identify corridors where the city could target improvement projects, five quality of service measures have been defined (see Table 2). These are measured along each street segment within a UVTN corridor, and then aggregated for the whole corridor according to various statistics.

The data for measuring performance are provided by King County Metro Transit (KCM), from three databases:

Transit Enterprise Database (TED): The database used to create the transit schedules and routes, updated three times per year: in February, June and September.

Automatic Passenger Collection (APC) database: data on passenger loading, collected by automated passenger counters which are installed on buses on a rotating basis. Metro attempts to sample every scheduled trip at least once during each scheduling cycle.

Automatic Vehicle Location (AVL) database: Data collected daily through a radio/AVL system that records the time it takes the vehicle to travel between time point interchanges (TPIs). All Metro buses are equipped with this system and most of the data generated can be used for analysis.

Table 2 lists the measures and the statistics used to calculate performance scores. With the exception of speed, these indicators reflect the least desirable conditions that occur during the day. For both the initial report and this update, the acceptable threshold for span of service is 12 hours.

Table 2. UVTN Quality of Service Measures and Statistics

Measure	Statistic	Source
Frequency: Gap in minutes between consecutive buses along a corridor	Maximum	TED
Span: The number of hours in a day that a service runs at UVTN frequencies (15 minutes or less)	Minimum	TED
Speed: Measured as a percentage of the posted speed limit	Average	AVL
Load: Passenger load that occurs 85% of the time on the most crowded route	Maximum	APC
Reliability: The degree to which the posted schedule is met - a ratio between actual travel time and expected travel time	Maximum	AVL/ speed limit classification

The first report measured data collected during the fall of 2005; the data for this report were collected during October 2007.

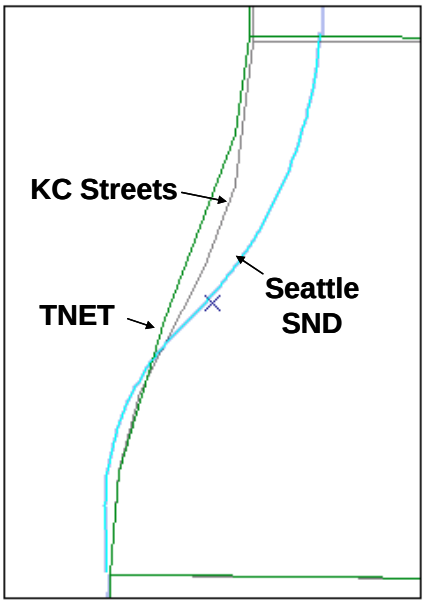
A detailed description of the rationale for and measurement of the performance indicators is included in the first UVTN monitoring report.[6] The measures that SDOT mitigations have the most potential impact are speed and reliability, through traffic improvements such as exclusive transit lanes and signal priority for buses. The UVTN monitoring reports can also provide recommendations to the City and KCM for improvements to service frequency, span and load. As was noted in the first UVTN report, the measures are intended to identify potential problem areas for further analysis rather than suggest specific corrective actions.

Methodology

UVTN performance indicators are reported at the street segment level. Data are provided by KCM through a series of SQL (Structured Query Language) queries of three databases (see Appendix 1: Data Creation for UVTN Performance Analysis), which are then linked spatially to Seattle's Street Network Database (SND). For the first report, the UVTN was based on the King County street network; the common fields "Trans_Link" and "Ramkey" were used to join the performance data to street segments.

SDOT has completed an update to its own street network (SND) that is highly accurate spatially, and the UVTN is a subset of this file. Concurrently, King County has developed a Transportation Network (TNET) initiative, envisioned as a seamless database of transportation-related spatial and attribute datasets to be used and maintained by participating city and county agencies.[7] Figure 3 displays the spatial differences between the Seattle, old King County and new TNET street networks that occur in some parts of the city.

Figure 3. Street Networks in Seattle



In 2007, KCM route performance data was reported on the new TNET street network, linked with the new field "TLINK_ID." The challenge for reporting on UVTN performance on the Seattle SND is that there is no common field for joining datasets. To conduct analysis of the UVTN it was therefore necessary to create a version of the UVTN that contained the TLINK_ID in order to connect the UVTN to KCM's performance data.
Because there was no common field, it was necessary to join the datasets spatially and create a new UVTN shapefile. The original UVTN shapefile with attributes of the SND was spatially joined one-

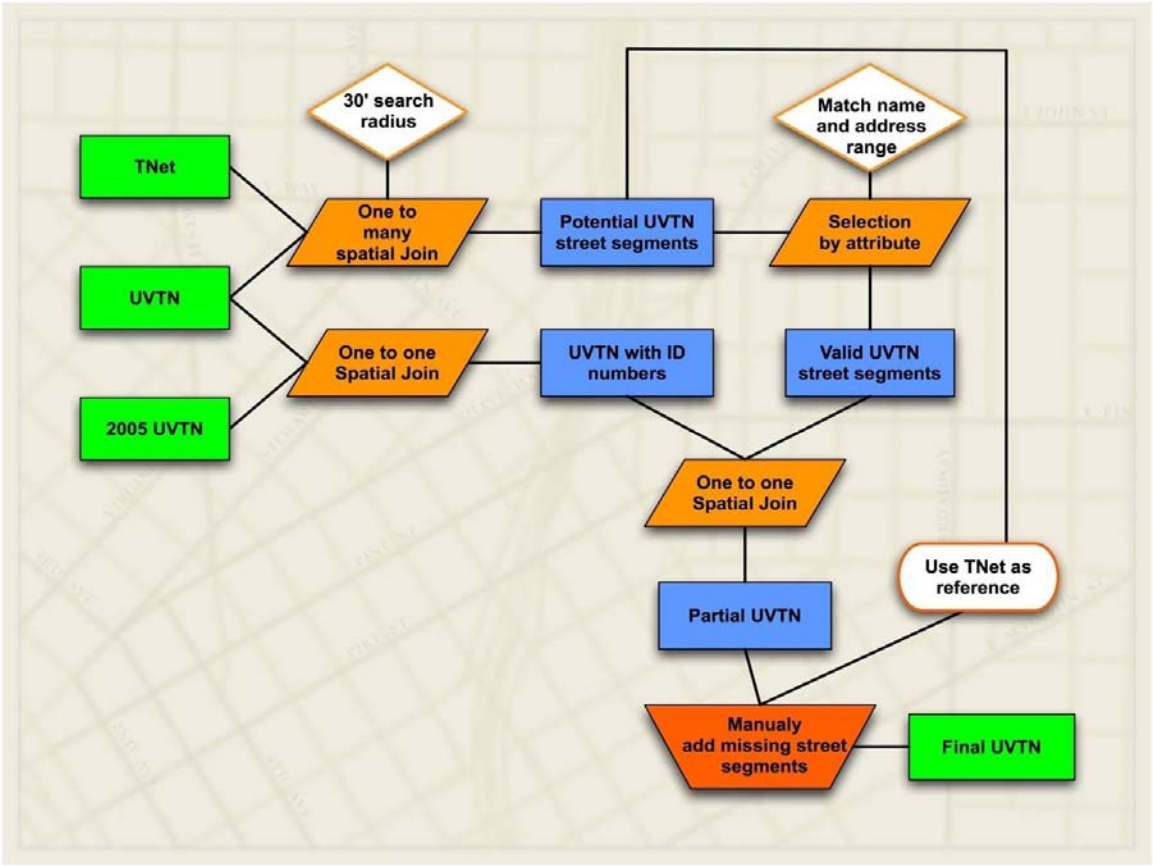
[6] Seattle Department of Transportation. (February 2007). *UVTN Monitoring Project: Final Report.* http://www.seattle.gov/transportation/uvtn.htm

[7] King County Department of Transportation. (June 2007). *Transportation Network (TNET) Consortium: Guide Book and Best Practices (version 0.4.3 draft).* http://www.metrokc.gov/gis/Projects/TNET/docs/AttmtB-TNETConsortiumManual.pdf

to-many to the TNET with a search radius of 15 feet to capture all potential matching TNET segments for each UVTN segment. Selections were made to match the street name and address range of the segments in the joined file. This resulted in a partially complete version of the UVTN that contained the unique TLINK_ID from the TNET. The remaining missing segments were added through a manual selection process that matched potential UVTN segments based on the TLIN_ID identified from the TNET for a given segment.

The resulting complete UVTN shapefile with the TLINK_ID field was checked for accuracy by displaying the file showing performance data and comparing this to a display of the same data connected to the TNET, allowing discrepancies to be identified and corrected. The steps for creating the new UVTN shapefile are shown in Figure 4, below, and outlined in Appendix 2.

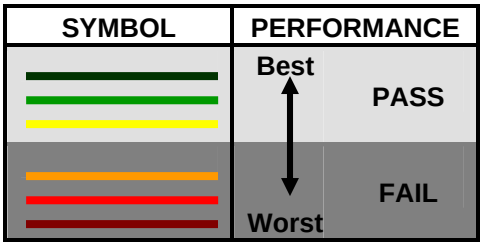
Figure 4. Creation of the UVTN Shapefile



Once the UVTN shapefile linked the Seattle SND to the KCM performance data, maps could be created that show how the UVTN performed according to each of the five measures, by segment and by corridor. The segments were aggregated into corridors using the GIS dissolve function, with statistics calculated for each measure as outlined in Table 2.

2007 UVTN Performance

Performance scores were classified into six categories according to criteria developed for the first report (see Appendix 3) based on performance measures set forth in the 2005 Seattle Transit Plan. These six categories were divided into three passing and three failing levels symbolized for both street segments and corridors as follows:



It should be noted that four out of the five measures (frequency, span, reliability and load) are reported using the worst case scenario (see Table 2). When statistics are calculated in the process of dissolving segments into corridors, the whole corridor displays the value of the "worst" segment. For the speed measure, the average along the corridor is reported, so a corridor can be considered to be performing satisfactorily even if speeds are slow along some segments of the corridor. Figures 5 and 6 illustrate differences when selected performance measures are displayed by segment and by corridor.

Figure 5. SPEED by UVTN Segment & Corridor

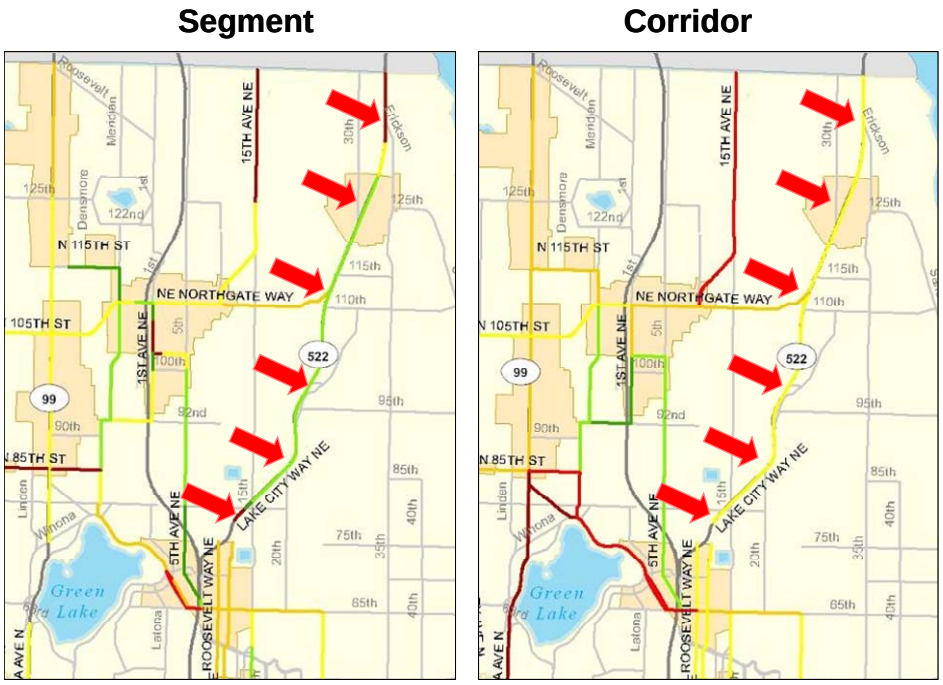
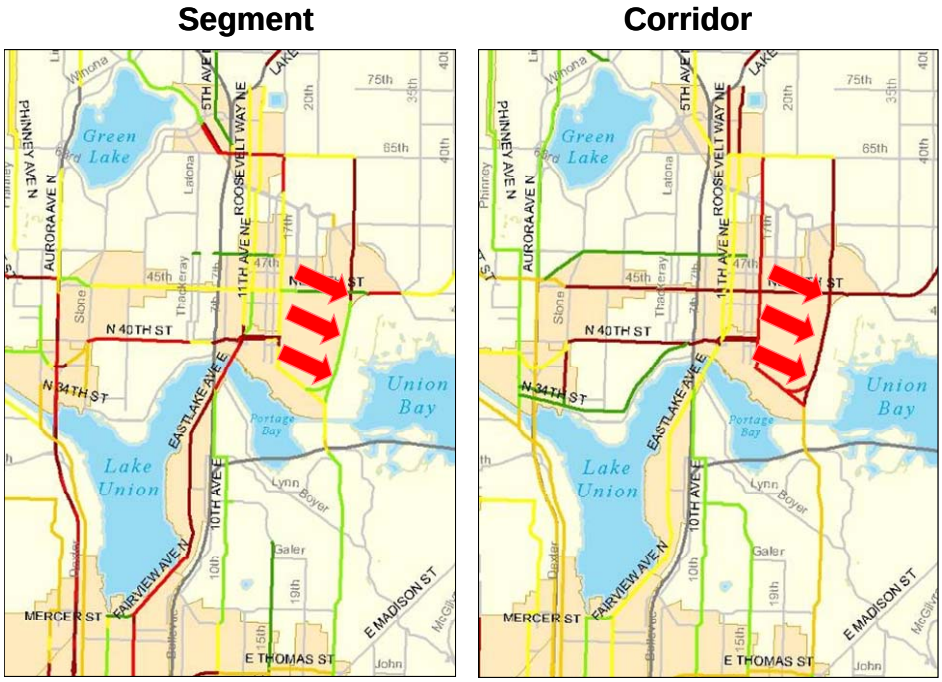


Figure 6. PASSENGER LOAD by UVTN Segment & Corridor



Figures 7 through 16 show UVTN performance for each of the five measures, by segment and by corridor. . The maps of performance by street segment display performance data only on street segments that have transit service. Any gaps in performance data are the result of no transit service on those particular street segments. The maps of performance by corridor display the values for the entire corridor regardless of whether the entire corridor has transit service. All the maps display performance data only for corridors classified as definite UVTN corridors and their potential alternates. Performance data for corridors classified as candidate were not mapped for this report but exists in the associated geodatabase.

