Technical Memorandum #1

Evaluation Methods and Screening

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Date: May 15, 2008

This memo provides a summary of the evaluation approach being used during the West Olympia Access Study as well as addresses initial work, to date, performed to develop the improvement options for the West Olympia Access Study.

Purpose for Action

The purpose of the West Olympia Access and Circulation Study is to evaluate current and future mobility concerns on Olympia's west side and to identify a strategy for improving access and circulation.

The study objectives are to identify a range of measures to address mobility, to include Travel Demand Management (TDM), transit, and bike-pedestrian strategies, in a manner that is safe, while minimizing and/or mitigating impacts on the neighborhoods and natural environment.

Need for Action

This study has been identified in the WSDOT Highway System Plan (HSP) 2003-2022 as well as the current HSP 2007-2026 as a need for a conceptual planning study. In addition the City of Olympia Comprehensive Plan identifies the need for additional access to West Olympia from US 101.

There is growing concern within the community about congestion on both the local and state networks. Mounting congestion raises questions about the best ways to accommodate growth while maintaining safe and acceptable levels of mobility.

The existing transportation network in West Olympia, which encompasses the Black Lake and Crosby Boulevard/Cooper Point Road interchanges and Cooper Point/Black Lake Boulevard intersection, is inadequate to meet growing demand based on forecasts. A primary indicator of this west side congestion is the Black Lake Boulevard/Cooper Point Road intersection, where delay often impacts vehicle trips, including emergency responders who must access Capital Medical Center. The 2025 Regional Transportation Plan indicates that even with efficiency measures, the Cooper Point Road/Black Lake Boulevard intersection will fail within the next 20 years. This would cause undesirable delays and would also adversely impact nearby roads and intersections, including US 101 interchange operations.

In addition three of the four ramps at the Black Lake interchange have in the past been designated as High Accident Locations (HAL). Other freeway location designated high accident sites along US 101 include the eastbound on-ramp at the Crosby/Mottman interchange and two

High Accident Corridors (HAC), both eastbound and west bound from the vicinity of the Crosby/Mottman interchange to the end of US 101 at the I-5/US 101 interchange. While on the local system the Black Lake Boulevard/Cooper Point Road intersection has the highest number of collisions occurring within the city.

Overview of Option Screening

The West Olympia Access Study adopted a planning level approach whereby solutions or concepts are gradually screened down. Improvement options considered can range from local road improvements and/or highway access modifications, to Travel Demand Management (TDM) strategies. The planning approach includes conducting a broad public outreach, in this case using the Bleiker process to address neighborhood and public issues in the area and get informed consent for the study.

With input received during the preceding pubic outreach efforts, which included interviews with local jurisdictions and resource agencies, the study identified a broad range of options and screened these options to eliminate those that were impractical or infeasible to meet study objectives. The study followed a tiered process to study options and to select the most promising options. Through the screening process each concept/option was measured by criteria established by the study team. Representation from the City of Olympia, WSDOT Olympic Region, and Thurston Regional Planning Council (TRPC) made up the study team. The criteria and their performance measures were based on the study objectives as well as input compiled during the public process. Both quantitative and qualitative information were considered in determining which concepts should be removed from consideration and which should be selected for more analysis. .

Solution Development, Evaluation and Selection

Fatal Flaw Screening

Each level of screening of the evaluation process developed screening criteria. During the first evaluation suggested solutions received during Phase I of the public involvement process were reviewed to ascertain fatal flaws with any of the concepts to meet study objectives. This screening was designed to provide a qualitative assessment of concepts/suggested solutions compiled from stakeholder, resource agencies, and WSDOT interviews, public meetings, and other public outreach activities. It is to eliminate solutions that are not found to meet the study objectives.

To make this screening process relatively simple and easy to understand, a simple yes/no rating was used to indicate the potential effectiveness and ability to meet study objectives. The following criterion was used for the fatal flaw screening; any concept that received a “no” in any of the criterion was judged to have a fatal flaw

- Would the concept reasonably meet the purpose of the study?
- Would the concept be consistent with local, regional, or state policies/standards?
- Would the concept likely receive the required environmental and design permits? (Concept inordinately difficult and/or time-consuming to permit)

- Would the concept be feasible to implement? (Limitations or physical constraints that reasonably prevent implementation)

Over 200 various suggestions were compiled during a formal public outreach process; these suggested solutions included land use policy/regulation changes, transit, bicycle, pedestrian, roadway, intersection and interchange ideas. The study team met with WSDOT on July 17, 2008 to conduct the fatal flaw analysis.

One of the parameters established for this study was that land use considered during the study was based on the current adopted regional and local plans and that the study would not address changes to land use and/or policies. Therefore, land use concepts were identified as fatal flaws, but were placed in a "parking lot" for future consideration by the local and regional jurisdictions.

Those ideas that were identified as transit, bicycle and pedestrian concepts were put into abeyance for further consideration later in the study process. Over 59 of the concepts were identified as transit, bicycle or pedestrian solutions. These TDM concepts will be packaged and evaluated separately as to compatibility with the reasonable/preferred options developed and screened during this process. A list of possible Transportation System Management (TSM) improvements was also developed from the suggested solutions that could be considered later for incorporation into build options.

The ideas/concepts that remained after the July 17th fatal flaw analysis, were the basis to identify/develop options at the study's August 14th Option Development Charrette. During the fatal flaw analysis it was determined that no new full interchange could be considered due to spacing issues between existing interchanges as defined by the WSDOT Design Manual. During the discussions at this screening it was noted that due to the spacing requirements, if a new or modified access point were necessary it would probably have to be associated with one of the existing interchanges. The results of the fatal flaw screening are listed in Attachment A.

Option Development

On August 14th the study team met with WSDOT and FHWA representatives to develop an initial set of improvements, including low cost TSM/TDM options. The various options developed during the charrette were grouped into five categories:

- Network Connections
- Corridor Improvements
- Interchange Modifications
- Improve Existing (Local system)
- Access Management & Operation Improvements

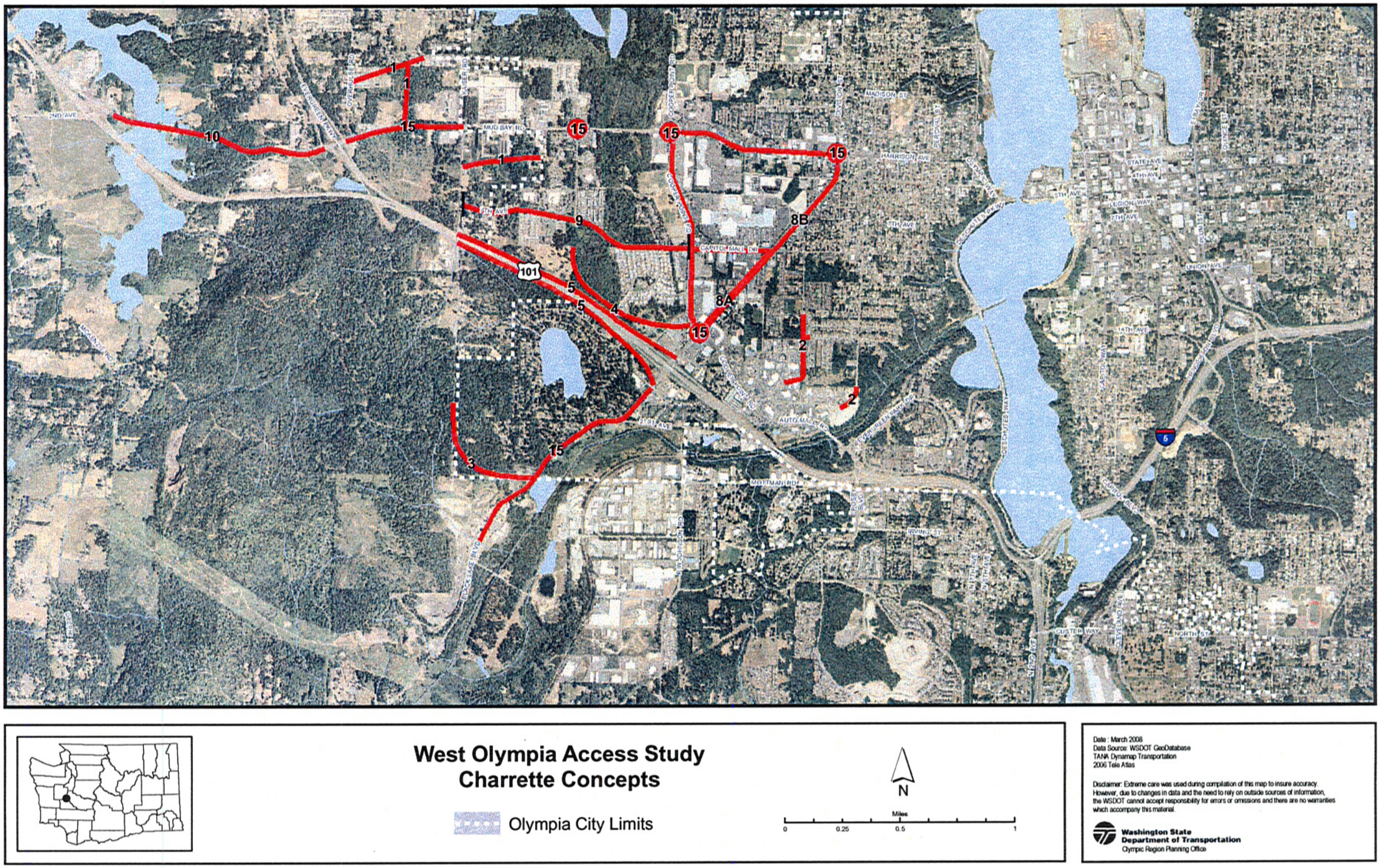
The options are summarized in the following table and are depicted in Figure 1 and 2. Concepts that were considered and/or discussed but not advanced to the screening process included:

- Diverging Diamond Interchange and/or Continuous Flow-Double Crossing Intersection at Black Lake – It was determined that there was insufficient room in order to implement this concept at Black Lake.

- Split Interchanges at Crosby/Mottman and Blake Lake Interchange - was deemed fatal flaw, not consistent with policies for allowing for full movement. Result in partial interchange.
- Close westbound ramps at Crosby/Mottman Interchange - was deemed fatal flaw, not consistent with policies for allowing for full movement. Result in partial interchange.
- Close westbound off ramp to Black Lake Blvd and construct off ramp to Yauger Way - not consistent with WSDOT/FHWA policies for allowing for full movement. Result in partial interchange
- Single Point Urban Interchange (SPUI) at Crosby Blvd/Mottman Road – SPUI was considered during the Value Engineering Study of this interchange. A diamond interchange design was adopted by the study; therefore there was no need to further consider this concept.
- Triple Left turn Black Lake eastbound onto US 101 – was deemed fatal flaw, not consistent with standards; insufficient space to allow for traffic to merge safely.
- Add clover leaf on-ramps at Black Lake Interchange – was deemed fatal flaw, not consistent with standards; do not mix loop ramps with SPUI. Adding loop with direct ramp may cause additional conflict.
- Change Harrison Avenue and 4th Avenue into one-way couplet from Harrison Avenue/Black Lake to vicinity of 4th Avenue Bridge – previous studies for the 4th/5th Avenue Corridor examined this concept and found it inconsistent with the City's Comprehensive Plan goals, policies, and visions for this street and neighborhood.
- Connect 5th Avenue to 4th Avenue roundabout - was examined during the previous 4th Avenue Bridge study, which demonstrated that the concept did not provide enough benefit to consider implementing.

Option #	Option	Description
	Network Connections	
1	Complete Comp Plan Grid Connections	New connection bearing east-west between McPhee and Kaiser south of Mud Bay. New connection bearing east-west between Overhulse south of Mud Bay from 5th Ave to 6th Ave – includes and north-south connection to Mud Bay. New connection from Harrison Ave to 4th Ave vicinity of Kenyon St
2	SW Neighborhood Grid Connections	Decatur Street Extension; Fern Street Extension; 16th Street Extension
3	Kaiser Road Extension	Extend Kaiser Road east-west between US 101 to Black Lake
4	Yauger Way Extension	New connection bearing east-west between Yauger Way to vicinity of Tops Food (Cooper Point Road)
5	Black Lake/Kaiser Frontage Road	Add frontage road connecting vicinity of Black Lake and Kaiser and add frontage road connecting Kaiser and Black Lake South of US 101
	Corridor Improvements	
6	US 101 Auxiliary Lanes	Add WB Auxiliary lane I-5 to Crosby I/C (MP 366.65 – MP 366.91). Provides a deceleration lane into Crosby I/C off ramp and would serve as a climbing lane. Add EB Auxiliary lane Crosby-Mottman I/C to 2nd Ave (MP 366.75-MP 367.35). Provides a ramp acceleration lane into 2nd Ave off ramp and would serve as a climbing lane.
7	US 101 Climbing Lane	Add EB truck climbing lane from Delphi to Evergreen Pkwy Interchange
8A	Black Lake/Cooper Point Couplet	Change Black Lake/Cooper Point into one-way couplet from Black Lake/Cooper Point Intersection to 9th Ave. Widen Capitol Mall Drive to 4-lanes (Black Lake Blvd to Cooper Point) Modify Cooper Point & Capitol Mall Intersection and Black Lake Blvd & 9th Ave/ Capitol Mall Drive Intersection
8B	Black Lake/Cooper Point Couplet	Change Black Lake/Cooper Point into one-way couplet from Black Lake/Cooper Point Intersection to Harrison Ave/Division. Modify Harrison/Black Lake & Division Intersection and Harrison/Cooper Point Intersection
9	7th Ave (Capitol Mall Dr)	Widen 7th Ave & Capitol Mall Drive (Cooper Point to Kaiser)
10	Mud Bay	Widen Mud Bay to 4 lanes (Evergreen Parkway to 2nd Street)
	Interchange Modifications	
11	Crosby Mottman Interchange	Widen structure to 6 lanes to allow 2 NB lanes and add one NB lane from US 101 to Irving
12A	Black Lake Interchange-Yauger Ramp	Add off ramp Westbound to vicinity of Yauger Way and add on ramp Eastbound from Yauger Way onto US 101
12B	Black Lake Interchange-Yauger Ramp	Add off ramp Westbound to vicinity of Yauger Way, extend Yauger Way over US 101 to Black Lake South of US 101
12C	Black Lake Interchange-Flyover Ramp	Fly over ramp from vicinity Black Lake & Cooper Point intersection to vicinity of Eastbound on ramp
13A	Evergreen Interchange	Build Out current Evergreen Interchange by adding ramps to/from the West
13B	Evergreen Interchange with Kaiser Ramps	Build Out current Evergreen Interchange by adding ramps to/from the West and add ramps to/from East at Kaiser Road with frontage road to Evergreen Parkway
14	Collector Distributor	Collector Distributor from Crosby Interchange to Kaiser Road
	Improve Existing	
15A	Improve Existing, includes Intersection Improvements	Widen Harrison Ave to 5 lanes with TWTL (Black Lake & Division to vicinity West Bay); widen Harrison Ave (Mud Bay) to 4 lanes from Kaiser Road to Evergreen Parkway; widen Black Lake to 3 lanes (Black Lake I/C to Black Lake Belmore Rd). Improve Harrison/Black Lake & Division, Harrison/Cooper Point, and Black Lake /Cooper Point intersections
15B	Improve Existing, includes Roundabouts	Widen Harrison Ave (Mud Bay) to 4 lanes from Kaiser Road to Evergreen Parkway; widen Black Lake to 3 lanes (Black Lake I/C to Black Lake Belmore Rd). Improve Harrison/Black Lake & Division, Cooper Point /Capitol Mall, and Black Lake /Cooper Point intersections Add Roundabout at Harrison/McPhee and Harrison/Cooper Point intersections
	Access Management & Operation Improvement	
16	Ramp Metering	Ramp meter at Henderson SB onto I-5; at Plum St NB onto I-5; at Mottman Rd EB; at (Cooper Point)
17	Harrison Avenue	Add barrier/median with left turn channelization at major intersections
18	Cooper Point Road	Add barrier/median with left turn channelization at major intersections

Figure 1


West Olympia Access Study
Charrette Concepts
Olympia City Limits
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Miles
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Date : March 2008
Data Source: WSDOT GeoDatabase
TANA Dynamap Transportation
2006 Tele Atlas
Disclaimer: Extreme care was used during compilation of this map to insure accuracy. However, due to changes in data and the need to rely on outside sources of information, the WSDOT cannot accept responsibility for errors or omissions and there are no warranties which accompany this material.
Washington State
Department of Transportation
Olympic Region Planning Office
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MUD BAY RD
CAPITAL MALL DR
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UNION AVE
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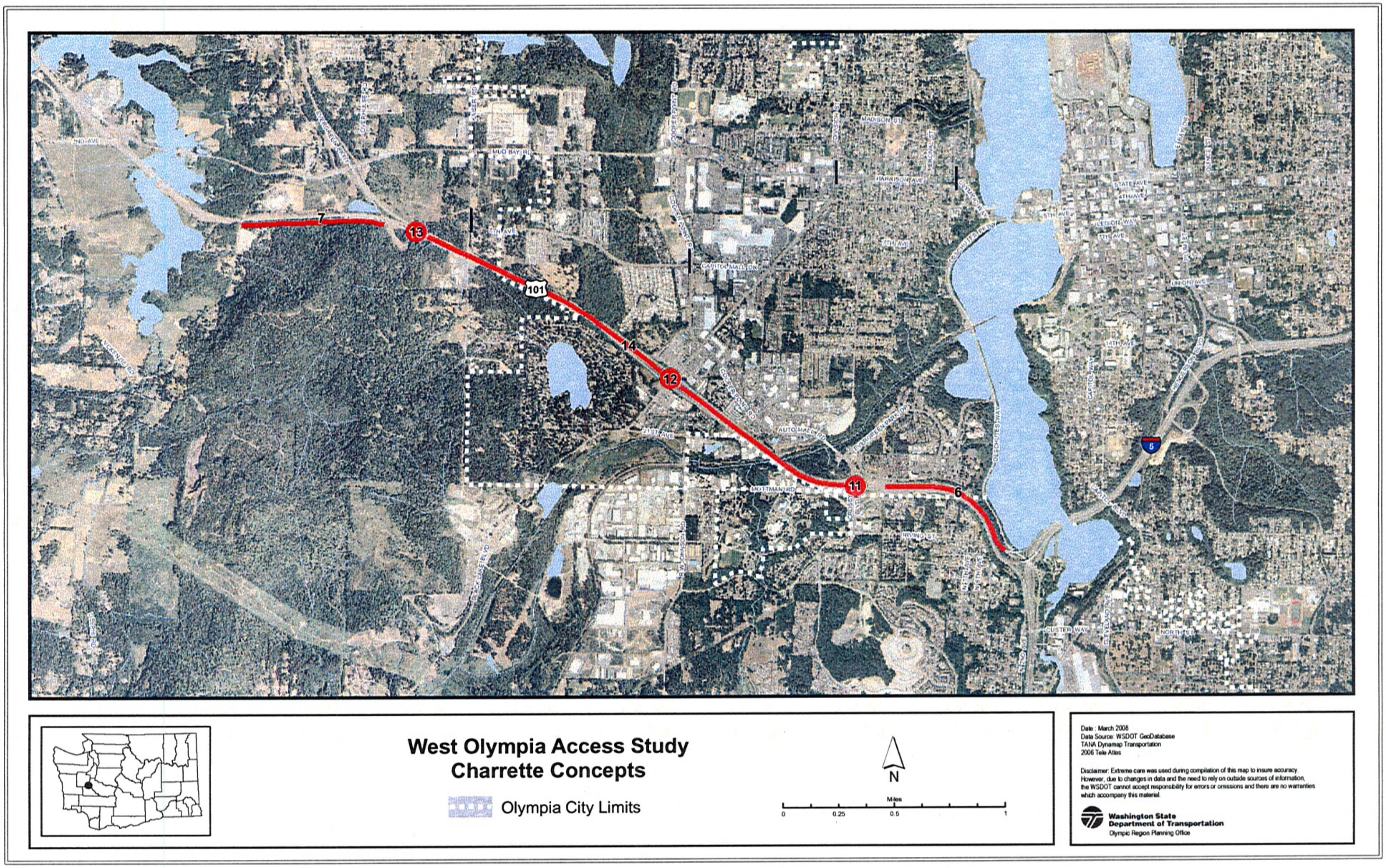
NORTH ST
MADISON ST

Figure 2



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MADISON ST
AUTO MALL DR
MOTTMAN RD
IRVING ST
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Washington State
Department of Transportation
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Initial Screening of Charrette Options

The initial screening was developed to provide a broad assessment of the options as advanced at the August 14th meeting. The purpose of this screening was to eliminate options that were not found to merit further consideration because they do not address the study objectives. With input gathered during the public involvement process that included project stakeholders and the public, criterion were developed that specifically addressed transportation benefit and quality of life (impact to natural and built environment). The criteria listed in the following table were established by consensus of the study team.

Screening Criteria and Description

Element	Description
***Quality of Life* - Community Impacts Criteria**	
Economic Vitality (Business Impacts)	What affect does the option have on commercial properties?
Residential Impacts	What affect does the option have on residential properties?
Neighborhood Traffic	How would implementation of an option affect neighborhood traffic?
***Quality of Life* - Natural Environment Impacts Criteria**	
Wetland/Shorelines	How would implementation of an option impact known wetlands and shorelines?
Water Resources	How would implementation of an option impact water basins/& sub basins?
Feasibility Criteria	
Timeliness	How feasible is the option to implement?
Safety Criteria	
Vehicle accident reduction	How effective will the option be in minimizing traffic collisions?
Mobility Criteria	
Connectivity	How does this option affect access to key destinations within the West Olympia area?
Circulation	How does the option affect circulation within the West Olympia area?
Highway Impact	How does the option affect traffic operations on the highway?
Travel Options Criteria	
Pedestrian/ Bicycle Impacts	How does the option affect biking and pedestrian activities?

Options were evaluated based on planning level estimates, qualitative technical review and other available information. No individual criterion was weighted higher than another criterion in this evaluation process. The initial screening was conducted at a broad, non-quantitative level to rate each option on a scale from most impacts (worst) to least impacts (best). Information from the evaluation of options were used in a consensus-based decision-making process to eliminate some options from further consideration, and advance others for more detailed analysis. To make the initial screening process relatively simple and easy to understand, the study team utilized a rating scale of five symbols to indicate the potential performance as noted in the scale below.

Rating Scale

WORST				BEST
○	◔	◑	◕	●
Ineffective or High Impacts or Direct Impacts	Medium Impacts	Effective or Low Impacts or Indirect Impacts	Least Impacts	Very Effective or No Impacts or No Impacts

The study team met on October 17th and 30th to screen the initial options from the August 14th option development charrette against criteria as identified in the table above. Where possible a quantitative measure of effectiveness was developed and applied to each criterion. Some of the criteria were not quantifiable; as a result the team relied on the knowledge and technical expertise of team members and stakeholders as well as data available to allow adequate judgments.

Criteria and Measures of Effectiveness

Quality of Life Impacts Criteria

Description: The category Quality of Life was divided into two sub-categories Community (Built Environmental) and Natural Environment impacts. Five (5) elements were selected for the initial screening of the options to address the city and public concerns about community and natural impacts. Ratings were given by determining potential impacts to each element and then assigning a score; the final score for each criterion was an average of the element scores. Screen-line drawings on aerial photos using GIS data were used, recognizing that the options evaluated are not actual designs; as such the criteria represented an order of magnitude estimate of the impact of the options.

Community Impacts

Economic Vitality - Based on the proximity of business properties, this element assessed the potential for any direct or indirect impacts on commercial properties, to include access restrictions/loss of parking.

Residential Impacts - Residential impacts provided a planning level estimate of how many residential properties could be impacted, specifically whether or not the option would disrupt any existing neighborhoods. This element relates closely to the issues of environmental justice as addressed in environmental impact documents.

Neighborhood traffic - A concern to the City of Olympia is impacts to neighborhood(s) from cut-through traffic, creation of or change in physical barriers. A subjective assessment of traffic impacts to neighborhood was evaluated. During the evaluation it was decided that the model data provided did not offer enough detail to allow the group to make an accurate conclusion. Therefore, the element was not considered during this analysis, but could be considered later in the study.

Natural Environment Impacts

Wetland/Shorelines - A broad level analysis for wetland screening was conducted based on GIS data and proximity of options in relation to identified wetlands and buffers. This criterion assessed the potential for any direct or indirect impacts. GIS data layers for wetlands consisted of wetland data from the City, Thurston County, and Thurston Regional Planning Council (TRPC).

Water Resources – A qualitative planning level analysis of potential impacts on surface and ground water was conducted. Any proposed project that may affect water quantity and/or quality must adhere to current regulation and best management practices. A major concern of the City of Olympia is the potential impacts to the Allison Springs wellhead protection area located within the study area. The amount of new impervious surface area was estimated by determining the area of the project's new pavement footprint (concept's estimated length and lane and shoulder widths based on the appropriate jurisdiction standards). In addition the options were evaluated as to where they are located within the Allison Springs wellhead protection area capture zones.

Safety Criteria
Vehicle accident reduction - This criterion subjectively evaluated the potential for reduced vehicle accidents (percentage) associated with improvements. Accident reduction factors based on "Informational Guide for Highway Safety Improvements" 1978 – FHWA Highway Safety Improvement Program were used to determine reduction percentages. The percentage reduction was compared with collisions data obtained from the WSDOT Traffic Data Office for the 2003-2005 time period to rate this criterion.

Feasibility Criteria
Timeliness – Feasibility criterion provides an indication of the ability to "construct" an option sooner rather than later. Consideration for this criterion includes such factors as ability to phase the project and ability to secure funding, as well as implementation strategies identified in the WSDOT 2007-2026 Highway System Plan for options that involved improvement to the state system.

