

APRIL 26, 2001

TRANS SYSTEMS CORPORATION CONSULTANTS.

## Table of Contents

<b>Background – Purpose of Study Addendum .....</b>	<b>Page 1</b>
<b>Revised Forecast Traffic Volume .....</b>	<b>2</b>
<b>Traffic Signal Warrant Assessment .....</b>	<b>12</b>
<b>Corridor Operations Assessment .....</b>	<b>16</b>
<b>Corridor Geometry Recommendations .....</b>	<b>21</b>
<b>Conclusions &amp; Recommendations .....</b>	<b>23</b>

## Technical Appendix

---

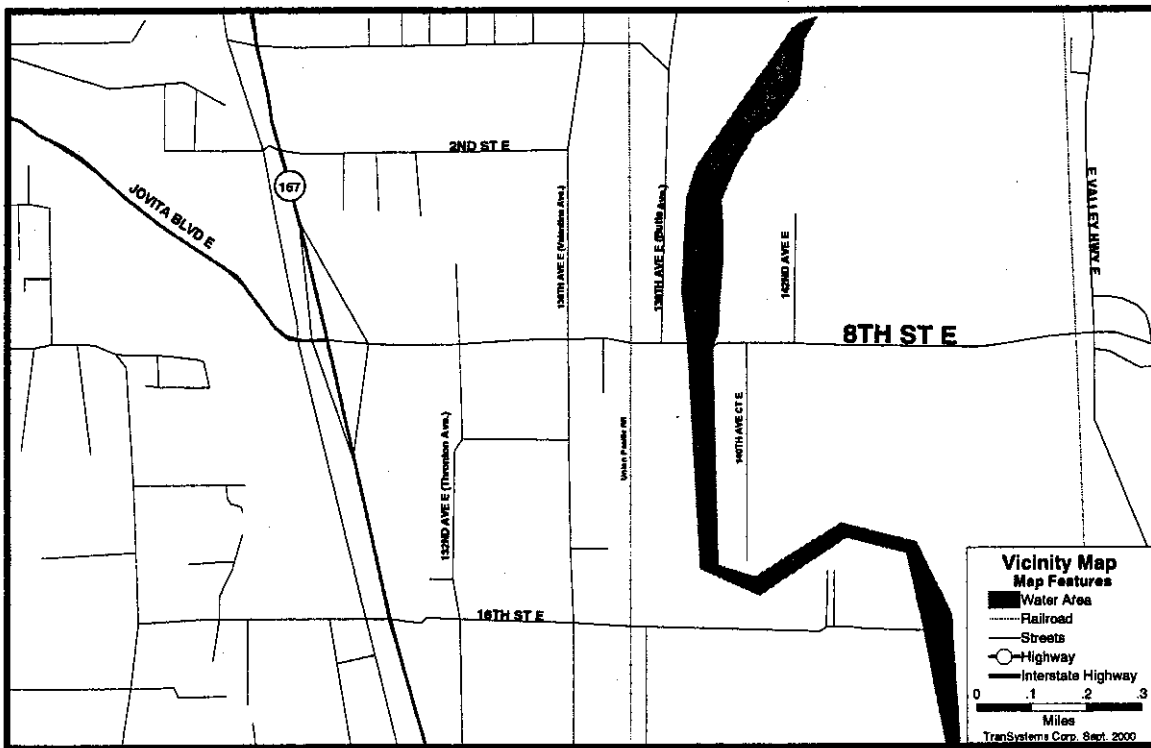
**BACKGROUND – PURPOSE OF STUDY ADDENDUM**

TranSystems is currently performing design services for Pierce County for 8<sup>th</sup> Street East between SR167 and the access to the proposed Greenwater Corporate Park (about 145<sup>th</sup> Avenue East). The design project will provide a widened street section with appropriate auxiliary lanes at major intersections. A map showing the project location is included as Figure 1.

Subsequent to publication of the Traffic Engineering Report for 8<sup>th</sup> Street East (TranSystems Corporation, January 8, 2001), a revised development plan was made available for the Greenwater Corporate Park. The revised development plan shows significantly less intensive development than the original plan (December, 1999), resulting with significantly reduce travel demand estimates.

With cooperation of Pierce County, revised corridor traffic volumes were developed which recognized reduced development intensity at the Greenwater Corporate Center. Corridor peak hour traffic volume estimates were re-formulated for year 2005 conditions with and without the proposed 24th Street interchange with SR167, and for the year 2025 conditions. Revised peak hour traffic estimates are utilized in this addendum to re-assess signal warrants and recommended intersection geometry throughout the corridor.

**Figure 1 – Project Location Map**



### **REVISED FORECAST TRAFFIC VOLUME**

Peak Hour traffic volume forecasts for this corridor were provided by Pierce County. Peak hour turning volume projections were provided for the 8<sup>th</sup> Street East intersections with West Valley Highway, SR167 ramps, Thornton Avenue (132<sup>nd</sup> Ave. E.), and Valentine Avenue (136<sup>th</sup> Ave. E.). Near-term (year 2005) peak hour traffic projections for these locations were provided for two development scenarios; with and without the proposed 24<sup>th</sup> Street East interchange with SR167. Peak hour projections were also provided for the long-range future design year 2025 (24<sup>th</sup> Street Interchange assumed by 2025).