Figure 7. Frequency by Segment

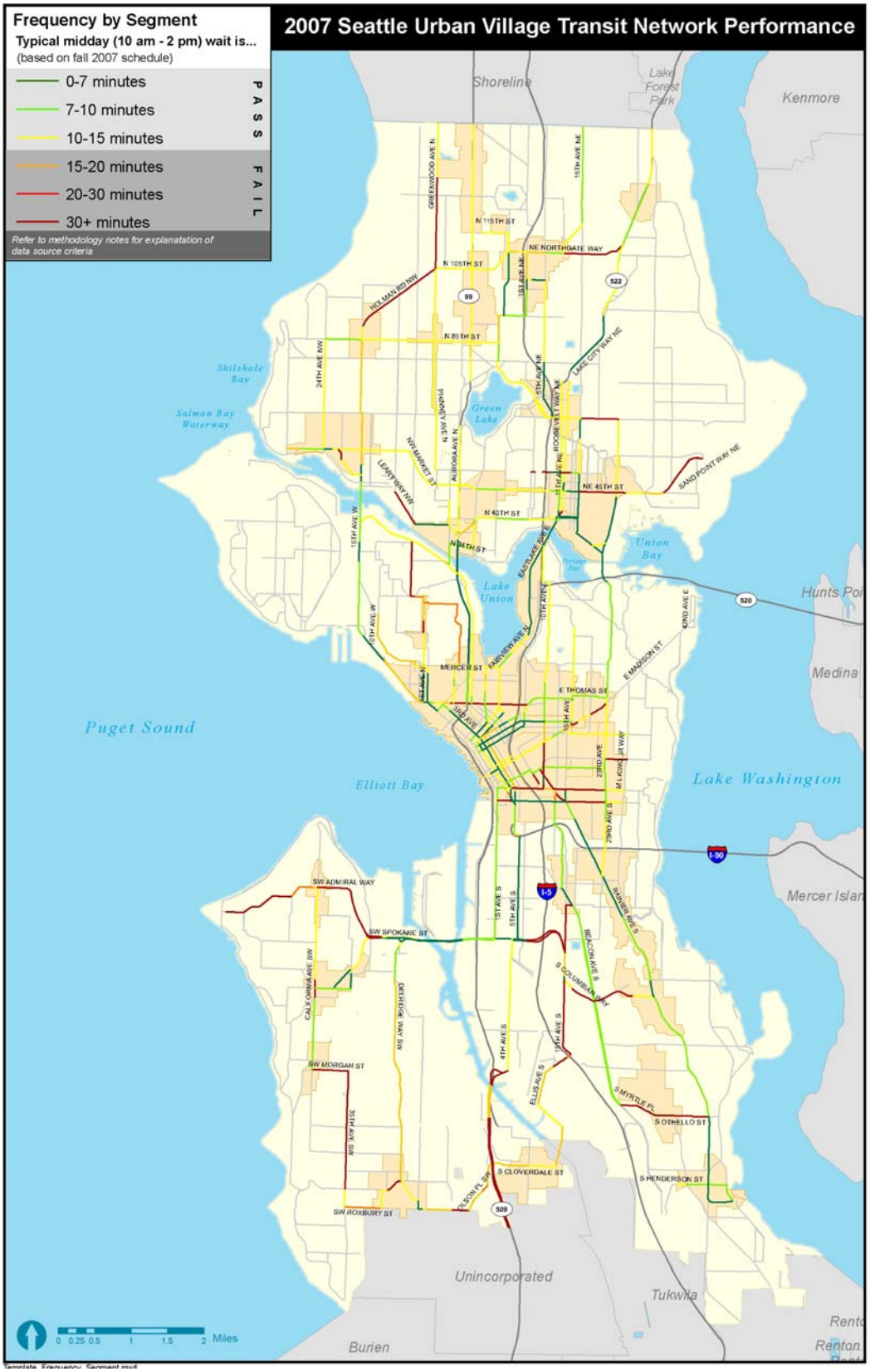


Figure 8. Frequency by Corridor

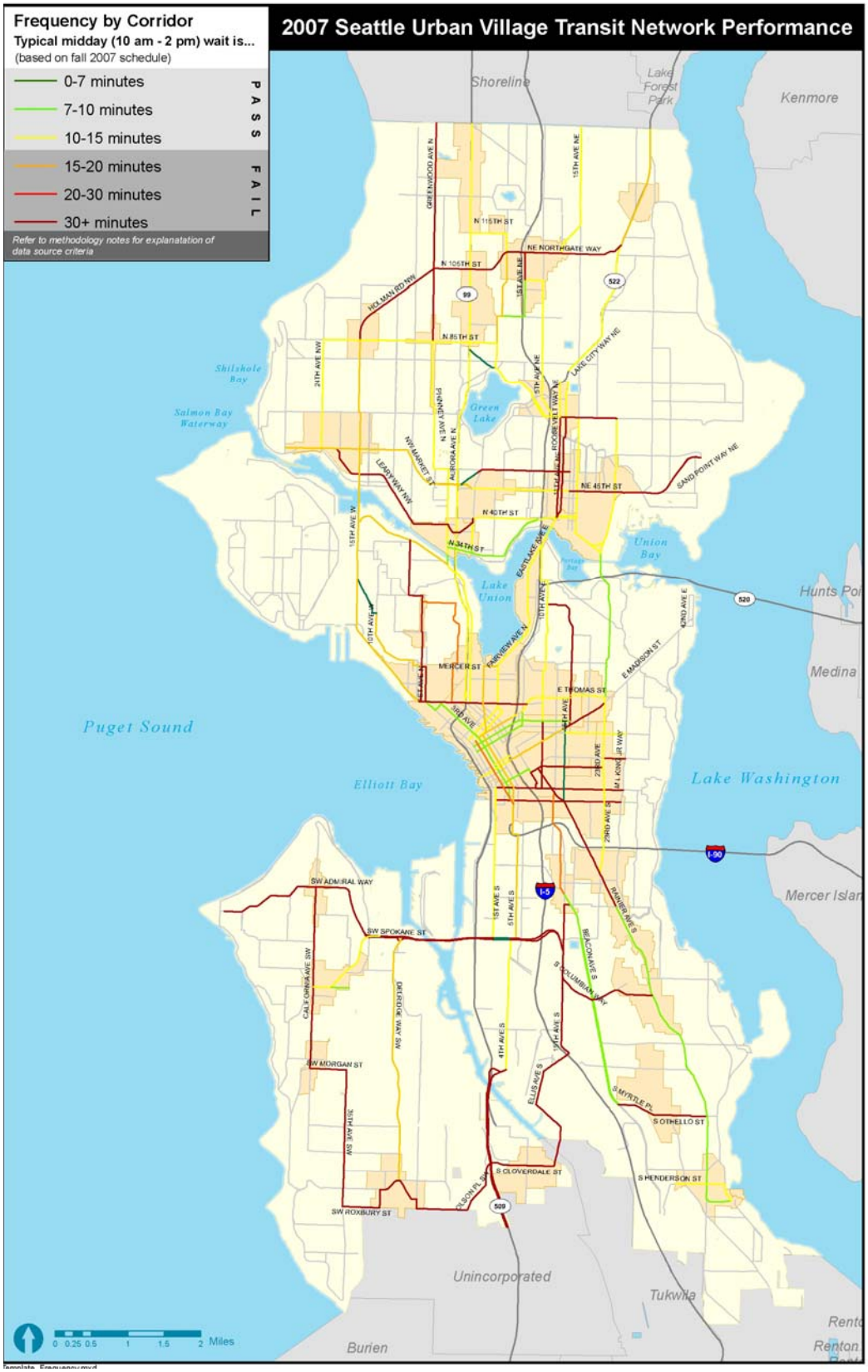


Figure 9. Span by Segment

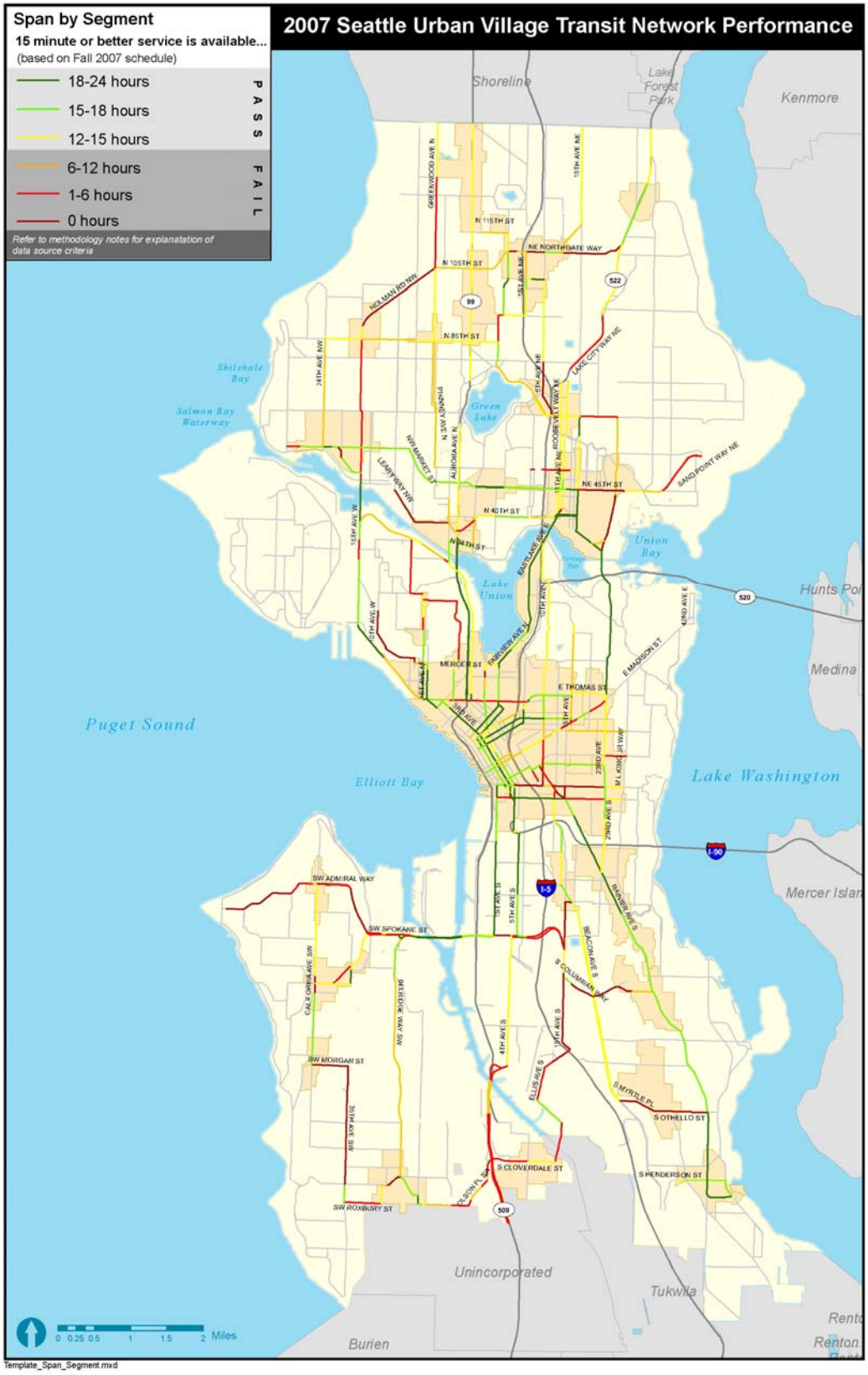


Figure 10 . Span by Corridor

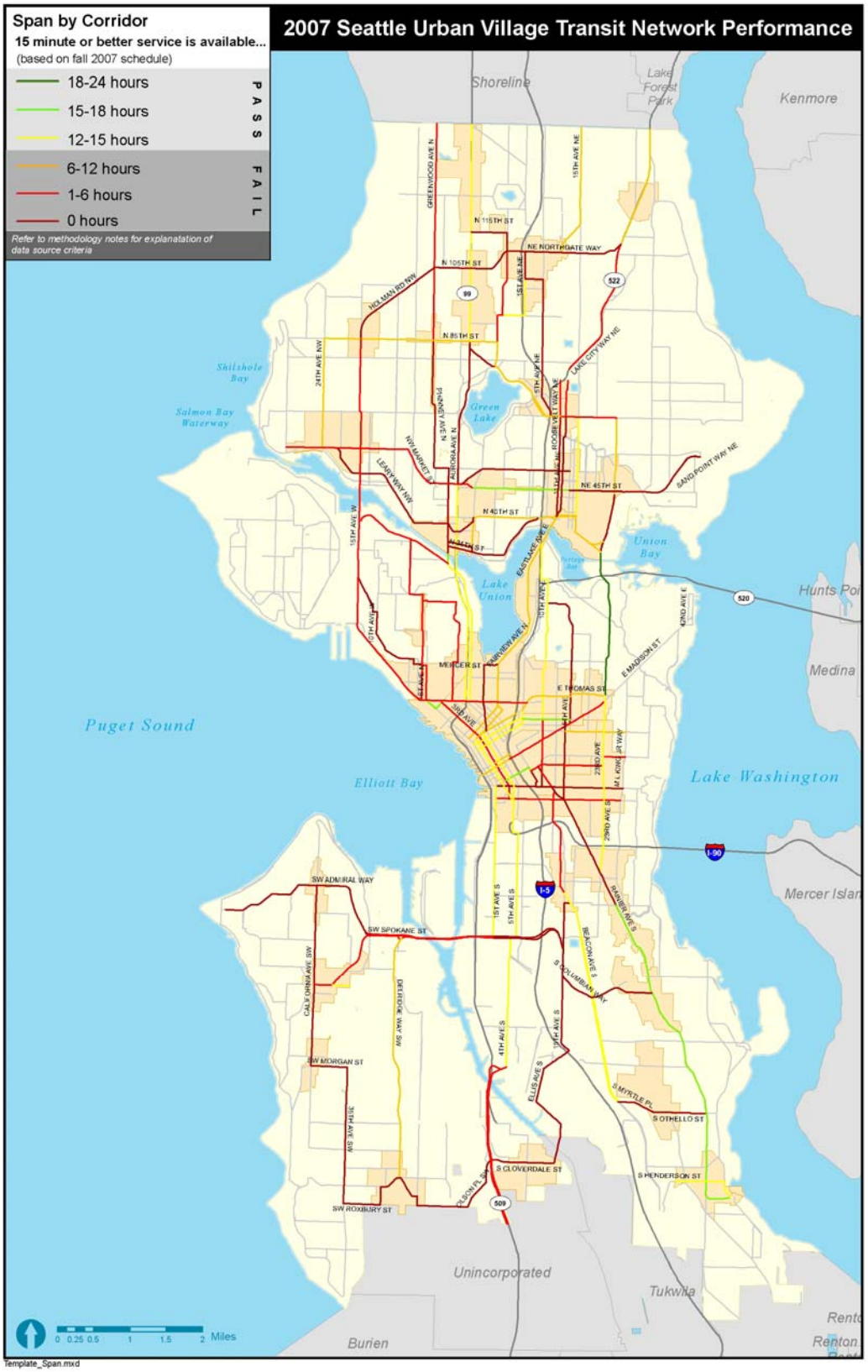


Figure 11. Speed by Segment

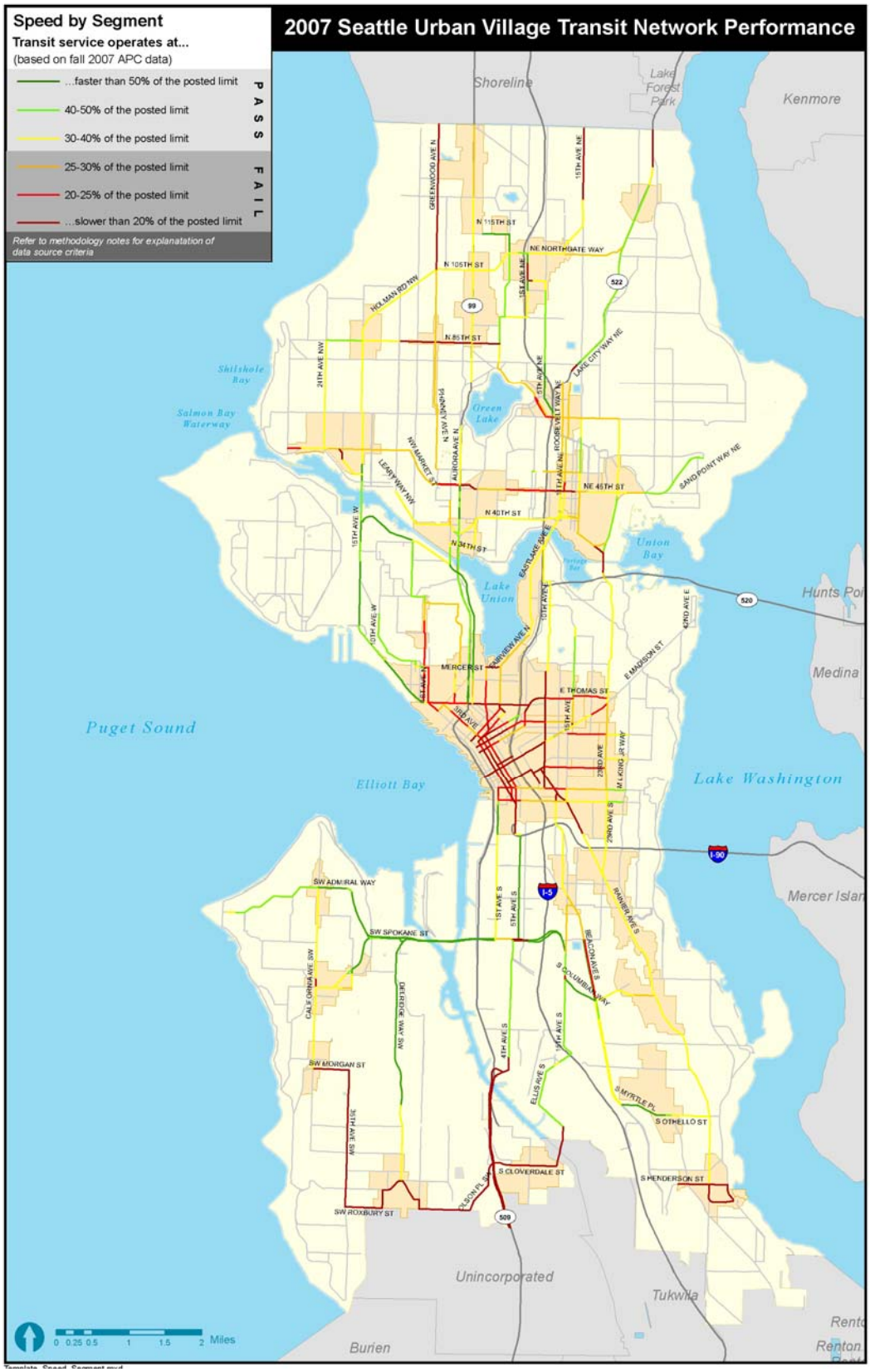


Figure 12. Speed by Corridor

Figure 13. Load by Segment

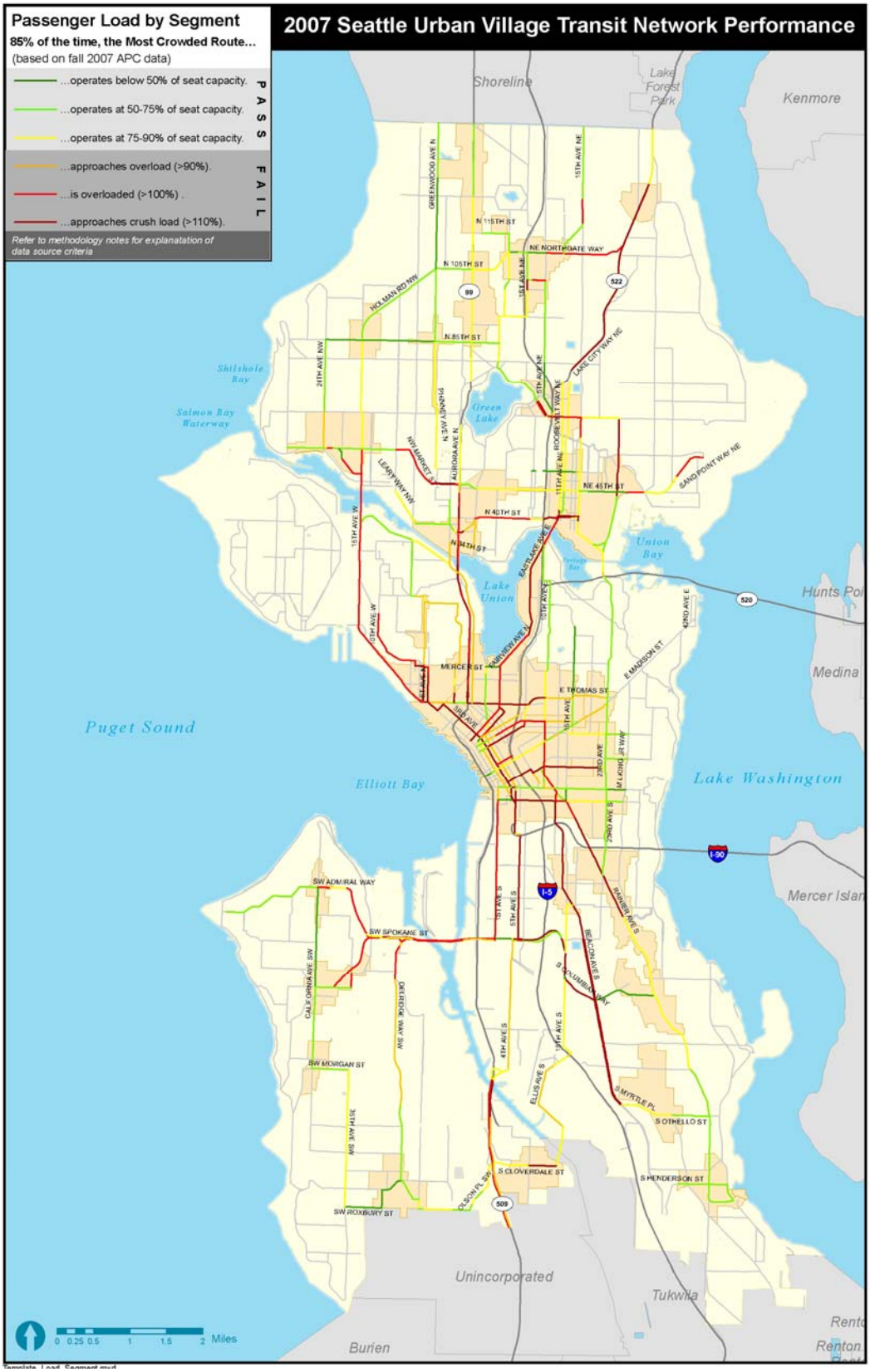


Figure 14. Load by Corridor

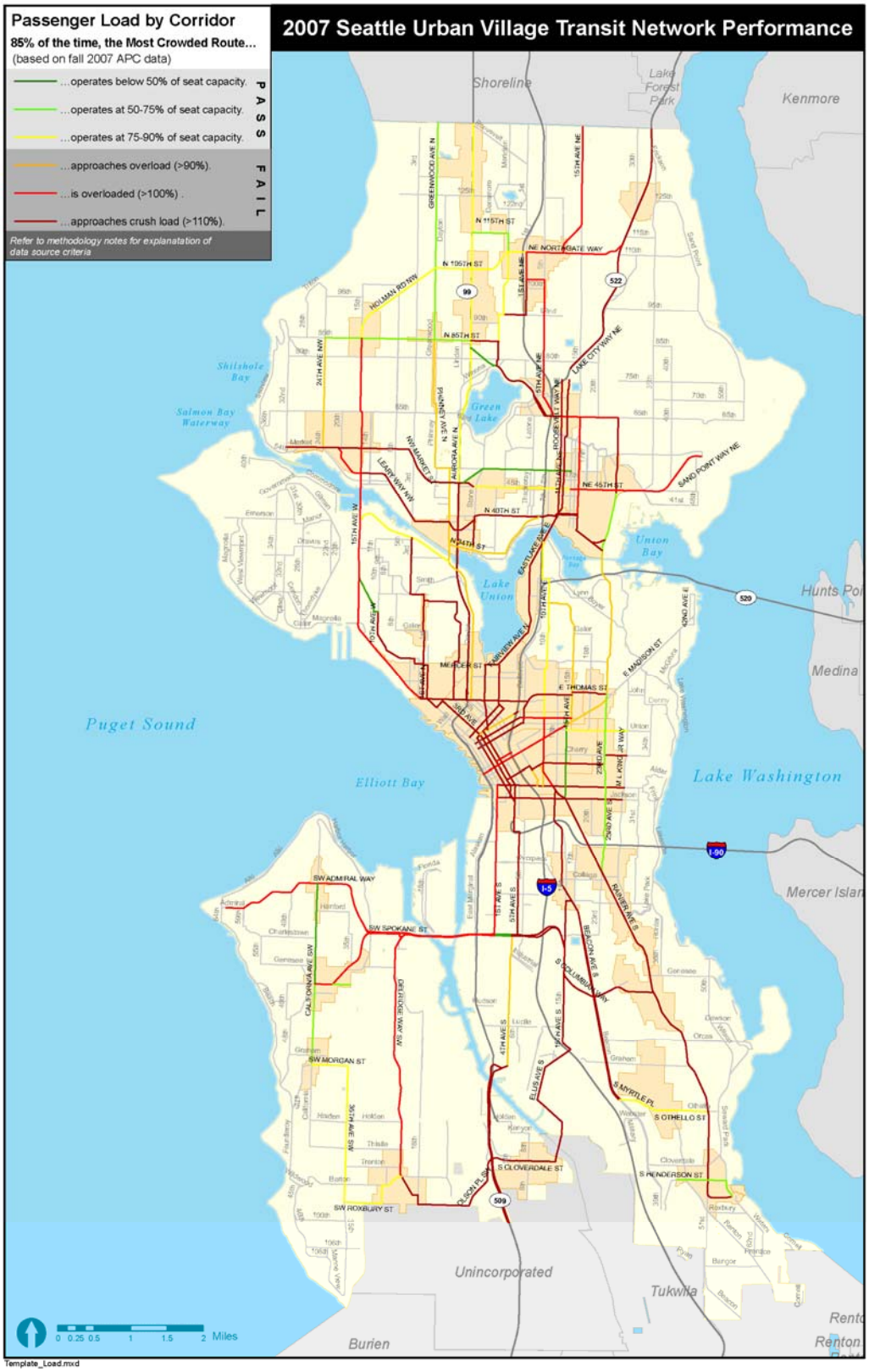


Figure 15. Reliability by Segment

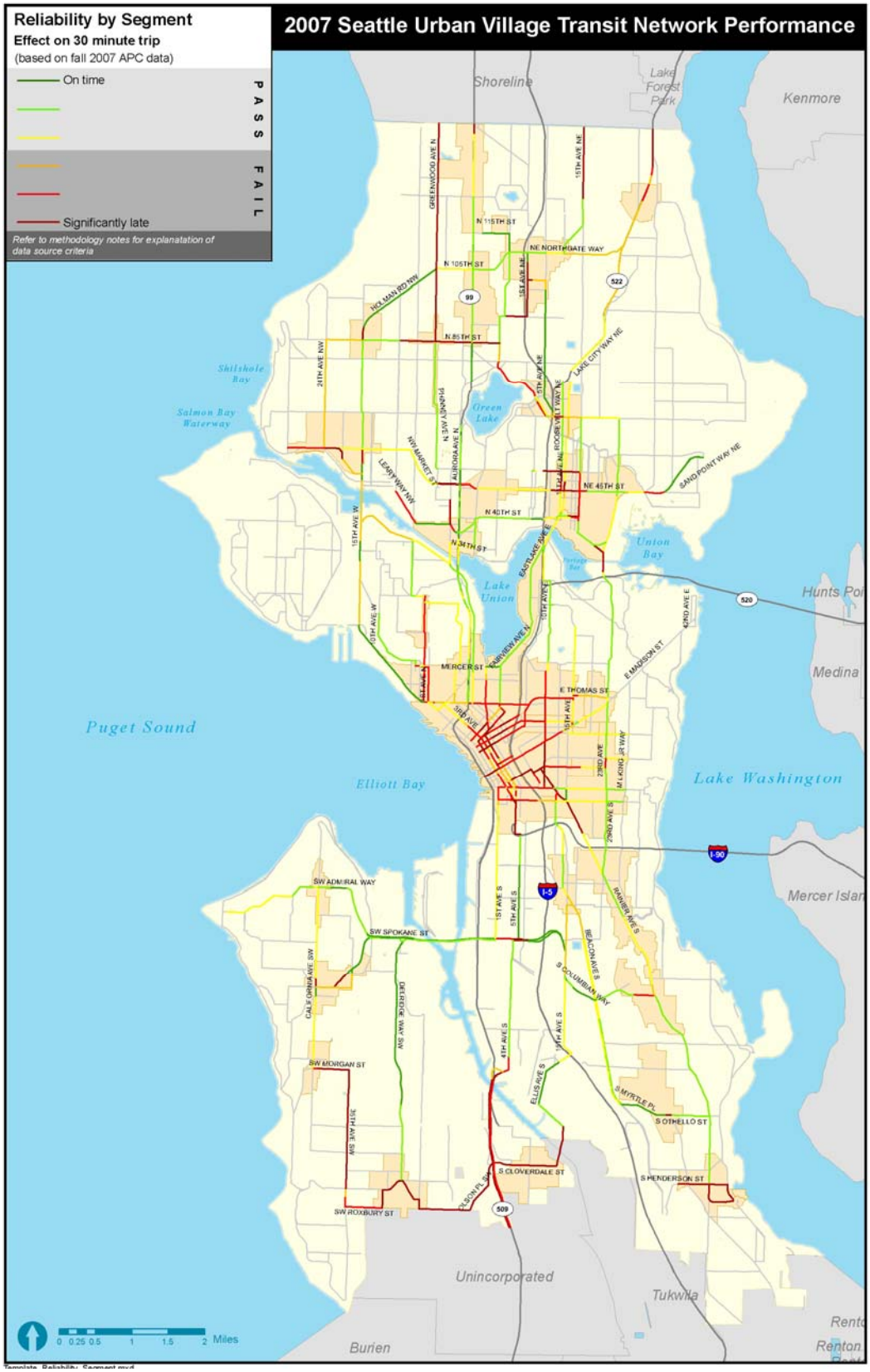


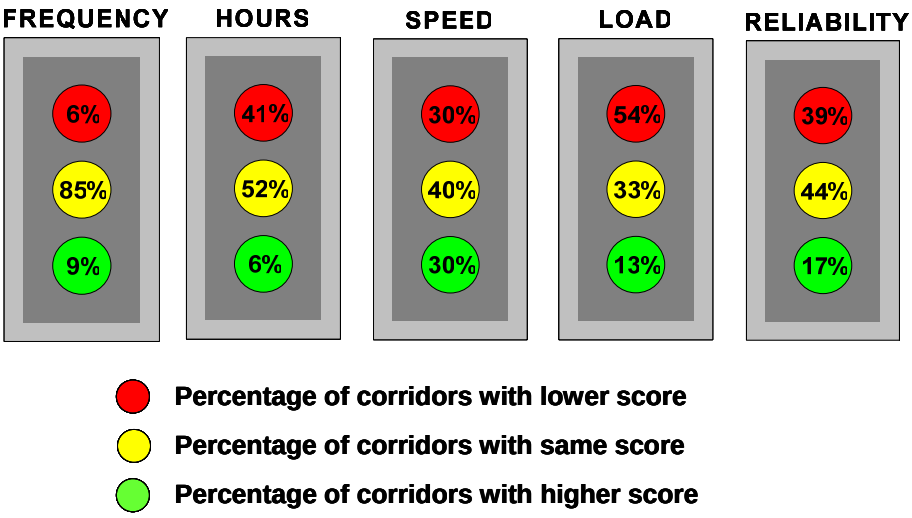
Figure 16. Reliability by Corridor

UVTN Change in Performance 2005 – 2007

One of the objectives of this second review of UVTN performance was to detect any changes in performance along UVTN corridors, especially those where infrastructure improvements were implemented. Because so many factors affect performance, and because performance on one measure can affect the performance of another measure, it is difficult to attribute causes for changes. For example, increased ridership – which is a goal of transportation plans – can cause overloaded buses, which in turn can cause reductions in speed and reliability.

Changes in performance scores for corridors between 2005 and 2007 for each measure are summarized below. The percentages reflect whether or not a score was better, worse or the same, but do not consider the magnitude of change.

Figure 17. UVTN Corridors: Change in Performance Score 2005 – 2007