Travel Options Criteria
Pedestrian/ Bicycle Impacts –Travel Option provides an indication of how the option will limit or impact completing the non-motorized grid. A planning-level estimate of how many bike lane miles and linear feet of sidewalks are added to the network for each was used to rate the option. Negative consideration for this criterion included identifying where widening of facility could increase difficulty to cross a facility.

Mobility Criteria
Description: A broad-screening analysis was employed to provide a preliminary assessment of the impacts of each option on the transportation system. To provide quantitative information for the concept screening, concepts generated at the Option Development Charette were incorporated into the Design Year Baseline VISUM traffic-demand model. Using the VISUM traffic-demand model, options were tested to identify PM peak hour traffic volume changes at key screen-line locations. In addition Synchro was used to test certain options to determine their effectiveness.

Circulation – Qualitative assessment of traffic volumes at critical intersections in West Olympia (the "triangle"), these were identified as Black Lake Boulevard SW/Cooper Point Road SW, Harrison Avenue NW/Division Street NW, and Harrison Avenue NW/Cooper Point Road SW. Options were ranked by measuring the impact to these key intersections based on the amount of change of traffic volume in relation to the 2030 Design Year Baseline.

Highway Impact – This element provides a preliminary planning assessment as to the options potential affect on freeway operations. Changes in PM peak period traffic volumes at locations on highway links were summarized and compared in relation to the 2030 Design Year Baseline. These links equate to the segments along the freeway as coded in the VISUM traffic demand model.

Connectivity – This criterion measures qualitatively how the proposed concept will impact access within the area. Using VISUM select link application a subjective assessment was performed to determine the ease of travel between key points in the study area.

The following tables summarize the volumes shifts generated by the options concepts, which were developed by running the VISUM traffic demand model for the 2030 Design Year PM Peak hour for the concept. The first table summarizes the shift in volume at the three identified critical intersections (the triangle) as discussed above. The numbers provided in the second table indicate change in volume for an option for each freeway segments along US 101 and I-5 between the 2030 Design Year Baseline network and the concept under consideration. The information used in these tables assisted options that met the criteria identified above. The table on page 15 summarizes the scoring results from the October initial screening for all criteria

2030 PM Peak Hour Intersection Volumes

		Black Lake/Cooper Pt			Harrison/Division			Harrison/Cooper Pt		
Option	Description	Volume	Change +/-	Change %	Volume	Change +/-	Change %	Volume	Change +/-	Change %
	2030 No Build	7153			4523			4066		
1	Comp Plan Grid Connections	6977	-176	-2.5	4505	-87	-1.9	4037	-163	-4.0
2	SW Neighborhood Connections	6396	-757	-10.6	4438	-85	-1.9	3931	-135	-3.3
3	Kaiser Extension	7006	-147	-2.1	4497	26	0.6	4051	15	0.4
4	Yauger Way Extension	7159	6	0.1	4508	15	0.3	4093	-27	-0.7
5	Frontage Rd with Connections at Yauger, Kaiser, and Blk Lk	6986	-167	-2.3	4530	-7	-0.2	4085	-19	-0.5
7	US 101 Acceleration lanes	7095	-58	-0.8	4484	39	0.9	4070	-4	-0.1
9	7th Ave & Capital Mall Dr Widening (Cooper Pt. to Kaiser)	7159	6	0.1	4498	25	0.6	4069	-3	-0.1
10	Mud Bay Widening (from Evergreen to 2nd St.)	6976	-177	-2.5	4517	6	0.1	4223	-157	-3.9
12A	Yauger Ramps (Off-ramp to US 101)	6429	-724	-10.1	4495	-28	-0.6	4059	-7	-0.2
12B	Yauger Ramps (Off-ramp to Black Lake)	6454	-699	-9.8	4444	-28	-0.6	4091	-7	-0.2
12C	Flyover from Top Foods	6330	-823	-11.5	4562	39	0.9	4129	63	-1.5
13A	Evergreen IC Build out	7117	-36	-0.5	4547	-24	-0.5	4105	-39	-1.0
13B	Evergreen IC Build out Plus Kaiser Ramps	6681	-472	-6.6	4548	-25	-0.6	4158	-92	-2.3
14	CD- Crosby to Evergreen	6778	-375	-5.2	4487	36	0.8	3984	82	2.0

Note: Volumes are approximate and are meant to convey relative magnitude of change.

2030 PM Peak Hour Freeway Segment Volume Changes

US 101

Option		Mud Bay	Evergreen Pkwy		Black Lake		Crosby		I-5
2030 No Build	**US 101 WB**	3260	3260	3820	3820	5000	4700	5670	5670
	US 101 EB	1950	1950	2550	2550	4100	3960		5640
Comp Plan Grid Connections	**US 101 WB**	*-10*	*-10*	*-40*	*-40*	*-10*	*-10*	*0*	*0*
	US 101 EB	*-10*	*-10*	*-30*	*-30*	*30*	*30*		*-10*
Flyover from Top Foods	**US 101 WB**	*-10*	*-10*	*0*	*0*	*-30*	*10*	*10*	*10*
	US 101 EB	*-10*	*-10*	*-110*	*-110*	*320*	*290*		*120*
Yauger Ramps A	**US 101 WB**	*0*	*0*	*-110*	*-110*	*-350*	*10*	*10*	*10*
	US 101 EB	*0*	*0*	*-140*	*-140*	*260*	*150*		*50*
Yauger Ramps B	**US 101 WB**	*-10*	*-10*	*-110*	*-110*	*-380*	*20*	*5680*	*5680*
	US 101 EB	*-10*	*-10*	*-150*	*-150*	*170*	*150*		*40*
SW Neighborhood Connections	**US 101 WB**	*20*	*20*	*10*	*10*	*-130*	*-170*	*0*	*0*
	US 101 EB	*30*	*30*	*60*	*60*	*-40*	*-40*		*-30*
Evergreen IC Build out	**US 101 WB**	*40*	*40*	*-50*	*-50*	*-20*	*-10*	*-10*	*-10*
	US 101 EB	*20*	*-50*	*-50*	*-50*	*0*	*0*		*-10*
Evergreen IC Build out Plus Kaiser Ramps	**US 101 WB**	*30*	*30*	*-230*	*90*	*20*	*10*	*0*	*0*
	US 101 EB	*60*	*60*	*-610*	*210*	*120*	*110*		*20*
Yauger Way Extension	**US 101 WB**	*-10*	*-10*	*-40*	*-40*	*0*	*0*	*0*	*0*
	US 101 EB	*-20*	*-20*	*-20*	*-20*	*0*	*0*		*0*
Kaiser Extension	**US 101 WB**	*-10*	*-10*	*-40*	*-40*	*-10*	*0*	*0*	*0*
	US 101 EB	*-10*	*-10*	*-30*	*-30*	*20*	*20*		*-20*
CD- Crosby to Evergreen	**US 101 WB**	*70*	*70*	*0*	*510*	*280*	*40*	*50*	*50*
	US 101 EB	*20*	*20*	*30*	*30*	*0*	*0*		*0*
Frontage Rd	**US 101 WB**	*-40*	*-40*	*-40*	*-40*	*-30*	*-10*	*0*	*0*
	US 101 EB	*-10*	*-10*	*-140*	*-140*	*60*	*50*		*0*
7th Ave & Capital Mall Dr Widening (Cooper Pt. to Kaiser)	**US 101 WB**	*-10*	*-10*	*-20*	*-20*	*-10*	*0*	*0*	*0*
	US 101 EB	*-10*	*-10*	*-20*	*-20*	*0*	*0*		*0*
Mud Bay Widening (from Evergreen to 2nd St.)	**US 101 WB**	*-170*	*-170*	*-110*	*-110*	*-10*	*0*	*0*	*0*
	US 101 EB	*-170*	*-170*	*-160*	*-160*	*-20*	*-20*		*-30*
US 101 Auxiliary Lanes	**US 101 WB**	*10*	*10*	*10*	*10*	*90*	*130*	*200*	*200*
	US 101 EB	*0*	*0*	*10*	*10*	*60*	*50*		*150*

Volumes are approximate and are meant to convey relative magnitude of change.

I-5

				US 101 I/C		
I-5 SB	8160	9880	9880	9880	7390	7390
I-5 NB	8340	9370	9370	9370	6960	6960
I-5 SB	*10*	*0*	*0*	*0*	*-10*	*-10*
I-5 NB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 SB	*-30*	*-30*	*-30*	*-30*	*10*	*10*
I-5 NB	*8340*	*9360*	*-10*	*-10*	*10*	*10*
I-5 SB	*-10*	*-30*	*-30*	*-30*	*0*	*0*
I-5 NB	*-190*	*-10*	*-10*	*-10*	*10*	*10*
I-5 SB	*-10*	*-20*	*-20*	*-20*	*0*	*0*
I-5 NB	*0*	*-10*	*-10*	*-10*	*10*	*10*
I-5 SB	*-30*	*-40*	*-40*	*-40*	*0*	*0*
I-5 NB	*0*	*-50*	*-50*	*-50*	*20*	*20*
I-5 SB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 NB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 SB	*-10*	*-20*	*-20*	*-20*	*0*	*0*
I-5 NB	*0*	*0*	*0*	*0*	*10*	*10*
I-5 SB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 NB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 SB	*0*	*10*	*10*	*10*	*-20*	*-20*
I-5 NB	*0*	*0*	*-10*	*-10*	*-10*	*-10*
I-5 SB	*10*	*30*	*30*	*30*	*0*	*0*
I-5 NB	*0*	*-10*	*-10*	*-10*	*0*	*0*
I-5 SB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 NB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 SB	*-10*	*0*	*0*	*0*	*0*	*0*
I-5 NB	*0*	*0*	*0*	*0*	*0*	*0*
I-5 SB	*-10*	*-20*	*-20*	*-20*	*0*	*0*
I-5 NB	*0*	*-30*		*-30*	*0*	*0*
I-5 SB	*-40*	*80*	*80*	*80*	*-10*	*-10*
I-5 NB	*10*	*10*	*10*	*10*	*10*	*10*

West Olympia Access Study																							
	2030																						
	City Connection					Corridor Improvements						Interchange Modifications							Improve Existing		Access Mgmt & Operational Improvements		
	Opt 1	Opt 2	Opt 3	Opt 4	Opt 5	Opt 6	Opt 7	Opt 8A	Opt 8B	Opt 9	Opt 10	Opt 11	Opt 12A	Opt 12B	Opt 12C	Opt 13A	Opt 13B	Opt 14	Opt 15A	Opt 15B	Opt 16	Opt 17	Opt 18
Safety	◔	◑	◑	◑	◑	◕	◕	◑	◑	◑	◔	◕	◔	◑	◔	◔	◕	◔	◕	●	●	◕	◕
Natural Environment Impacts	◕	◕	◕	◔	◔	◑	◔	◕	◕	◑	○	◑	◔	◔	◑	○	○	○	◑	◕	●	●	●
Community Impacts	◕	◑	◕	◑	◔	●	●	◕	◕	◑	◑	●	◑	◔	◑	●	◑	○	◔	◔	●	◑	◕
Feasibility	◕	◕	◕	◕	◔	◕	◑	○	○	◑	◔	◔	◔	◔	◔	◔	◑	◔	◑	◑	●	◕	◕
Travel Options	●	●	●	◕	◑	◔	◔	◑	◑	◔	○	◔	◔	◔	◔	◔	◔	◔	○	○	◔	◔	◔
Mobility	◑	◑	◕	◑	○	◔	○	○	○	◑	◑	◔	◑	◑	◔	○	◕	◑	◕	◕	○	◔	◔

WORST				BEST
○	◔	◑	◕	●
Ineffective or High Impacts or Direct Impacts	Medium Impacts	Effective or Low Impacts or Indirect Impacts	Least Impacts	Very Effective or No Impacts or No Impacts

Based on the information outlined in this Technical Memorandum and using the screening criteria, the study team evaluated the options, and comparing scores within each category, made the following recommendations:

SCREENING RESULTS		
Option 1	Complete Comp Plan Grid Connections	**Combined Options 1, 3 ,4 into option 1A and retained for consideration**
Option 3	Kaiser Road Extension	
Option 4	Yauger Way Extension	
Option 2	SW Neighborhood Grid Connections	**Retained for further consideration**
Option 5	Black Lake/Kaiser Frontage Road	**Eliminate** – Environmental impacts – impacts right of way and neighborhood severely. Improvement to West Olympia center ("triangle") is minimal.
Option 6	US 101 Auxiliary Lanes	**Eliminate** – - Does not meet Purpose & Need, does not improve access or circulation to West Olympia. Though this improvement could improve this section of freeway it could create additional weaving to/from I-5.
Option 7	US 101 Climbing Lane	**Eliminate** - Does not meet Purpose & Need, does not improve access or circulation to West Olympia. Though the option provides localized capacity improvement it's not being added to a location with significant existing congestion.
Option 8A	Black Lake/Cooper Point Couplet	**Eliminate** - Operationally does not work well; the option increases vehicle travel and results in increased left turns, which impact safety and collision concerns. Though the option improves the Black Lake/Cooper Point intersection it passes the congestion problem to the next intersection.
Option 8B	Black Lake/Cooper Point Couplet	**Eliminate** - Operationally does not work well; the option increases vehicle travel and results in increased left turns, which impact safety and collision concerns. Though the option improves the Black Lake/Cooper Point intersection it passes the congestion problem to the next intersection.
Option 9	Widen 7th Ave (Capitol Mall Dr)	**Eliminate** – Does not improve access to West Olympia
Option 10	Widen Mud Bay	**Eliminate** - Environmental constraints. Improvement is outside the city UGA and cannot be implemented by the City of Olympia. Benefit to West Olympia center is marginal.
Option 11	Crosby Mottman Interchange	**Eliminate** – Improves interchange and intersection operations at Crosby and Mottman, but does not necessarily improve mainline operations. Benefit in access improvement to West Olympia center is questionable.
Option 12A	Black Lake Interchange- Yauger Ramp B (on ramp terminal on US 101)	**Retained for further consideration**
Option 12B	Black Lake Interchange- Yauger Ramp B(on ramp terminal on Black Lake)	**Retained for further consideration**

Option 12C	Black Lake Interchange- Flyover Ramp	**Retained for further consideration**
Option 13A	Build Out Evergreen Interchange	**Eliminate** – Does not improve access to West Olympia
Option 13B	Build Out Evergreen Interchange with Kaiser Ramps	**Retained for further consideration**
Option 14	Collector Distributor	**Eliminate** - Environmentally challenged – impacts right of way, private property and wetlands severely. Improves highway capacity at same time could create more concentrated weaving may offset decrease in mainline volume.
Option 15A	Improve Existing	Retained for further consideration
Option 15B	Improve Existing	**Eliminate** - Operationally roundabouts are not the most feasible at identified intersections due to approach volumes not being equal or the need for 3-lane roundabout at some locations
Option 16	Ramp Metering	Retained for further consideration
Option 17	Harrison Ave - Add barrier/median with left turn channelization at major intersections	**Eliminate** - Doesn't improve access to West Olympia
Option 18	Cooper Point - Add barrier/median with left turn channelization at major intersections	Retained for further consideration

Preliminary Screening Conclusions

Based on the preliminary screening efforts, the options that were selected for further consideration were packaged into scenarios (preliminary alternatives) to better assess their effectiveness as a system. This assessment will primarily focus on traffic analysis using four analysis tools to analyze different components of the transportation system. These four analysis tools include:

- VISSIM (freeway operations)
- Synchro (signalized intersection operations)
- HCS+ (unsignalized intersection operations)
- VISUM (travel demand modeling)

Three build scenarios were developed and will be compared against a "No-Build" option, which is based on the VISUM 2030 model design year.. The intent of packaging the options advanced out of the initial screening was to:

- Determine if a local only option could fulfill the study objectives
- Resolve if new or modified access to US 101 would be required
- If a new or modified access were required where should it occur based on the result of travel pattern changes and traffic operations

Build Scenarios

The build scenarios being considered are as follows:

Local System Only

The Local System Only Scenario was developed by combining two options from the initial screening process: Option 1A (Comp Plan Connections, Kaiser Road and Yauger Way Extensions), Option 15A (Improve Existing), and Option 2 (SW Neighborhood Connections). During the development of the scenarios it was determined that there was a need to evaluate Local System Only and the SW Neighborhood Connections separately. Therefore the analysis would evaluate the Local System with and without the SW Neighborhood Connections.

Black Lake Interchange Scenario

Three different options at the Black Lake interchange (Option 12A, 12B, and 12C) were retained for further consideration as a result of the initial screening process. At a follow on meeting with WSDOT and FHWA in March 2008 concern was expressed as to the viability of the Flyover option at the Black Lake Interchange (Option 12C) and its potential for backups on Cooper Point and Black Lake. It was further suggested that the option was fatally flawed and therefore there is no need to analyze it. Further d discussion of this option led to the recommendation to remove the option from further consideration. Since the remaining two options could be considered variations of the same option, the study group decided to create one scenario using one of the retained options to determine if modifications within the Black Lake area would improve traffic patterns and operations. The Black Lake Interchange Scenario chosen for analysis features a WB off-ramp to Yauger Way and add a EB on-ramp from Yauger Way onto US 101 (Option 12A) along with the following local improvements: Kaiser Road connection, three-lane widening of Black Lake Boulevard south of US 101, four-lane widening of Harrison Ave (Mud Bay) between Kaiser and Evergreen Parkway.

Evergreen Interchange Scenario

The Evergreen Interchange Scenario was developed through the refinement of Option 13B along with the following local improvements: Kaiser Road connection, Yauger Way Extension, four-lane widening of Harrison Ave (Mud Bay) between Kaiser and Evergreen Parkway. A second variation of this option was discussed during scenario development. The variation extended the Evergreen Way off ramp in the form of a collector-distributor connecting with Kaiser Road.

During scenario development it was recommended that both interchange scenarios would be evaluated with and without SW Neighborhood Connections to determine their effectiveness.

Second Screening Criteria

The Second Screening will conduct a more detailed traffic evaluation of the option scenarios to review changes in travel patterns and identify whether the scenarios may relieve congestions at failing intersections and congested freeway locations. The following measures of effectiveness will primarily be used for the Second Screening process:

Compatibility with Freeway Operations	• Operational analysis for merge, diverge, mainline and weave locations • Travel Speeds

Local Arterial Operations	• Average Vehicle Delay
	• Total vehicle delay at three critical intersections (the "triangle"), including Black Lake Boulevard SW/Cooper Point Road SW, Harrison Avenue NW/Division Street NW, and Harrison Avenue NW/Cooper Point Road SW
	• Total number of intersections operating at
	  ○ LOS A, B, or C
	  ○ LOS D, or E
	  ○ LOS F

ENDORSEMENT

The undersigned parties have reviewed and concur with the assumptions, methodologies, and conclusions presented in this technical memorandum.

WSDOT Assistant Design Engineer

[illegible signature]
Signature

Assistant State Design Engineer – OR
Date

6/19/08

FHWA

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FHWA – Olympic Region Area Engineer
Title

6/18/2008
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WSDOT Headquarters

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ACCESS & HEARINGS MGR.
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June 19, 2008
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City of Olympia

Randy Wesselman
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7/2/08
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Region Traf Eng
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6/24/2008
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Thera Black.
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Senior Planner.
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6.30.2008
Date

APPENDIX A
FATAL FLAW SCREENING SUMMARY

FATAL FLAW SCREENING SUMMARY

The following table contains the results of the Fatal Flaw Screening Session, conducted on July 17, 2007 at the Thurston Regional Planning Council (TRPC).

Suggestion	Location	Fatal Flaw	Comments
LOCAL SYSTEM			
Add roadway 3 lanes	7th Ave W of Kaiser Rd to Overhulse Rd	YES	Currently being Built - College Station
Fix bridge to accommodate bikes and pedestrians	Percival Creek Bridge	YES	Currently exist
Add bike lanes along Black Lake Blvd	Black Lake Blvd S of Hwy 101	YES	Currently exists
Add continuous bike lanes	Crosby Blvd (Cooper Point Rd) from Evergreen Park Dr to Mottman Rd	YES	Currently exists
Add sidewalk to Decatur Westside Park	Decatur St west side from 9th Ave to 11th Ave	YES	Currently exists
Add traffic signal	Cooper Point Rd and Conger Ave	YES	Currently exists
Retain existing traffic signal	Cooper Point Rd and Capitol Mall access road	YES	Currently exists
Add stop signs *(traffic calming)*	SW Neighborhood	YES	Does not meet the purpose of the study
DO NOT fix congestion *(make use of Evergreen Pkwy)*	Cooper Point Rd and Black Lake Blvd	YES	Does not meet the purpose of the study
Fix intersection paint left and right turn arrows	Conger Ave westbound and Cooper Pt Rd	YES	Does not meet the purpose of the study
Fix traffic calming for emergency vehicles	4th Ave and Percival St	YES	Does not meet the purpose of the study
Preserve land bridges for wildlife habitat	Harrison Ave corridor near Grass Lake Park	YES	Does not meet the purpose of the study
Prohibit neighborhood connection	16th Ave	YES	Does not meet the purpose of the study
Prohibit neighborhood connection	Decatur St and Caton Way	YES	Does not meet the purpose of the study
Require Forest Banking for development impacts		YES	Does not meet the purpose of the study
Resign 16th Ave as "One Way" eastbound	16th Ave - west of Decatur St	YES	Does not meet the purpose of the study
Resign every other street as "One Way"	SW Neighborhood	YES	Does not meet the purpose of the study
Resign streets "One Way" from the neighborhood	16th Ave and Decatur St	YES	Does not meet the purpose of the study
Re-strip Harrison Ave to accommodate left turns	Harrison Ave from Division St to West Bay Dr	YES	Does not meet the purpose of the study
Re-strip to make 3 lanes northbound and remove left turn lane	Black Lake Blvd from 9th Ave to Cooper Point Rd	YES	Does not meet the purpose of the study
Retain regulations that limit streets to 5 lanes		YES	Does not meet the purpose of the study
Revise regulations for transit-oriented land use designs		YES	Does not meet the purpose of the study

FATAL FLAW SCREENING SUMMARY

Suggestion	Location	Fatal Flaw	Comments
Construct grade separation overpass of Black Lake Blvd and Cooper Point Rd intersection	Black Lake Blvd and Cooper Point Rd	YES	Inordinately difficult and/or time-consuming to permit & not feasible - physical constrains or limitations
Revise regulations to allow 6 to 7 lane roadways		YES	Not consistent with city policies
Revise regulations to eliminate landscape strips and medians		YES	Not consistent with city policies
Revise regulations to widen streets in subdivisions		YES	Not consistent with city policies
Add traffic calming to reduce speeds	Harrison Ave	YES	Not consistent with policies
Add traffic calming to reduce speeds	Mud Bay Rd (Harrison Ave)	YES	Not consistent with policies
DO NOT add bike lanes where no one uses them	Black Lake Blvd and Hwy 101	YES	Not consistent with policies
Prohibit new development in SW Neighborhood until 9th Ave is fixed	SW Neighborhood	YES	Not consistent with policies
Retime signal by shortening pedestrian time to cross Evergreen Park Dr	Cooper Point Rd (Auto Mall Dr) and Evergreen Park Dr	YES	Not consistent with policies
Require LEED certification along high density corridors		YES	Not consistent with policies - Does not meet the purpose of the study
Require low impact development along high density corridors		YES	Not consistent with policies - Does not meet the purpose of the study
Revise regulations to allow bicycles on sidewalks		YES	Not consistent with policies - RCW - Does not meet the purpose of the study
Add connection from Cooper Point Rd & Black Lake Blvd	E-W from Toys R Us and Westmoor Crt	YES	Not feasible - physical constrains or limitations
Add roadway	9th Ave E of Percival St downhill to Deschutes Pkwy	YES	Not feasible - physical constrains or limitations
Fix intersection turning radius at corner for transit	Columbia St and 5th Ave	YES	Outside Area - City w/discuss with Intercity Transit
Fix traffic calming to not divert traffic	Rogers St and Hays Ave	YES	Outside Scope
Add continuous sidewalks	Conger Ave from Cooper Pt Rd & Division St	YES	Outside Study Area
Add footbridge over Schneider Ck ravine	Fairview Ave to Walnut Rd (14th Ave)	YES	Outside Study Area
Add longer left turn lane westbound	Conger Ave and Cooper Point Rd	YES	Outside Study Area
Add pedestrian signals along Conger Ave corridor	Conger Ave	YES	Outside Study Area
Add roundabout	Division St and Bowman Ave	YES	Outside Study Area
Resign street "One Way" northbound	Roger St north of Harrison Ave	YES	Outside Study Area
Widen Cooper Point Rd to 5 lanes	Cooper Point Rd from Harrison to Conger Ave	YES	Outside Study Area
Widen Kaiser Rd	Kaiser Rd N of Mud Bay Rd (Harrison Ave)	YES	Outside study area

FATAL FLAW SCREENING SUMMARY

Suggestion	Location	Fatal Flaw	Comments
Create one-way couplet north to Black Lake Blvd and Cooper Point Rd intersection	Black Lake Blvd, Cooper Point Rd, and Capital Mall Dr (both ways)		
Widen 7th Ave to 3 lanes	7th Ave from McPhee St to Kaiser Rd		
Widen Kaiser Rd to 3 lanes	Kaiser Rd from 7th Ave to Mud Bay Rd		
Create one-way couplet north to Black Lake Blvd and Cooper Point Rd intersection	Black Lake Blvd, Cooper Point Rd, Capital Mall Dr (both ways) and Harrison Ave (both ways)		
Widen Mud Bay Rd (Harrison Ave)	Mud Bay Rd (Harrison Ave) from Kaiser Rd to Evergreen Pkwy		

FATAL FLAW SCREENING SUMMARY

Suggestion	Location	Fatal Flaw	Comments
Add lane westbound (drop) to Hwy 101	Hwy 101 from I-5 W of Deschutes Parkway to Crosby Blvd (Cooper Point Rd)		
Close westbound off ramp to Black Lake Blvd and construct off ramp to Yauger Way	Hwy 101, Black Lake Blvd and Yauger Way		
Fix interchange, provide access to Hwy 101 westbound	Hwy 101 and Evergreen Pkwy		
Widen Crosby overcrossing (over US 101) and re-strip for 6 lanes (*2N, 2S & 2 turn)*	Hwy 101 and Crosby Blvd (Cooper Point Rd)		
Construct a single point urban interchange at Crosby Blvd	Hwy 101 and Crosby Blvd (Cooper Point Rd)		
Construct grade separation overpass of Hwy 101 for eastbound onramp of Hwy 101 (Yauger ramps)	Black Lake Blvd from Cooper Point to S of Hwy 101		

FATAL FLAW SCREENING SUMMARY

Suggestion	Location	Fatal Flaw	Comments
Formalize paths between properties	Near IHOP & Walgreens shopping area	Parking Lot	Bike/Ped
Improve bike routes to and from SPSCC (4) & TESC	SPSCC and TESC	Parking Lot	Bike/Ped
Improve bike routes to and from Top Foods	West Neighborhood	Parking Lot	Bike/Ped
Maintain trail facilities at level equal to maintenance of road for autos		Parking Lot	Bike/Ped
Revise sidewalks to be "pedestrian friendly" along 5 lane roads		Parking Lot	Bike/Ped
Sign bike lanes on neighborhood streets and not collectors		Parking Lot	Bike/Ped
Improve access to Capitol Mall from adjacent developments		Parking Lot	Bike/Ped
Add bus pullouts on major arterials		Parking Lot	Transit
Add bus service "DASH" *like* for the West Side	From Capitol Mall to hospital, neighborhoods, park-n-ride etc,	Parking Lot	Transit
Add bus service along Mud Bay Rd (Harrison Ave) from Mud Bay Park N Ride lot	Mud Bay Rd (Harrison Ave)	Parking Lot	Transit
Add bus service alternative route from Ken Lake to downtown		Parking Lot	Transit
Add bus service from Olympia to Fife		Parking Lot	Transit
Add bus service to and from new Park N Ride Lots		Parking Lot	Transit
Add bus service to Tacoma & Sound Transit		Parking Lot	Transit
Add bus stop	Harrison Ave and Cooper Point Rd	Parking Lot	Transit
Add bus stop	Harrison Ave and Division St	Parking Lot	Transit
Add gondola from remote parking to shopping areas		Parking Lot	Transit
Add high speed transit line *(light rail)* along Hwy 101	Hwy 101	Parking Lot	Transit
Add mini Park N Ride lots		Parking Lot	Transit
Add more bus service *(Internal to West Side -3, SW Neighborhood -1)*	West Olympia	Parking Lot	Transit
Add more bus service for later at night & weekends		Parking Lot	Transit
Add more bus service to TESC	TESC	Parking Lot	Transit
Add Park-n-Ride lots	Capitol Mall -4, Outside UGA -1, USFS -1, Steamboat Is Rd -1	Parking Lot	Transit
Add transportation connections from Capitol Mall to Downtown Olympia		Parking Lot	Transit

FATAL FLAW SCREENING SUMMARY

The following are possible Transportation System Management (TSM) improvements that were identified for consideration.