Peak hour traffic for remaining study area intersections were developed as part of this traffic study addendum with cooperation and assistance from Pierce County. Information obtained from the Greenwater Revised Traffic Count memorandum (provided by the City of Sumner) was utilized to formulate projections at that development access point. Pierce County provided corridor background traffic volume information and peak period directional distribution estimates obtained from their EMME/2 travel demand model, and assisted with development of intersection turning traffic estimates.

Proportion of heavy vehicle traffic for future conditions assessments was maintained at observed levels for current conditions. Where observations were not available, 10% of traffic was assumed to be heavy vehicle traffic.

Future daily traffic projections were derived utilizing the derived relationships between the existing daily traffic and existing peak hour traffic, future average daily traffic was derived for year 2005 (with and without the 24<sup>th</sup> Street Interchange) and year 2025. Estimated future daily traffic volumes are shown in Figures 3 through 5. The methodology for deriving traffic volumes is included in the Appendix.

Peak hour traffic projections utilized for the assessment of corridor traffic operations, including projections for the SR167 ramps and West Valley Highway intersections, are illustrated in Figures 6 through 11. Details of the process utilized to develop revised future design hour traffic volumes are contained in the Appendix to this memorandum.

Figure 3 – Year 2005 Daily Traffic without 24th Street Interchange

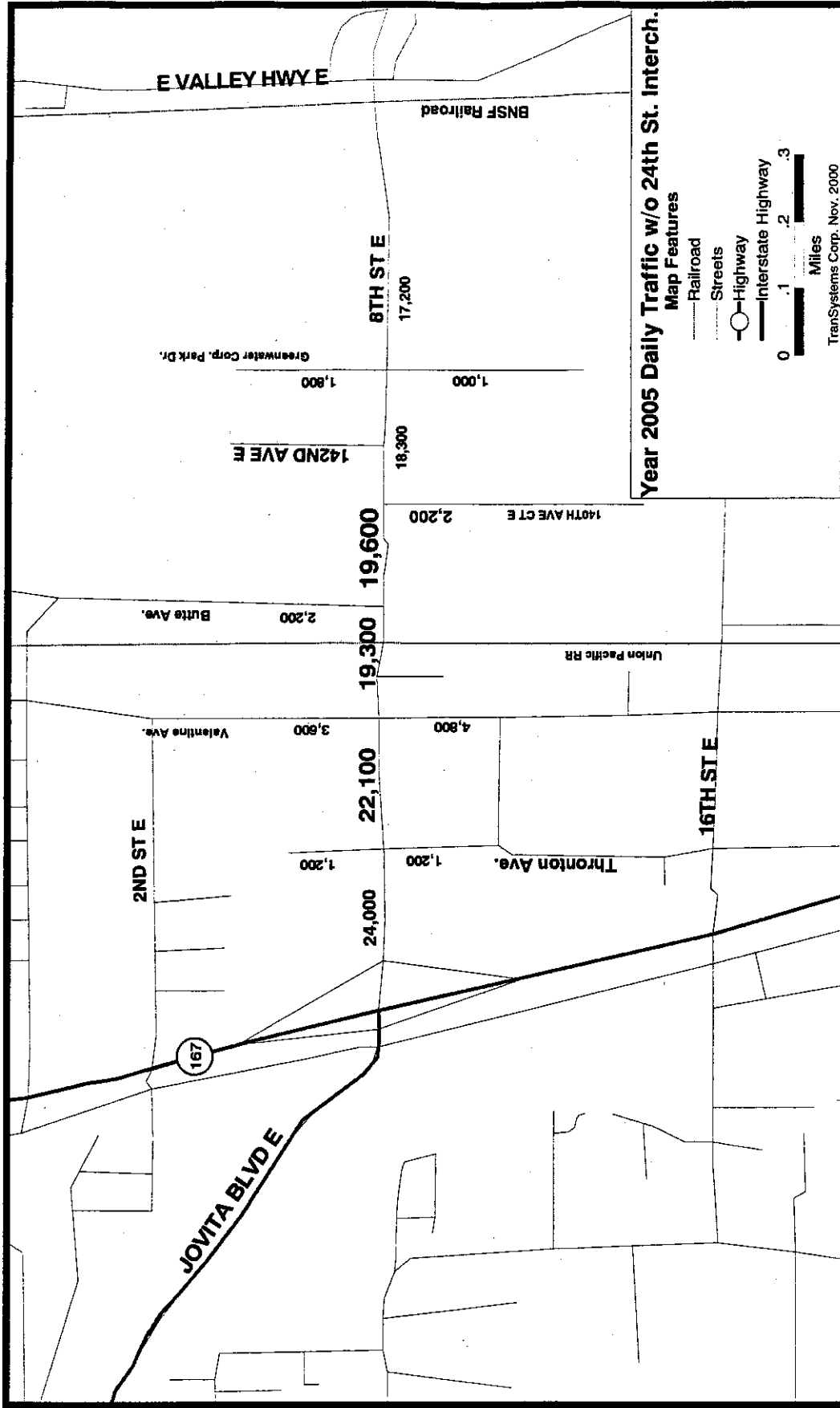


Figure 4 – Year 2005 Daily Traffic with 24th Street Interchange

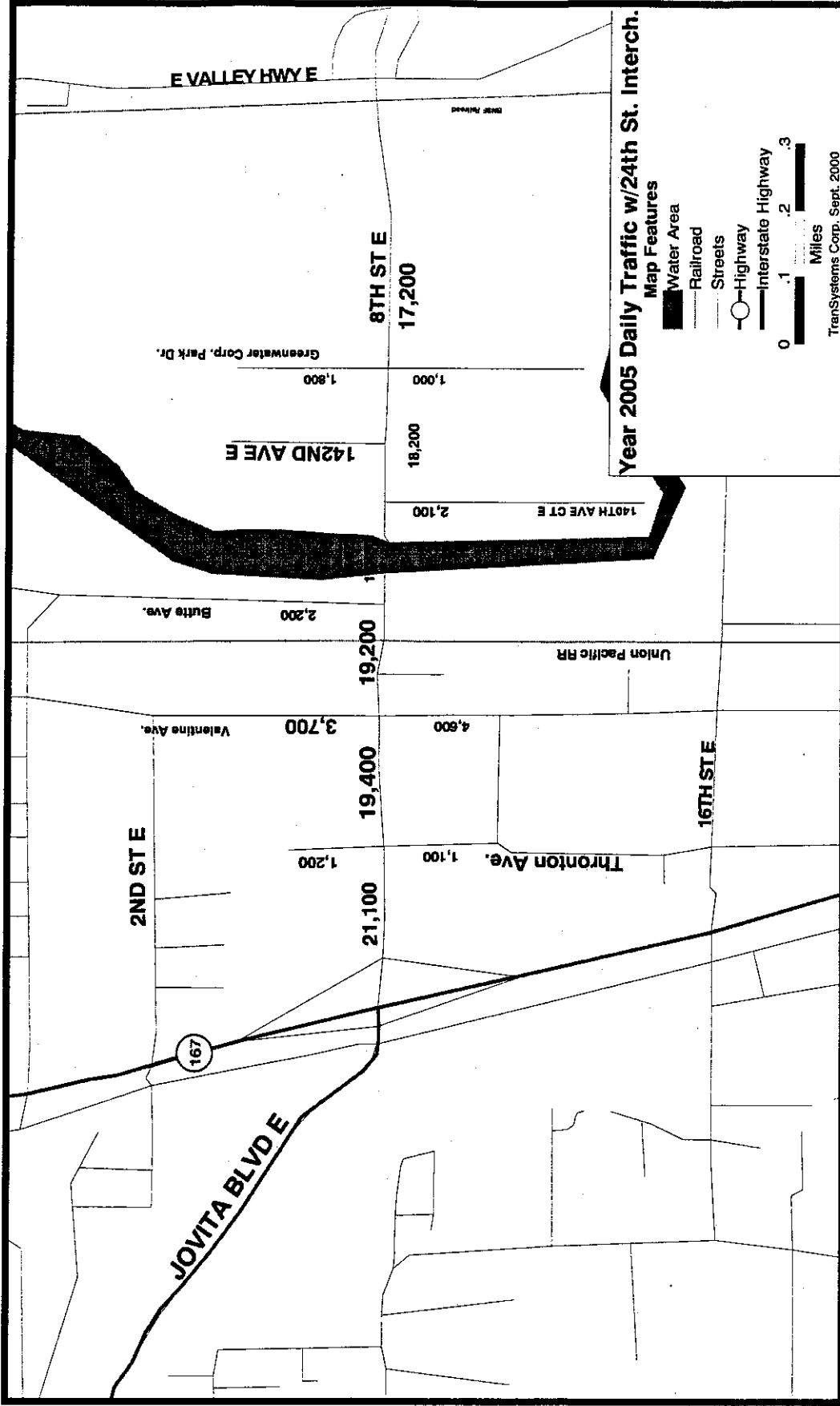
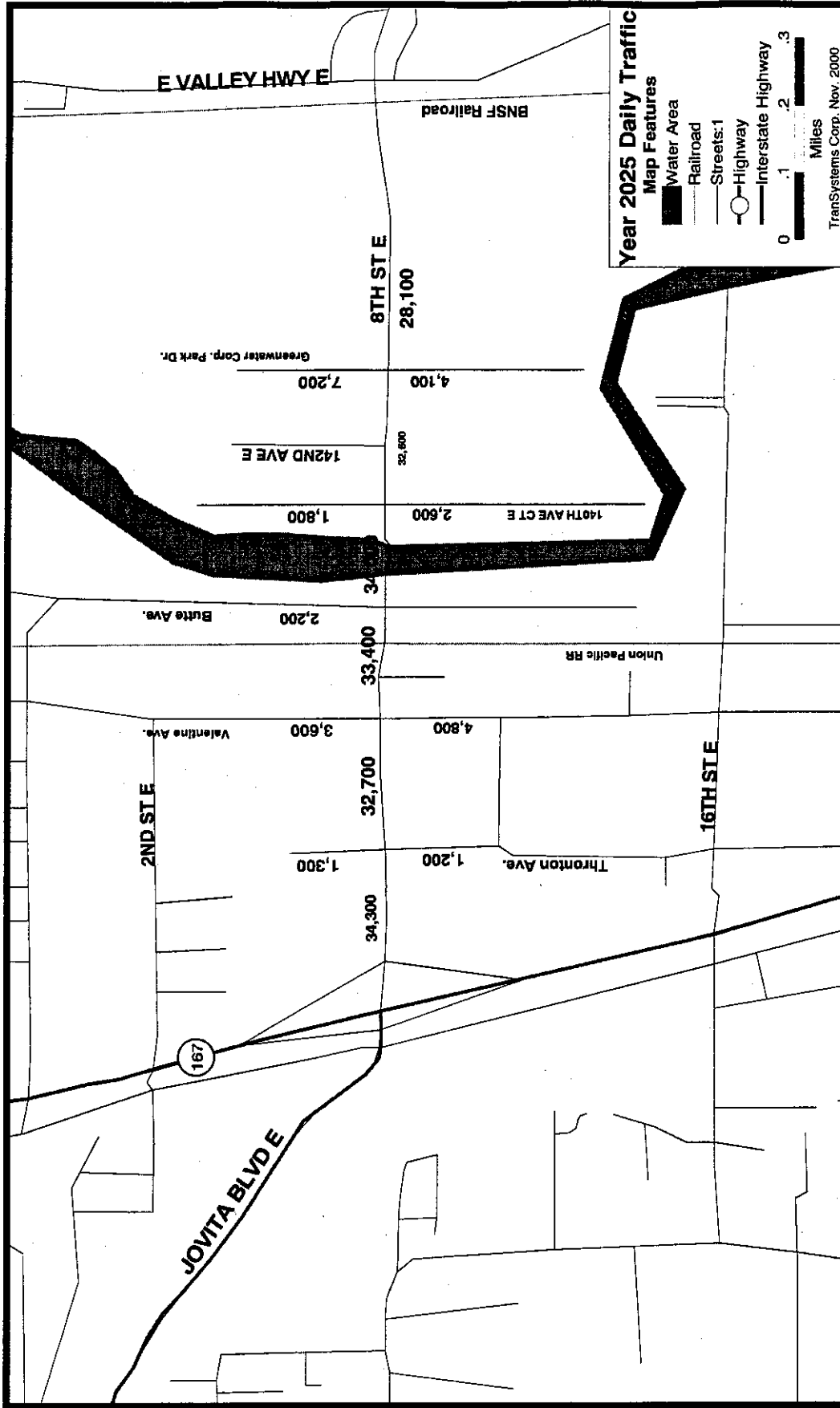