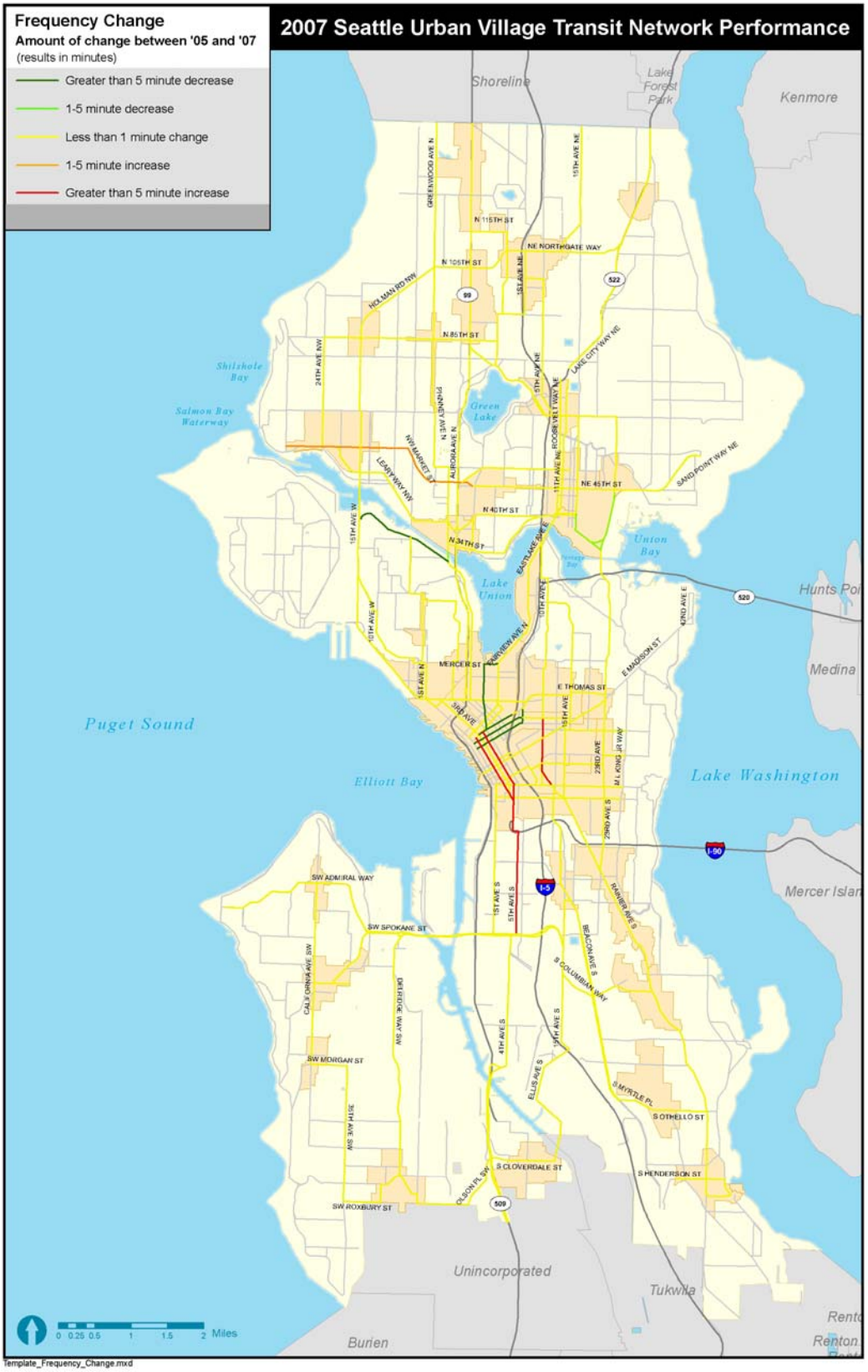
The maps on the following pages display changes in performance scores for each measure, by corridor. See the UVTN Report Card (p. 31) for descriptions and scores for individual corridors.

Frequency

The frequency change map shows the change in headway (time between bus arrivals) measured in minutes between 2005 and 2007 by corridor. In general there was little or no change to frequency over most of the UVTN. This reflects the fact that transit schedules have remained relatively constant in the City of Seattle. Only seven corridors showed an increase of more than one minute in their frequency and only corridors 5, 6, 33, 51, and 61 saw significant increases of 5 minutes or more. Only in case of corridors 6 and 33 did this improvement move the corridor from failing to passing on the frequency performance measure, with the other three corridors still receiving a failing grade despite their improvements. On the negative side, only five corridors saw decreases in frequency of more

than one minute with three of these, corridors 43, 57,and 58 having significant decreases of over 10 minutes. The changes on corridors 57 and 58 may reflect some routes on these corridors moving back into the bus tunnel after its reopening. Even corridor 43 only saw significant decreases in frequency along the northern section that runs along 4th Ave S and Royal Brougham Way while the remainder of the corridor along the busway retained its high frequency levels of 2005.