Suggestion	Location	Fatal Flaw	Comments
Add traffic calming to reduce speeds	8th Ave		TSM
Add traffic calming to reduce speeds *(need more)*	4th Avenue		TSM
Add traffic signal	7th Ave and McPhee St		TSM
Add traffic signal	7th Ave and Yauger Way		TSM
Add traffic signal	Deschutes Pkwy and Lakeridge Dr		TSM
Add traffic signal	Evergreen Park Dr and Evergreen Park Crt		TSM
Add traffic signal	Evergreen Park Dr and Lakeridge Dr		TSM
Add traffic signal	Evergreen Pkwy off ramp to Mud Bay Rd (Harrison Ave)		TSM
Add traffic signal	Evergreen Pkwy onramp from Mud Bay Rd (Harrison Ave)		TSM
Add traffic signal	Hwy 101 off ramp to 2nd Ave overpass (Mud Bay Road - Harrison Ave)		TSM
Add traffic signal	Kaiser Rd and 7th Ave		TSM
Add traffic signal	Mud Bay Rd (Harrison Ave) and College Station Rd		TSM
Add traffic signal	Mud Bay Rd (Harrison Ave) and Kaiser Rd		TSM
Add traffic signal	Mud Bay Rd (Harrison Ave) and Overhulse Rd		TSM
Add traffic signal	Evergreen Pkwy and Mud Bay Rd (Harrison Ave)		TSM
Add traffic signal	Mottman Rd and Black Lake Blvd		TSM
Add traffic signal	Auto Mall Dr (Cooper Pt Rd) and Caton Way		TSM
Prohibit "Left Turns" along Black Lake Blvd	Black Lake Blvd		TSM
Prohibit "Left Turns" along Cooper Point Rd	Cooper Point Rd		TSM

FATAL FLAW SCREENING SUMMARY

Suggestion	Location	Fatal Flaw	Comments
Add right turn lane northbound	Black Lake Blvd and Harrison Ave at Division St		TSM
Add roundabout	Auto Mall Dr (Cooper Point Rd) and Carriage Loop		TSM
Retime signals synchronize			TSM
Add roundabout	Cooper Point Rd and Mud Bay Rd (Harrison Ave)		TSM
Add roundabout	Harrison Ave and Division St		TSM
Add roundabout	Mottman Rd and RW Johnson Blvd		TSM
Add roundabout	Mud Bay Rd (Harrison Ave) and Kaiser Rd		TSM
Add roundabout, 3 lanes	Cooper Point Rd and Black Lake Blvd		TSM
Consider roundabouts			TSM
Ramp meter 14th Ave onto I-5	I-5 and 14th Ave		TSM
Ramp meter 2nd Ave onto Hwy 101 westbound	Hwy 101 onramp from 2nd Ave overpass (Mud Bay Road - Harrison Ave)		TSM
Ramp meter Black Lake Blvd onto Hwy 101	Hwy 101 and Black Lake Blvd		TSM
Ramp meter Crosby Blvd (Cooper Point Rd) and Mottman Rd onto Hwy 101	Hwy 101 and Crosby Blvd (Cooper Point Rd)		TSM
Ramp meter Plum Street onto I-5	I-5 and Plum St		TSM

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TECHNICAL MEMORANDUM #2

Date:	July 2, 2008
To:	George Kovich, WSDOT Project Manager Randy Wessleman, City of Olympia Project Manager
From:	Peter Chen
Subject:	West Olympia Access Study – Existing 2007 and Year 2030 No-Build Technical Memorandum #2
cc:	James Colyar, PE, FHWA Doug McClannahan, PE, WSDOT Headquarters John Perlic, PE, Parametrix
Project Number:	554-1631-062 (03/05)
Project Name:	West Olympia Access Study

INTRODUCTION

The purpose of this technical memorandum #2 is to document the freeway and local traffic analysis process and results for the West Olympia Access Study (WOAS). This documentation includes a discussion on existing local and freeway road characteristics, data collection and methodology, micro-simulation model calibration and validation, and existing 2007 and future year 2030 No-Build traffic conditions.

The study area for the WOAS, shown in Figure 1, can be broadly categorized from a traffic operations perspective as two systems: freeway corridors (I-5 and US 101) and the local transportation system in the cities of Olympia and Tumwater. The study area along the I-5 corridor is approximately 2.81 miles long and includes interchanges with US 101 and the southern half of the City Center interchange. The portion of the US 101 corridor within the study area is approximately 4.82 miles long and spans four interchanges, including Mud Bay Road, Evergreen Parkway, Black Lake Boulevard, and Crosby Boulevard/Cooper Point. The study area for the local transportation system is in the cities of Olympia and Tumwater and is located to the north and south of US 101.

EXISTING ROADWAY CHARACTERISTICS

Freeways and Interchange Areas

The WOAS includes analyzing two freeway corridors, a 2.81-mile section of I-5 (MP 106.23 to MP 103.42) and a 4.82 mile portion of US 101 (MP 367.41 to MP 362.59). This section of the report briefly describes the geometric configurations of each of these freeways and their associated interchanges.

I-5

I-5 is the primary route for north-south interstate travel through Washington and provides connections between some of the largest cities in the Puget Sound region. Between the US 101 and City Center interchanges, I-5 has three to four northbound lanes and three to four southbound lanes, both with a posted speed limit of 60 mph. WSDOT classifies this portion of I-5 as an Urban-Interstate (U5) and as a Highway of Statewide Significance (HSS).

I-5/US 101 Interchange

Note: For the purpose of the report, northbound US 101 will be referred to as eastbound US 101 (increasing milepost) and southbound US 101 will be referred to as westbound US 101 (decreasing milepost) since the directional orientation within the study area is closer to east-west than north-south.

The I-5 southbound off-ramp (exit 104) and the I-5 northbound off-ramp (exit 104), which crosses under I-5 and receives traffic from Deschutes Parkway SW, join to form westbound US 101 (decreasing milepost). The 2nd Avenue SW off-ramp (exit 103) from southbound I-5 is located just south of the US 101 exit, approximately 0.2 miles. Southbound I-5 receives traffic from eastbound US 101 (increasing milepost) approximately 0.4 miles south of the 2nd Avenue SW exit.

Traffic on eastbound US 101 has the option to travel south on 2nd Avenue SW, merge with southbound I-5 traffic, or connect to northbound I-5 traffic via a flyover ramp. The flyover ramp from eastbound US 101 also accepts traffic from Deschutes Parkway SW prior to merging with northbound I-5.

I-5/City Center Interchange

Traveling south on I-5, an exit ramp (exit 105) splits with one lane that connects to Plum Street and the other to 14th Avenue SE. Two on-ramps, one from 14th Avenue SE and one from Henderson Boulevard SE, merge together prior to merging onto southbound I-5. The City Center northbound off-ramp also splits with one lane that merges into Henderson Boulevard SE and Plum Street, which passes under I-5 for local northbound traffic. The other I-5 northbound off-ramp lane merges into 14th Avenue SE, which crosses over I-5 and leads to local westbound traffic and is the main entrance to the capital campus. The northbound I-5 on-ramp stems from the 14th Avenue SE overpass as a loop ramp.

US 101

US 101 is a state highway that predominantly serves regional travel demand and connects the Olympic Peninsula to major activity centers on the east side of Puget Sound. Within the study area, US 101 is a two- to three-lane highway in each direction. US 101 is classified by WSDOT as an Urban-Principal Arterial (U1) and has a posted speed limit of 60 mph. US 101 is also listed as an HSS.

US 101/Mud Bay Road Interchange

This interchange represents the westernmost study interchange along US 101. At this interchange, the US 101 mainline has two westbound and two eastbound lanes. The westbound ramps terminus exhibits a configuration similar to a full diamond; however, the left and right turns are channelized and the through movement (from off-ramp to on-ramp) is restricted. The eastbound ramps terminus has a diamond-style off-ramp and a trumpet on-ramp. This interchange primarily serves low-density residential areas to the west, a few commercial uses to the east, and a connection to the Evergreen Parkway interchange via Mud Bay Road NW.

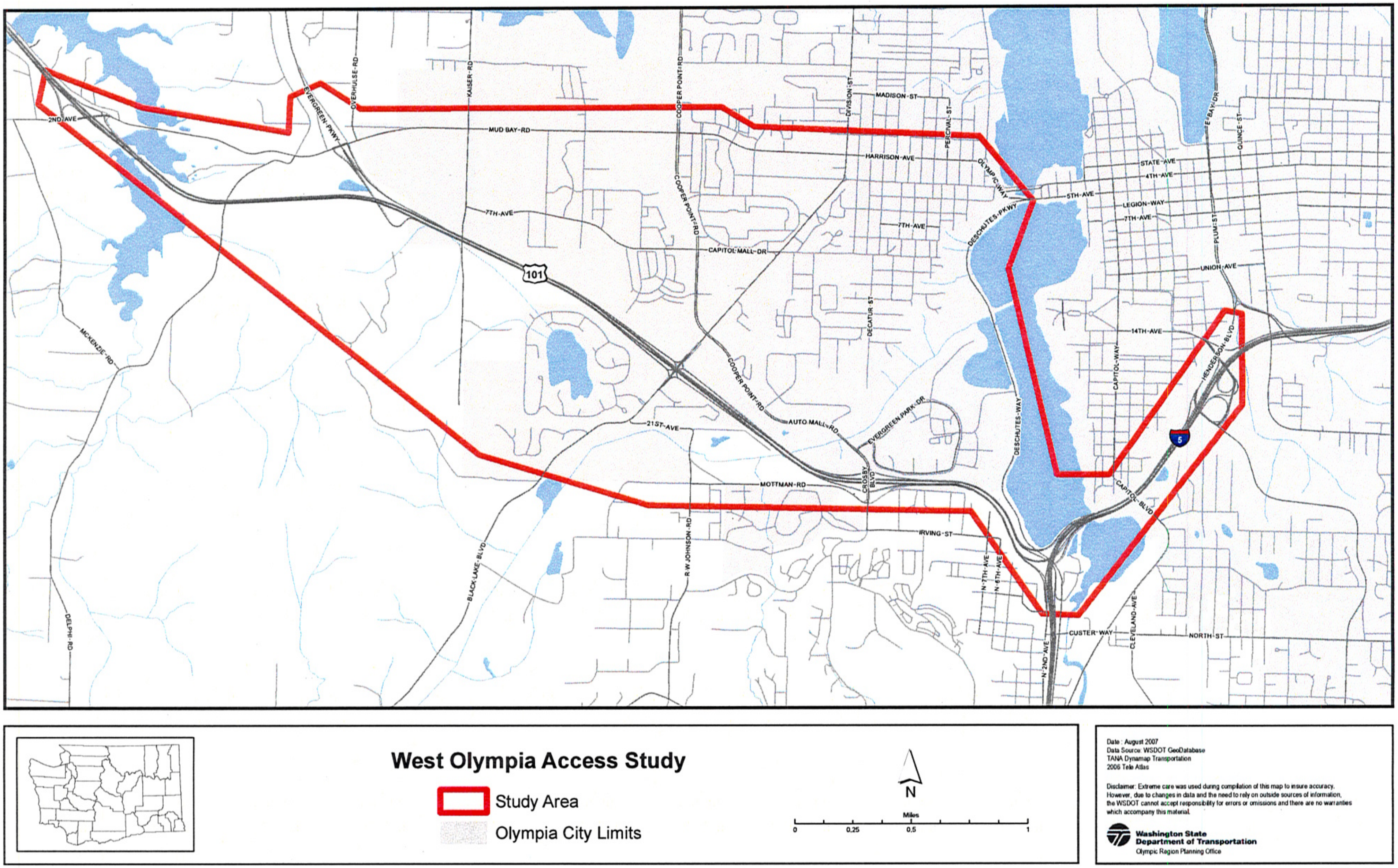


Figure 1
Study Area

US 101/Evergreen Parkway Interchange

Direct movements between US 101 and Evergreen Parkway NW are limited at this interchange. Westbound traffic on US 101 is allowed to exit to Evergreen Parkway NW (westbound off-ramp), but there is no direct connection for traffic on Evergreen Parkway NW to enter onto westbound US 101 (westbound on-ramp). Similarly, there is no exit from eastbound US 101 to Evergreen Parkway NW (eastbound off-ramp); however, eastbound US 101 accepts traffic from Evergreen Parkway NW (eastbound on-ramp). Just north of US 101, the westbound off-ramp and eastbound on-ramp connect with Mud Bay Road NW to form a full diamond-style interchange with Evergreen Parkway NW elevated over Mud Bay Road NW. This interchange provides access to low-density residential areas to the west and north and connection to Mud Bay Road NW, which extends eastward towards higher-density commercial, public, and residential areas.

US 101/Black Lake Boulevard Interchange

The Black Lake Boulevard interchange is configured as a single-point urban interchange (SPUI). With this configuration, left- and right-turns to and from the mainline are separated, with the left-turns converging at a single signalized intersection. This interchange provides the primary access to several important regional facilities, including the Capital Medical Center, the Westfield Capital Mall, several commercial developments and parks, and residential area to the south.

US 101/Crosby Boulevard/Cooper Point Interchange

This interchange is similar to a standard full diamond interchange configuration, except a separate access point on the south side of US 101 from Mottman Road SW to eastbound US 101 is located in the middle of the on-ramp. This interchange primarily serves the Capital Auto Mall and commercial office uses north of the interchange, South Puget Sound Community College, single and multi-family residences in Tumwater south of the interchange, and is the last interchange before US 101 connects to I-5.

Local Streets and Intersections

This section of the report summarizes the functional classifications and characteristics of the local roadway network within the study area. The City of Olympia currently has four functional classifications: Arterial, Major Collector, Neighborhood Collector, and Local Access Street.

Black Lake Boulevard SW is classified as an arterial spanning from the City of Tumwater north to Harrison Avenue NW. Within the study area, Black Lake Boulevard SW provides access to and from US 101 and serves as a critical four- to five-lane north-south arterial through West Olympia. Several major businesses, including Walgreens, Top Foods, Auto Mall, and the Westfield Capital Mall have driveways along the corridor. The posted speed limit varies between 25 and 30 mph throughout the study area.

Cooper Point Road SW provides access from US 101 and continues northwest to the northernmost point of the Cooper Point peninsula. This four- to five-lane arterial provides access to the Olympia Auto Mall, the Evergreen Park business park and the Westfield Capital Mall. The posted speed limit is 35 mph in the study area.

Division Street SW is classified by the City of Olympia as an arterial within the study area. This two-lane roadway is the north-south extension of Black Lake Boulevard SW that serves commercial and residential land uses near Harrison Avenue NW. The posted speed limit is 25 to 30 mph throughout the study area.

Mud Bay Road NW/Harrison Avenue NW is an arterial roadway that extends from US 101 to W Bay Drive and is the northern study area limit for the WOAS. This roadway operates as a four- to five-lane section between Yauger Way SW and W Bay Drive and has a two-lane cross-section from US 101 to Yauger Way SW. The roadway connects with the 4th Avenue and 5th Avenue bridges that cross over Budd Inlet, this roadway provides access between several businesses and residential neighborhoods and serves as the major east-west corridor connecting downtown Olympia to West Olympia. The posted speed limit varies from 30 mph to 35 mph between Division Street SW and the northbound ramps at the US 101/Mud Bay Road interchange. West of the southbound ramps at the US 101/Mud Bay Road interchange, the speed limit along Mud Bay Road NW is 45 mph.

7th Avenue SW/Capitol Mall Drive NW is a neighborhood collector that begins west of Kaiser Road SW and runs semi-parallel to the north side of US 101. As 7th Avenue SW continues east, this roadway becomes Capitol Mall Drive NW, which fronts Yauger Park and Westfield Capital Mall, and then connects to a residential area as 9th Avenue SW. The western end of 7th Avenue SW begins at Kaiser Road SW as a two-lane roadway that expands to four lanes (one westbound lane, a two-way left-turn lane, and two eastbound lanes) just west of McPhee Road SW and continues with this lane configuration until Black Lake Boulevard SW before reducing down to a two-lane facility again. The posted speed limit is 25 mph.

Decatur Street SW is a major collector throughout the study area that begins south of 15th Avenue SW and continues to the northern study area limit at Harrison Avenue NW. This roadway primarily serves residential traffic; however, a planned extension to Caton Way SW would connect residential neighborhoods to commercialized areas along Capitol Auto Mall Drive SW. The posted speed limit along Decatur Street SW is 25 throughout the study area.

Yauger Way SW is a major collector that begins at 7th Avenue SW and terminates in a residential subdivision north of Mud Bay Road NW. This two- to three-lane road provides access to major regional points of interest including Yauger Park and the Capital Medical Center, the primary medical facility for West Olympia. The current posted speed limit is 25 to 30 mph within the study area.

Kaiser Road SW is classified as a major collector that extends from just south of US 101, over US 101, and continues northward until it terminates several miles north at Cooper Point Road SW. This two-lane roadway provides access to residential land uses on the west side of Olympia. The posted speed limit is 35 mph.

Deschutes Parkway SW is a major collector that begins with a connection to northbound I-5 at the exit 103 off-ramp, continues north along the east side of I-5, crosses under I-5 near US 101, then travels north along the western edge of Capitol Lake, and ends with a connection to 5th Avenue SW, which crosses Budd Inlet. This two-lane roadway serves north-south travel with a posted speed limit of 30 mph. A parking lane on the east side of the Deschutes Parkway SW is also provided for the majority of the roadway's length.

Kenyon Street SW is a major collector between Harrison Avenue NW and Westfield Capital. This four-lane roadway primarily serves commercial/industrial land uses within the study area and has a posted speed limit of 25.

Several intersections within the study area were analyzed because they currently or are anticipated in the future to operate poorly, provide access to major regional landmarks, or are ramp terminals for current freeway facilities. In total, 22 locations (24 intersections including the two additional right-turn intersections associated with the Black Lake Boulevard interchange) were studied as part of the WOAS, including:

- Harrison Avenue NW/Division Street NW (Signalized)
- Cooper Point Road SW/Black Lake Boulevard SW (Signalized)
- Black Lake Boulevard SW/US 101 (Signalized)
- Cooper Point Road SW/Harrison Avenue NW (Signalized)
- Black Lake Boulevard SW/9th Avenue SW (Signalized)
- Cooper Point Road SW/Capitol Mall Drive SW (Signalized)
- Cooper Point Road SW/Evergreen Park Drive SW (Signalized)
- Cooper Point Road SW/Top Food Entrance (Signalized)
- Crosby Boulevard SW/US 101 Westbound Ramps (Signalized)
- Crosby Boulevard SW/US 101 Eastbound Ramps (Signalized)
- Crosby Boulevard SW/Mottman Road SW (Signalized)
- Crosby Boulevard SW/Irving Street SW (Signalized)
- Harrison Avenue NW/Kenyon Street NW (Signalized)
- Black Lake Boulevard SW/Capital Mall Entrance (Signalized)
- Harrison Avenue NW/Yauger Way SW (Signalized)
- Harrison Avenue NW/McPhee Road SW (Unsignalized)
- Harrison Avenue NW /Kaiser Road NW (Unsignalized)
- Mud Bay Road W/Evergreen Parkway NW Eastbound Ramps (Unsignalized)
- Mud Bay Road NW/Evergreen Parkway NW Westbound Ramps (Unsignalized)
- Black Lake Boulevard SW/Top Foods Entrance (Unsignalized)
- Lakeridge Drive SW/Deschutes Parkway SW (Unsignalized)
- Capital Mall Drive SW/Yauger Way SW (Unsignalized)

DATA COLLECTION AND METHODOLOGY

A variety of data from different sources were used to develop the traffic analysis models. These data and their sources are identified in Table 1.

Table 1. Data Sources used in the West Olympia Access Study

Source	Data
WSDOT	Freeway ATR traffic count data
WSDOT	Freeway ramp tube counts
WSDOT	Freeway truck classification volumes from past ATRs and the WSDOT 2006 Annual Traffic Report
WSDOT	Freeway speed data
WSDOT	Corridor aerial photos
local.live.com	Intersection geometrics (using bird's eye view)

Table 1. Data Sources Used In The West Olympia Access Study (continued)

Source	Data
WSDOT	Freeway grades
WSDOT/Parametrix	Estimated ramp grades
City of Olympia	Signal timing plans
City of Olympia/WSDOT	Local intersection turning movement counts
City of Olympia/WSDOT	Existing conditions Synchro model
Parametrix	Freeway travel times
Parametrix	Field reconnaissance to verify and supplement data, including travel times, queue lengths, and lane channelization
WSDOT	Year 2005, 2010, and Year 2030 travel demand models

Traffic Analysis Tools

Four analysis tools were used for the WOAS traffic analysis. These tools were used to analyze different components of the transportation system, based on the advantages of each tool and WSDOT recommendations. These four analysis tools included:

- VISSIM (freeway operations)
- Synchro (signalized intersection operations)
- HCS+ (unsignalized intersection operations)
- VISUM (travel demand modeling)

VISSIM

VISSIM is a microscopic, behavior-based, multi-purpose traffic simulation program used for signal systems, freeway systems, or a combined signal and freeway system having complex or simple conditions. VISSIM offers a wide variety of urban and highway applications, integrating public and private transportation modes. VISSIM version 4.3 was used to simulate freeway operations along the I-5 and US 101 corridors, including all mainline basic segments, ramps, interchanges, weave sections, and freeway connections. The analysis was conducted for a two-hour PM peak period analysis period between 4:00 and 6:00 PM, but the results are for the peak one-hour. Ramp terminals and a few local intersections were included in the model to simulate the metering and operational effects of these intersections on freeway operations.

Synchro

Synchro is a software application ideal for optimizing traffic signal splits, offsets, and cycle lengths for individual intersections, an arterial, or a transportation system. This application performs intersection capacity and level of service (LOS) analyses using either the intersection capacity utilization (ICU) method or the HCM method. For the WOAS, the HCS Signals module of Synchro version 7 (build 761) was used to calculate the LOS at signalized intersections. The LOS analysis and results are reported for a one-hour PM peak hour (4:30 to 5:30 PM) and are also reported for a two-hour PM peak period consistent with the City of Olympia's transportation concurrency requirements, depending on the intersection (see the Measures of Effectives and Standards section).

HCS+

HCS+ is the latest version of the traffic operations software package co-developed by the Federal Highway Administration (FHWA) and the University of Florida. This analysis tool is the literal electronic translation of methodologies outlined in the Highway Capacity Manual (HCM) and was used to analyze unsignalized intersections. HCS+ was used for a PM peak hour analysis and is also reported for a two-hour PM peak period, depending on the intersection (see the Measures of Effectives and Standards section).