Figure 5 – Year 2025 Daily Traffic (with 24th Street Interchange)



## **TRAFFIC SIGNAL WARRANT ASSESSMENT**

The 8<sup>th</sup> Street East project will improve a segment of 8<sup>th</sup> Street by widening, intersection improvements and a grade separation at the Union Pacific Railroad crossing. This section addresses the basis and warrants for installation of traffic signals at six key access points and intersections within the project limits.

The Manual of Uniform Traffic Control Devices (MUTCD) establishes eleven (11) warrants for installation of traffic signals. The warrants set forth in the MUTCD are:

1. Minimum Vehicular Volume
2. Interruption of Continuous Traffic
3. Minimum Pedestrian Volume
4. School Crossing
5. Progressive Movement
6. Accident Experience
7. Systems Warrant
8. Combination of Warrants
9. Four Hour Volumes
10. Peak Hour Delay
11. Peak Hour Volume

The MUTCD states that while satisfaction of one or more warrants does not *require* installation of a traffic signal, traffic signals should not be installed unless one or more warrants are met. Traffic signals may be installed for a variety of reasons, including high volume intersecting traffic, side-street delay, accident mitigation and pedestrian safety.

Based on peak hour traffic volumes developed for study area intersections, this analysis makes an assessment of warrants number 1, 2, and 11. For purposes of this assessment, it is assumed that 60% of the peak hour traffic represents the 8<sup>th</sup> highest hour approach volume (as agreed by Pierce County). Truck traffic volume (significant in this corridor) is converted to passenger car equivalents (PCE's) at a ratio of 2:1 for use with warrant evaluations.

Six different intersections with 8<sup>th</sup> Street are evaluated as part of this assessment as follows:

- Thornton Avenue (132<sup>nd</sup> Avenue E)
- Valentine Avenue (136<sup>th</sup> Avenue E)
- Butte Avenue (138<sup>th</sup> Avenue E)
- 140<sup>st</sup> Avenue Ct. E
- New 8<sup>th</sup> Street intersection at Sta 69+/-
- New intersection for Greenwater Corporate Park at Sta 58+/-

Warrant assessments are made for both near and long-range future conditions. Year 2005 traffic (without proposed 24<sup>th</sup> Street interchange on SR167) is used as representative "opening day" conditions, while year 2025 traffic projections are utilized for the long-range future condition. The results of the warrant analysis at each study area intersection are discussed in the following sections. Details of the analysis are included in the Appendix.

Thornton Avenue (132<sup>nd</sup> Avenue E)

Year 2005 PM peak hour conditions are expected to generate up to 100 vehicles per hour (vph) on the south approach to this intersection, with up to 103 vph on the north approach under year 2025 PM peak hour conditions. Truck volumes are expected to represent about 10% of the Thornton Avenue approach volume (based on current counts).

As a single lane approach, this intersection would need to experience at least 150 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 75 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8<sup>th</sup> highest hour, this intersection can be expected to generate at least 66 vph (PCE's) or more for eight hours of an average day. Expected eight-hour traffic volume at this location is not sufficient to meet the conditions of warrant #1 or #2.

Conclusion: This location experiences 110 vph as PCE's under year 2005 PM peak hour conditions. This volume is sufficient to meet conditions of warrant #11 with the proposed single approach lane.