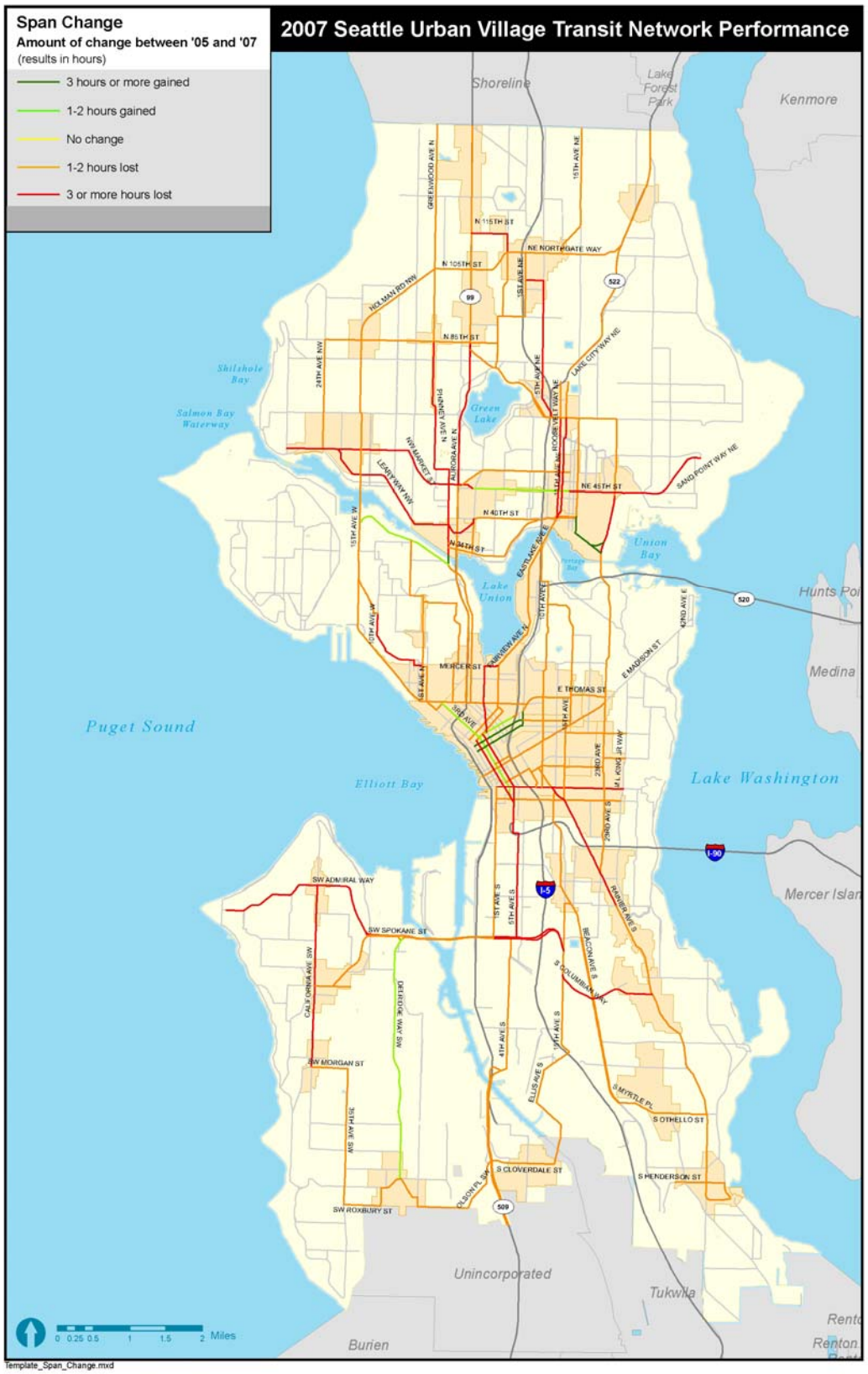
Figure 18. Frequency Change 2005-2007



Hours of service (span)

The span change map shows the change in span of UVTN level service measured in hours by corridor. On initial inspection it appears that 33 corridors lost hours of UVTN service and many appear to have lost significant numbers of hours. This trend appears to be an anomaly due to process used to generate the 2005 report. In the 2005 report it appears that street segments having no hours of UVTN service were dropped when aggregating the street segments into their corridors for the span performance measure. This led to incorrectly high values for the span measurement for many corridors. Because of this error in process one should not accept any results showing a loss of hours without examining the data at the street segment level as many of the corridors showing a loss on this change map show no change when examined at the street segment level. This error in process does not reflect in corridors that did not have street segments having no hours of UVTN level service. The eight corridors showing improvement in hours of service all fall in to this category and their change values appear to be valid. As well most of the corridors showing no change appear to be valid. The process error detected during analysis of the Span Change map demonstrates the importance of analyzing change at the street segment level as well as at the corridor level as performed for this report. This topic will be discussed in more detail later in this report.