VISUM

VISUM is a comprehensive software application used for transportation planning, travel demand modeling, and network data management. Designed for multi-modal analyses, VISUM integrates all relevant models of transportation into one network model while providing a variety of assignment procedures. VISUM version 9.4 provided the basic travel demand forecasts, which were then post-processed and used as the volume inputs in the freeway and local traffic operation models.

Model Calibration and Validation

Freeway Model

Per FHWA guidelines, the two-hour VISSIM model was calibrated against several parameters, including: matching model throughput volumes with expected and field measured volumes, field observed queue lengths, and field observed travel times. Model inputs and calibration assumptions are provided in Appendix A.

Traffic volumes were calibrated and validated using the Geoff E. Havers (GEH) statistic, which is used to assess the goodness of fit between model results and observed traffic volumes. According to guidelines provided by the FHWA, the model is considered calibrated to observed volumes if the GEH value is less than five for 85 percent or more of the model links and less than four for the sum of all link counts (FHWA 2004). The GEH value is a modified chi-square statistic that incorporates both relative and absolute differences, in comparison of modeled and observed volumes. In the West Olympia model, 100 percent of the links had a GEH value of less than five and the GEH value for the sum of all links was 3.06, suggesting that the model was sufficiently calibrated to FHWA calibration targets. This methodology included measuring all basic freeway sections, ramps, and intersection turning movement counts. Appendix B provides a detailed comparison of the observed field volumes against the model volumes.

Model vehicle queue lengths at selected study locations were visually compared against PM peak period field observations conducted by Parametrix and were used to substantiate model validation. Locations where queues were observed in the field included: southbound I-5 before the US 101 interchange, Black Lake Boulevard SPUI, Black Lake Boulevard/Cooper Point Road SW intersection, and the Cooper Point Road SW/Top Foods/Old Navy intersection. These locations were selected for observation based on known operations and queuing conditions.

Parametrix also conducted a floating car travel time survey during the PM peak period (4:00 PM to 6:00 PM) in August 2007 along I-5 and US 101 to determine existing travel times. Seven travel time runs were conducted for northbound I-5 and eight runs for southbound I-5. Several travel time runs were conducted for eastbound and westbound 101 since both mainlines were observed to operate near free flow conditions, except for westbound US 101 between I-5 and the Crosby Boulevard off-ramp, which operated around 40 mph in the two right-most lanes and slightly higher in the left-most lane. The traffic team observed varied travel times along I-5 throughout the PM peak period, primarily dependant on the travel lane. Typically, the outside southbound I-5 lane north of the US 101 interchange was much slower than the inside two lanes. Since VISSIM cannot measure travel times on a lane-by-lane basis, average vehicle travel times were determined across all lanes for both field measured and model observed travel times. Table 2 compares model travel times against field observed travel times.

The percent difference for individual travel time segments ranged from five percent to 47 percent; however, the absolute differences in time (seconds) were generally low (less than 10 seconds) for the majority of the travel time segments. These differences were assumed to be attributed to lane utilization since the observed travel times varied substantially depending on the lane of travel. Although observed travel times were averaged for multiple lanes, the data were collected at different times within the peak period; for example, the travel time survey for lane 1 was started at 4:30 PM, while the travel time survey for lane 2 was started at 4:45 PM. This methodology contrasts to VISSIM, which reports an average travel time across all lanes during the same time frame.

Corridor travel times, which are the sum of all travel time segments along a corridor for each direction, estimated by the VISSIM model were within 10 percent of the averaged field observed travel time runs for northbound I-5 and eastbound and westbound US 101. For southbound I-5, the model estimated slightly longer travel times; however, the model results were still within the range of the observed travel times runs. Discrepancies between the observed and modeled travel times could suggest inaccurate levels of congestion; however, modeled traffic volumes were consistent with the expected throughput, which indicates that the cause of travel time differences is likely due to lane utilization. Accordingly, the VISSIM model was assumed to be calibrated to travel times for both I-5 and US 101 for each direction of travel.

Table 2. Modeled and Observed Travel Times

Cross Street	Model Travel Time (sec)	Observed Travel Time (sec)	Percent Difference	Absolute Difference (sec)
NB I-5: Begin at S End of Study Area				
US 101 On-Ramp	31.4	24.0	-31%	7.4
14th St Off-Ramp	41.0	55.0	25%	14.0
Total (seconds)	72.5	79.0	8%	6.5
Min (-10% of averaged travel time runs)		71.1		
Max (+10% of averaged travel time runs)		86.9		
SB I-5: Begin at N End of Study Area				
14th St On-Ramp	185.2	145.0	-28%	40.2
US 101 Off-Ramp	33.7	47.0	28%	13.3
US 101 On-Ramp	42.5	34.0	-25%	8.5
Total (seconds)	261.4	226.0	-16%	35.4
Min (shortest travel time run)		207.0		
Max (longest travel time run)		288.0		

Table 2. Modeled and Observed Travel Times (continued)

Cross Street	Model Travel Time (sec)	Observed Travel Time (sec)	Percent Difference	Absolute Difference (sec)
EB 101: Begin at E End of Study Area				
Mud Bay Off-Ramp	25.8	29.8	13%	4.0
Mud Bay On-Ramp	16.7	13.9	-20%	2.8
EB 101 before Evergreen Prkwy On-Ramp	78.8	85.1	7%	6.3
Evergreen Prkwy On-Ramp	17.1	18.3	6%	1.2
Black Lake Off-Ramp	57.4	67.1	14%	9.7
Black Lake On-Ramp	42.3	32.7	-29%	9.6
Crosby Blvd Off-Ramp	25.0	26.2	5%	1.2
Crosby Blvd On-Ramp	25.1	31.6	20%	6.5
101 EB to I-5 Off-Ramp	35.6	28.2	-26%	7.3
Total (seconds)	323.7	332.9	3%	9.2
Min (-10% of averaged travel time runs)		299.6		
Max (+10% of averaged travel time runs)		366.1		
WB 101: Begin at W End of Study Area				
Crosby Blvd Off-Ramp	41.5	28.2	-47%	13.3
Crosby Blvd On-Ramp	30.6	32.7	6%	2.1
Black Lake Off-Ramp	18.4	24.4	24%	6.0
Black Lake On-Ramp	52.9	43.2	-22%	9.7
Evergreen Prkwy Off-Ramp	43.1	60.0	28%	16.9
WB 101 after Evergreen Prkwy Off-Ramp	28.5	32.7	13%	4.3
Mud Bay Off-Ramp	62.9	81.3	23%	18.4
Mud Bay On-Ramp	25.6	21.6	-18%	4.0
Model End	32.8	38.2	14%	5.4
Total (seconds)	336.3	362.4	7%	26.0
Min (-10% of averaged travel time runs)		326.1		
Max (+10% of averaged travel time runs)		398.6		

Local Streets and Intersections Model

The City of Olympia provided the existing conditions Synchro model that was used for analysis of City streets and freeway ramp terminals. This tool is already used by the City on their local system and works well. In 2005-2006, the City of Olympia worked with WSDOT on updating the model. Existing signal timing and phasing for each of the traffic signals analyzed were collected from City of Olympia. This information was input into the Synchro traffic operations model to update existing signal timing.

Traffic volumes were updated using traffic counts collected within the past three years from WSDOT, City of Olympia, and City of Tumwater. These included 2005-2006 city traffic counts; freeway ramp volumes, and permanent recorder data for US 101 and I-5 located within the study area was collected and provided in early 2007 by the WSDOT Transportation Data Office.

The existing conditions model volumes were compared to 2007 actual counts obtained in May 2007 to ensure that the model data was reflective of the existing field conditions. Some volumes were adjusted in the model based on the 2007 counts analysis, these included the following intersections:

- Harrison Avenue NW/Division Street NW,
- Cooper Point Road SW/Black Lake Boulevard SW,
- Black Lake Boulevard SW/Capital Mall Entrance,
- Black Lake Boulevard SW/Capital Mall Drive SW/9th Avenue SW
- Cooper Point Road SW/Evergreen Park Drive
- Crosby/US 101 Northbound and Southbound off-ramps
- Crosby Boulevard SW/Mottman Road SW
- Crosby Boulevard SW/Irving Street SW

Field visual observations were made at several of the intersections in the study area during the peak hour including those within the "Triangle" area (area bounded by Harrison Avenue SW/Division Street SW, Cooper Point Road SW/Black Lake Boulevard SW, and Cooper Point Road SW/Harrison Avenue SW intersections) to confirm queue lengths, lane configurations (number of turn lanes) and signal timing in the field.

MEASURES OF EFFECTIVENESS AND STANDARDS

Freeway Traffic

Two primary measures of effectiveness (MOEs) were used to evaluate freeway operations in West Olympia. The MOEs used to analyze freeway conditions were as follows:

- LOS based on density for freeway basic, merge, diverge, and weave locations (each segment based on VISSIM methodology and converted to a HCM analogue)
- Travel speeds

WSDOT owns the traffic signals at the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges along US 101, but the City of Olympia operates and maintains them by agreement. WSDOT identifies LOS D or better for freeway segments and ramp terminal intersections along urban state highway facilities and state operated signals as acceptable. WSDOT makes the final decision regarding the acceptable level of service for HSS. Both US 101 and I-5 within the study area are considered HSS.

One industry standard for evaluating freeway traffic conditions is based on the Transportation Research Board's (TRB) methodology outlined in the Highway Capacity Manual (HCM), Special Report 209 (TRB 2000). Using one of the HCM methodologies, freeway traffic conditions can be assessed with respect to densities along various freeway segments. The letter "A" is used to describe the least amount of congestion and best operations, and the letter "F" indicates the highest amount of congestion and worst operations. Table 3 shows how the HCM relates densities to LOS.

Table 3. Level of Service Criteria for Freeways

Basic Segment		Weave Segment		Merge/Diverge Areas	
Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
0	A	0	A	0	A
11	B	12	B	10	B
18	C	24	C	20	C
26	D	32	D	28	D
35	E	36	E	35	E
45	F	40	F	NA [a]	F

Source: HCM 2000, Exhibits 23-2, 24-2, and 25-4.

pc/mi/ln = passenger cars per mile per lane

[a] The HCM does not provide a density for LOS F for merge and diverge areas. A density of 45 pc/mi/ln, which is the same for basic segments, was assumed to distinguish between LOS E and F.

Local Intersection Traffic

The MOEs used to evaluate local intersection operations included:

- Level of service based on average vehicle delay (seconds/vehicle)
- Aggregated MOEs, including:
  - Total number of intersections operating at LOS A, B, or C
  - Total number of intersections operating at LOS D or E
  - Total number of intersections operating at LOS F
  - Total vehicle delay at three critical intersections (the "triangle"), including Black Lake Boulevard SW/Cooper Point Road SW, Harrison Avenue NW/Division Street NW, and Harrison Avenue NW/Cooper Point Road NW

The City of Olympia controls the majority of the study intersections, including all intersections north of US 101. The City has defined LOS E as acceptable through the downtown area and along high-density residential corridors. Study intersections that are south of Harrison Avenue NW, west of Black Lake Boulevard SW, and east of Cooper Point Road SW are considered part of the West Olympia high-density residential corridor; therefore, LOS E or better is defined as acceptable. Throughout the rest of the city, urban growth area, and ramp termini at the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges along US 101, LOS D is defined as acceptable.

Two study intersections, Crosby Boulevard SW/Mottman Road SW and Crosby Boulevard SW/Irving Street SW, fall within the City of Tumwater. The City of Tumwater has adopted LOS D as the minimum acceptable standard for all intersections and roadways within the city and urban growth area.

Similar to freeway traffic operations, the HCM also provides methodologies for evaluating intersection operations. The HCM derives intersection LOS from average vehicle delays for the intersection as a whole or by worst movement. The LOS lettering nomenclature is consistent with the freeway operations naming convention; the letter "A" is used to describe the least amount of delay and best operations and the letter "F" for the highest amount of delay and worst operations. The 2000 HCM level of service criteria for signalized and unsignalized intersections are shown in Table 4.

Table 4. Level of Service Criteria for Signalized and Unsignalized Intersections

LOS Rating	Average Delay for Signalized Intersections (seconds/vehicle)	Average Delay for Unsignalized Intersections (seconds/vehicle)[a]
A	0 – 10	0 – 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

Source: HCM 2000, modified from Exhibits 16-2 and 17-2

a LOS ratings for all-way stop-controlled intersections are defined by the intersection operations as a whole; LOS ratings for two-way stop-controlled intersections are defined by the worst lane group.

The City of Olympia uses a slightly modified methodology for estimating intersection LOS for their transportation concurrency requirements. While the general equations and the relationship between delay and LOS grade is consistent with the HCM definitions, the City of Olympia's LOS standards are based on a two-hour peak period, as opposed to a one-hour peak hour. To estimate the two-hour LOS, a volume adjustment factor is applied to one-hour peak hour volumes. This volume adjustment factor can be represented as:

2-Hour Adjustment Factor = (2 hour volume/2) / (peak hour volume)

For example, if 8,500 vehicles entered an intersection over two hours and the peak hour volume within those two hours was 4,500 entering vehicles, the 2-Hour Adjustment Factor would be:

2-Hour Adjustment Factor = (8,500/2)/(4,500)

2-Hour Adjustment Factor = (4,250)/(4,500)

2-Hour Adjustment Factor = 0.94

The 2-Hour Adjustment Factors were provided by the City of Olympia and applied to intersection turning movement volumes to estimate the two-hour LOS at locations where the intersections fall under the City of Olympia's jurisdiction (i.e., all study intersections excluding the Crosby Boulevard SW/Mottman Road SW and Crosby Boulevard SW/Irving Street SW intersections in the City of Tumwater and the Mud Bay interchange in Thurston County).

The ramp termini at the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges along US 101 are operated and maintained by the City of Olympia and therefore have a LOS D standard. However, the 2-Hour Adjustment Factor was not applied to these locations for planning purposes.

EXISTING TRAFFIC VOLUMES

Freeway traffic volumes were determined by using a combination of WSDOT permanent traffic recorders (PTRs) and tube counts on ramps located within the study area. Since only one WSDOT PTR recorder is operational in the study area (R098), freeway volumes were derived by using PTRs outside of the study area, and ramp tube counts were either added or subtracted to produce the expected mainline freeway volume within the study area. The PTRs used to develop freeway volumes include:

- R003 – US 101 at the US 101/US 12 split
- P4 – I-5 north of the Olympia City Center Interchange
- R097 – I-5 south of exit 100 in Tumwater
- R098 – US 101 west of the US 101/I-5 Intersection

The derived volume matrix was compared with PTR counts at R098 to verify correct model input volumes, which were developed for 15-minute intervals to account for peaking characteristics. PTR traffic volumes are an average of Tuesday through Thursday volumes taken from October 2006 and ramp tube counts were conducted in January and February 2007. Appendix B shows the expected volumes for each corridor. Figures 2 and 3 illustrate the volume validation at PTR R098, and compare the actual volume, the VISSIM throughput volume, and the derived freeway demand volumes.

Figure 2 shows a good volume correlation between the observed counts at the R098 PTR and the VISSIM model throughput along westbound US 101. The VISSIM model volume lags the actual counts by approximately 15 minutes; however, by 6:00 PM both the VISSIM model and the PTR counts are approximately equal. Figure 3 indicates the VISSIM model overestimates traffic volumes by about 9 percent during the middle of the peak analysis period. This volume imbalance is partially due to matching freeway ramp volumes to intersection turning movement counts. Although the VISSIM model is conservatively high through this location, comparing the VISSIM model traffic volume against the WSDOT 2006 Peak Hour Report, the traffic volumes are still within the overall range of volumes through the location.

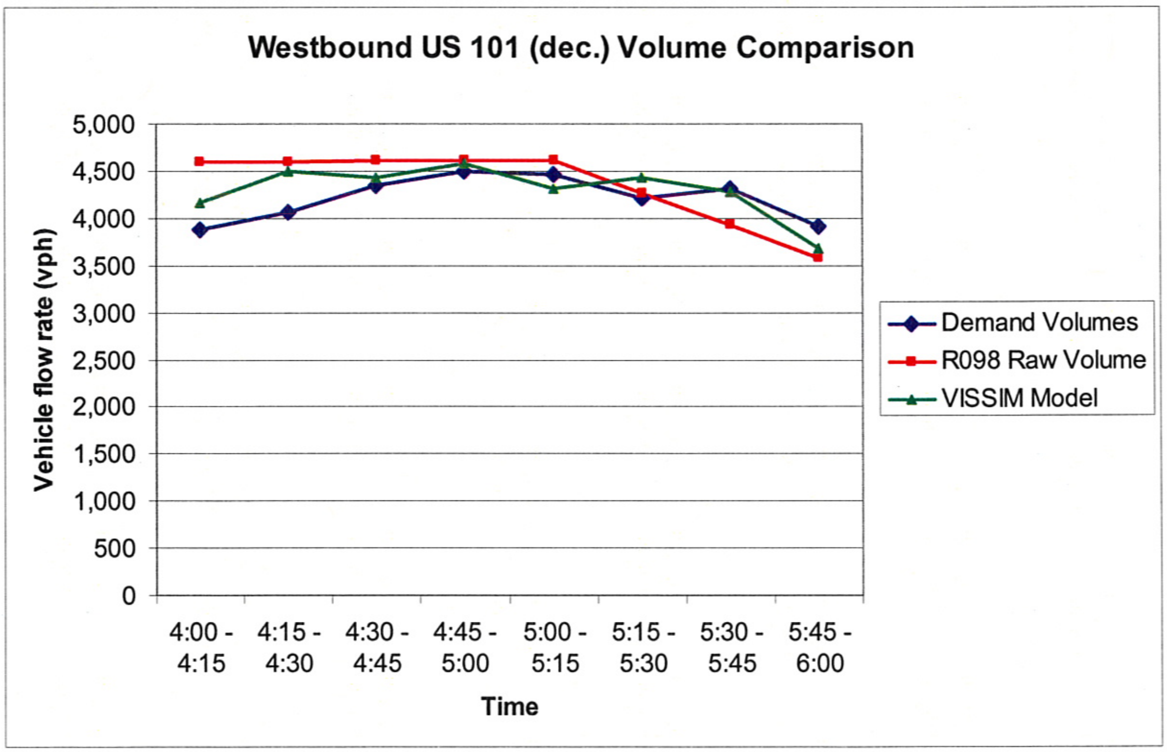


Figure 2. Westbound US 101 Existing and Model Traffic Volumes

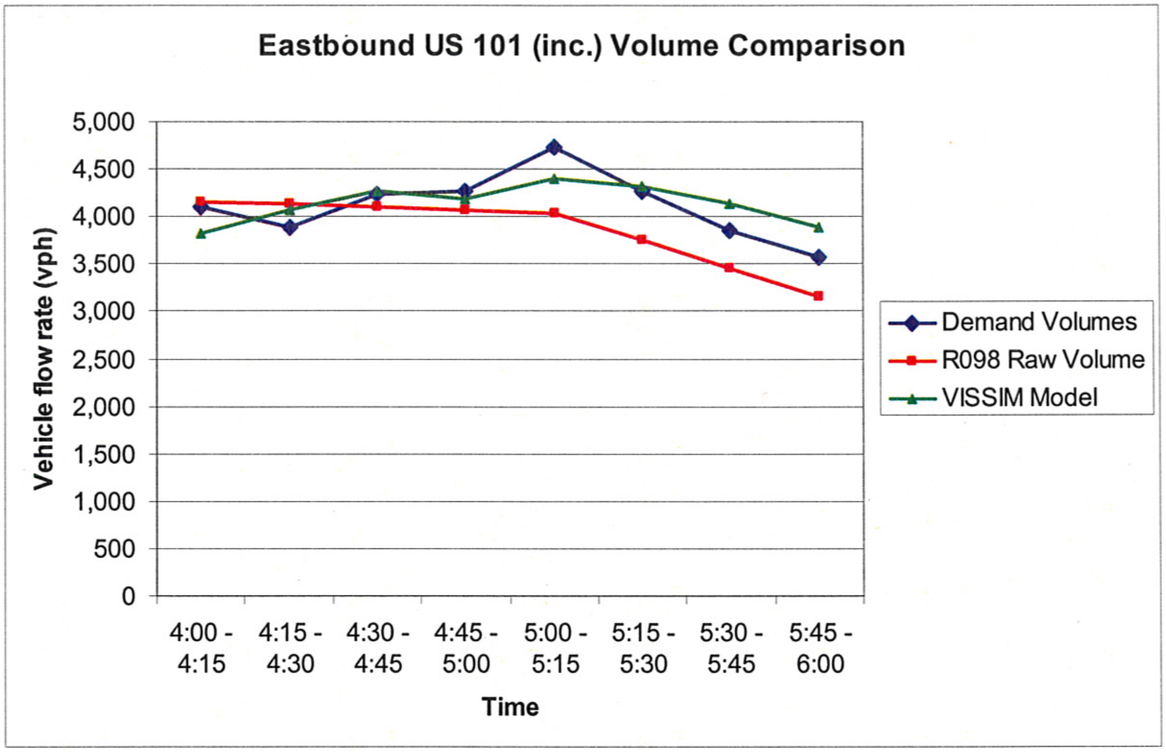
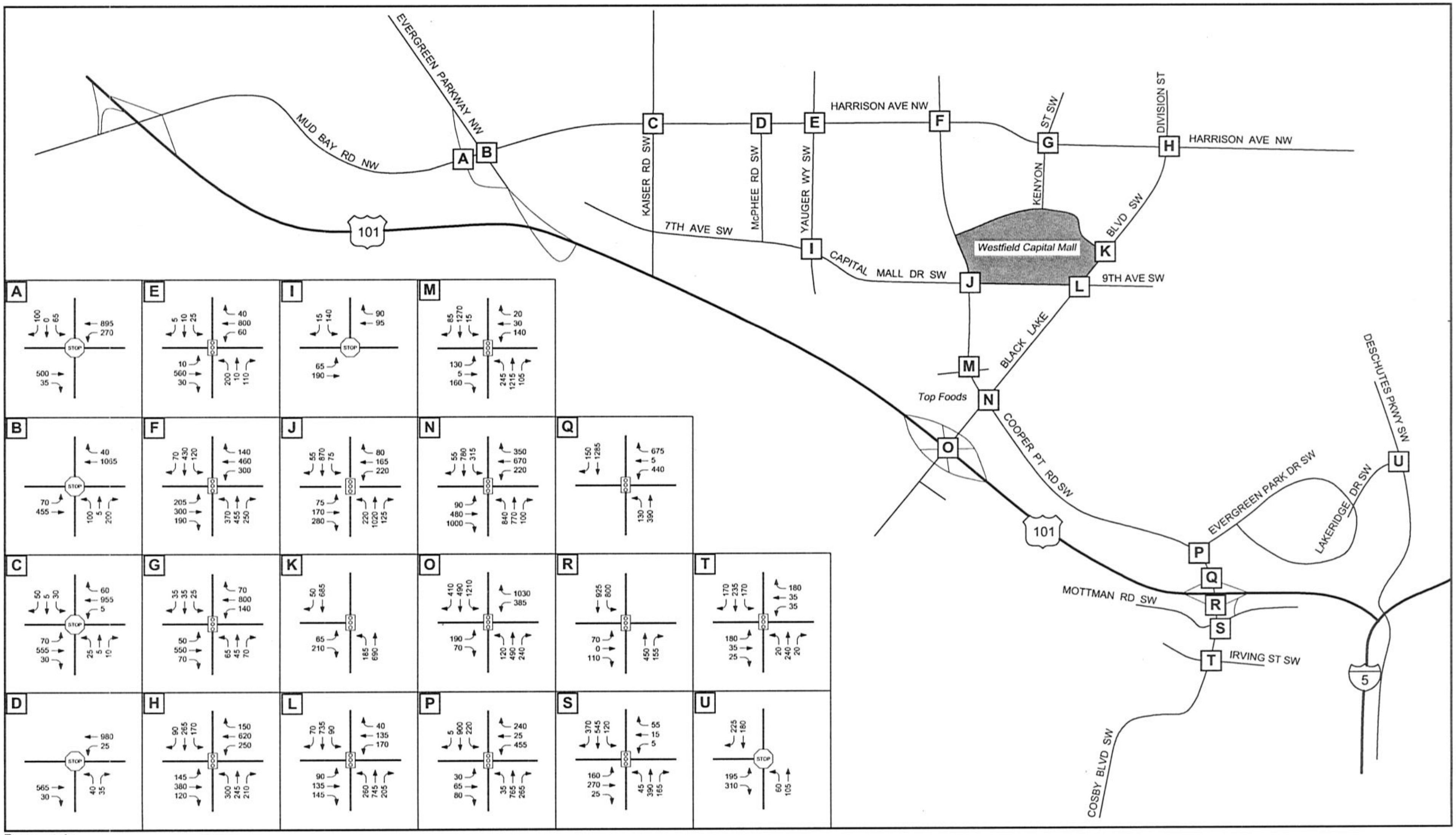


Figure 3. Eastbound US 101 Existing and Model Traffic Volumes

Local turning movement counts were conducted by the City of Olympia between 2003 and 2007. These traffic volumes were balanced between intersections, and were used as the basis of the local intersection analysis used for both Synchro and VISSIM. The existing PM peak hour turning movement counts are shown in Figure 4.



Parametrix DATE: Jun 02, 2008 FILE: BL1631062P03T05_F04A

N

No Scale

X Study Intersection

Turning Movement Volume

Stop - Controlled Intersection

Signalized Intersection

Figure 4
Existing 2007 PM Peak Hour Intersection Volumes

EXISTING FREEWAY TRAFFIC OPERATIONS

Volumes

Northbound I-5 traffic volumes vary substantially throughout the study area. During the PM peak hour (4:30 to 5:30 PM), approximately 4,000 vehicles enter the study area. A relatively small volume exits to the US 101 (around 900 vehicles) and 14th Avenue (around 500 vehicles) off-ramps; however, a substantial volume enters northbound I-5 from the US 101 and Deschutes Parkway on-ramp (around 2,900 vehicles). Figure 5 shows the VISSIM model traffic volumes along different segment types of the northbound I-5 mainline during the existing 2007 PM peak hour.