Valentine Avenue (136<sup>th</sup> Avenue E)

Year 2005 PM peak hour conditions are expected to generate up to 260 vehicles per hour (vph) on the south approach and up to 228 vph on the north approach at this intersection. Truck volumes are expected to represent about 21% of the south approach volume and 6% of the north approach volume of Valentine Avenue (based on current counts).

As a two-lane approach, this intersection would need to experience at least 200 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 100 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8<sup>th</sup> highest hour, this intersection can be expected to generate at least 189 vph (PCE's) or more for eight hours of an average day on the north approach. Expected eight hour traffic volume at this location is not sufficient to meet the conditions of warrant #1, but is sufficient to meet warrant #2 requirements.

Conclusion: This location experiences 316 vph as PCE's under year 2005 PM peak hour conditions (south approach). This volume is sufficient to meet conditions of warrant #11 with the proposed single approach lane.

Butte Avenue (138<sup>th</sup> Avenue E)

Year 2005 PM peak hour conditions are expected to generate up to 90 vehicles per hour (vph) on the north approach at this intersection. Truck volumes are expected to represent about 10% of the approach volume of Butte Avenue.

As a two-lane approach, this intersection would need to experience at least 200 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 100 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8<sup>th</sup> highest hour, this intersection can be expected to generate about 59 vph (PCE's) or more for eight hours of an average day on the north approach for opening day conditions, and about 103 vph (PCE's) or more for eight hours of an average day by year the 2025. Expected eight-hour traffic volume at this location is not sufficient to meet the conditions of warrant #1 under either design year. This volume is not sufficient to meet the conditions for warrant #2 under opening day (year 2005) conditions, but is sufficient to meet warrant #2 requirements under year 2025 conditions.

Conclusion: This location experiences 99 vph as PCE's under year 2005 PM peak hour conditions and 171 vph by the year 2025. This volume is deemed sufficient to meet conditions of warrant #11 with the proposed two-lane approach for both design years.

#### 140<sup>th</sup> Avenue Ct. E

Year 2005 PM peak hour conditions are expected to generate up to 147 vph on the south approach at this intersection. Truck volumes are expected to represent about 5-6% of the approach volume of this side street.

As a single lane approach (south leg), this intersection would need to experience at least 150 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 75 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8<sup>th</sup> highest hour, this intersection can be expected to generate about 97 vph (PCE's) or more for eight hours of an average day on the south approach. Expected eight-hour traffic volume at this location is not sufficient to meet the conditions of warrant #1, but is sufficient to meet warrant #2 requirements.

Conclusion: This location experiences 162 vph as PCE's under year 2005 PM peak hour conditions. This volume is sufficient to meet conditions of warrant #11 with the proposed two-lane approach.

#### New 8<sup>th</sup> Street East Intersection at Sta 69 +/-

Traffic volumes were not generated for this intersection as part of the corridor geometric assessment. For purposes of this traffic signal warrant analysis, traffic volume was estimated based on information gathered from the Summer Meadows Golf Links. At that location, peak hour traffic varies from 40-80 vph, averaging about 65 vph during the week and about 68 vph on weekends. This peak usually occurs in the late morning or early afternoon. Data indicates that peak directional traffic is usually split 60/40 with the inbound peak occurring in the late morning and the outbound peak happening in the early afternoon. Peak approach traffic to 8<sup>th</sup> Street East is estimated to reach 35-40 vph. This volume is not sufficient to meet the requirements of warrants 1, 2 or 11.

#### Greenwater Corporate Park Access

The proposed access to the Greenwater Corporate Park development was the subject of a Transportation Impact Analysis (TIA) prepared by SCA Engineering in December 1999 and subsequently revised. Revised traffic volumes projected for this access point were based on development intensity and proposed land use. The original TIA stated that a "signal will be required" for this intersection under year 2002 conditions. The revised traffic generation memorandum did not address requirements for a traffic signal.

Based on revised trip generation estimates, this location is expected to generate 91 vph on the north approach under year 2005 PM peak hour conditions. Assuming 2% truck traffic, this approach will generate 100 vph (PCE's) under year 2005 PM peak hour conditions which is not sufficient to meet the conditions of warrant #1. Expected growth of the Greenwater Corporate Park is projected to produce 375 vph under 2025 PM peak hour conditions (413 vph – PCE's).

Assuming the development access will be constructed as a multi-lane approach (required for ultimate build-out of the development), expected traffic demands are not sufficient to meet conditions to satisfy warrants #1, 2 or 11 under year 2005 conditions, but will be sufficient to meet these warrants under year 2025 conditions.

It is possible that this location may meet conditions for warrant #10 (Peak Hour Delay) under year 2005 conditions since analysis shows poor levels of service for access traffic turning left a 8<sup>th</sup> Street. Full assessment of this warrant requires field measurements of vehicle delay and should be conducted following the opening of this access to traffic.

**Conclusions & Recommendations**

This assessment examined projected traffic conditions to assess requirements of traffic signal warrants number 1, 2 and 11 as listed in the MUTCD. While not all locations are expected to meet the requirements of warrants #1 and #2, all locations except the 8<sup>th</sup> Street intersection at Sta 69+/- and the Greenwater Corporate Park access were estimated to meet the requirements of warrant #11. Table 1 contains a summary of the assessment conducted for study area intersections relative to warrants 1, 2 and 11.