Figure 19. Hours of Service Change 2005-2007



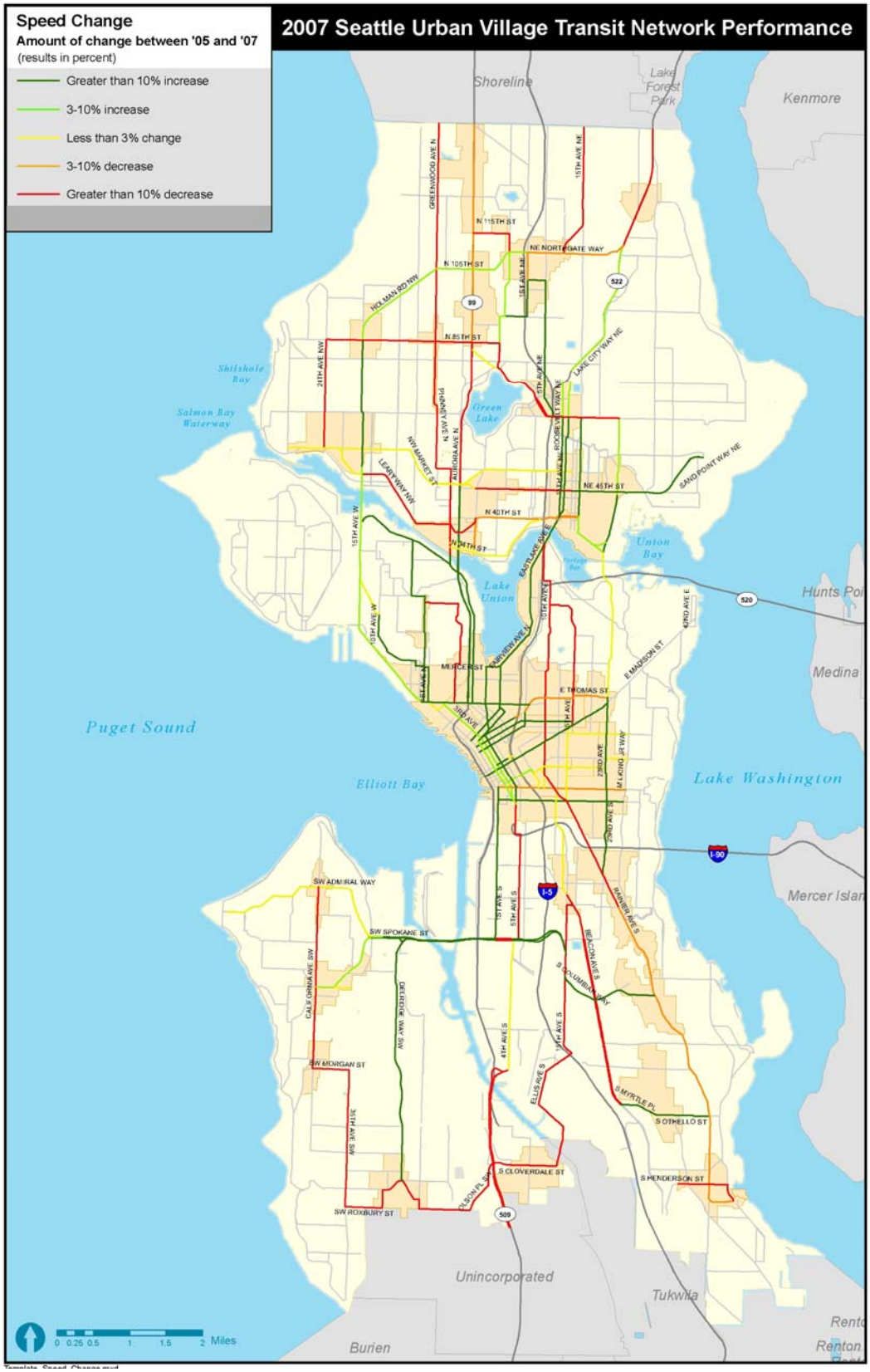
Speed

The change in speed map shows the percent change in the speed performance measure between 2005 and 2007 by corridor. In general the speed improvements were concentrated in the center of the city with areas to the extreme north and south showing a decrease in speed. The map shows 39 corridors where speed improved by 3% or more and 32 corridors where speed decreased by 3% or more, leaving 9 corridors essentially unchanged.

The map shows that 27 corridors had a decrease in speed of 10% or greater with 14 showing a decrease of speed greater than 25% or more. Some of these corridors, such as 29.1 (Lake City Way), 8.1 (15th Ave E), 43 (5th Ave S), and 40.2 (15th Ave S) had improvements in speed over much of the corridor only to be dragged down by a decrease on other parts of the corridor. Four corridors of concern showed a decrease of speed greater than 50%, these were 19.1, 41.2, 44.3, and 48. Corridor 19.1 (Greenwood Ave N) showed a significant decrease in speed north of N 105th St. Corridors 41.2 (SR 509), 44.3 (S Henderson St), and 48 (Morgan, 35th Ave SW, Roxbury) showed significant decreases in speed for their entire measured lengths. Of the corridors showing a decrease in the speed performance measure, 17 decreased by enough to change them from passing to failing on this measure. Though three of these, 8.1, 17.2, and 19.2, likely moved from passing to failing due to the inclusion of street segments with no transit service, which were not included in the 2005 analysis of these corridors.

On the positive side, the map shows that 31 corridors had an increase in speed of 10% or greater with four (6, 7.2, 45.2, 30) showing increases of 25% or greater. Of the corridors showing an improvement in speed only seven showed enough improvement to move them from passing to failing on the speed performance measure and 18 of the corridors showing improvement of 3% or greater are still receiving a failing mark for speed.

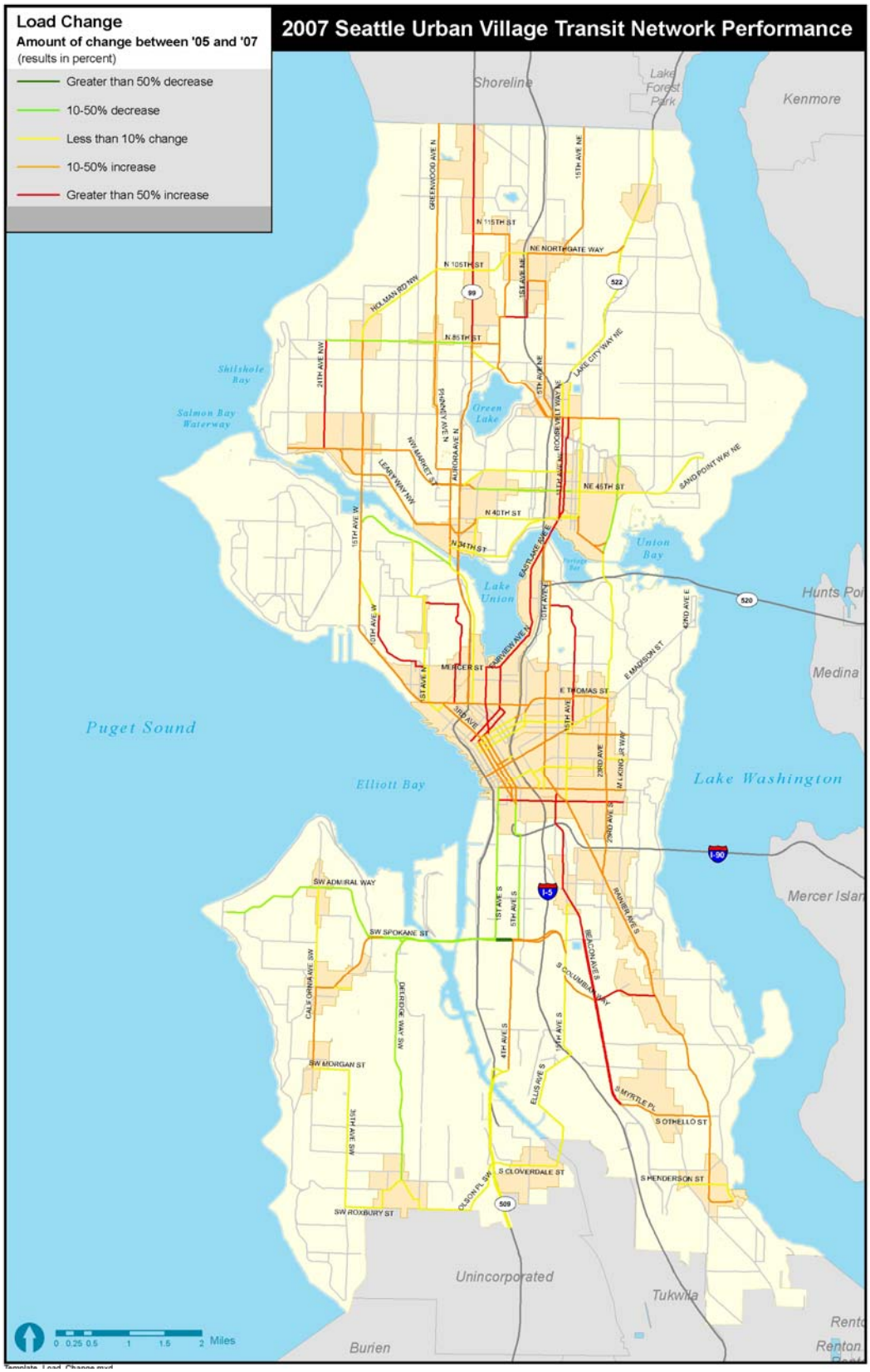
Figure 20. Speed Change 2005-2007



Passenger Load

The load change map shows the change by corridor, between 2005 and 2007, in passenger load calculated as a percent change in the load performance. In general the buses are fuller city-wide with only 11 corridors displaying a significant decrease of 10% or more in passenger load. These routes showing a decrease in passenger load were all outside the downtown core. Of these 11, only three, corridors 20 (N 45th St), 51 (Nickerson), and 30 (Montlake), improved enough to move their scores from failing to passing for this performance measure. West Seattle in general saw the most improvement in passenger load. On the negative side 49 corridors saw a increase in passenger load, with 40 of these receiving a failing grade for this performance measure. Of these 40 that are now failing 23 moved from passing to failing during this period as a result from their increases in passenger load. Corridors of particular concern for overloading are 1 (Fairview/Eastlake), 40.1 (14th S), 42.1 (Beacon), and 52 (Olympic/10th W) as these corridors showed some of the highest rates of increase over the measured period and are now operating above 100% of load capacity.

Figure 21. Passenger Load Change 2005-2007

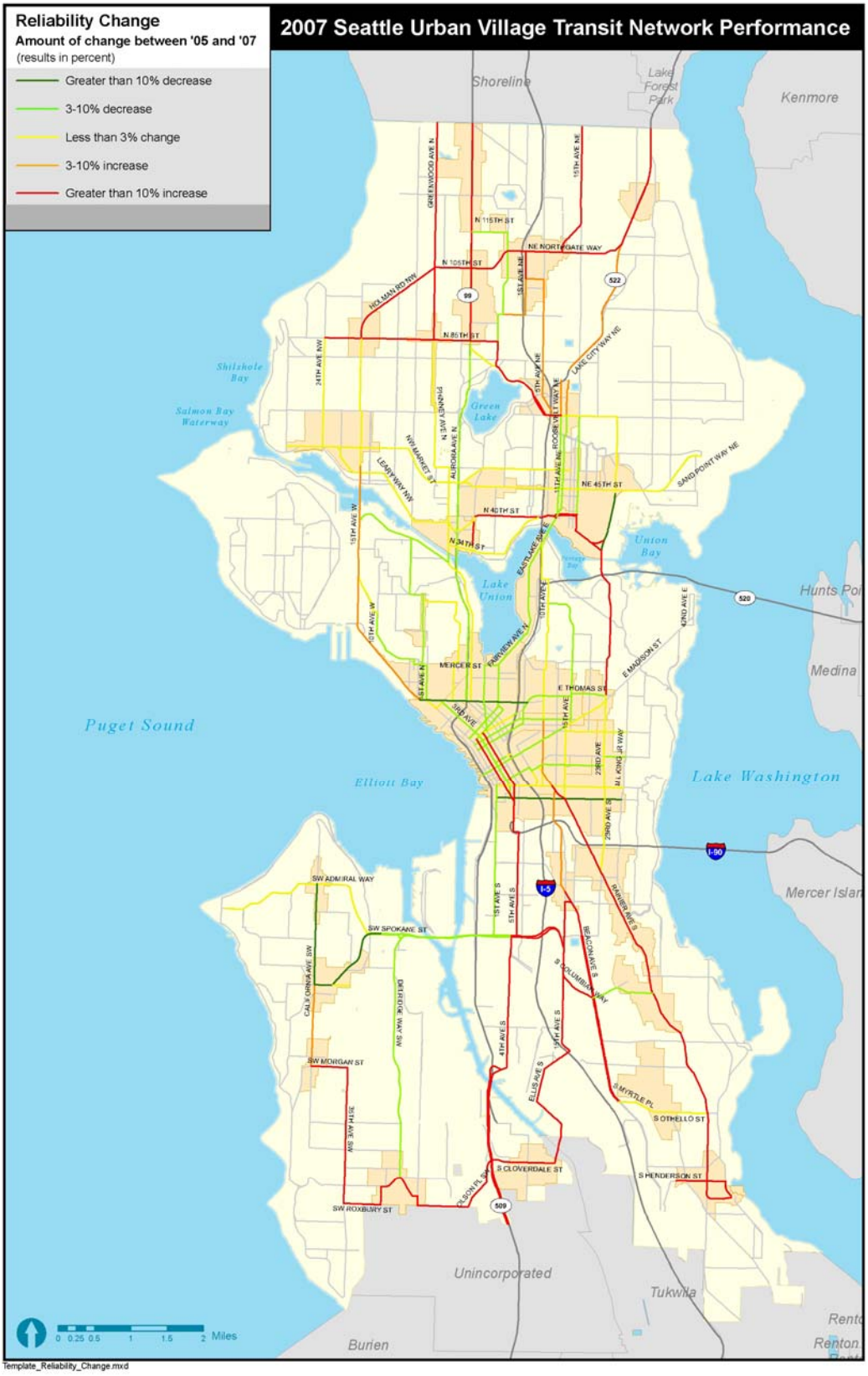


Reliability

The change in reliability map shows the percent change in the reliability performance measure between 2005 and 2007 by corridor. It shows that 21 corridors had a decrease of 10% percent or more. Of these 21, seven moved from a passing grade on reliability to failing as a result of their decrease. Some of these saw their performance decrease only as a result of a few blocks along the corridor such as the Montlake Bridge on corridor 15.1 and the few blocks north of NW 85th St of Holman Rd NW on corridor 24. Performance uniformly decreased in south central Seattle including on SR509, though this may be an anomaly in the data possibly due to traffic problems on SR509 itself.

On the positive side, the map shows that 25 corridors saw improvements in reliability of 10% or greater. Of these 25 corridors showing improvement of 10% or greater 18 are still receiving a failing mark for reliability. Five corridors (7.2, 30, 46.1, 55, and 56) saw improvements greater than 50%. Though only in the case of corridor 30 (Montlake Ave) was this improvement enough to move the corridor from failing to passing.

Figure 22. Reliability Change 2005-2007



Impact of SDOT infrastructure improvements on UVTN performance

King County Metro operates and controls nearly all of the current transit service on the UVTN. Their decisions determine what corridors have service and are the primary influence on the performance measures of span, frequency, and passenger loading. The City of Seattle owns the infrastructure of the UVTN on which Metro transit operates. By making improvements to this infrastructure the City can influence the performance measures of speed and reliability. For this report, some of the infrastructure improvements made by SDOT were examined with regard to their influence to the UVTN performance measures of speed and reliability. Improvements made to traffic signals in the form of signal synchronization and transit priority at signals were geographically referenced for this report and are included in the UVTN geodatabase. Other improvement such as parking changes and lane reorganizations were not analyzed for this report as these were not as wide spread on the UVTN.