Approximately 4,600 vehicles enter the southbound I-5 study area during the PM peak hour and, similar to northbound I-5, traffic volumes vary greatly along the corridor. The City Center on-ramp and US 101 off-ramp are approximately 2,000 feet apart, creating a short weave section. Around this weave section, southbound I-5 mainline volumes increase from 4,600 vehicles to 6,200 vehicles, then decrease to 3,200 vehicles just south of the US 101 off-ramp where approximately 3,000 vehicles exit to US 101. Of this volume exiting to westbound US 101 from southbound I-5, 13 percent from the 14th/Plum Street on-ramp and the remaining 87 percent comes from southbound I-5 north of the City Center interchange. The weave distribution percentages were based on the VISUM model and applied to the expected freeway volumes that were based on balanced PTR data. A relatively small volume exits to 2nd Avenue SW (less than 200), then the US 101 on-ramp adds approximately 900 vehicles to the southbound I-5 mainline. Figure 6 shows the VISSIM model traffic volumes along different segment types of the southbound I-5 mainline during the existing 2007 PM peak hour.

Eastbound traffic volumes on US 101 exhibit relatively little variation from around the Mud Bay Road and Evergreen Parkway interchanges. Continuing east, a substantial volume enters the mainline from the Black Lake Boulevard (approximately 1,400 vehicles) and Crosby Boulevard/Cooper Point (approximately 1,300 vehicles) interchanges. Figure 7 shows the VISSIM model traffic volumes along different segment types of the eastbound US 101 mainline during the existing 2007 PM peak hour.

Off-ramps from southbound and northbound I-5 converge to create westbound US 101, which has approximately 4,400 vehicles entering the study area during the PM peak hour. Similar to eastbound US 101, the majority of mainline traffic volume variation occurs between the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges, with exiting and entering volumes generally ranging between 1,200 to 500 vehicles. West of the Black Lake Boulevard interchange, traffic volume changes are generally less than 400 vehicles during the PM peak hour to and from Evergreen Parkway NW and Mud Bay Road NW. Figure 8 shows the VISSIM model traffic volumes along different segment types of the westbound US 101 mainline during the existing 2007 PM peak hour.

LOS (Densities)

As described above, freeway operations were analyzed using VISSIM version 4.3, which calculates freeway densities in terms of vehicles per mile per lane. These densities were converted into passenger cars per mile per lane based on heavy vehicle percentages and HCM adjustments to determine the freeway LOS. Table 5 identifies the various study segments by type for I-5 and US 101 that are currently operating at LOS E or F.

As shown in Table 5, three segments of I-5 and one segment of US 101 currently operate worse than LOS D during the PM peak hour. In general, LOS D is the WSDOT threshold for urban freeway facilities; however, WSDOT makes the final decision regarding the acceptable level of service for HSS facilities, such as I-5 and US 101. Figures 5 through 8 show the mainline densities and LOS for each I-5 and US 101 mainline segment type. An expanded table that shows the densities and LOS for all segments of I-5 and US 101 is provided in Appendix C.

Table 5. Existing 2007 PM Peak Hour Freeway Operations

Mainline Segment	Segment Type	Density (pc/mi/ln)	LOS (HCM Equivalent)
Northbound I-5			
Northbound I-5 US 101 On-Ramp	Merge	35.1	E
Southbound I-5			
Southbound I-5	Basic	73.4	F
Southbound I-5 to US 101 Weave	Weave	53.3	F
Westbound US 101			
Westbound US 101 e/o Crosby Blvd	Basic	35.1	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	48.4	F

pc/mi/ln = passenger cars per mile per lane

Note: The HCM does not provide a density for LOS F for merge and diverge areas. A density of 45 pc/mi/ln, which is the same for basic segments, was assumed to distinguish between LOS E and F.

As described above, a substantial volume (approximately 2,900 vehicles) of traffic is added to the northbound I-5 mainline from the US 101 and Deschutes Parkway on-ramp. This volume, coupled with a three-lane merge condition, results in the existing congestion at this location of I-5.

On southbound I-5, the short weave segment between the City Center on-ramp and the US 101 off-ramp experiences a high amount of lane changes, which results in high traffic densities in this area and in the upstream segment of southbound I-5.

Congestion near the westbound Crosby Boulevard interchange is related to several factors, including high traffic volumes, weaving, horizontal curves, and steep grades.

Speeds

Travel speeds along I-5 and US 101 were also identified as an operational MOE. The existing PM peak period speed conditions along I-5 are shown in Figures 5 and 6, and Figures 7 and 8 display the speeds along US 101. Note that these figures illustrate the operational speeds during the PM peak period (4:00 to 6:00 PM, two hours), but the LOS, densities, and volumes are for the PM peak hour (4:30 to 5:30 PM, one hour).

As shown in Figure 5, above, existing northbound I-5 mainline speeds are generally around free flow conditions. A slight reduction (from 60-70 mph to 50-60 mph) in speed occurs around the US 101 off- and on-ramps.

Southbound I-5 travel speeds are substantially reduced around the I-5/City Center interchange, and range between 30-50 mph for the majority of the PM peak period and 10-20 mph between 5:00 and 5:30 PM. This reduction in speeds is primarily due to the high volumes of lane changes between the City Center on-ramp and US 101 off-ramp, which is a short weave section approximately 2,000 feet in length. South of the City Center interchange, operational speeds increase to free flow conditions (50-70 mph). Figure 6 shows the PM peak period travel speeds along southbound I-5.

Figure 7 shows the PM peak period travel speeds for eastbound US 101. Eastbound US 101 travel speeds are currently around free flow conditions, with slight decreases (from 60-70 mph to 50-60 mph) near the Evergreen Parkway, Black Lake Boulevard, and Crosby Boulevard/Cooper Point on-ramps.

During the PM peak period, travel speeds along westbound US 101 are generally between 40-50 mph between I-5 and the Crosby Boulevard interchange. Continuing west, speeds increase to 50-60 mph with a brief section operating at 60-70 mph near the Evergreen Parkway off-ramp. Figure 8 shows the PM peak period travel speeds along westbound US 101.

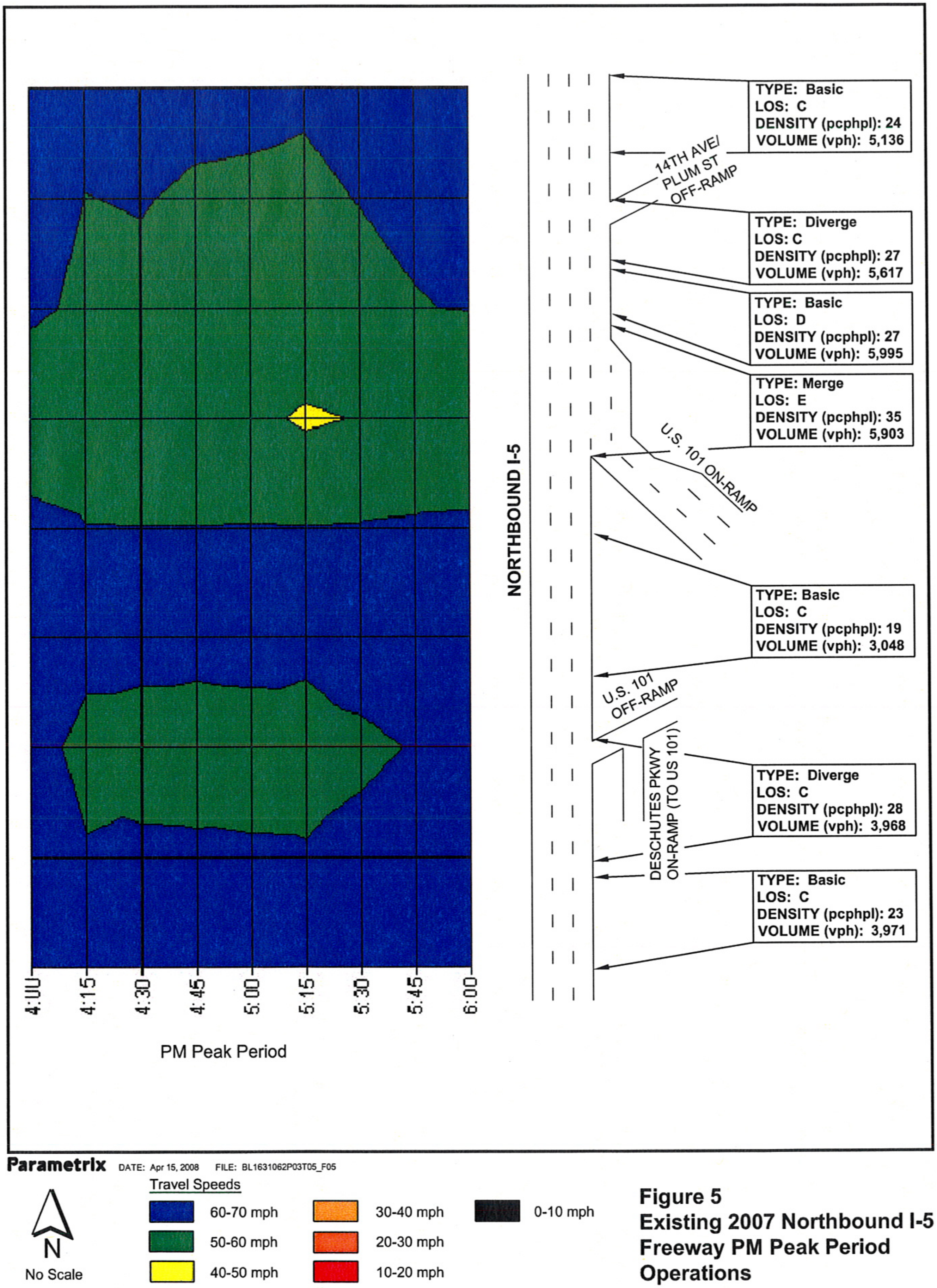
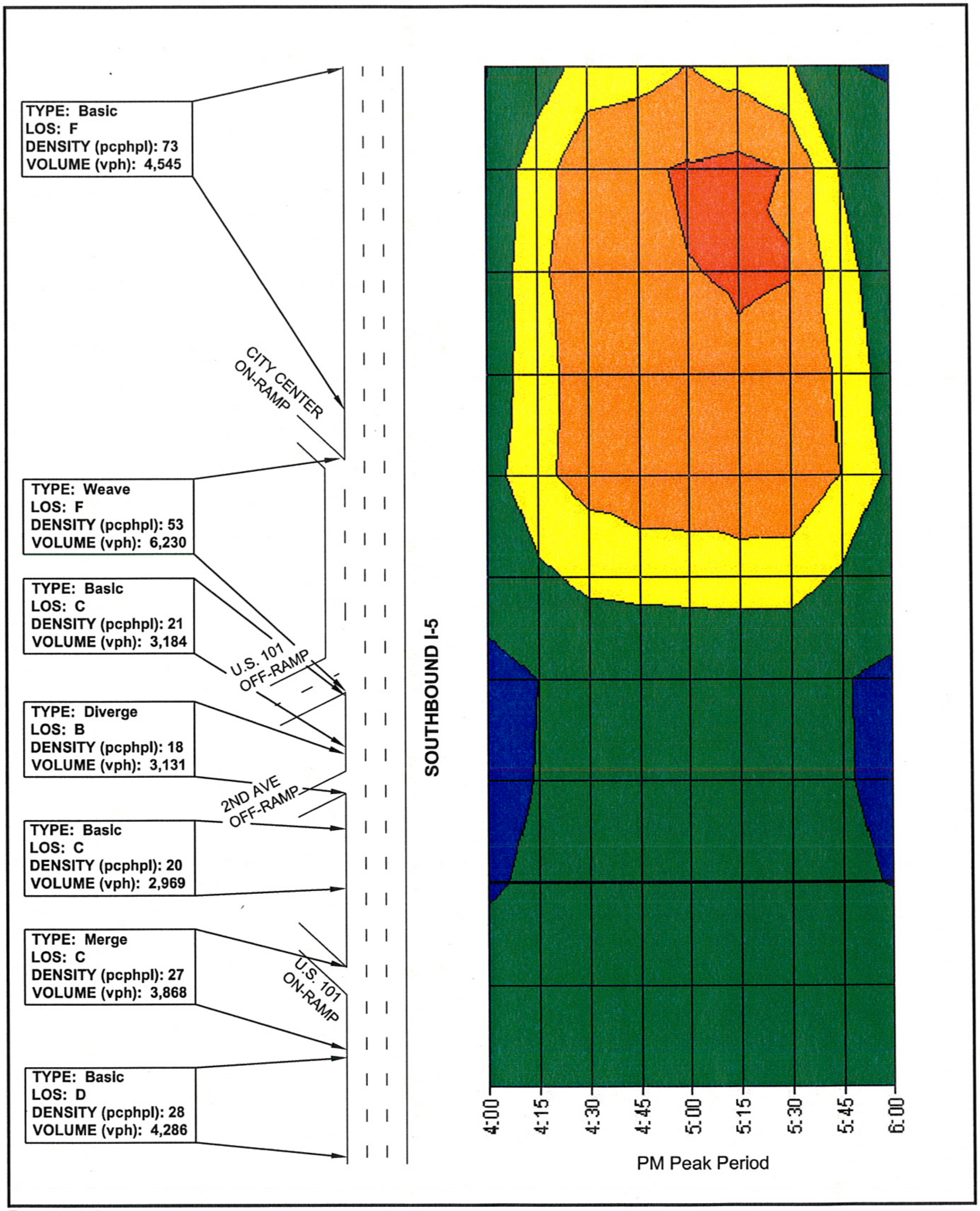


Figure 5
Existing 2007 Northbound I-5 Freeway PM Peak Period Operations



Parametrix DATE: Apr 15, 2008 FILE: BL1631062P03T05_F06

N
No Scale

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 6
Existing 2007 Southbound I-5 Freeway PM Peak Period Operations

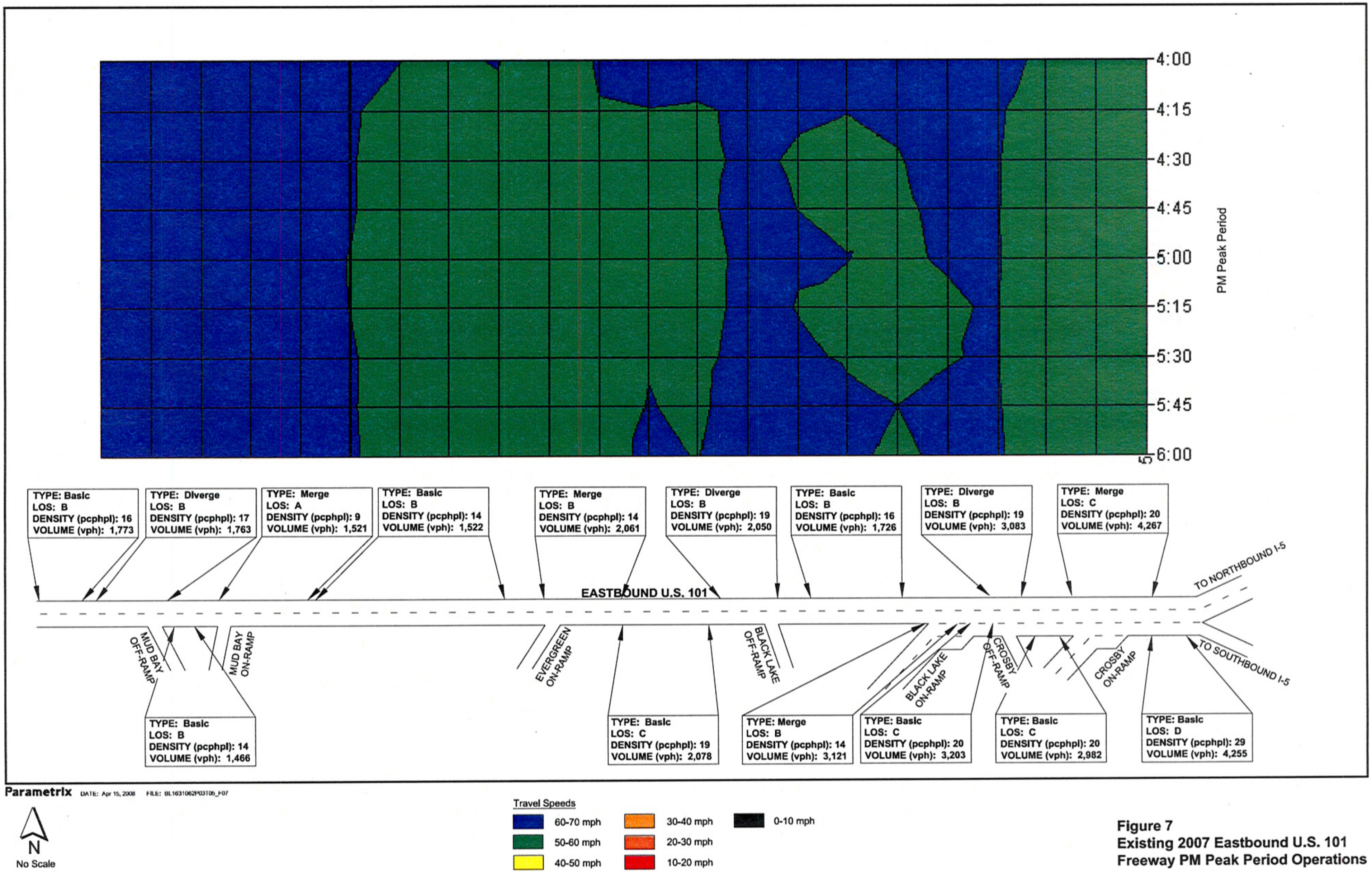


Figure 7
Existing 2007 Eastbound U.S. 101
Freeway PM Peak Period Operations

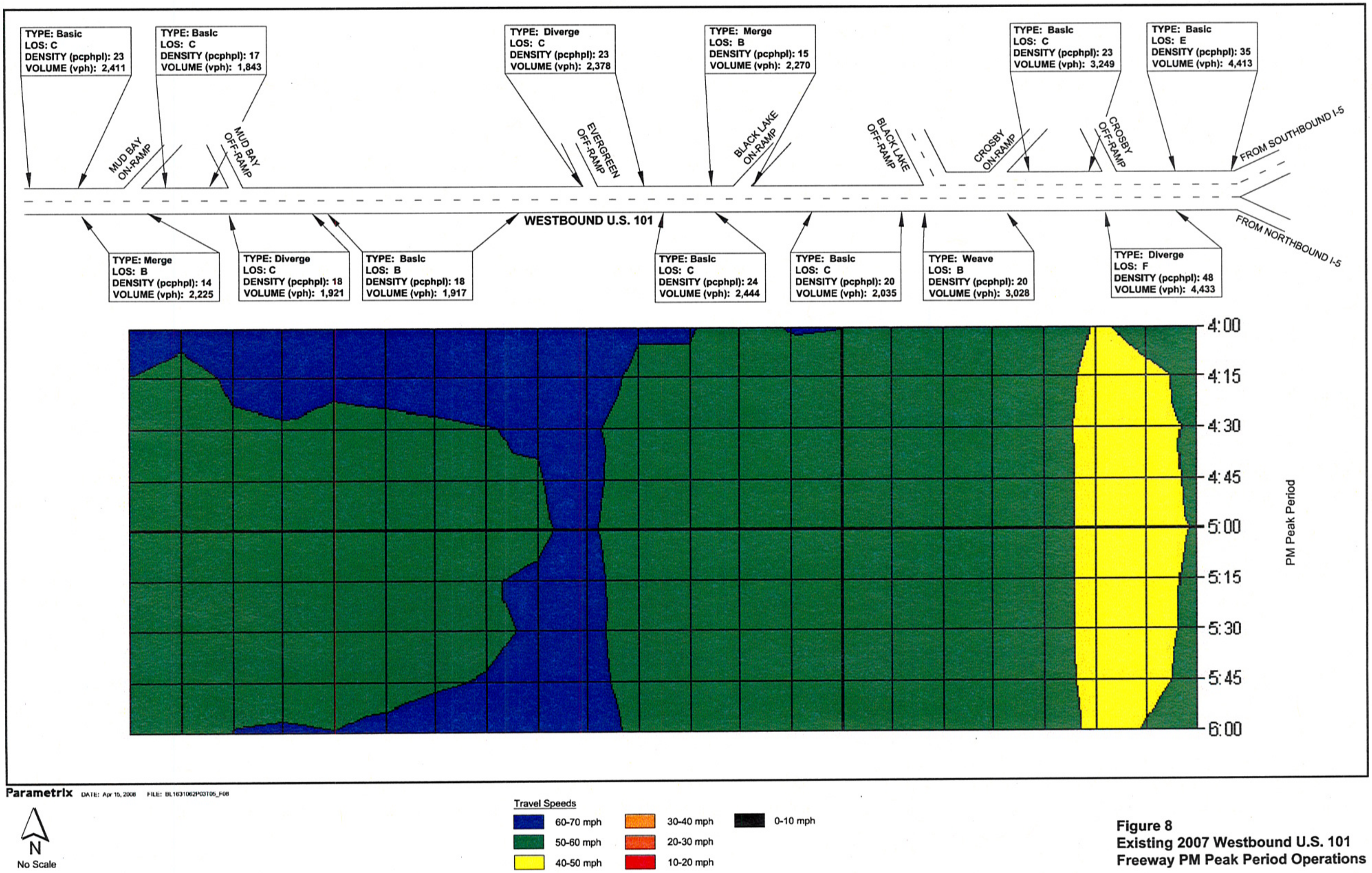


Figure 8
Existing 2007 Westbound U.S. 101
Freeway PM Peak Period Operations

EXISTING LOCAL INTERSECTION TRAFFIC OPERATIONS

LOS (Average Delays)

As described above, the LOS for local intersections was measured by the total average vehicle delays. The existing 2007 local traffic operations are summarized in Table 6.

Table 6. Existing 2007 PM Peak Hour Local Traffic Operations

		One-Hour Peak[b]			Two-Hour Peak[b]		
Intersection Description	Intersection Control[a]	LOS	Delay (sec/veh)	Max v/c Ratio	LOS	Delay (sec/veh)	Max v/c Ratio
Harrison Avenue/Division Street	Signalized	F	84.7	1.00	E	73.4	0.96
Black Lake Blvd/Cooper Point Road	Signalized	F	85.2	1.18	E	74.1	1.12
Black Lake Road/US 101 SPUI (Through/Lefts)	Signalized	E	63.2	0.98	E	60.1	0.96
Cooper Point Road/Harrison/Mud Bay	Signalized	D	49.6	0.81	D	45.0	0.80
Cooper Point Road/Capitol Mall Blvd	Signalized	D	38.2	0.73	C	34.9	0.70
Black Lake Blvd/9th Ave/Capital Mall Drive	Signalized	C	32.6	0.69	C	31.5	0.66
Cooper Point Road Automall Drive/Evergreen Park Drive	Signalized	C	27.6	0.74	C	25.7	0.69
Cooper Point Road/Top Foods Entrance	Signalized	C	24.3	0.73	C	23.1	0.69
Crosby Blvd/US 101 Westbound Ramps (dec.)	Signalized	C	21.0	0.64	B	19.9	0.58
Crosby Blvd/US 101 Eastbound Ramps (inc.)	Signalized	B	19.3	0.67	B	18.6	0.62
Crosby Blvd/Mottman Road	Signalized	B	19.0	0.60	NA	NA	NA
Crosby Blvd/Irving Street	Signalized	B	14.5	0.44	NA	NA	NA
Harrison Avenue/Kenyon Street	Signalized	B	12.5	0.55	B	12.2	0.54
Black Lake Blvd/Capital Mall Entrance	Signalized	B	10.4	0.46	B	10.0	0.43
Harrison Avenue/Yauger Way	Signalized	A	8.6	0.53	A	8.4	0.51
Black Lake Road/US 101 SPUI Westbound US 101 (dec.) Off-Ramp Right Turns	Signalized	A	8.0	0.73	A	7.8	0.65
Black Lake Road/US 101 SPUI Eastbound US 101 (inc.) Off-Ramp Right Turns	Signalized	A	2.7	0.35	A	2.7	0.34
Harrison Avenue/McPhee Road	Unsignalized	F	>100	0.77	F	76.3	0.64
Harrison Avenue/Kaiser Road	Unsignalized	F	>100	0.73	F	>100	0.55

Table 6. Existing 2007 PM Peak Hour Local Traffic Operations (continued)

Intersection Description	Intersection Control[a]	One-Hour Peak[b] LOS	One-Hour Peak[b] Delay (sec/veh)	One-Hour Peak[b] Max v/c Ratio	Two-Hour Peak[b] LOS	Two-Hour Peak[b] Delay (sec/veh)	Two-Hour Peak[b] Max v/c Ratio
Mud Bay Road/Evergreen Parkway Northbound Ramp	Unsignalized	F	>100	1.12	NA	NA	NA
Mud Bay Road/Evergreen Parkway Southbound Ramp	Unsignalized	F	>100	2.54	NA	NA	NA
Black Lake Blvd/Top Foods Entrance	Unsignalized	C	19.4	0.45	C	16.9	0.39
Lakeridge Drive/Deschutes Parkway	Unsignalized	C	16.7	0.47	C	16.1	0.36
Capital Mall Drive/Yauger Way	Unsignalized	B	13.5	0.28	B	12.0	0.19

[a] Unsignalized LOS and delay were calculated by HCS+. The LOS and delay for all-way stop-controlled intersections are reported for the intersection as a whole, whereas the LOS and delay for two-way stop-controlled intersections are reported for the worst approach. Signalized intersection LOS and delay were calculated from the HCM Signals Report feature of Synchro 7 (build 757).