**Table 1 – Signal Warrant Summary**

<i>INTERSECTION</i>	<b>Year</b>	<b>Warrant #1</b>	<b>Warrant #2</b>	<b>Warrant #11</b>	<b>Signal Warranted ?</b>
<b>Thornton Avenue</b>	2005	No	No	Yes	Yes
	2025	No	No	Yes	Yes
<b>Valentine Avenue</b>	2005	No	Yes	Yes	Yes
	2025	No	Yes	Yes	Yes
<b>Butte Avenue</b>	2005	No	No	Yes	Yes
	2025	No	Yes	Yes	Yes
<b>140 Ave. Ct. E</b>	2005	No	Yes	Yes	Yes
	2025	No	Yes	Yes	Yes
<b>New 8<sup>th</sup> Street Intersection at Sta 69+/-</b>	2005	No	No	No	No
	2025	No	No	No	No
<b>Greenwater Corp. Park Access</b>	2005	No	No	No	No
	2025	Yes	Yes	Yes	Yes

Although an engineering study will be eventually required to fully assess the warrants under actual operating conditions, our opinion is that warrant #10 (peak hour delay) would be met at most locations studied, and that warrant #8 (combination of warrants) may also be met at many of the locations. Warrant #10, peak hour delay would likely be met at most locations under actual operating conditions, but would need to be assessed under actual observations. Further assessment of accident data would also enable more aggressive assessment of warrant #6 (accident experience).

Based on this assessment of corridor traffic and analysis of traffic signal needs, it is recommend that traffic signals be installed with the reconstruction project at Valentine Avenue, Butte Avenue, and at 140<sup>th</sup> Avenue Ct. East. Since it is likely that the Greenwater Corporate Park access will meet warrants for a traffic signal soon, and will likely generate sufficient traffic to eventually meet warrants, the necessary infrastructure for installation of a signal should be installed at this location although installation of the signal itself should be delayed until warrants are confirmed.

## **CORRIDOR OPERATIONS ASSESSMENT**

Corridor operations were assessed for opening day conditions assuming traffic signal control at all intersections deemed to meet signal warrants (SR167 ramps, Thornton Avenue, Valentine Avenue, Butte Avenue, and 140<sup>th</sup> Avenue Ct. E.). Opening day conditions were also assessed assuming a signal installation at the Greenwater Corporate Center access. Corridor operations for long range future conditions (year 2025) were assessed with an additional signal at the Greenwater Corporate Park Access. Traffic signal operations for the corridor were assessed utilizing the Syncro V5.0 software platform. Intersection operating conditions are reported as level of service (LOS) in accordance with the methods and procedures specified in the Highway Capacity Manual. Intersection LOS is based on average vehicle delay expected and is reported using letter grades from A to F. Much like school grades, LOS A represents excellent operating conditions of free flow traffic with little delay or congestion, while LOS F represents congested conditions characterized by long traffic queues and excessive delays.

The corridor assessment was undertaken to determine how the corridor, as well as the individual intersections, would function under expected future traffic loads and signal control. The assessment was also used to determine required intersection geometry to maintain adequate level of service conditions. For purposes of this assessment, minimum "acceptable" operating conditions were defined as overall LOS D conditions with no single movement or lane group operating below LOS D.

Since 8<sup>th</sup> Street East is being constructed as a 5-lane facility (two traffic lanes in each direction with continuous left turn lane), this geometry was utilized as a starting point for the corridor assessment. (A three-lane section was tested for 8<sup>th</sup> Street East for year 2005 conditions (without 24th Street Interchange) and found to be marginally unacceptable. With only three through lanes, some individual lane groups fell below the acceptable LOS standard of LOS D. To test the long-term functionality of a 3-lane section, 2025 AM traffic was also tested as a three lane section and found to provide unacceptable levels of service as well. Details of the three-lane assessment, including a summary LOS table, are provided in the Appendix.) Initial operational assessments were performed without benefit of any auxiliary lanes (turn lanes). Without separate turn-bays for left turns, the corridor was found to operate at conditions below acceptable minimums since waiting left-turn vehicles reduced through lane capacity.

Next, left-turn lanes were added at intersections and allowed to function as permitted movements. Since a heavy left turn traffic is forecast for the eastbound left turn access to the Greenwater Corporate Park access under long range future conditions, protected/permissive left turn phasing was employed at this location for the long range planning horizon. As permitted movements, left turn traffic does not have a protected signal phase and must yield to opposing through traffic. The addition of left turn bays and protected/permissive phasing at the Greenwater Corporate Park access improved intersection operations to acceptable levels throughout the study area. The cross-product of eastbound and westbound conflicting flows suggests, however, that protected left-turn phasing may also be desirable at 136<sup>th</sup>, 138<sup>th</sup> and 140<sup>th</sup> Avenues. The need for protected left-turn phasing at these locations should be re-examined periodically and compared against local policy for implementation at these locations.

This assessment was conducted for six (6) different corridor scenarios:

1. 2005 AM Traffic without the proposed 24<sup>th</sup> Street interchange with SR167
2. 2005 PM Traffic without the proposed 24<sup>th</sup> Street interchange with SR167
3. 2005 AM Traffic with the proposed 24<sup>th</sup> Street interchange with SR167
4. 2005 PM Traffic with the proposed 24<sup>th</sup> Street interchange with SR167
5. 2025 AM Traffic (24<sup>th</sup> Street interchange assumed)
6. 2025 PM Traffic (24<sup>th</sup> Street interchange assumed)

The assessments were conducted in the order listed above to examine the need for additional auxiliary lanes or different traffic control schemes as the model scenario changed. Conducting the assessment in this manner allowed a determination of when particular improvements may be required to serve projected traffic demands. The assessment indicated that separate left turn lane are desirable for the 140<sup>th</sup> Avenue Ct. E. approaches under year 2025 conditions, but that the south approach (northbound traffic) can function at acceptable levels of service without the left turn lane under 2005 conditions. Under the revised (lower) development scenario for the Greenwater Corporate Park, a single eastbound left turn lane was found to be sufficient at this location. Intersection lane requirements to provide adequate level of service are shown for 2005 conditions in Figure 12. Figure 13 shows lane requirements for year 2025 traffic conditions.