Fourteen improvement projects for traffic signals occurring on the UVTN between 2006 and 2007 were georeferenced and analyzed for this report. Changes made in 2005 could not be definitively dated as having been implemented after the collection of data in 2005 and thus were not included. It is possible that some of the 2007 changes were made after data was collected in the fall of 2007 and thus may not be valid for analysis purposes. Obtaining data on the exact dates of the various improvements would lend greater credibility and accuracy to the analysis of impacts on performance. For this report change in performance was mapped only at the corridor level, due to a change in data structure between the 2005 report and this report. Most of the improvements to signals occurred over only a portion of a UVTN corridor and thus it is necessary to examine the effects on performance change at the street segment level. Though it was not possible to mathematically calculate the change in performance factors at the street segment level (due to a change in data structure between 2005 and 2007), the change could be visually observed in the GIS at the scoring levels used in the mapping schema.

The results of this visual analysis along with mathematical analysis at the corridor level showed no significant effect of these projects on the speed or reliability performance measures. When examining either the change in speed or reliability individually, the percentage of sites showing positive or negative change is essentially identical regardless of whether they benefitted from signal improvements. When looked at together four of fourteen, or 29%, saw improvement in both speed and reliability. By comparison 29% of corridors receiving no improvements to signals display similar gains in both speed and reliability. Further reinforcing this trend is the fact that four sites, or 29%, receiving such improvements saw a decrease in both speed and reliability nearly matching the 33% of corridors not receiving improvements.

There are a great number of interrelated factors influencing each of the five performance measures. No one factor operates alone to increase or decrease performance. Based on the data available for this report improvements to traffic signals in the form of synchronization and transit priority do not appear to have a discernable influence on the performance factors of speed and reliability. Critical to further study of these and other improvements to infrastructure is the mapping of change in performance at the street segment level.

UVTN Report Card

The UVTN Report Card on the following pages displays the performance scores for each corridor re-classified to a common index for both 2005 and 2007 (see Appendix 3 for classification key). The report card contains performance data on all classifications of UVTN corridors (definite, alternate, candidate). Performance data from 2005 do not exist for all of these types of corridors.

UVTN REPORT CARD 2005 & 2007

	Indicates corridors that are not definite and/or have no performance data for 2005			Quality of Service									
	UVTN Segment			2005					2007				
UVTN ID	Primary Street of Corridor Segment	Between...	And...	HOURS	FREQ	SPEED	LOAD	RELIAB	HOURS	FREQ	SPEED	LOAD	RELIAB
Downtown/East/West													
1	Fairview, Stewart/Virginia	Stewart	University Dist.	1	1	-6	1	-9	-9	1	-3	-9	-9
2	1st, Broad	Denny & QA Ave	3rd & Broad	3	2	-6	-9	2	3	2	-6	-9	1
3	3rd	Cedar	Jackson	-6	2	-6	-9	-9	-6	2	-6	-9	-9
4	James	3rd	9th & Jefferson	3	2	-9	-6	-9	3	2	-9	-9	-9
5	Olive	1st	I-5	-3	-6	-6	-3	-9	-3	-3	-3	-3	-9
6	Pike/Pine	1st & Pike/Pine	Pine & Summit	-3	-6	-9	-9	-9	1	2	-6	-9	-9
7.1	Yesler	1st	MLK	1	-6	1	1	-6	-9	-6	-3	-9	-6
7.2	Jackson	1st	MLK	-6	-6	-6	-9	-9	-6	-6	1	-9	-9
7.3	Broadway (or 8th/9th Ave?)	Yesler	Jefferson						-9	-9	-9	-3	-9
8.1	Boston/15th Ave	10th/Boston	Madison	-6	-6	1	3	-9	-9	-6	-6	-3	-6
8.2	14th Ave	Madison	Jackson			-9	2		-9	3	-9	2	3
9.1	Broadway, 10th Ave E	Eastlake	Thomas	1	1	1	3	-6	1	1	-3	1	-6
9.2	Broadway	Thomas	Yesler	-6	-9	-6	1	-6	-6	-9	-9	-6	-9
10	Jefferson, Cherry	9th & Jefferson	MLK & Cherry	-6	-6	-3	-6	-9	-6	-6	-3	-9	-9
11.1	Madison	6th Ave	14th Ave	-3	-3	-9	1	-9	-3	-3	-6	-6	-6
11.2	Madison	14th Ave	23rd Ave	-6	-6	-3	1	-3	-6	-6	1	-3	-3
12	Madison, Spring, Marion	Western Ave	6th Ave	1	1	-9	1	-9	1	1	-9	-6	-9
12.1	Spring	6th Ave	7th Ave						1	1	-9	-6	-6
13	Olive, John, Thomas	Pine & Summit	23rd & Thomas	1	1	-6	-3	-6	-9	1	-6	-9	-6
14.1	Pine	Pine & Summit	Madison	2	2	-6	-6	-6	2	2	-6	-6	-6
14.2	Union	Madison	MLK & Union	-3	1	-3	3	2	-3	1	-3	1	1
15.1	23rd/24th Ave	Montlake Station	Thomas	3	3	1	-3	1	3	2	1	-3	-9
15.2	23rd/24th Ave	Thomas	Rainier	1	1	-3	3	-6	1	1	1	3	-6
61	South Lake Union Streetcar corridor	Olive & Westlake	Fairview & Valley	-6	-6	-9	3	-9	-9	-3	-6	-9	-6
69.1	W Mercer Pl/St	Elliott Ave W	Westlake Ave N						-9	-6	1	-9	-9
69.2	Mercer St, Lakeview Blvd E, Belmont Ave E, E Roy St	Westlake Ave N	Broadway E						-9	-9	-9	-9	-9
70	E Madison, 42nd/43rd Ave E, E Blaine St	23rd Ave E	43rd & McGilvra/Blaine						-6	-6	1	-3	1

UVTN REPORT CARD 2005 & 2007

Indicates corridors that are not definite and/or have no performance data for 2005

	UVTN Segment			Quality of Service									
				2005					2007				
UVTN ID	Primary Street of Corridor Segment	Between...	And...	HOURS	FREQ	SPEED	LOAD	RELIAB	HOURS	FREQ	SPEED	LOAD	RELIAB
North													
16	92nd St, 1st Ave NE	92nd & Meridian (NSCC)	Northgate LRT	1	2	2	-3	-9	1	2	3	-9	-9
17.1	Aurora	Denny	45th St	1	1	1	3	-6	-6	1	2	-9	1
17.2	Aurora	45th St	85th St	1	1	1	3	1	-9	1	-9	1	2
17.3	Aurora	85th St	145th St	1	1	1	-3	1	1	1	-3	1	-9
18	Green Lake, 65th St, Wallingford, 85th St	85th St & Aurora	Roosevelt LRT	-3	1	-3	-3	-6	-3	1	-6	-9	-9
19.1	Greenwood	85th St	145th St	-6	-6	1	2	-3	-6	-6	-9	3	-9
19.2	Greenwood, Phinney, Fremont	85th St	Fremont Bridge	-3	1	1	3	-6	-9	1	-6	-3	-9
19.3	Fremont	Fremont Bridge	Nickerson	1	2	1	-3	-3	2	2	2	-3	1
20	N 45th St	Stone Way	University Dist.	1	1	-6	-9	-9	2	1	-9	1	-9
20.1	N 50th St	Green Lake Way N	University Dist.						-9	-9	-9	2	-9
21	Wallingford, College Wy, Meridian (NSCC)	85th St	Northgate Wy	-6	-3	2	3	2	-6	-3	2	1	2
22	N 115th St, Meridian Av	115th St & Aurora	Meridian & Northgate Wy	1	1	2	3	3	-9	1	-3	3	3
23	N/NE 40th St	Stone Way	University Dist.	-3	1	1	-9	-9	-3	1	1	-9	-9
23.1	N 34th/35th St, N/NE Pacific St	Fremont Ave N	NE 40th						-9	2	-9	-3	1
24	Holden, NE 105th St, Northgate Wy	Crown Hill	1st Ave NE	-6	-6	1	1	1	-9	-6	1	1	-9
25	5th Ave NE, Weedin Pl, 103rd St	Roosevelt LRT	Northgate LRT	1	1	2	1	-9	-9	1	2	-6	-9
26	15th Ave NE	University Dist	Roosevelt LRT	1	1	1	-6	-9	1	1	1	-6	-6
27	15th Ave NE, Pinehurst	Northgate Wy	145th St	1	1	1	1	1	1	1	-6	-6	-9
28	25th Ave NE	NE 45th St	NE 65th St	1	1	1	-9	3	1	1	1	-9	2
29.1	Lake City Wy	Northgate Wy	145th St	-3	-3	1	-9	-3	-3	-3	1	-9	-9
29.2	Lake City Wy	NE 65th St	Northgate Wy	-3	1	1	-9	2	-3	1	1	-9	-3
30	Montlake	Montlake Station	NE 45th St	-6	-3	-6	-9	-9	-9	1	1	3	1

UVTN REPORT CARD 2005 & 2007

Indicates corridors that are not definite and/or have no performance data for 2005

	UVTN Segment			Quality of Service									
				2005					2007				
UVTN ID	Primary Street of Corridor Segment	Between…	And…	HOURS	FREQ	SPEED	LOAD	RELIAB	HOURS	FREQ	SPEED	LOAD	RELIAB
North, continued													
31	NE 45th St, Sand Point	University Dist	50th St)	-6	-9	1	-9	-9	-9	-9	1	-6	-9
32	NE 65th St	Roosevelt LRT	25th Ave NE	-6	-6	1	1	-3	-6	-6	-3	-6	-3
32.1	NE 65th St	25th Ave NE	35th Ave NE						-6	-6	-3	1	-3
33	Pacific St	Montlake Station	University Dist.	-6	-3	-6	-6	-6	-3	1	-6	-9	-9
34	24th Ave NW	NW 65th St	NW 85th St	1	1	2	3	1	1	1	1	-3	-3
35	Leary, 20th Ave NW	20th Ave & Market	14th Ave NW & Leary	2	-6	-3	1	-9	-9	-6	-3	-6	-9
36	Leary, NW 39th St	14th Ave NW & Leary	Stone Way	-6	-6	1	1	-6	-9	-6	-3	-9	-6
37	Market, N 46th St	32nd Ave NW & Market	Stone Way	1	1	-3	-3	-9	-6	-3	-3	-9	-9
38	NW 85th St	24th Ave NW	Aurora	1	1	1	1	-6	1	1	-3	3	-9
49	5th Ave N, Taylor Ave N, Boston	Denny & 5th Ave N	Boston & Queen Anne Ave	-3	-3	1	1	1	-3	-6	1	-9	-3
50	Dexter, Nickerson	Denny & Dexter	Nickerson	1	1	1	-3	1	1	1	2	-3	1
51	Nickerson, 15th Ave W	Dravus & 15th Ave NW	Nickerson	-6	-6	1	-3	-6	-9	-6	2	1	-6
52	Olympic, 10th Ave W, Gilman Drive W	Denny & QA Ave	Dravus & 15th Ave NW	-6	-3	2	3	-6	-9	-3	2	-9	-6
53	Queen Anne Ave, McGraw, 3rd Ave W	Denny & QA Ave	Nickerson & 3rd Ave NW	-6	-6	-3	-9	-9	-6	-6	1	-9	-6
55	Denny Wy	Western Ave	Olive	-6	-6	-9	-6	-9	-6	-6	-6	-9	-6
54.1	15th Ave NW	Leary	85th St	-6	-3	-3	1	-6	-6	-3	1	-6	-9
54.2	15th Ave W, Elliott	Leary Ave NW	Denny Wy	-6	-3	2	1	2	-6	-3	2	-6	-3
57	2nd Ave	Stewart	Jackson	3	3	-9	-9	-9	2	-6	-9	-9	-9
58	4th Ave	Stewart	Jackson	3	3	-9	-9	-9	2	-3	-6	-9	-9
59	5th Ave NE, Northgate Wy	5th Ave NE & 103rd St	Wy	-6	-6	1	1	1	-9	-6	-3	-6	-9
60	11th Ave NE, Roosevelt Wy	NE 40th St	NE 65th St	-6	-6	-3	1	-9	-9	-6	1	-9	-9
62.1	N 130th St	Greenwood Ave N	Meridian Ave N						-9	-6	-9	3	-9
62.2	N 130th St	Meridian Ave N	5th Ave NE						-9	3	-9	2	2
62.3	Roosevelt Way NE, NE 125th St	5th Ave NE	35th Ave NE						-9	-3	-9	3	-9
63	35th Ave NE	NE 125th St	NE 45th St						-6	-9	2	-6	-6
64	25th Ave NE	Lake City Way	NE 65th St						-6	-6	1	-9	1
65	Sandpoint Way	Princeton	Magnuson Park						-6	-6	2	-6	-6
66	NE 50th St, 20th Ave NE, NE 55th St	University Dist	Sandpoint Way						-9	-6	1	-3	-9
67	Wallingford, Meridian, NE 65th St	NE 40th St	65th St & Ravenna						-9	-6	-6	3	2
68	NW 65th St	24th Ave NW	15th Ave NW						-9	3	-9	2	3

UVTN REPORT CARD 2005 & 2007

Indicates corridors that are not definite and/or have no performance data for 2005