[b] The one-hour analysis is based on HCM methodologies and provided the basis for intersection improvements. The two-hour analysis results account for the 2-Hour Adjustment Factor that the City of Olympia uses to define their LOS standards. A "NA" indicates intersections that are not under the jurisdiction of the City of Olympia and therefore a 2-Hour Adjustment Factor is not applicable.

Accounting for the 2-Hour Adjustment Factor, where applicable, of the 24 study intersections:

- 16 intersections operate at LOS A, B, or C
- four intersections operate at LOS D or E, and
- four intersections operate at LOS F.

Based on the different LOS standards for WSDOT and the cities of Olympia and Tumwater, this represents five intersections that are currently operating unacceptably below their respective LOS standards.

The "triangle" delay, which is the sum total of intersection delays at the Black Lake Boulevard SW/Cooper Point Road SW, Harrison Avenue NW/Division Street NW, and Harrison Avenue NW/Cooper Point Road NW intersections, is 192.5 seconds/vehicle.

YEAR 2030 NO-BUILD TRAFFIC VOLUMES

The 2030 Thurston Regional Planning Council (TRPC) travel demand model was used to develop traffic volume forecasts for the 2030 design year. The 2030 WOAS model included all transportation improvement projects adopted in the Regional Transportation Plan (RTP) for which funds have been secured. The transportation improvement projects assumed for the 2030 design year are shown in Table 7. This table provides a brief description of the network assumptions for each project. The future No-Build scenario does not include any representation of network elements that are currently being contemplated as study options, or for which construction funds have not yet been secured. In particular, any new or modified ramps at Yauger Way and US 101, or any additions or changes to connections between southwest Olympia and west Tumwater, were not included in the No-Build demand model. These planned long-range projects are not included in the 2030 No-Build network, but may be evaluated later as part of the build options.

Table 7. Projects Included in the 2030 No-Build TRPC Demand Model

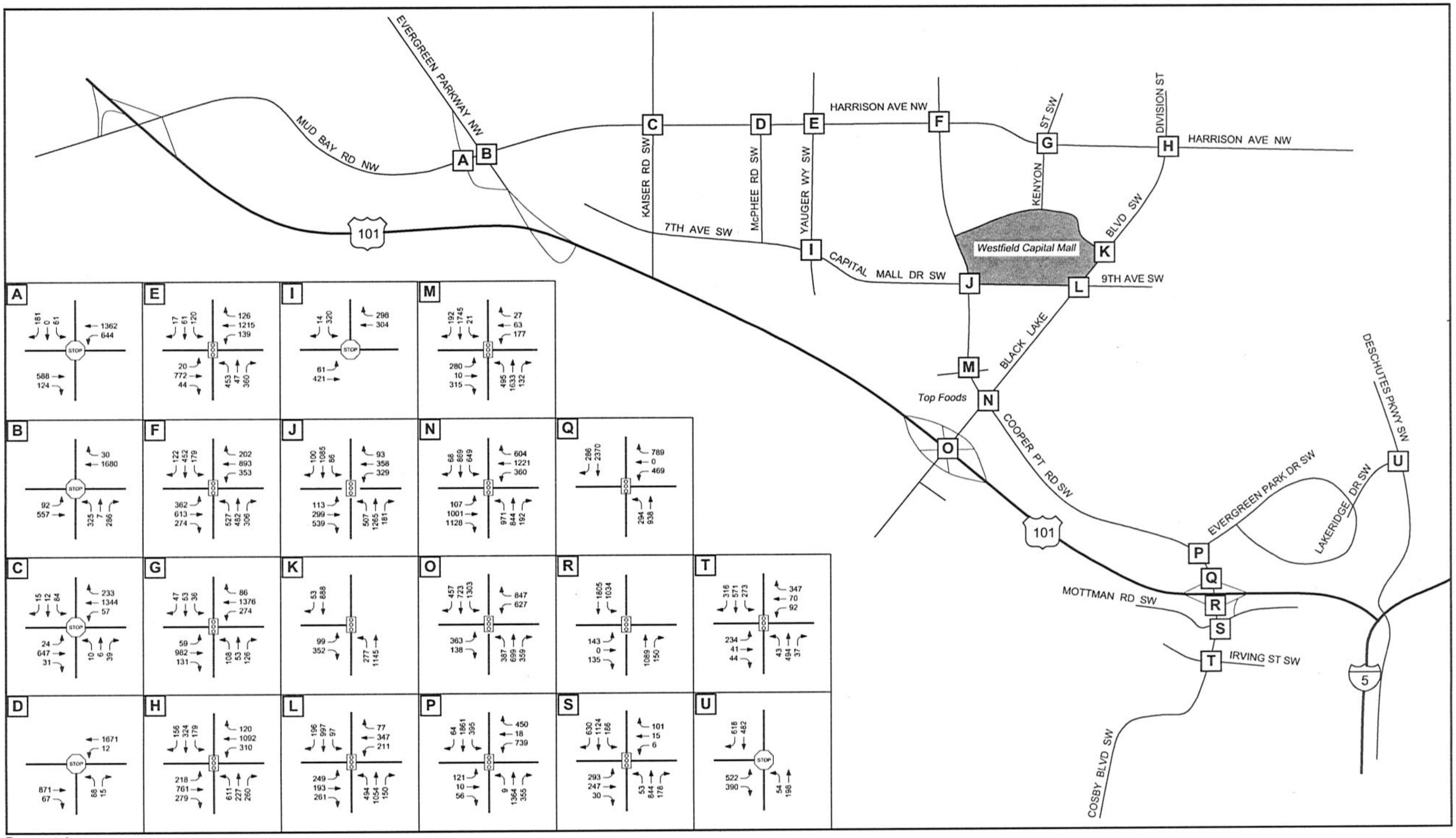
Project Name	Project Description
4th/5th Avenue Corridor Bridge Project	Project is completed
Harrison Avenue Widening, Phase II	Widen from 2 lanes to 4/5 lanes from Yauger Way to Kaiser Road
Evergreen Parkway Repair and Upgrade	Reduce number of lanes on Evergreen Parkway from 4 lanes to 2 lanes from 17th Avenue to Kaiser Road
College Station Connection	Connection from Mud Bay to Kaiser Road
Harrison Avenue/Kaiser Road Signal	Add a signal to the Harrison Avenue/Kaiser Road intersection and widen Harrison Avenue to five lanes for 300' of either side of the intersection

The TRPC EMME/2 travel demand model information has been transferred to VISUM to evaluate the West Olympia sub-area. The EMME/2 travel demand model provided a travel demand matrix output that was assigned to the VISUM subarea model. Further VISUM model assumptions, calibration, and validation results are documented in the West Olympia Access Study Model Documentation (PTV America 2007). Table 8 compares the existing 2007 and forecasted 2030 PM peak hour traffic volumes at key locations within the study area.

Table 8. PM Peak Hour Projected Traffic Volume Growths (2007-2030)

Mainline Segment	2007 Volume	2030 Volume	Absolute Difference	Percent Difference	Growth Rate
Westbound US 101					
Northbound I-5 On	1,403	1,888	485	34.6%	1.5%
Southbound I-5 On	2,978	3,707	730	24.5%	1.1%
US 101 WB Mainline	4,381	5,595	1,215	27.7%	1.2%
Crosby Blvd Off	1,120	1,244	123	11.0%	0.5%
US 101 WB Mainline	3,260	4,352	1,092	33.5%	1.5%
Crosby Blvd On	285	604	319	112.1%	4.9%
US 101 WB Mainline	3,545	4,956	1,411	39.8%	1.7%
Black Lake Blvd Off	1,414	1,457	42	3.0%	0.1%
US 101 WB Mainline	2,131	3,499	1,368	64.2%	2.8%
Black Lake Blvd On	530	795	265	50.0%	2.2%
US 101 WB Mainline	2,660	4,294	1,633	61.4%	2.7%
Eastbound US 101					
US 101 EB Mainline	2,080	3,455	1,376	66.1%	2.9%
Black Lake Blvd Off	260	491	231	89.0%	3.9%
US 101 EB Mainline	1,820	2,965	1,145	62.9%	2.7%
Black Lake Blvd on	1,450	1,580	130	9.0%	0.4%
US 101 EB Mainline	3,270	4,545	1,275	39.0%	1.7%
Crosby Blvd Off	180	286	106	58.7%	2.6%
US 101 EB Mainline	3,090	4,258	1,169	37.8%	1.6%
Crosby Blvd On	1,285	1,478	193	15.0%	0.7%
US 101 EB Mainline	4,375	5,736	1,361	31.1%	1.4%
Northbound I-5 Off	2,645	3,253	608	23.0%	1.0%
Southbound I-5 Off	1,340	1,850	510	38.0%	1.7%
Deschutes Pkwy Off	389	633	244	62.6%	2.7%
Southbound I-5					
I-5 SB Mainline	4,585	6,282	1,697	37.0%	1.6%
Plum Avenue/14th On	1,663	1,729	66	4.0%	0.2%
I-5 SB Mainline	6,248	8,010	1,763	28.2%	1.2%
US 101 Off	2,978	3,707	730	24.5%	1.1%
I-5 SB Mainline	3,270	4,303	1,033	31.6%	1.4%
2nd Avenue Off	276	265	-11	-4.1%	-0.2%
I-5 SB Mainline	2,994	4,038	1,044	34.9%	1.5%
US 101 On	1,340	1,850	509	38.0%	1.7%
I-5 SB Mainline	4,334	5,888	1,553	35.8%	1.6%
Northbound I-5					
I-5 NB Mainline	3,855	5,475	1,619	42.0%	1.8%
US 101 Westbound Off	907	1,233	326	36.0%	1.6%
I-5 NB Mainline	2,949	4,242	1,293	43.8%	1.9%
US 101 WB/Deschutes Pkwy On	3,021	3,671	650	21.5%	0.9%
I-5 NB Mainline	5,970	7,913	1,943	32.5%	1.4%
Plum Street/14th Off	881	1,049	168	19.0%	0.8%
I-5 NB Mainline	5,089	6,864	1,775	34.9%	1.5%
14th Avenue On	700	756	56	8.0%	0.3%
I-5 NB Mainline	5,789	7,620	1,831	31.6%	1.4%

Local turning movement counts were also forecasted by the TRPC demand model and are shown in Figure 9 for the year 2030 PM peak hour.



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N

No Scale

X Study Intersection

Turning Movement Volume

Stop - Controlled Intersection

Signalized Intersection

Figure 9
Future 2030 No-Build PM Peak Hour Intersection Volumes

YEAR 2030 NO-BUILD FREEWAY TRAFFIC OPERATIONS

Volumes

Traffic volumes along northbound I-5 are expected to substantially increase by the year 2030. Volumes entering the study area on northbound I-5 are expected to substantially increase from 4,000 vehicles during the PM peak hour to approximately 5,700 vehicles. Similar to the existing conditions, a substantial change in mainline volumes is expected to occur around the US 101 interchange with approximately 1,300 vehicles exiting to US 101 and roughly 2,900 vehicles entering the northbound I-5 mainline from US 101 and Deschutes Parkway SW. Figure 10 shows the VISSIM mainline volumes for northbound I-5 for each of the mainline segment types during the 2030 PM peak hour.

The volume of traffic entering the study area along southbound I-5 is expected to be relatively similar to the existing conditions (4,600 vehicles for existing conditions and 4,700 vehicles for year 2030). Although the demand is expected much higher, this portion of southbound I-5 is expected to reach capacity and, therefore, the proportion of the demand that is served will only slightly increase while the unmet demand will increase. Similar to the existing conditions, the short weave section and high volume of lane changes is expected to create a bottleneck and constrain the amount of throughput. South of the US 101 interchange, mainline volumes are expected to increase by 400 to 600 vehicles per hour. Figure 11 shows the modeled volumes for each mainline segment type along southbound I-5 during the 2030 PM peak hour.

From the beginning of the western limit of the study area, eastbound US 101 volumes are expected to substantially increase from approximately 1,800 vehicles per hour to 2,800 vehicles per hour. Substantial changes in mainline traffic volumes are also expected at the Evergreen Parkway on-ramp, Black Lake Boulevard interchange (off- and on-ramps), and Crosby Boulevard/Cooper Point on-ramp. Conversely, the amount of traffic to and from Mud Bay Road SW and to the Crosby Boulevard/Cooper Point off-ramp is expected to experience relatively small changes in traffic volumes compared to the existing conditions. Figure 12 provides the traffic volumes for each mainline segment type along eastbound US 101 during the 2030 PM peak hour.

Traffic volume growth entering the study area for westbound US 101 is relatively small, around 300 vehicles per hour during the PM peak hour. Continuing west, more pronounced changes in mainline volumes are expected, with increases ranging between 800 vehicles per hour west of the Black Lake Boulevard interchange to 1,000 vehicles per hour after the Mud Bay Road interchange. Mainline volumes for each segment type during the 2030 PM peak hour are shown in Figure 13.

LOS (Densities)

Similar to the existing conditions freeway analysis, VISSIM version 4.3 was used to calculate freeway densities in terms of vehicles per mile per lane. Heavy vehicle percentages and HCM adjustment factors were used to convert vehicles per mile per lane to passenger cars per mile per lane to determine the freeway LOS. Table 9 compares existing and future I-5 and US 101 mainline segment types expected to operate at LOS E or F.

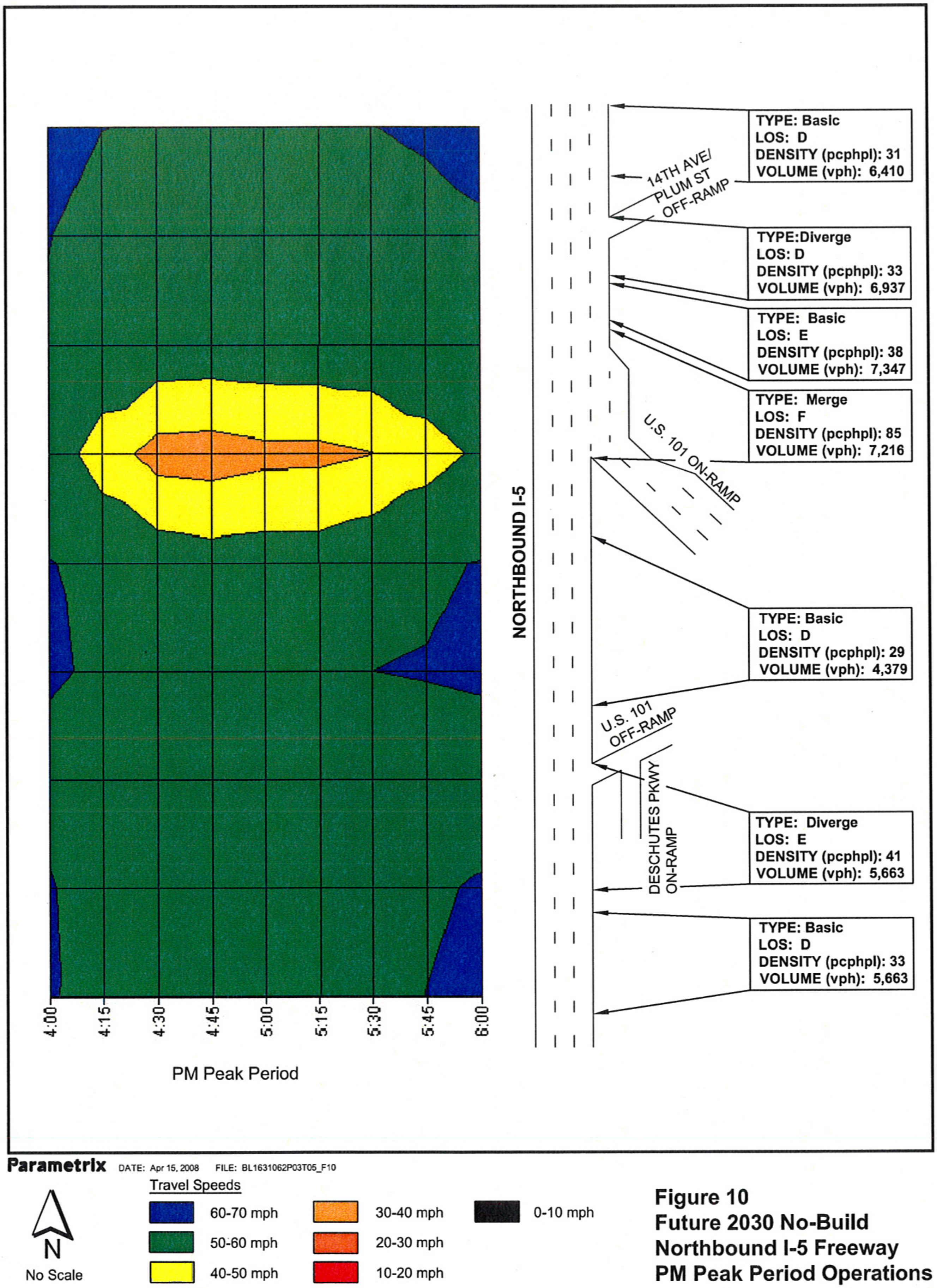
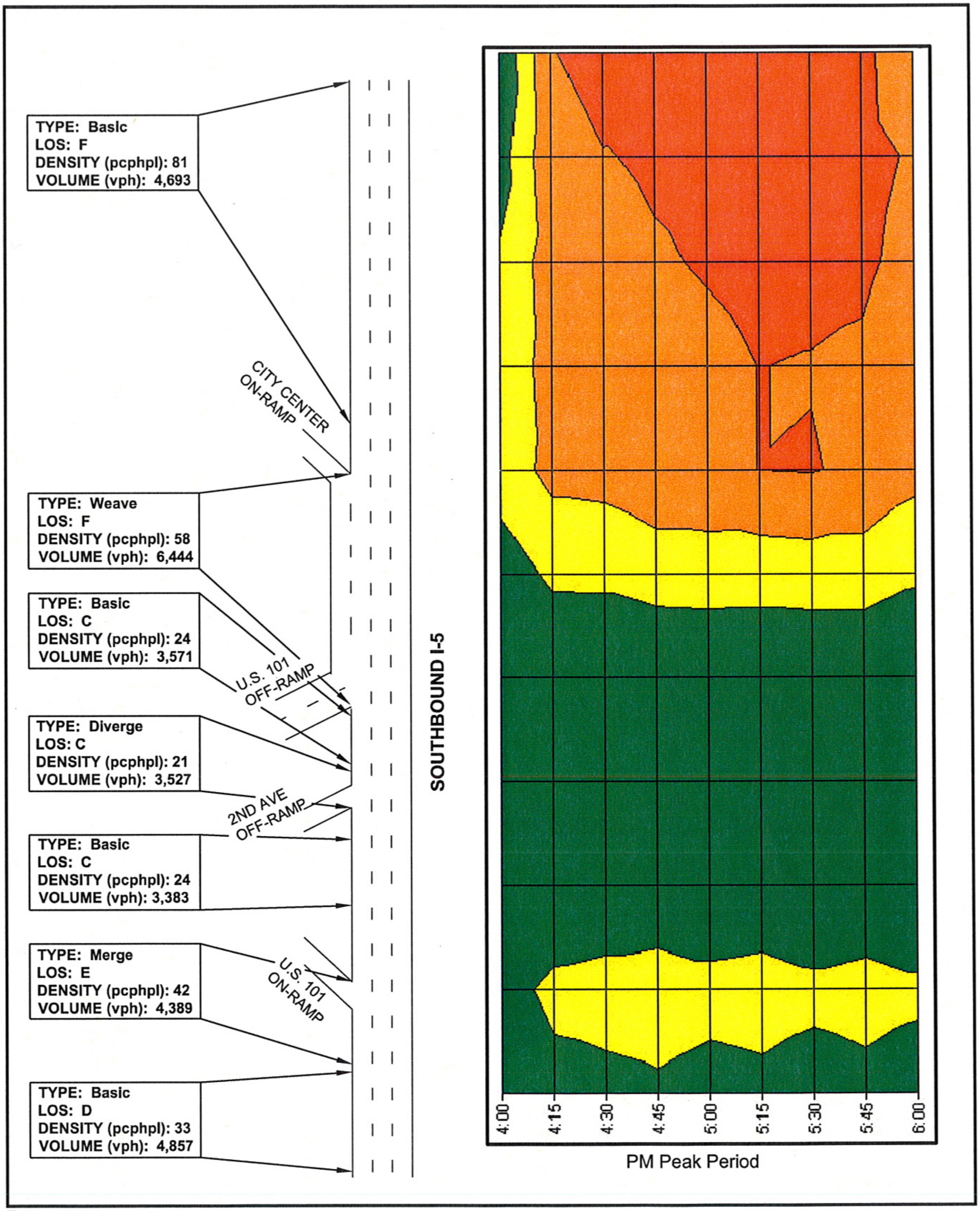


Figure 10
Future 2030 No-Build
Northbound I-5 Freeway
PM Peak Period Operations



Parametrix DATE: Apr 15, 2008 FILE: BL1631062P03T05_F11

Travel Speeds

60-70 mph	30-40 mph	0-10 mph
50-60 mph	20-30 mph	
40-50 mph	10-20 mph	

N
No Scale

Figure 11
Future 2030 No-Build
Southbound I-5 Freeway
PM Peak Period Operations

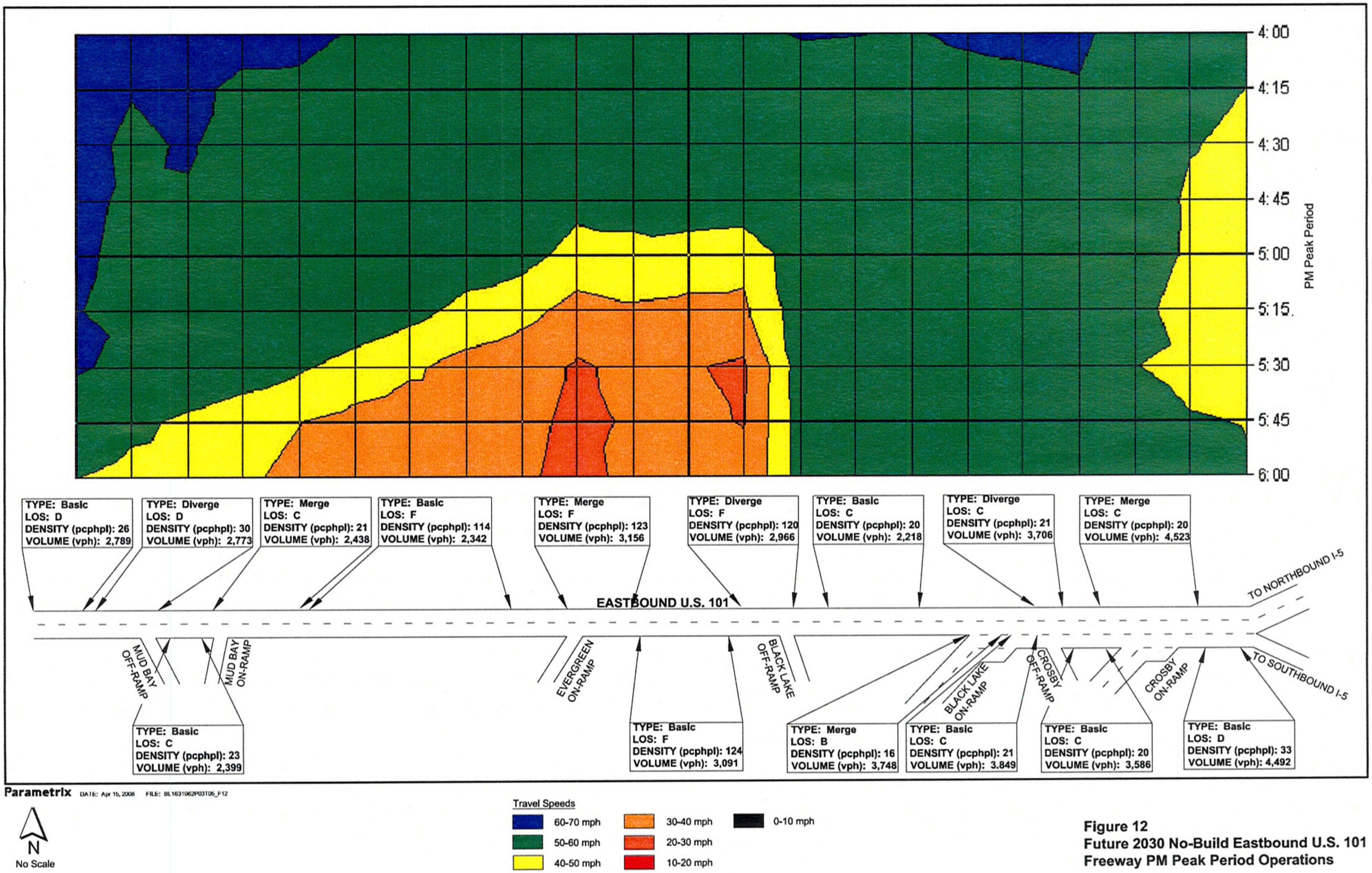


Figure 12
Future 2030 No-Build Eastbound U.S. 101
Freeway PM Peak Period Operations