In addition to modeling and optimizing individual intersections, the Syncro platform also performs signal timing optimization for optimum corridor progression. With good progression, vehicles are able to move through the entire corridor with minimal stops or delays. A progression assessment will ascertain if potential signal locations can fit within a good progression scheme, or if a proposed location will degrade overall corridor progression.

Corridor progression can be measured with several "yardsticks". Generally, corridor bandwidths as well as the number of total stops incurred are the measures utilized to compare progression potential. Bandwidth is the theoretical 'window' of time that exists where a vehicle can travel through the entire corridor without encountering a red light and is calculated for the 50<sup>th</sup> percentile peak hour traffic volume. Total stops are a measure of vehicle stops predicted for traffic traveling the corridor during the peak hour and takes vehicle queuing into consideration. Generally more weight is given to minimizing the number of stops since doing so will usually reduce the travel time through the corridor and reduce the potential for rear-end type accidents.

The progression assessment indicated that good signal progression is feasible for all potential signalized locations between the SR167 northbound ramp intersection to the Greenwater Corporate Park intersection. Link bandwidths are typically 30 seconds or greater for all scenarios modeled. Intersection levels of service and progression parameters for various build scenarios are summarized in Table 2 and Table 3. Complete details of corridor and intersection analysis are contained in the Appendix.

**Table 2 – Overall Intersection Level of Service**

SCENARIO	INTERSECTION LEVEL OF SERVICE					
	SR167 NB Ramps	Thornton Avenue	Valentine Avenue	Butte Avenue	140 <sup>th</sup> Ave.Ct. E	Greenwater Corp. Pk.*
2005 AM without 24 <sup>th</sup> St. Interchange	A	A	A	A	A	A(A)
2005 PM without 24 <sup>th</sup> St. Interchange	A	A	B	A	A	A(A)
2005 AM with 24 <sup>th</sup> St. Interchange	A	A	A	A	A	A(A)
2005 PM with 24 <sup>th</sup> St. Interchange	A	A	A	A	A	A(A)
2025 AM (with 24 <sup>th</sup> St. Interchange)	B	A	A	A	A	C
2025 PM (with 24 <sup>th</sup> St. Interchange)	B	A	A	A	A	B

\*Value in parentheses include a traffic signal at Greenwater Corporate Park Access for 2005 conditions

**Table 3 – 8<sup>th</sup> Street Corridor Performance Summary\***

SCENARIO	PERFORMANCE MEASURE			
	EASTBOUND BANDWIDTH	WESTBOUND BANDWIDTH	STOPS / VEH	TOTAL STOPS
2005 AM without 24 <sup>th</sup> Street Interchange	41(39)	32(32)	0.22 (0.22)	2,147 (2,192)
2005 PM without 24 <sup>th</sup> Street Interchange	55(55)	30(31)	0.25 (0.26)	2,832 (2,961)
2005 AM with 24 <sup>th</sup> Street Interchange	47(38)	44(47)	0.21 (0.21)	1,945 (1,911)
2005 PM with 24 <sup>th</sup> Street Interchange	45(42)	30(28)	0.24 (0.25)	2,675 (2,802)
2025 AM (with 24 <sup>th</sup> Street Interchange)	22	39	0.28	4,388
2025 PM (with 24 <sup>th</sup> Street Interchange)	26	23	.38	6,273

\*Values in parentheses include a signal at GCP access for 2005 conditions

A discussion of corridor progression is not complete without a discussion of the impacts of the SR167 interchange ramps. The southbound SR167 ramp intersection and the West Valley Highway intersection were both included in corridor modeling. In addition, the traffic demand expected within the corridor indicates improvements west of the northbound SR167 ramp intersection would be required to maintain acceptable levels of service at the SR167 northbound ramp intersection. Through volumes expected at this intersection indicate the need for a four-lane facility to the west as well. The discussion included in the original traffic report was not revised with this addendum.

**CORRIDOR GEOMETRY RECOMMENDATIONS**

This revised analysis was used to revise the auxiliary lanes needed to provide acceptable operating level of service. This section discusses the length of auxiliary lanes necessary to accommodate revised expected vehicle queues.

Since the year 2025 forecast represents the heaviest traffic volume, and since roadway improvements should be constructed for long-range future projected conditions, the queuing requirements for year 2025 operations were utilized for geometric recommendations. Both the morning and evening peak hour conditions were examined to determine the worst-case requirements for intersection geometry. When considering lengths of left and right turn lanes, the length of the through movement queues is also considered so that access to the auxiliary lane is not blocked. For purposes of this assessment, queuing requirements utilized will represent 95<sup>th</sup> percentile queuing...that is the queue length that is not expected to be exceeded for 95% of signal cycles during the peak period.