	UVTN Segment			Quality of Service									
				2005					2007				
UVTN ID	Primary Street of Corridor Segment	Between...	And...	HOURS	FREQ	SPEED	LOAD	RELIAB	HOURS	FREQ	SPEED	LOAD	RELIAB
South													
39	1st Ave S	Yesler	Spokane	1	1	1	-9	-9	-9	-9	1	-9	-6
40.1	14th Ave S	Jackson	Beacon	-6	-6	1	-6	-3	-6	-6	1	-9	-6
40.2	15th Ave S, Albro, through Georgetown and South Park to White Ctr	Beacon	Delridge & Barton	-6	-9	1	-9	1	-9	-9	-6	-9	-9
41.1	4th Ave S	Spokane	Michigan St	1	1	2	3	3	1	1	2	-3	-9
41.2	1st Ave S Bridge ,SR 99 Limited Stop	Michigan	SR 99	-6	-9	2	-9	3	-6	-9	-9	-9	-9
42.1	Beacon	Beacon & 14th Ave S	Beacon & Myrtle	1	2	2	-3	-6	1	2	1	-9	-9
42.2	Myrtle, Othello	Beacon & Myrtle	East end of Othello	-9	-6	1	3	-9	-9	-6	2	1	-9
43	E3 Transitway, Limited Stop	King Street LRT	Spokane	3	3	1	-9	-3	-6	-6	1	-9	-9
44.1	Rainier	Yesler	Rainier & McClellan	-3	-9	-3	-6	-3	-9	-9	-6	-9	-9
44.2	Rainier	Rainier & McClellan	Rainier & Seward Park	2	2	1	-6	-6	2	2	1	-9	-9
44.3	Henderson, Seward Park	Henderson & MLK	Seward Park & Rainier	1	1	2	3	-6	1	1	-9	3	-9
45	Spokane	1st Ave S	4th Ave S	-6	3	-3	1	-9	-9	3	-9	2	-6
45.2	Spokane	Spokane & Admiral Wy	Spokane & 1st Ave S	-6	-6	2	-9	1	-6	-6	3	-6	2
45.3	Columbian	Spokane & 4th Ave S	Columbian & Beacon	-6	-6	1	-6	-3	-9	-6	2	-9	-9
45.4	Columbian & Alaska Wy	Columbian & Beacon	Alaska & Rainier	-3	-6	-3	1	-9	-9	-6	1	-9	-6
71.1	ML King Way E	Madison	E Yesler Way						-9	-6	2	2	3
71.2	ML King Way S	E Yesler Way	S Jackson St										
71.3	ML King Way S	S Jackson St	Rainer Ave S						-9	-6	2	1	1
71.4	ML King Way S	Rainier Ave S	S Henderson St						-9	-6	1	-9	-6
72.1	Swift Ave S	S Albro Pl	Beacon Ave S						-9	-6	3	-3	3
72.2	S Michigan St	4th Ave S	S Albro Pl						-9	-6	3	1	-6

UVTN REPORT CARD 2005 & 2007

Indicates corridors that are not definite and/or have no performance data for 2005

	UVTN Segment			Quality of Service									
				2005					2007				
UVTN ID	Primary Street of Corridor Segment	Between...	And...	HOURS	FREQ	SPEED	LOAD	RELIAB	HOURS	FREQ	SPEED	LOAD	RELIAB
Southwest													
45.1	Admiral Way	63rd Ave SW	Spokane & Admiral	-6	-6	2	-9	1	-9	-6	2	-6	1
46.1	California	Admiral Wy	Alaska Wy	2	-9	1	3	-9	-9	-9	1	2	-9
46.2	California	Alaska Wy	Morgan Jct.	2	-6	2	3	3	-9	-6	1	3	1
47	Delridge	Spokane	Center	-3	-3	2	-9	2	1	-3	3	-6	2
48	Morgan, 35th Ave SW, Roxbury	Morgan Jct.	Center	-6	-6	1	1	-3	-9	-6	-9	1	-9
56	Avalon, Alaska	Avalon & Spokane	Alaska & California	-6	1	1	1	-9	-6	1	2	-6	-9
56.1	SW Alaska St	Fauntleroy Wy SW	35th Ave SW						1	2	-3	3	-3
72.3	SW Morgan, Sylvan Wy SW, SW Holden, Highland Park Wy SW	35th Ave SW	SR 109						-9	-6	2	-3	2
73.0	23rd/22nd/21st Ave SW, SW Dawson St, 16th Ave SW	Delridge Way SW	SW Austin St						-9	-6	2	-9	2
74.0	SW Henderson St, 9th Ave SW	SW Holden St	Delridge Way SW						-9	-6	1	3	3
75.0	35th Ave SW	Fauntleroy Way SW	SW Morgan St						-9	-6	2	-6	-3

Recommendations

Generate reports more frequently

As stated in the previous report generating these reports frequently is important in order to closely monitor performance levels. Generating the report on a quarterly basis would be of value to better show changes in performance and help eliminate potential anomalies in the data such as poor performance due to construction, weather, or other temporary factors.

Consider methods to eliminate outliers

As stated above, generating the reports more frequently could help to identify outliers in the data by giving a more frequent picture of performance. Due to the choice of aggregating methods data outliers at the street segment level can throw off the performance of an entire corridor. Therefore, methods such as eliminating outliers in the data at the street segment level should be considered for the report of performance at the corridor level. This would help reduce the number corridors that may be influenced by potentially invalid data as opposed to poor performance.

Map change at the street segment level

Mapping change at the street segment level will paint a more realistic portrait of actual change over time than mapping change at the corridor level which can be thrown off by a few street segments with radically different levels of changes from others on a corridor. This type of map will be more useful to SDOT for identifying areas of concern meriting more in-depth analysis and will also serve as a quality assurance measure to ensure the maps at the corridor level are correctly generated. Mapping change at the street segment level was not possible with this report due to the change in street networks, but will be simple to generate in future reports due to the creation of a new UVTN shapefile included in the geodatabase associated with this report.

Consider other corridors or aggregating some streets into one corridor

From the transit user experience there are some streets that serve destinations, such as University Way in the University District, that are not part of the UVTN but serve essentially the same corridor as a street that is part of the UVTN (in this case 15th Ave NE). Adding these to the UVTN either as separate corridors or aggregating them into existing corridors would better reflect the options available to a transit user when traveling to or from certain urban villages.

Consider closing gaps in the UVTN by rerouting corridors to align with existing transit service

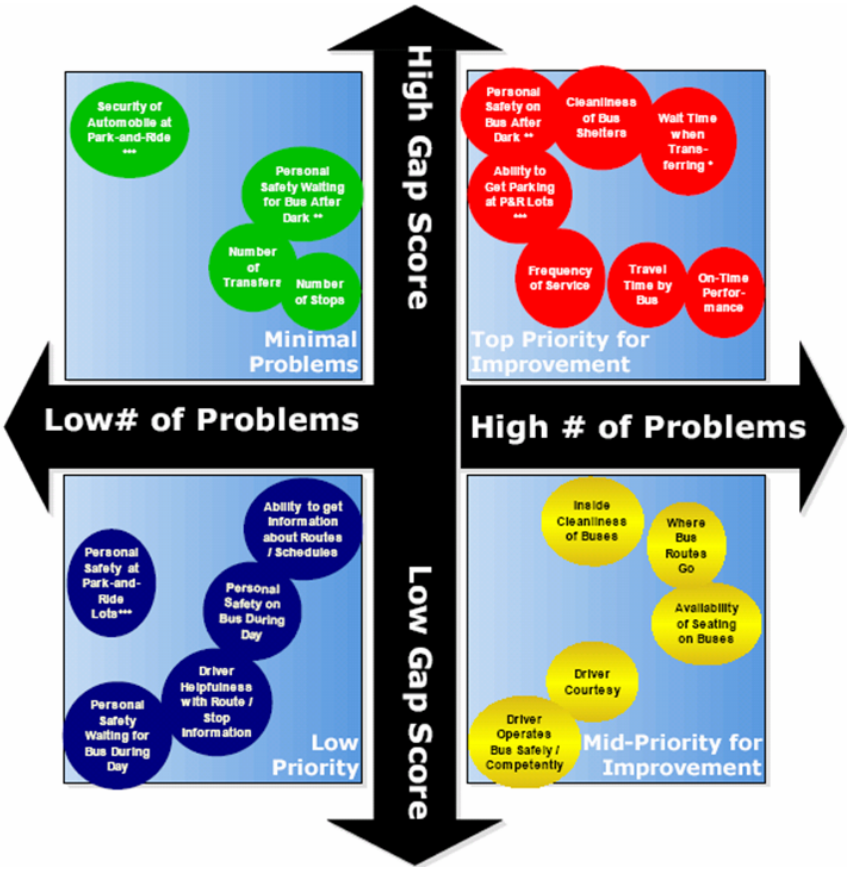
There are many gaps in UVTN where there is no existing transit service. Many times the transit service follows a slightly different route than the UVTN but serves essentially the same area. We have modified the UVTN routing to match transit service where the deviations were very minor. In other cases alternate routings for the UVTN exist, which match current transit service and still serve essentially the same area. There are some cases where there are no viable alternative routings for the UVTN that match existing transit service. Rerouting should be looked at on a case-by-case basis and the City should consider its priorities as to whether it is more important to lobby to obtain new service to fill a gap in

the UVTN or to reroute the corridor to match existing service. One possible solution would be to designate either the current gap in the UVTN or its corresponding rerouting to match existing transit service as an alternate corridor.

Consider incorporating customer opinion and origin/destination information

While the intent of the performance measurement system is to consider the customer's perspective, the rider experience is not included in the analysis. For example, the standard for frequency of service along the UVTN assumes that multiple routes can be used to reach a rider's destination. In fact, this is only true for selected origins and destinations, such as from downtown (Third Avenue) to Seattle Center, or downtown to the University district (with routes that are not on the UVTN). Each year KCM conducts a rider/non-rider survey, and SDOT could explore contracting with KCM for an increased sampling in the city, with additional questions regarding origin and destination. The Rider/Non-Rider survey and regional surveys done by the Puget Sound Regional Council can provide an important perspective.

The figure below is a from the KCM 2006 Rider/Non-Rider survey.[8] Customer concerns in the upper right quadrant are those recommended as top priority for improvement; two of those relate to performance measures SDOT has control over improving.



[8] Northwest Research Group. (2007). *King County Metro 2006 Metro Rider/Non-Rider Survey Final Report.*

Market the UVTN

To reinforce the notion of the UVTN as a permanent network, the 2004 development plan called for the UVTN to have a unique identity – a different "look and feel" – from the rest of the transit system, with uniform branding.[9] SDOT could post UVTN markers along the corridors, and post information at selected bus stops about how to use the UVTN to travel between urban villages (e.g., maps with routes and transfer points).

The future: trends that can affect UVTN monitoring

Growing ridership

As anyone who tries to board a bus in the downtown tunnel during evening rush hour can tell you, more and more people are riding the bus, in part because of rising gasoline prices. In fact, Seattle experienced the greatest increase in ridership in the country between 2006 and 2008.[10] Routes along several UVTN corridors have the highest transit ridership in Puget Sound.[11] High passenger loads can slow buses down, so unless service frequency is increased, overall performance might actually decline.

Technological enhancements

Within the next few years, KCM plans to install GPS-based systems in place of its current AVL and install new, more accurate systems to count passengers boarding and leaving the bus. These new methods will increase the accuracy of and reliability of the performance data used to monitor the UVTN. They may also result in the need to devise new methodologies to query and categorize this new data to meet the need of UVTN monitoring, which may or may not align well with previous data.

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[9] Nelson\Nygaard Consulting Associates, & Seattle Department of Transportation. (September 2004). *Seattle Transit Network Development Plan: Final Draft*. http://www.seattle.gov/transportation/docs/transitplan_SEATTLEuvtn%20FINAL%20DRAFT.pdf

[10] Pulkkinen, L. (March 10, 2008) Sound Transit ridership rose 12.7% in 2007. *Seattle P-I*. http://seattlepi.nwsource.com/transportation/354495_sound11.html

[11] Charnews, M., & Ryan, J. *Regional Transit Performance Database* [PowerPoint presentation at Puget Sound Regional Council, Regional Technical Forum, May 21, 2008]. http://www.psrc.org/boards/advisory/rtf_52008_TransitDatabase.pdf

Regional transportation planning

The Washington State Department of Transportation is developing WA-Trans, a statewide GIS transportation database, envisioned as a geospatial database that is seamless, consistent and continuous between jurisdictions in the state. A recent pilot linked the King County TNET with Pierce County's transportation data.[12] The Puget Sound Regional Council has been working on a regional transit performance database, to be updated monthly and annually with route-level data from six transit agencies. Eventually the database will provide route and corridor-level web-based modeling tools.[11]

[12] Griffin, T. WA-Trans: *A project to facilitate sharing of transporation geospatial data statewide* [PowerPoint presentation at Puget Sound Regional Council, Regional Technical Forum, May 21, 2008]. from http://www.psrc.org/boards/advisory/rtf_52008_WATrans.pdf

Appendix 1

Data Creation for UVTN Performance Analysis

The data used to analyze the performance of the UVTN is sourced from King County Metro. Three data bases serve as the primary source of the data:

Transit Enterprise Database (TED). This is the database used to create the transit schedules and routes. It is created as part of the scheduling and planning process at Metro and is updated three times per year: in February, June, and September. This data is the basis for the Frequency and Span of Service performance measures.
Automatic Passenger Collection (APC) database. This database contains data on passenger loading and is collected by automated passenger counters which are installed on busses on a rotating basis. Metro attempts to sample every scheduled trip at least once during each scheduling cycle. This data is the basis for the Passenger Load performance measure.
Automatic Vehicle Location (AVL) database. This data is collected daily through a radio/AVL system that records the time it takes the vehicle to travel between time point interchanges (TPIs). All Metro buses are equipped with this system and most of the data generated can be used for analysis. This data is the basis for the Speed and Reliability performance measures.

Below are step by step processes for the creation of data for each of the five performance measures. Each step includes the name of the file generated by the step in bold, followed by a brief text description, and the actual SQL query used to generate the file.

Steps for creation of the Frequency performance data

sched_step0
Created from the TED contains following fields:

TLINK_ID
FLOW_DIREC
TOD
TRIP_ID
TRIP_MID
TRIP_HOUR
SRTE

sched_step2
Selects the number of trips and the number of flow directions.

```
SELECT sched_step0.TLINK_ID, Avg(([FLOW_DIRECTION])) AS FLOW_Q,
sched_step0.TRIP_HOUR, Count(sched_step0.TRIP_ID) AS TRIPS
FROM sched_step0
GROUP BY sched_step0.TLINK_ID, sched_step0.TRIP_HOUR;
```

sched_step3
Determines how many directions of transit traffic there are on the street segment in question.