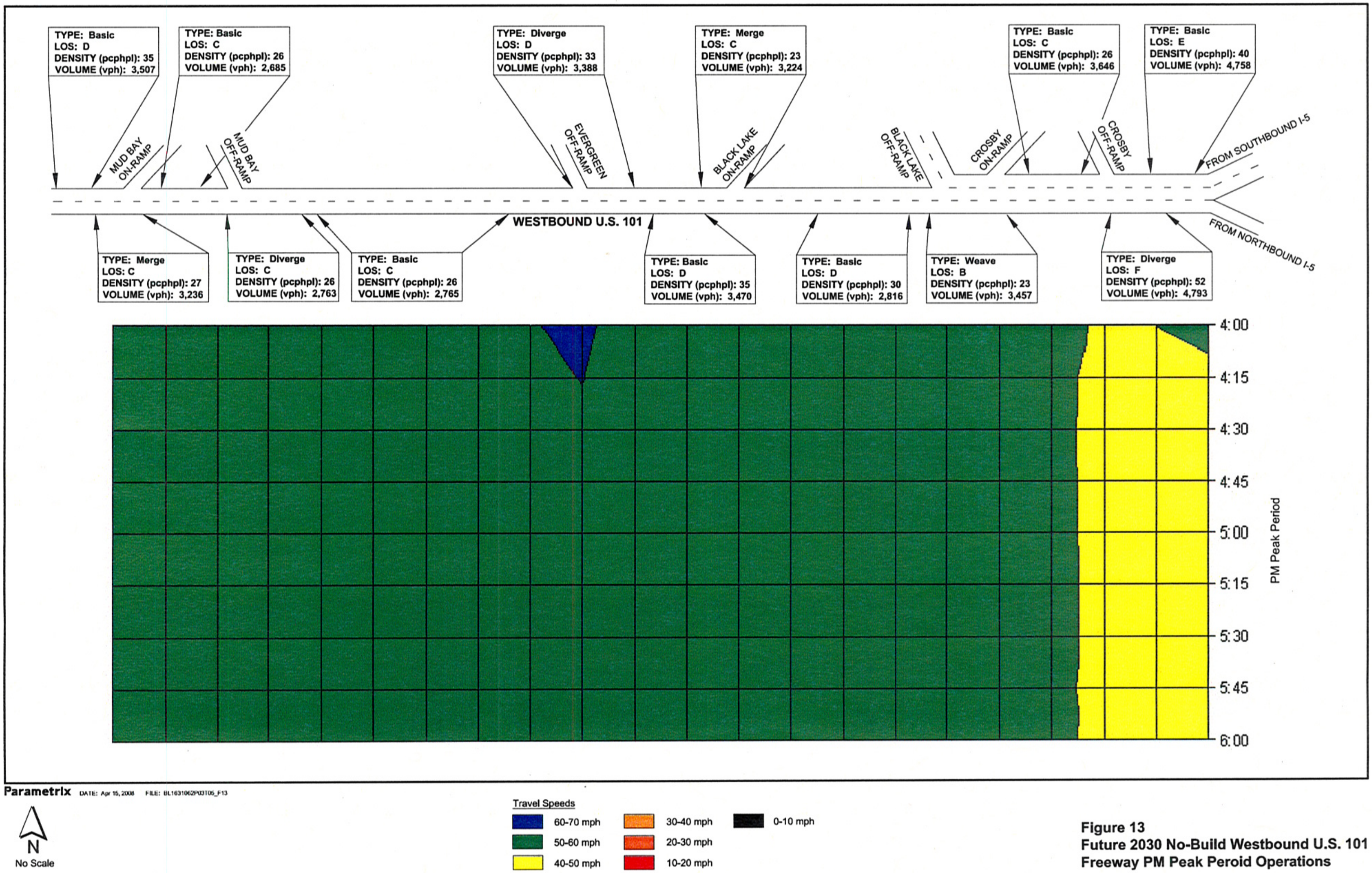


Figure 13
Future 2030 No-Build Westbound U.S. 101
Freeway PM Peak Peroid Operations

Table 9. Existing 2007 and No-Build 2030 PM Peak Hour Freeway Operations

Mainline Segment	Type	Existing 2007 Density (pc/mi/ln)	Existing 2007 LOS (HCM Equivalent)	No-Build 2030 Density (pc/mi/ln)	No-Build 2030 LOS (HCM Equivalent)
Northbound I-5					
Northbound I-5 to US 101 Off-Ramp	Diverge	27.6	C	40.7	E
Northbound I-5 US 101 On-Ramp	Merge	35.1	E	84.8	F
Northbound I-5	Basic	27.08	D	38.1	E
Southbound I-5					
Southbound I-5	Basic	73.4	F	81.4	F
Southbound I-5 to US 101 Weave	Weave	53.3	F	57.6	F
Southbound I-5 US 101 On-Ramp	Merge	27.23	C	42.1	E
Eastbound US 101					
Eastbound US 101	Basic	14.4	B	113.8	F
Eastbound US 101 Evergreen On-Ramp	Merge	13.5	B	122.9	F
Eastbound US 101	Basic	19.4	C	123.6	F
Eastbound US 101 Black Lake Off-Ramp	Diverge	19.1	B	120.3	F
Westbound US 101					
Westbound US 101 e/o Crosby Blvd	Basic	35.1	E	39.5	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	48.4	F	51.6	F

pc/mi/ln = passenger cars per mile per lane

Note: The HCM does not provide a density for LOS F for merge and diverge areas. A density of 45 pc/mi/ln, which is the same for basic segments, was assumed to distinguish between LOS E and F.

The number of mainline segment types expected to operate at LOS E or F is expected to increase from five locations in 2007 to 12 locations in 2030. Half of the segments along I-5 are expected to degrade by one LOS grade and two segments are expected to worsen by two LOS grades. Changes to densities and LOS along US 101 are expected to be much more dramatic with more locations operating unacceptably and the magnitude of degradation ranging from two to four LOS letter grades. Of particular interest are the substantial density increases along eastbound US 101 that appear disproportionate to the increase in volumes. The substantial increases in density are due to bottleneck conditions that limit the amount of throughput while increasing densities, which is substantiated by the low travel speeds. The bottleneck at this location is the result of over saturated conditions at the Black Lake Boulevard/Cooper Point Road SW intersection; the northeast bound left turn experiences a high demand and queues to the Black Lake SPUI, which creates a queue at the eastbound Black Lake SPUI off-ramp and US 101 eastbound mainline. Figures 10 through 13 show the mainline densities and LOS for each I-5 and US 101 mainline segment type. An expanded table that shows the densities and LOS for all segments of I-5 and US 101 is provided in Appendix C.

Speeds

Northbound I-5 operating speeds are expected to decrease by a relatively small amount, from primarily 60-70 mph to 50-60 mph in the year 2030. However, the increased volumes coming from US 101 (approximately 1,350 vehicles per hour) are expected to reduce operating speeds to 30-50 mph around the merge area for the duration of the PM peak period. The year 2030 speed conditions for northbound I-5 are shown in Figure 10.

Poor operating speeds prior to the short weave section on southbound I-5 between the City Center and US 101 off-ramps are expected to be exacerbated by increased travel demand. While this section experiences travel speeds around 30-40 mph for the majority of the PM peak period under existing conditions, future year 2030 travel speeds are expected to decrease to 20-30 mph for roughly half of the PM peak period. South of the weave section, travel speeds are expected to be similar to existing conditions (50-60 mph) with a brief reduction to 40-50 mph near the US 101 on-ramp merge area. Travel speeds for the southbound I-5 year 2030 PM peak period are illustrated in Figure 11.

While the existing eastbound US 101 travel speeds intermittently vary between 50-70 mph, future year 2030 conditions are expected to substantially degrade. For roughly half of the PM peak period (5:00 to 6:00 PM), travel speeds beginning at the western limit of the study area are expected to decrease to 40-50 mph around the Mud Bay Road interchange, progressively worsen to 30-40 mph just after the Mud Bay Road on-ramp, and continue to decrease to 20-30 mph for a short period just after the Evergreen on-ramp. Near the Crosby Boulevard/Cooper Point on-ramp, travel speeds are also expected to decrease from 50-60 mph in 2007 to 40-50 mph in the year 2030. This decrease in travel speeds is due to the high volume of traffic merging onto the US 101 mainline, lane changes, and interactions with I-5, which are shown on Figures 10 and 11. Figure 12 shows the year 2030 operating speeds along eastbound US 101 during the PM peak period.

Travel speeds along westbound US 101 are expected to be moderately lower in the year 2030 compared to 2007 conditions. Currently westbound US 101 generally experiences operating speeds around 40-50 mph prior to the Crosby Boulevard interchange, and 50-60 mph continuing west with a slight and brief increase to 60-70 mph after the Evergreen Parkway off-ramp. The year 2030 travel speeds would be similar to existing conditions, but without the short portion that operates at 60-70 mph and the lower operating speeds east of the Crosby Boulevard interchange extend further back towards I-5. Travel speeds along westbound US 101 are shown in Figure 13 for the year 2030 during the PM peak period.

YEAR 2030 NO-BUILD LOCAL INTERSECTION TRAFFIC OPERATIONS

LOS (Average Delays)

Similar to the freeway operations, increased travel demand on the local streets is expected to degrade the local transportation system. Table 10 compares the existing 2007 and No-Build 2030 local traffic operations for the PM peak hour.

Table 10. Existing 2007 and Future No-Build 2030 PM Peak Hour Local Traffic Operations

		One-Hour Peak[b]			Two-Hour Peak[b]			One-Hour Peak[b]			Two-Hour Peak[b]		
Intersection Description	Intersection Control[a]	LOS[b,c]	Delay (sec/veh)	Max v/c Ratio	LOS	Delay (sec/veh)	Max v/c Ratio	LOS	Delay (sec/veh)	Max v/c Ratio	LOS	Delay (sec/veh)	Max v/c Ratio
Harrison Avenue/Division Street	Signalized	F	84.7	1.00	E	73.4	0.96	F	187.1	1.46	F	163.6	1.38
Black Lake Blvd/Cooper Point Road	Signalized	F	85.2	1.18	E	74.1	1.12	F	199.9	1.39	F	173.5	1.32
Black Lake Road/US 101 SPUI (Through/Lefts)	Signalized	E	63.2	0.98	E	60.1	0.96	F	187	1.31	F	178.6	1.28
Cooper Point Road/Harrison/Mud Bay	Signalized	D	49.6	0.81	D	45.0	0.80	F	110.3	1.11	F	95.5	1.05
Cooper Point Road/Capitol Mall Blvd	Signalized	D	38.2	0.73	C	34.9	0.70	F	112.8	1.18	F	94.3	1.11
Black Lake Blvd/9th Ave/Capital Mall Drive	Signalized	C	32.6	0.69	C	31.5	0.66	F	101.2	1.19	F	89.3	1.10
Cooper Point Road Automall Drive/Evergreen Park Drive	Signalized	C	27.6	0.74	C	25.7	0.69	F	162.4	1.21	F	121.4	1.13
Cooper Point Road/Top Foods Entrance	Signalized	C	24.3	0.73	C	23.1	0.69	F	85.7	1.41	E	67.2	1.26
Crosby Blvd/US 101 Westbound Ramps (dec.)	Signalized	C	21.0	0.64	B	19.9	0.58	E	65.9	1.14	D	35.2	1.00
Crosby Blvd/US 101 Eastbound Ramps (inc.)	Signalized	B	19.3	0.67	B	18.6	0.62	F	114.5	1.22	F	86.3	1.13
Crosby Blvd/Mottman Road	Signalized	B	19.0	0.60				E	64.4	0.97			
Crosby Blvd/Irving Street	Signalized	B	14.5	0.44				C	24.7	0.81			
Harrison Avenue/Kenyon Street	Signalized	B	12.5	0.55	B	12.2	0.54	C	20.7	0.72	B	19.7	0.70
Black Lake Blvd/Capital Mall Entrance	Signalized	B	10.4	0.46	B	10.0	0.43	B	12.3	0.59	B	11.6	0.55
Harrison Avenue/Yauger Way	Signalized	A	8.6	0.53	A	8.4	0.51	C	20.7	0.88	B	19.1	0.86
Black Lake Road/US 101 SPUI Westbound US 101 (dec.) Off-Ramp Right Turns	Signalized	A	8.0	0.73	A	7.8	0.65	A	6.4	0.72	A	6.2	0.70
Black Lake Road/US 101 SPUI Eastbound US 101 (inc.) Off-Ramp Right Turns	Signalized	A	2.7	0.35	A	2.7	0.34	A	7.3	0.52	A	7.1	0.51
Harrison Avenue/McPhee Road	Unsignalized	F	>100	0.77	F	76.3	0.64	F	>100	0.91	F	>100	0.91
Harrison Avenue/Kaiser Road	Unsignalized	F	>100	0.73	F	>100	0.55	A[c]	9	0.65	A[c]	7.7	0.64
Mud Bay Road/Evergreen Parkway Northbound Ramp	Unsignalized	F	>100	1.12				F	>100	6.57			
Mud Bay Road/Evergreen Parkway Southbound Ramp	Unsignalized	F	>100	2.54				F	>100	63.5			
Black Lake Blvd/Top Foods Entrance	Unsignalized	C	19.4	0.45	C	16.9	0.39	D	29.3	0.64	C	21.0	0.49
Lakeridge Drive/Deschutes Parkway	Unsignalized	C	16.7	0.47	C	16.1	0.36	F	>100	2.84	F	>100	1.90
Capital Mall Drive/Yauger Way	Unsignalized	B	13.5	0.28	B	12.0	0.19	F	135.9	1.16	F	135.9	1.16

[a] Unsignalized LOS and delay were calculated by HCS+. The LOS and delay for all-way stop-controlled intersections are reported for the intersection as a whole, whereas the LOS and delay for two-way stop-controlled intersections are reported for the worst approach. Signalized intersection LOS and delay were calculated from the HCM Signals Report feature of Synchro 7 (build 757).

[b] The one-hour analysis is based on HCM methodologies and provided the basis for intersection improvements. The two-hour analysis results account for the 2-Hour Adjustment Factor that the City of Olympia uses to define their LOS standards. A "NA" indicates intersections that are not under the jurisdiction of the City of Olympia and therefore a 2-Hour Adjustment Factor is not applicable.

[c] Traffic signalization is planned and programmed and will be constructed by 2010.

Accounting for the 2-Hour Adjustment Factor, where applicable, of the 24 study intersections:

- eight intersections operate at LOS A, B, or C (compared to 16 in 2007)
- three intersections operate at LOS D or E (compared to four in 2007), and
- 13 intersections operate at LOS F (compared to four in 2007).

Of the 16 intersections operating at LOS D, E, or F in the year 2030 (compared to eight in 2007), 14 would be unacceptably below their respective LOS standards (compared to five in 2007).

Compared to the existing 2007 "triangle" delay, which is 192.5 seconds/vehicle, the year 2030 "triangle" delay substantially increases to 432.6 seconds/vehicle.

REFERENCES

FHWA (Federal Highway Administration). 2004. *Traffic Analysis Toolbox, Volume 3, Guidelines for Applying Traffic Microsimulation Modeling Software.*

PTV America. 2007. *West Olympia Access Study, Model Documentation.*

TRB (Transportation Research Board). 2000. *Highway Capacity Manual (HCM), Special Report 209.*

STAKEHOLDER ACCEPTANCE

The undersigned parties concur with the assumptions, methodologies, and conclusions of the traffic analysis presented in this have reviewed this technical memorandum.

WSDOT Assistant Design Engineer

Signature

Assistant State Design Engineer

~~Date~~ Title

7/9/08

Date

FHWA

Signature

FHWA – Olympic Region Area Engineer

Title

6/18/2008

Date

WSDOT Headquarters

Signature

Access & Hearing Specialist

Title

7/9/08

Date

City of Olympia

Randy Wesselman

Signature

Transportation Engineering & Planning Manager

Title

7/2/08

Date

WSDOT Olympic Region

Signature

Region Traf Engr.

Title

6/24/2008

Date

TRPC

Thera Black

Signature

Thurston Regional Planning Council Senior Planner

Title

Date 6.30.2008

ATTACHMENT A

Model Inputs and Calibration Assumptions

Model Inputs and Calibration Assumptions

Model Input	Data Source(s)	Relevant Values	Remarks
Vehicle Speeds	WSDOT Annual Speed Report for 60 mph facilities Speed group distribution (R097, R003E, and P4)	55-58 mph (7%), 58-60 mph (43%), 60-67 mph (36%), 67-70 mph (12%), 70-75 mph (2%)	Northbound P4 speeds were used as representative of network (best available data)
Vehicle Compositions	Freeway: WSDOT P4 ADC and WSDOT R003E ADC Classification Summaries Annual Traffic Summary Local: City of Olympia Turning Movement Counts	US 101 Heavy Vehicles = 7% I-5 Heavy Vehicles = 9% Local Heavy Vehicles = 3%	PM Peak Period Heavy Vehicle Percentages
Volumes	*Freeway Volumes:* WSDOT ADC Locations P4, R003E, R097, R098 (October 2006) *On- and Off-Ramp Volumes:* WSDOT Tube Counts (January 2007) *Local Turning Movement Counts*: City of Olympia Existing Conditions Synchro Model (Base 2005) , City of Olympia Turning Movement Counts (2005-2007)	See Figures Tech Memo Figure 2, 3, and 4	Freeway: Average weekday PM peak period (4:00-6:00) counts. Local: Two hour weekday PM peak period(4:00 - 6:00) turning movement counts
Signal Timings	City of Olympia Existing Conditions Synchro Model, Consultant Field Measurements	n/a	Field Verified Signal Timings per field visit
Network Channelization	WSDOT Aerial SID File (Year 2007) local.live.com Consultant Field Visits	n/a	Existing channelization measured from scaled SID file. Number of lanes and channelization verified using local.live.com and consultant field visits

Model Inputs and Calibration Assumptions

Model Input	Data Source(s)	Relevant Values	Remarks
Vehicle Routing	Existing Turning Movement Splits, Existing Conditions VISUM Model	Static Routing	Used VISSIM static routing feature utilizing existing turning movement splits and on-and off-ramp percentages. For SB I-5 from 14th/Plum Avenue, utilized the existing conditions VISUM model to estimate O-D in the I-5/US 101 weave section.
Calibration Parameters	Primary: Lane Change Distances Secondary: Driver Behavior Parameter CC1 (Headway Time)	Modified CC1 on Southbound I-5 between 14th/Plum Avenue On-Ramp and US-101 Off Ramp from 0.9 to 1.3. Lane change distances varied between 2,500' to 7,500'	Modified driver behavior parameters to replicate field measured travel times and speeds. The model would not replicate the queue across all lanes by only changing lane change distances.

ATTACHMENT B

Modeled and Expected Volumes Comparison and GEH Statistics

West Olympia Existing PM Peak Conditions VISSIM Model Calibration-Volumes

West Olympia Existing Conditions											
Intersection Name	Measurement Point #	Data Collection Points	Expected Volume	Model Volume				Total Volume	Percent Difference	Absolute Difference	GEH
			4:30 - 5:30	4:30	4:45	5:00	5:15	4:30 - 5:30	4:30 - 5:30	4:30 - 5:30	
Freeway Volumes											
Southbound I-5											
Model Entry	100	28,29,30	4585	1197	1165	1139	1039	4540	1%	45	0.668
SB I-5 Mainline	103	37,38,39	4585	1167	1174	1112	1114	4567	0%	18	0.265
Plum On/US 101 Off Weave	105	43,44,45,46	6248	1560	1567	1544	1541	6212	1%	36	0.452
SB I-5 Mainline	106	47,48,49	3270	800	779	818	773	3169	3%	101	1.773
2nd Avenue Off	106	47,48,49	3270	800	779	818	773	3169	3%	101	1.773
SB I-5 Mainline	107	50,51,52	2994	744	725	760	722	2951	1%	43	0.791
US 101 On	109	56,57,58	4334	1065	1052	1095	1069	4280	1%	55	0.830
Model Exit	110	59,60,61	4334	1064	1054	1098	1068	4284	1%	50	0.765
Northbound I-5											
Model Entry	200	62,63,64	3855	986	978	1007	892	3863	0%	-8	0.135
US 101 Off	202	68,69,70	3855	987	979	1010	896	3872	0%	-17	0.280
NB I-5 Mainline	204	74,75,76	2960	767	745	773	697	2982	-1%	-22	0.396
US 101 On-ramp Merge	205	77,78,79,80	5958	1495	1448	1559	1457	5960	0%	-2	0.023
US 101/14th Ave Off-ramp Diverge	206	81,82,83,84	5958	1496	1449	1551	1460	5957	0%	1	0.014
NB I-5 Mainline	207	85,86,87,88	5077	1287	1242	1331	1260	5119	-1%	-42	0.592
Plum On	208	89,90,91,92,93	5777	1452	1378	1519	1462	5812	-1%	-35	0.453
Model Exit	208	89,90,91,92,93	5789	1452	1378	1519	1462	5812	0%	-23	
Westbound 101											
Model Entry	300	94,95,96	4381	1106	1147	1078	1108	4439	-1%	-58	0.866
Crosby Blvd Off	302	100,101,102	4381	1104	1145	1083	1108	4440	-1%	-59	0.887
WB 101 Mainline	303	103,104,105	3261	819	842	805	817	3283	-1%	-22	0.383
Crosby Blvd/Black Lake Weave	305	110,111,112	3487	874	898	869	871	3512	-1%	-25	0.414
WB 101 Mainline	306	113,114	2073	513	539	504	511	2066	0%	7	0.145
Black Lake On	309	119,120	2467	603	644	596	621	2463	0%	4	0.073
WB 101 Mainline	310	121,122	2467	599	641	600	624	2463	0%	4	0.081
Evergreen Off	311	123,124	2467	599	642	598	623	2462	0%	5	0.107
WB 101 Mainline	312	125,126	1891	467	504	465	487	1924	-2%	-33	0.749
Mud Bay Off	317	293,294	1891	468	504	475	479	1926	-2%	-35	0.799
WB 101 Mainline	318	297,298	1805	449	484	450	461	1844	-2%	-39	0.906
Mud Bay On	320	305,306	2401	594	622	594	593	2403	0%	-2	0.037
WB 101 Mainline	320	305,306	2401	594	622	594	593	2403	0%	-2	0.037
Model Exit	320	305,306	2401	594	622	594	593	2403	0%	-2	0.037
Eastbound 101											
Model Entry	4000	278,279	1773	433	443	455	438	1769	0%	5	0.107
Mudbay Off	4000	278,279	1773	433	443	455	438	1769	0%	5	0.107
EB 101 Mainline	4002	299,300	1460	357	361	375	359	1451	1%	9	0.236
Mudbay On	4003	280,281,282	1520	376	376	391	371	1514	0%	6	0.159
EB 101 Mainline	4004	295,296	1520	375	375	393	370	1513	0%	7	0.175
Evergreen On	401	131,132,133	2080	511	515	531	507	2064	1%	16	0.354
EB 101 Mainline	403	136,137	2080	511	517	532	506	2066	1%	15	0.318
Black Lake Off	404	138,139	2080	509	517	532	506	2064	1%	16	0.356
EB 101 Mainline	407	144,145	1820	449	452	466	443	1810	1%	10	0.239
Black Lake On	408	146,147,148,149	3270	790	797	824	807	3218	2%	52	0.911
EB 101 Mainline	409	150,151,152	3270	789	784	825	813	3211	2%	59	1.044
Crosby Blvd Off	409	150,151,152	3270	789	784	825	813	3211	2%	59	1.044
EB 101 Mainline	410	153,154,155	3090	749	739	766	772	3026	2%	64	1.157
Crosby Blvd On	411	156,157,158,159,160	4375	1059	1030	1113	1086	4288	2%	87	1.317
Model Exit	413	164,165,166	4375	1069	1048	1102	1082	4300	2%	75	1.139
			85119					84848	Comprehensive Model GEH -->		0.93

ATTACHMENT C

Expanded Freeway Density and LOS Table

West Olympia Access Study Existing PM Peak Conditions Freeway Density

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,519	73.5	F
Southbound I-5 to US 101 Weave	Weave	6,212	53.4	F
Southbound I-5	Basic	3,159	20.9	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,107	17.8	B
Southbound I-5	Basic	2,952	19.8	C
Southbound I-5 US 101 On-Ramp	Merge	3,867	27.2	C
Southbound I-5	Basic	4,282	27.9	D
Northbound I-5	Basic	3,871	22.6	C
Northbound I-5 to US 101 Off-Ramp	Diverge	3,871	27.6	C
Northbound I-5	Basic	2,980	19.2	C
Northbound I-5 US 101 On-Ramp	Merge	5,852	35.0	E
Northbound I-5	Basic	5,955	27.0	D
Northbound I-5 Plum/14th Off-Ramp	Diverge	5,583	27.4	C
Northbound I-5	Basic	5,112	24.1	C
Westbound US 101 e/o Crosby Blvd	Basic	4,411	35.1	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,433	48.4	F
Westbound US 101	Basic	3,244	22.7	C
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,021	20.0	B
Westbound US 101	Basic	2,029	20.2	C
Westbound US 101 Black Lake On-Ramp	Merge	2,276	15.1	B
Westbound US 101	Basic	2,453	23.6	C
Westbound US 101 Evergreen Off-Ramp	Diverge	2,389	22.6	C
Westbound US 101	Basic	1,924	18.0	C
Westbound US 101 Mud Bay Off-Ramp	Diverge	1,918	18.1	C
Westbound US 101	Basic	1,843	17.3	B
Westbound US 101 Mud Bay On-Ramp	Merge	2,216	14.4	B
Westbound US 101	Basic	2,400	22.9	C
Eastbound US 101	Basic	1,768	16.3	B
Eastbound US 101 Mud Bay Off-Ramp	Diverge	1,760	16.5	B
Eastbound US 101	Basic	1,460	13.5	B
Eastbound US 101 Mud Bay On-Ramp	Merge	1,511	8.9	A
Eastbound US 101	Basic	1,513	14.4	B
Eastbound US 101 Evergreen On-Ramp	Merge	2,049	13.5	B
Eastbound US 101	Basic	2,065	19.4	C
Eastbound US 101 Black Lake Off-Ramp	Diverge	2,037	19.1	B
Eastbound US 101	Basic	1,726	15.7	B
Eastbound US 101 Black Lake On-Ramp	Merge	3,125	14.4	B
Eastbound US 101	Basic	3,214	19.5	C
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	3,098	19.2	B
Eastbound US 101	Basic	3,000	18.2	C
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,283	20.4	C
Eastbound US 101	Basic	4,267	29.4	D

West Olympia Year 2030 No Build PM Peak Freeway Density Summary

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,650	81.4	F
Southbound I-5 to US 101 Weave	Weave	6,414	57.6	F
Southbound I-5	Basic	3,553	24.1	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,506	21.2	C
Southbound I-5	Basic	3,363	23.5	C
Southbound I-5 US 101 On-Ramp	Merge	4,336	42.1	E
Southbound I-5	Basic	4,792	33.0	D
Northbound I-5	Basic	5,518	33.1	D
Northbound I-5 to US 101 Off-Ramp	Diverge	5,519	40.7	E
Northbound I-5	Basic	4,273	28.7	D
Northbound I-5 US 101 On-Ramp	Merge	7,133	84.8	F
Northbound I-5	Basic	7,271	38.1	E
Northbound I-5 Plum/14th Off-Ramp	Diverge	6,857	32.4	D
Northbound I-5	Basic	6,328	30.8	D
Westbound US 101 e/o Crosby Blvd	Basic	4,733	39.5	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,758	51.6	F
Westbound US 101	Basic	3,618	25.7	C
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,433	23.2	B
Westbound US 101	Basic	2,796	29.7	D
Westbound US 101 Black Lake On-Ramp	Merge	3,205	23.3	C
Westbound US 101	Basic	3,451	34.9	D
Westbound US 101 Evergreen Off-Ramp	Diverge	3,367	32.6	D
Westbound US 101	Basic	2,742	26.0	C
Westbound US 101 Mud Bay Off-Ramp	Diverge	2,738	26.3	C
Westbound US 101	Basic	2,661	25.5	C
Westbound US 101 Mud Bay On-Ramp	Merge	3,196	27.0	C
Westbound US 101	Basic	3,467	35.0	D
Eastbound US 101	Basic	2,776	26.2	D
Eastbound US 101 Mud Bay Off-Ramp	Diverge	2,764	29.8	D
Eastbound US 101	Basic	2,391	23.3	C
Eastbound US 101 Mud Bay On-Ramp	Merge	2,415	21.1	C
Eastbound US 101	Basic	2,214	113.9	F
Eastbound US 101 Evergreen On-Ramp	Merge	2,960	123.1	F
Eastbound US 101	Basic	2,909	123.8	F
Eastbound US 101 Black Lake Off-Ramp	Diverge	2,795	120.5	F
Eastbound US 101	Basic	2,218	19.5	C
Eastbound US 101 Black Lake On-Ramp	Merge	3,603	15.7	B
Eastbound US 101	Basic	3,710	21.2	C
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	3,574	20.5	C
Eastbound US 101	Basic	3,460	19.7	C
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,400	20.1	C
Eastbound US 101	Basic	4,375	32.9	D

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TECHNICAL MEMORANDUM 3

Date:	November 10, 2008
To:	George Kovich, WSDOT Project Manager Randy Wessleman, City of Olympia Project Manager
From:	Peter Chen
Subject:	West Olympia Access Study – Traffic Operations Analysis Technical Memorandum 3
cc:	James Colyar, PE, FHWA Doug McClannahan, PE, WSDOT Headquarters John Perlic, PE, Parametrix
Project Number:	554-1631-062 (03/04)
Project Name:	West Olympia Access Study

EXECUTIVE SUMMARY

Need for Improvements

During the last 5 to 10 years, observed congestion along United States route 101 (US 101) and at local intersections in the West Olympia vicinity has resulted in the need to study the area and identify potential operating deficiencies. With the aid of the Thurston Regional Planning Council (TRPC) and the cities of Olympia and Tumwater, existing and future traffic conditions were modeled and the conclusions of that study confirmed operational challenges along the US 101 corridor and the local transportation system in West Olympia (see Technical Memorandum 2, Parametrix 2008).