Auxiliary turn lanes serve two distinct functions within the corridor; they provide storage for turning vehicles so through lanes remain unimpeded, and they provide space for turning vehicles to decelerate clear of through traffic to retain capacity in the through lanes. Auxiliary lanes have three components; entering taper, deceleration length and storage length. Ideally all three should be provided. In urban locations, however, it is common to forgo most of the deceleration length typically allocated and provide only storage and taper, accepting that some of the deceleration will take place in the through

lane. This practice has evolved due to the expense of providing longer auxiliary lanes and the frequency of intersections typical of urban environments.

It is the recommendation of this study that auxiliary left-turn lanes provide full storage requirements and taper length. Due to the large percentage of truck traffic within this corridor, it is recommended that auxiliary turn lanes provide a minimum of 100 ft. for storage lengths. Based on a 35mph travel speed, auxiliary lane entering tapers of 8:1 to 12:1 are appropriate. (It should be noted that taper ratios recommended are for auxiliary lane entering tapers only. Transition sections where roadway cross-section changes from two to four lanes or vice-versa should be provided with much longer tapers, on the order of 20:1.)

Each major intersection within the study area of 8<sup>th</sup> Street East was examined for queuing requirements under the revised traffic volume. Table 4 lists the 95<sup>th</sup> percentile queues expected for left turn and through lane approaches to all intersections within the study area. Table 5 lists recommended storage requirements for study area auxiliary lanes. Details of queuing analysis are contained in the appendix to this memorandum.

**Table 4 - Year 2025 95<sup>th</sup> Percentile Queue Length**

INTERSECTION	95 <sup>th</sup> Percentile Queue Length (ft.)							
	EBL	EBTh	WBL	WBTh	NBL	NBTh	SBL	SBTh
<b>NB SR167 Ramps</b>								
AM Peak Hour	85	129	N/A	104	N/A	136	N/A	N/A
PM Peak Hour	142	293	N/A	307	N/A	98	N/A	N/A
<b>Thornton Ave (132<sup>nd</sup>)</b>								
AM Peak Hour	66	22	2	0	N/A	42	N/A	26
PM Peak Hour	6	136	15	197	N/A	89	N/A	64
<b>Valentine Ave (136<sup>th</sup>)</b>								
AM Peak Hour	113	107	4	0	120	64	141	31
PM Peak Hour	22	128	60	224	141	36	52	60
<b>Butte Ave (138<sup>th</sup>)</b>								
AM Peak Hour	138	23	N/A	0	N/A	N/A	134	N/A
PM Peak Hour	2	8	N/A	0	N/A	N/A	82	N/A
<b>140<sup>th</sup> Avenue Ct. E.</b>								
AM Peak Hour	99	0	1	7	17	0	5	0
PM Peak Hour	2	0	8	91	94	32	45	35
<b>Greenwater Corp. Pk.</b>								
AM Peak Hour	234	81	41	517	68	25	87	19
PM Peak Hour	9	2	37	131	146	21	139	18

**Table 5 - Recommended Intersection Geometry**

<b>INTERSECTION</b>	<b>Recommended Minimum Auxiliary Lane Length (ft. – excluding taper*)</b>							
	<b>EBL</b>	<b>EBR</b>	<b>WBL</b>	<b>WBR</b>	<b>NBL</b>	<b>NBR</b>	<b>SBL</b>	<b>SBR</b>
<b>NB SR167 Ramps</b>	250**	N/A	N/A	N/A	N/A	150	N/A	N/A
<b>Thornton Ave (132<sup>nd</sup>)</b>	150	N/A	200	N/A	N/A	N/A	N/A	N/A
<b>Valentine Ave (136<sup>th</sup>)</b>	150	N/A	225	N/A	150	N/A	150	N/A
<b>Butte Ave (138<sup>th</sup>)</b>	150	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>140<sup>th</sup> Avenue Ct. E.</b>	100	N/A	100	N/A	100	N/A	100	N/A
<b>Greenwater Corp. Pk.</b>	250	N/A	500	N/A	150	100	150	100

\*Auxiliary lane entering tapers of 8:1 (96 ft. for 12 ft. lane widths) are recommended in addition to lane length specified.

\*\*Approximately ½ of distance between ramps, less 96 ft. for shared lane taper.

**CONCLUSIONS & RECOMMENDATIONS**

Development within and near the 8<sup>th</sup> Street East corridor will increase year 2025 traffic to levels over twice existing daily volume. Planned widening of 8<sup>th</sup> Street East to a five-lane facility will provide adequate capacity to meet expected 20-year forecasted demand. Expected traffic signal installations within the corridor will provide good level of service for major intersections and can be implemented without any significant detrimental impacts to corridor level of service or traffic progression. To adequately and safely handle expected future traffic demands within the corridor, left-turn auxiliary lanes are recommended for 8<sup>th</sup> Street at signalized intersections. As a minimum, these left-turn lanes should provide 100 feet of deceleration/storage length with a minimum 8:1 (96 ft.) entering taper. Left turn auxiliary lanes should also be provided for side street approaches at Valentine Avenue (136<sup>th</sup> Ave. E.) and 140<sup>th</sup> Avenue Ct. East. Side street approaches for the Greenwater Corporate Park access should provide separate lanes for left, through and right-turn approach traffic (as recommended in the original traffic study for the Greenwater Corporate Park).

To eliminate exposure and reduce delays in the corridor, the crossing of the UP Railroad tracks should be grade-separated.