Flows are either 0 or 1. If you average these for all the observations and get either 0 or 1, that was the only flow present. If it's anything in between both were used.

```
SELECT sched_step2.TLINK_ID, IIf([FLOW_Q]=0 Or [FLOW_Q]=1,1,2) AS FLOWS,
sched_step2.TRIP_HOUR, sched_step2.TRIPS INTO sched_step3_table
FROM sched_step2;
```

qosFreq_table
Divides the number of trips into 240 minutes to determine the average number of minutes between trips. Selects only trips between 10am and 2pm (Mid-day).

```
SELECT sched_step3_table.TRANS_LINK_ID AS Expr1, 240/Sum([trips]/[flows]) AS
MID_HDWY INTO qosFreq_table
FROM sched_step3_table
WHERE ((([sched_step3_table].[TRIP_HOUR])>=10 And
([sched_step3_table].[TRIP_HOUR])<14))
GROUP BY sched_step3_table.TRANS_LINK_ID;
```

Steps for creation of Span of Service performance data

Begins with TED and proceeds with the sequence used for creating the Frequency performance data through the creation of **sched_step3**.

qosSpan_table
Counts the hours where the number of trips is greater than or equal to 4 per hour.

```
SELECT sched_step3_table.TRANS_LINK_ID AS Expr1,
Count(sched_step3_table.TRIP_HOUR) AS UVTN_HOURS INTO qosSpan_table
FROM sched_step3_table
WHERE ((([TRIPS]/[FLOWS])>=4))
GROUP BY sched_step3_table.TRANS_LINK_ID;
```

Steps for creation of Passenger Load data

passload_step1
Assigns a time of day label on every observation based on the midpoint time from revenue service.

```
SELECT TPI_PATH.TRANS_LINK, apctpi.KeyTrip, apctpi.Route, apctpi.Ex, apctpi.AveMLoad,
apctpi.NumSeats, TOD.TOD, apctpi.TimeMid INTO passload_step1_table
FROM TOD, apctpi INNER JOIN TPI_PATH ON apctpi.KeyTPI = TPI_PATH.TPI_ID
WHERE (((apctpi.KeyTrip)>0) AND ((apctpi.Route)<500) AND ((apctpi.NumSeats)>0) AND
((apctpi.TimeMid)>=[tBegin] And (apctpi.TimeMid)<[tEnd]));
```

passload_step2

Gets the total number of trips, seats and passengers per trip for each time period, plus the variation in the load.

```
SELECT passload_step1_table.TRANS_LINK AS Expr1, passload_step1_table.TOD AS Expr2,
Count(passload_step1_table.KeyTrip) AS TRIPS, [ROUTE] & [EX] AS svcRte,
Sum(passload_step1_table.AveMLoad) AS TOT_LOAD,
Sum(passload_step1_table.NumSeats) AS TOT_SEATS,
StDev(passload_step1_table.AveMLoad) AS VAR_LOAD INTO passload_step2_table
FROM passload_step1_table
GROUP BY passload_step1_table.TRANS_LINK, passload_step1_table.TOD, [ROUTE] & [EX];
```

passload_step3
Gets the load per trip and passengers per trip, and assigns a 20% as variation in the load if none was calculable.

```
SELECT passload_step2_table.TRANS_LINK_ID AS Expr1, passload_step2_table.svcRte AS
Expr2, passload_step2_table.TOD AS Expr3, passload_step2_table.TRIPS AS Expr4,
passload_step2_table.TOT_LOAD AS Expr5, [TOT_LOAD]/[TRIPS] AS aLoad,
passload_step2_table.TOT_SEATS AS Expr6, [TOT_SEATS]/[TRIPS] AS aSeats,
IIf(IsNull([VAR_LOAD]),(0.2*[TOT_LOAD]/[TRIPS]),[VAR_LOAD]) AS sdLoad
FROM passload_step2_table;
```

passload_step4
Gets the average load factor (pass/seats) per route and estimates the max load 85% of the time (ave+1sd)

```
SELECT passload_step3.TRANS_LINK_ID AS Expr1, passload_step3.TOD AS Expr2,
passload_step3.svcRte AS Expr3, passload_step3.aLoad AS Expr4, passload_step3.sdLoad
AS Expr5, passload_step3.aSeats AS Expr6, [aload]/[aseats] AS LF, ([aload]+[sdload])/[aseats]
AS LF85
FROM passload_step3;
```

passload_step5
Gets average load factor across routes, and identifies the most crowded.

```
SELECT passload_step4.TRANS_LINK_ID AS Expr1, passload_step4.TOD AS Expr2,
Sum(passload_step4.aLoad) AS SumOfaLoad, Sum(passload_step4.aSeats) AS
SumOfaSeats, Sum([aload])/Sum([aseats]) AS agLF, Max(passload_step4.LF) AS maxLF,
Max(passload_step4.LF85) AS maxLF85
FROM passload_step4
GROUP BY passload_step4.TRANS_LINK_ID, passload_step4.TOD;
```

qosPassload
Applies the SDOT criteria.

```
SELECT passload_step5.TRANS_LINK_ID AS Expr1, Max(passload_step5.agLF) AS agLFd,
Max(passload_step5.maxLF) AS maxLFd, Max(passload_step5.maxLF85) AS maxLF85d INTO
qosPassload_table
FROM passload_step5
GROUP BY passload_step5.TRANS_LINK_ID;
```

Steps for creation of Speed and Reliability performance measures

ttVar_step1
Select street segments that are in Seattle and calculate their travel time at the posted speed limit.

```
SELECT TPI_PATH.TPI_ID, Avg(TPI_PATH.FLOW_DIREC) AS FLOW_Q,
Sum(TNet.SHAPE_LEN) AS TPI_LEN, Sum([SHAPE_LEN]/([SPEED_LIM]*5280/60)) AS
TPI_TIME, TNet.JURIS_R INTO ttVar_step1_table
FROM TNet INNER JOIN TPI_PATH ON TNet.TLINK_ID = TPI_PATH.TRANS_LINK
GROUP BY TPI_PATH.TPI_ID, TNet.JURIS_R
HAVING (((TPI_PATH.TPI_ID)>0) AND ((TNet.JURIS_R)=64))
ORDER BY TPI_PATH.TPI_ID;
```

ttVar_step2
calculates each street segment's share of the travel time between two timepoints.

```
SELECT TPI_PATH.TPI_ID, TPI_PATH.TPI_SEQ_NU, TPI_PATH.TRANS_LINK,
TNet.SHAPE_LEN, ttVar_step1_table.TPI_LEN, [SHAPE_LEN]/[TPI_LEN] AS
LINK_SHARE_LENGTH, [SHAPE_LEN]/([SPEED_LIM]*5280/60) AS LINK_TIME,
ttVar_step1_table.TPI_TIME, ([SHAPE_LEN]/([SPEED_LIM]*5280/60))/[TPI_TIME] AS
LINK_SHARE_TIME, TNet.SPEED_LIM, IIf([FLOW_Q]=0 Or [FLOW_Q]=1,1,2) AS FLOWS
INTO ttVar_step2_table
FROM (TPI_PATH INNER JOIN ttVar_step1_table ON TPI_PATH.TPI_ID =
ttVar_step1_table.TPI_ID) INNER JOIN TNet ON TPI_PATH.TRANS_LINK = TNet.TLINK_ID
ORDER BY TPI_PATH.TPI_ID, TPI_PATH.TPI_SEQ_NU;
```

ttVar_step3
Uses ttvar2 results to assign actual data collected by the avl system between timepoints to individual street segments.

```
SELECT ttVar_step2_table.TPI_ID AS Expr1, ttVar_step2_table.TRANS_LINK_ID AS Expr2,
ttVar_step2_table.LINK_TIME AS Expr3, ttVar_step2_table.LINK_LEN AS Expr4,
[tTime]*[LINK_SHARE_TIME] AS LINK_REALTIME,
([LINK_LEN]/5280)/([tTime]*[LINK_SHARE_TIME]/60) AS LINK_REALMPH,
ttVar_step2_table.POSTED AS Expr5, ([sTime])*24*60+[tTime]/2 AS todTime, [305AMt].blkRun
AS Expr6, [305AMt].blkTrip AS Expr7, [305AMt].svcRte AS Expr8, [305AMt].sDate AS Expr9
INTO ttVar3AMt
FROM ttVar_step2_table, 305AMt;
```

ttVar_step4

Summarizes the results of ttvar3 to determine averages and variation.

```
SELECT ttVar_step3_table.TRANS_LINK_ID AS Expr1, ttVar_step3_table.LINK_LEN AS
Expr2, ttVar_step3_table.LINK_TIME AS Expr3, ttVar_step3_table.POSTED AS Expr4,
Avg(ttVar_step3_table.LINK_REALTIME) AS AvgOfLINK_REALTIME,
StDev(ttVar_step3_table.LINK_REALTIME) AS StDevOfLINK_REALTIME,
Avg(ttVar_step3_table.LINK_REALMPH) AS AvgOfLINK_REALMPH, ttVar_step3_table.TOD
AS Expr5 INTO ttVar_table
FROM ttVar_step3_table
GROUP BY ttVar_step3_table.TRANS_LINK_ID, ttVar_step3_table.LINK_LEN,
ttVar_step3_table.LINK_TIME, ttVar_step3_table.POSTED, ttVar_step3_table.TOD;
```

qosSpeed&Reliability
Applies SDOT criteria

```
SELECT ttVar4t.TRANS_LINK_ID AS Expr1, ttVar4t.LINK_TIME AS Expr2, ttVar4t.LINK_LEN
AS Expr3, Min(ttVar4t.AvgOfLINK_REALMPH) AS MPH_SLOWEST, ttVar4t.POSTED AS
Expr4, Min([AvgOfLINK_REALMPH]/[ttvar4t].[POSTED]) AS SPEED,
Max(ttVar4t.StDevOfLINK_REALTIME) AS TTSD_HIGH,
0.3*Max([StDevOfLINK_REALTIME]/[LINK_TIME]) AS RELIABILITY INTO qosSpeed_table
FROM ttVar4t
GROUP BY ttVar4t.TRANS_LINK_ID, ttVar4t.LINK_TIME, ttVar4t.LINK_LEN, ttVar4t.POSTED;
```

Appendix 2

Process Used for Creation of the UVTN Shapefile

The City of Seattle created it UVTN based on its street network shapefile (SND). Metro's data concerning transit performance is stored in databases that link to King County's street network described by the TNET shapefile. The data is connected to the TNET via the TLINK_ID, which is an identifier unique to each street segment in the TNET. To conduct analysis of the UVTN it was therefore necessary to create a version of the UVTN that contained the TLINK_ID in order to connect the UVTN to the performance data. Being that the UVTN and TNET shapefiles did not contain a common field that could be used to link them it was necessary to link them spatially. Below is an outline of the process used to accomplish this linkage.

Summary of Creation Process for the UVTN Shapefile

The original UVTN shapefile with attributes of the SND was spatially joined one to many to the TNET with a search radius of 15 feet to capture all potential matching TNET segment for each UVTN segment. Selections were made to match the street name and address range of the segments in the joined file. This resulted in a partially complete version of the UVTN that contained the unique TLINK_ID from the TNET. The remaining missing segments were added through a manual selection process that matched potential segments based on the TLIN_ID identified from the TNET for a given segment. The resulting complete UVTN shapefile with containing the TLINK_ID field was checked for accuracy by displaying the file showing performance data and comparing this to a display of the same data connected to the TNET. This allowed for discrepancies to be identified and corrected.

The following steps create shapefile that contains street segments from the UVTN shapefile and the data from the corresponding street segments in the TNET shapefile.

UVTN_TNET_SpatialJoin3

Created by running a one to many spatial join of TNET_Seattle to UVTN_SNDSEG with a search radius of 15 feet. This search radius was found to be too small to capture all the needed records and a search radius of 30 feet was used for later additions and updates.

UVTN_TNET_NameSelect

Created by running query: "ORD_STNAME" = UPPER ("FULLNAME_R") OR "ORD_STREET" = UPPER ("FULLNAME_L") on UVTN_TNET_SpatialJoin3

UVTN_TNET_AddSelect

Created by running queries: "FR_ADD_R_T" >= "R_ADRS_FRO" AND "FR_ADD_R_T" <= "R_ADRS_TO" and "FR_ADD_L_T" >= "L_ADRS_FRO" AND "FR_ADD_L_T" <= "L_ADRS_TO" on UVTN_TNET_NameSelect

UVTN_TNET_IDs

Created by a one to many spatial join of UVTN_TNET_NameSelect to UVTN_ID with the result being exported as UVTN_TNET_IDs

The resulting shapefile from the above steps (UVTN_TNET_IDs) contains omissions that result from differences in either the name, address, or other spatial differences of street segments as described by the Seattle's SND shapefile and the King County's TNET shapefile. These omissions had to be manually added to the UVTN_TNET_IDs shapefile. To accomplish this, a shapefile was created which contained all possible TNET street segment for a given segment from the UVTN_SNDSEG. Below is the process used to create this shapefile.

UVTN_ID
Created from a one to one spatial join of uvtn_final_050506 to UVTN_SNDSEG

UVTN_TNET_SpaJoin
Created by running a one to many spatial join of TNET_Seattle to UVTN_SNDSEG with a search radius of 15 ft then joining the result to UVTN_ID and exporting that result as UVTN_TNET_SpaJoin . This search radius was found to be too small to capture all the needed records and a search radius of 30 feet was used for later additions and updates.

To manually correct for the omissions, the UVTN_TNET_IDs shapefile was displayed along with the UVTN_SNDSEG shapefile in differing colors so the omissions in the UVTN_TNET_IDs shapefile could be easily located. The TNET shapefile and UVTN_TNET_SpaJoin files were added. Then a missing segment was selected with the ID tool, with the ID tool displaying the corresponding records from the TNET and UVTN_TNET_SpaJoin files. The correct TLINK_ID of the corresponding street segment from TNET was identified. From the list of possible records from the UVTN_TNET_SpaJoin the one that contained the TLINK_ID identified above was selected and then pasted into the UVTN_TNET_IDs shapefile. Often there was more than one record that matched due to the alignment of the segment or due to bifurcated streets. In these cases there exist multiple records for each street segment in the UVTN.

Once the manual additions were complete the final UVTN shapefile was verified by joining performance data to it and comparing the results to the same data joined to the TNET shapefile.

Appendix 3

UVTN Quality of Service Classes

HOURS OF SERVICE

QOS	minSpan	maxSpan	pass	Hours of UVTN level service
3	18	24	1	18 hours or more at UVTN frequency
2	15	18	1	15-18 hours
1	12	15	1	12-15 hours
-3	6	12	0	6-12 hours
-6	1	6	0	1-6 hours
-9	0	0	0	No service at UVTN frequency

SPEED

QOS	minSF	maxSF	pass	Percentage of posted speed limits
3	0.5	1	1	50 - 100% of posted speed limit
2	0.4	0.5	1	40 - 50%
1	0.3	0.4	1	30 - 40%
-3	0.25	0.3	0	25 - 30%
-6	0.2	0.25	0	20 - 25%
-9	0	0.2	0	less than 20% of posted speed limit

PASSENGER LOAD

QOS	minLF	maxLF	pass	Most crowded route operates at…
3	0	0.5	1	...less than 50% of capacity
2	5	0.75	1	…50 - 75% capacity
1	0.75	0.9	1	... 75 - 90% capacity (full)
-3	0.9	1	0	… >90% capacity (apporaching overload)
-6	1	1.1	0	… >100% capacity (overloaded)
-9	1.1	2	0	… >110% capacity (crush load)

RELIABILITY

QOS	minDF	maxDF	pass	Deviation from schedule
3	0	0.2	1	Little or no variation in trip times
2	0.2	0.3	1	Most trips on time
1	0.3	0.4	1	Variation manageable within layover
-3	0.4	0.5	0	Variation impacts schedule
-6	0.5	0.75	0	Variation impacts multiple trips
-9	0.75	1	0	Variation greater factor than travel time