Short weave sections, frequent lane change maneuvers, and steep grades in some areas currently cause congestion along US 101 in the West Olympia vicinity during peak periods. Substantial traffic volume increases on US 101 and Interstate 5 (I-5) are expected to worsen poor operating conditions in the year 2030. In 2030, 14 sections of US 101 and I-5 are expected to experience heavy traffic congestion and unacceptable level of service (LOS) E and LOS F conditions.

In addition to US 101 and I-5 mainline challenges, the local transportation systems in West Olympia and Tumwater are also forecasted to substantially degrade and experience long delays and queues in the year 2030. Of particular concern are the Black Lake Boulevard Single Point Urban Interchange (SPUI), Black Lake Boulevard SW/Cooper Point Road SW intersection, and the Cooper Point Road SW/Top Foods Driveway intersection. The traffic demand at these locations is estimated to substantially exceed capacity and the resulting queues are expected to create bottleneck traffic congestion along eastbound US 101 from the Black Lake off-ramp to west of the Evergreen Parkway interchange.

The high level of interdependency between the freeway and local transportation systems pointed to a need to study improvements to US 101 and local intersections in the cities of Olympia and Tumwater. Without improvements, connectivity between regional activity centers would substantially degrade, congestion could become a detriment to local economic activities, and collision rates and severity would likely increase.

Screening Process

The screening process is documented in Technical Memorandum 1—Evaluation and Screening Methods. The first step of the screening process included reviewing suggestions during Phase I of the public involvement effort and conducting a fatal flaw analysis. The purpose of this analysis was to eliminate the options that did not meet the objectives of the study. It was concluded that no new interchange could be considered due to spacing issues between existing interchanges on US 101 as defined by the WSDOT Design Manual.

The options that remained after the fatal flaw analysis were included in the initial screening process. The purpose of this screening was to eliminate scenarios that were not found to merit further consideration because they do not address the study goals. Options were evaluated based on planning level estimates, qualitative technical review and other available information. The initial screening was conducted at a broad, non-quantitative level to rate each option from most impacts (worst) to least impacts (best).

Based on the preliminary screening process, options that were selected for further consideration were packaged into scenarios to assess their effectiveness as a system. A more detailed traffic evaluation of the scenarios was conducted in the second screening process, which this technical memorandum documents. This analysis focused on reviewing traffic changes and identifying whether the scenarios would relieve traffic congestion at failing intersections and congested freeway locations.

Improvement Scenarios

The result of the screening process effort eliminated potential improvement options with fatal flaws and identified a set of reasonable scenarios to be carried forward for further consideration.

Scenarios carried forward for additional analysis originally included the full range of improvements that would be required to meet applicable standards according to the traditional one-hour LOS analysis methodology. This approach maximized additional intersection improvements to the fullest extent and was most applicable to the Local System Only Scenarios (Scenario 2 and 3). A few of these improvements were later identified by the City of Olympia as infeasible and conflicted with adopted City policies to promote and encourage transit, pedestrian, and bicycle travel. Intersection safety for all travelers is the primary concern behind the identification and removal of these infeasible intersection widening improvements. Listed below are mores specific reasons some of the original improvements were deemed infeasible and removed from further consideration in the scenario analysis:

- Non-motorized crossings are the primary concern associated with intersection widening. The higher number of turn lanes added translates to a less pedestrian-friendly environment by lengthening crosswalks and requiring bicyclists to compete with more vehicle travel lanes at intersections.
- All intersections identified as needing expansion are served by Intercity Transit routes with the exception of the Mud Bay Road/Evergreen Parkway intersection. This suggests that the vast majority of intersections serve transit riders that need to safely and conveniently cross these intersections.
- Two-thirds of the affected intersections are located on established high-density corridors where special consideration of urban form and a pedestrian-friendly environment are crucial to achieving City and regional multi-modal objectives. Substantial increases to intersection crossings undermine the transportation and land use objectives for these corridors.

- Increased pedestrian crossing times would be needed to accommodate longer crossings, which would increase friction for opposing traffic.
- The number of conflict points increases with the addition of intersection turn lanes, increasing the potential for vehicle-to-vehicle collisions as well as vehicle-to-pedestrian/bicyclist collisions.

Additional detail on the justifications for removing some of the original intersection improvements is provided in Attachment A. The remaining improvements identified for each scenario were based on the traditional one-hour LOS analysis.

Local System Only (Scenarios 2 and 3)

These scenarios focus on changes to the local transportation system only and do not modify highway access. The difference between Scenario 2 and Scenario 3 is the inclusion of street connections between existing roadway facilities in the southwest residential area of West Olympia. These connections, collectively referred to as the "Southwest Connections," include:

- Decatur Street SW connection between Caton Way SW and Decatur Street SW (a pedestrian and bicycle connection is currently provided, but vehicular access is not allowed),
- Fern Street SW connection to Carriage Loop SW, and
- 16th Avenue SW connection to Fern Street SW (removal of existing barricade).

Scenario 2 does not include the Southwest Connections and Scenario 3 does include the Southwest Connections.

Improvements listed below apply to both Scenarios 2 and 3, except where noted. Intersection improvements were based on the traditional one-hour analysis methodology and include:

- two turn lanes at the Harrison Avenue/Division Street,
- one turn lane at the Black Lake Boulevard/Cooper Point Road intersection,
- one turn lane at the Cooper Point Road/Harrison Avenue intersection,
- one turn lane at the Black Lake Boulevard/Capital Mall Drive intersection for Scenario 2 only,
- one turn lane at the Cooper Point Road/Evergreen Park Drive intersection,
- one turn lane at the Cooper Point Road/Top Foods intersection,
- one through lane for Scenarios 2 and 3, and one additional turn lane for Scenario 3 at the US 101 Westbound Ramps/Crosby Boulevard intersection,
- one turn lane and signalization at the Mud Bay Road/Evergreen Parkway Westbound Ramp intersection,
- signalization of the Mud Bay Road/Evergreen Parkway Eastbound Ramp intersection, and
- signalization at the Lakeridge Drive/Deschutes Parkway intersection for both scenarios and an additional turn lane for Scenario 2.

The number of improvements for Scenario 2 totals nine turn lanes, one through lane, and three signals. For Scenario 3, the total number of improvements consists of eight turn lanes, one through lane, and three signals. Refer to Table 12 (page 107) for a specific listing of turn lanes at each intersection.

Black Lake Interchange (Scenarios 4 and 5)

Similar to Scenarios 2 and 3, the Black Lake interchange improvement scenarios are proposed without the Southwest Connections described above (Scenario 4) and with the Southwest Connections (Scenario 5). Both Scenarios 4 and 5 also include local system improvements as described below. For Scenarios 4 and

5, the existing Black Lake interchange would be modified with an additional lane diverging from the westbound off-ramp that connects to Yauger Way SW, and another lane from Yauger Way SW would connect to the existing eastbound on-ramp prior to merging with the US 101 mainline. The exact interchange modifications have not been designed at this time; however, Scenarios 4 and 5 both rely on modifications to the existing Black Lake Boulevard interchange.

The intersection and freeway traffic operations analysis was fully completed for Scenario 5 with the Southwest Connections, but not for Scenario 4. A freeway analysis was not conducted for Scenario 4 since traffic volumes on the US 101 mainline would be similar to Scenario 5 and the small differences would result in negligible changes to mainline operations.

Intersection improvements listed below apply to Scenarios 4 and 5, except where noted. These improvements were based on the traditional one-hour analysis methodology and include:

- two turn lanes at the Harrison Avenue/Division Street intersection,
- one turn lane at the Black Lake Boulevard/Cooper Point Road intersection for Scenario 4 only,
- one turn lane at the Cooper Point Road/Harrison Avenue intersection,
- one turn lane at the Black Lake Boulevard/Capital Mall Drive intersection,
- one turn lane at the Cooper Point Road/Evergreen Park Drive intersection for Scenario 4 only,
- one through lane and one turn lane at the US 101 Westbound Ramps/Crosby Boulevard intersection for Scenario 5 only,
- signalization of the Mud Bay Road/Evergreen Parkway Westbound and Eastbound Ramp intersections, and
- signalization of the Lakeridge Drive/Deschutes Parkway intersection for both Scenarios 4 and 5 and an additional turn lane for Scenario 4.

Scenario 4 includes a total of seven turn lanes and three signals, while Scenario 5 consists of five turn lanes, one through lane, and three signals. Refer to Table 12 (page 107) for a specific listing of turn lanes at each intersection.

Evergreen Interchange (Scenarios 6 and 7)

The Evergreen improvement scenarios can also be packaged without the Southwest Connections (Scenario 6) or with the Southwest Connections (Scenario 7). Modifications to US 101 under Scenarios 6 and 7 would primarily consist of adding an eastbound off-ramp and a westbound on-ramp, which would provide full access to and from all directions of travel at the Evergreen interchange. The existing eastbound on-ramp and westbound off-ramp would also be re-aligned to provide an at-grade connection with Kaiser Road SW prior to merging/after diverging from the US 101 mainline. Both Scenarios 6 and 7 also include local system improvements as described below. Similar to Scenarios 4 and 5, more specific detail regarding modifications to the interchange have not been designed; however, both Scenario 6 and 7 provide full access at the Evergreen interchange and add modified access ramps to and from the east at Kaiser Road.

The intersection and freeway traffic operations analysis was fully completed for Scenario 7 with the southwest connections, but not for Scenario 6. Similar to Scenarios 4 and 5, the US 101 mainline traffic volumes would be similar between Scenarios 6 and 7 and the small differences would have a negligible effect on freeway mainline operations. As a result, a freeway analysis was not conducted for Scenario 6.

Intersection improvements listed below apply to both Scenarios 6 and 7, except where specifically noted. These improvements were based on the traditional one-hour analysis methodology and include:

- two turn lanes at the Harrison Avenue/Division Street intersection,
- one turn lane at the Black Lake Boulevard/Cooper Point Road intersection,
- one turn lane at the Cooper Point Road/Harrison Avenue intersection,
- one turn lane at the Cooper Point Road/Capital Mall Boulevard intersection for Scenario 6 only,
- two turn lanes for Scenario 6 and one turn lane for Scenario 7 at the Black Lake Boulevard/Capital Mall Drive intersection,
- one turn lane at the Cooper Point Road/Evergreen Park Drive intersection for Scenario 6 only,
- one turn lane at the Cooper Point Road/Top Foods intersection for Scenario 6 only,
- one through lane and one turn lane at the US 101 Westbound Ramps/Crosby Boulevard intersection for Scenario 7 only,
- signalization of the Mud Bay Road/Evergreen Parkway Westbound and Eastbound Ramp intersections, and
- signalization of the Lakeridge Drive/Deschutes Parkway intersection, with an additional turn lane for Scenario 6 only.

The improvements for Scenario 6 total 10 turn lanes and three signals, and Scenario 7 includes six turn lanes, one through lane, and three signals. Refer to Table 12 (page 107) for a specific listing of turn lanes at each intersection.

Freeway Operations on I-5 and US-101

For all build scenarios, traffic volumes increase slightly along northbound and southbound I-5 at the US 101 on-ramps compared to No-Build Scenario 1. These increases in volumes come from the release of bottleneck congestion at the Black Lake interchange with No-Build Scenario 1. Although the densities increase slightly (up to 7 passenger cars per mile per lane (pc/mi/ln) for northbound I-5 and about 1 pc/mi/ln for southbound I-5), the operational effect on travel speeds is 3 mph or less on northbound I-5 and no difference on southbound I-5 speeds. Although some build scenarios result in traffic volume diversions and cause densities to decrease in some areas and increase in other areas, the overall traffic volumes, densities, and speeds for northbound and southbound I-5 are generally similar between No-Build Scenario 1 and the build scenarios. Refer to Table 10 (page 88) for more detailed information on I-5 freeway operations.

For eastbound US 101, all build scenarios substantially improve traffic operations on the mainline. Due to severe congestion at the Black Lake interchange under No-Build Scenario 1, the eastbound US 101 corridor is expected to have an overall average density of 42 pc/mi/ln, compared to the build scenario densities that range between 36 and 38 pc/mi/ln. This is caused by traffic queues on the eastbound off-ramp extending from the Black Lake Boulevard ramps intersection onto mainline US 101.

Although some build scenarios "relocate" congestion, the traffic volumes, average mainline densities, and speeds are fairly similar among all build scenarios. The sum total of all segment densities has been used as an aggregate measure of effectiveness since densities at specific locations vary among scenarios due to upstream bottlenecks and traffic volume changes. The sum total of all segment densities for the build scenarios range from 1,453 pc/mi/ln to 1,542 pc/mi/ln, compared to 1,710 pc/mi/ln under No-Build Scenario 1. This indicates that the build scenarios provide more vehicle throughput and the No-Build Scenario 1 has more congestion. Within the study area, the eastbound US 101 mainline is expected to operate near free flow conditions with average speeds ranging between 47 mph to 50 mph for the build scenarios compared to 29 mph under No-Build Scenario 1. Travel times and average mainline speeds for westbound US 101 and northbound and southbound I-5 are highly similar between the No-Build and build scenarios with differences of 3 mph or less.

Local Intersection Operations

In addition to freeway mainline operations, local system operations were also considered when identifying recommendations. As described above, the following local intersection improvements are required for each of the build scenarios to meet LOS standards:

- Local System Only Scenario 2; 9 turn lanes, 1 through lane, and 3 signals,
- Local System Only Scenario 3; 8 turn lanes, 1 through lane, and 3 signals,
- Black Lake Interchange Scenario 4; 7 turn lanes and 3 signals,
- Black Lake Interchange Scenario 5; 5 turn lanes, 1 through lane, and 3 signals,
- Evergreen Interchange Scenario 6; 10 turn lanes and 3 signals, and
- Evergreen Interchange Scenario 7; 6 turn lanes, 1 through lane, and 3 signals.

Black Lake Scenario 5 has the least number of required local intersection improvements compared to the other build scenarios. The one-hour intersection LOS methodology was required by WSDOT and FHWA and the two-hour intersection LOS methodology is consistent with City of Olympia transportation concurrency requirements. Refer to the Design Year 2030 Local Intersection Traffic Operations section starting on page 88 and Table 11 for more detail. With the one-hour analysis, Black Lake Scenario 5 also has the highest number of intersections operating at LOS A, B or C (13 intersections) and no intersections operating at LOS F. Scenarios 4 and 7 have the second highest number of intersections operating at LOS A, B, or C (12 intersections), but have 3 (Scenario 4) and 2 (Scenario 7) intersections operating at LOS F.

The intersection operations analysis demonstrates that the Local System Only Scenarios 2 and 3 do not meet the purpose of the study to improve access and circulation in West Olympia for the following reasons:

- The US 101 SPUI/Black Lake Boulevard intersection cannot be improved to meet City of Olympia or WSDOT intersection LOS standards. With maximum improvements at this intersection and adjacent intersections, the two Local System Only Scenarios 2 and 3 cannot achieve better than LOS F conditions with average vehicle delays ranging from 130 to 140 seconds. This results in long vehicle queues on both the eastbound and westbound off-ramps and on Black Lake Boulevard. There is a greater potential for vehicle queues extending back into the US 101 mainline with these scenarios due to the higher degree of congestion.
- The two Local System Only Scenarios 2 and 3 require more intersection turn lane improvements (up to 9 turn lanes) compared to either the Black Lake Scenario 5 or Evergreen Scenario 7 (5 and 6 turn lanes respectively). Most of these turn lane improvements would require property acquisition and displace businesses, and some intersections would continue to operate worse than their applicable LOS standards.

Recommendations

The recommendations from this study are primarily based on the freeway and local system operations analysis results. Black Lake Scenario 5 has the lowest aggregate densities, which indicate higher throughput and less freeway congestion; however, the system-wide freeway densities and speeds are relatively similar among all build scenarios.

Since freeway operations are comparable for all build scenarios, the recommendations place significant emphasis on the local system operations. The local system operations for the build scenarios can be summarized as:

- Local System Only Scenario 2; 11 intersections at LOS A, B, or C and 4 intersections at LOS F
- Local System Only Scenario 3; 9 intersections at LOS A, B, or C and 4 intersections at LOS F
- Black Lake Interchange Scenario 4; 12 intersections at LOS A, B, or C and 4 intersections at LOS F
- Black Lake Interchange Scenario 5; 13 intersections at LOS A, B, or C and 0 intersections at LOS F
- Evergreen Interchange Scenario 6; 11 intersections at LOS A, B, or C and 4 intersections at LOS F
- Evergreen Interchange Scenario 7; 12 intersections at LOS A, B, or C and 2 intersections at LOS F

The number of local intersection improvements is important to consider when identifying recommendations because land uses at the intersections needing improvements are generally built out and construction of the improvements would require property acquisition for right-of-way. Full or partial displacement of existing uses substantially increase project costs, lengthens project schedules, and can be more difficult to implement. Additionally, increasing the number of turn lanes at intersections also increases pedestrian crossing times, which is less conducive to a pedestrian-friendly environment and inconsistent with the City's Comprehensive Plan. As described above, Black Lake Scenario 5 and Evergreen Scenario 7 require the least amount of local intersection improvements (also see Table 12, page 107).

In addition to the best local system operations and least number of intersection improvements, Black Lake Scenario 5 provides the most traffic reduction at the highly congested Black Lake Boulevard SPUI and the Black Lake Boulevard/Cooper Point Road intersections (approximately 800 vph lower than Local System Only Scenario 3) by diverting traffic to the new access ramps at Yauger Way. This is the only scenario that does not require any improvement to the Black Lake Boulevard/Cooper Point Road intersection to meet City of Olympia intersection LOS standards in the year 2030. Black Lake Scenarios 4 and 5, and to a lesser degree, Evergreen Scenarios 6 and 7, also provide important travel time and accessibility benefits to the Capital Medical Center by providing a direct route to and from US 101 for emergency vehicles, avoiding the highly congested Black Lake Boulevard and Cooper Point Road corridors.

Black Lake Scenarios 4 and 5, and to a lesser degree, Evergreen Scenarios 6 and 7 also provide an important secondary route to and from Capital Mall and surrounding retail businesses during peak holiday shopping weekends and seasons. A holiday season peak period traffic analysis was not specifically conducted; however, the new ramp connection to and from Yauger Way would likely improve safety and reduce vehicle queues and congestion that oftentimes extends into the US 101 mainline during these peak shopping days.

In summary, the two study recommendations and reasons for the recommendations are:

1. Eliminate Local System Only Scenarios 2 and 3 from further consideration
    - Local system impacts are substantially higher than other build scenarios
    - There is no traffic volume reduction at the highly congested US 101/Black Lake Boulevard SPUI and Black Lake Boulevard/Cooper Point Road intersections

- With feasible improvements only, several intersections operate at unacceptable LOS E or F conditions with high delay at US 101/Black Lake Boulevard SPUI, Black Lake Boulevard/Cooper Point Road and three to four other intersections
- There is no accessibility or travel time benefit to Capital Medical Center and other key locations compared to other build scenarios
- There is no benefit during holiday shopping time periods compared to other build scenarios

2. Conduct further evaluation of the Black Lake and Evergreen interchange scenarios
    - Concept design, accident/safety analysis, and an environmental screening evaluation would be initiated to provide more detailed information to select a preferred interchange alternative
    - An Interchange Justification Report (IJR) and NEPA/SEPA environmental document would be prepared after selecting a preferred interchange alternative

INTRODUCTION

The purpose of this Technical Memorandum 3 is to document the freeway and local traffic operational analyses for the West Olympia Access Study (WOAS) build scenarios. This documentation includes a review of the existing local and freeway road characteristics, data collection and methodology, micro-simulation model calibration and validation, and existing 2007 traffic conditions as noted in Technical Memorandum 2. It also contains a discussion of the resulting traffic analysis for the future year 2030 No-Build and Build scenarios traffic conditions and operations.

The study area for the WOAS, shown in Figure 1, can be broadly categorized from a traffic operations perspective as two systems: freeway corridors (I-5 and US 101) and the local transportation system in the cities of Olympia and Tumwater. The study area along the I-5 corridor is approximately 2.81 miles long and includes interchanges with US 101 and the southern half of the City Center interchange. The portion of the US 101 corridor within the study area is approximately 4.82 miles long and spans four interchanges, including Mud Bay Road, Evergreen Parkway, Black Lake Boulevard, and Crosby Boulevard/Cooper Point. The study area for the local transportation system is in the cities of Olympia and Tumwater and is located to the north and south of US 101.

As noted in Technical Memorandum 1, the study adopted a planning level approach whereby solutions or concepts were gradually screened to smaller groups of possible improvement options. Options that remained after a fatal flaw analysis were included in an initial screening process. The purpose of this screening was to eliminate scenarios that were not found to merit further consideration because they did not address the study goals. Options were evaluated based on planning level cost estimates, qualitative technical review and other available information. The initial screening was conducted at a broad, non-quantitative level to rate each option from most impacts (worst) to least impacts (best).

Based on the preliminary screening processes, options that were selected for further consideration were packaged into scenarios to assess their effectiveness as a system. This assessment primarily focused on traffic analysis tools to analyze different components of the transportation system. The following sections of this technical memorandum explain in detail each scenario and their operational analyses. This second screening conducted a more detailed evaluation of the scenarios to review changes in traffic operation analysis results and identify whether the scenarios may relieve congestion at failing intersections and congested freeway locations.

EXISTING 2007 ROADWAY CHARACTERISTICS

Freeways and Interchange Areas

The WOAS includes analyzing two freeway corridors, a 2.81-mile section of I-5 (MP 106.23 to MP 103.42) and a 4.82 mile portion of US 101 (MP 367.41 to MP 362.59). This section of the report briefly describes the geometric configurations of each of these freeways and their associated interchanges.

I-5

I-5 is the primary route for north-south interstate travel through Washington and provides connections between some of the largest cities in the Puget Sound region. Between the US 101 and City Center interchanges, I-5 has three to four northbound lanes and three to four southbound lanes, both with a posted speed limit of 60 mph. WSDOT classifies this portion of I-5 as an Urban-Interstate (U5) and as a Highway of Statewide Significance (HSS).

I-5/US 101 Interchange

Note: For the purpose of the report, northbound US 101 will be referred to as eastbound US 101 (increasing milepost) and southbound US 101 will be referred to as westbound US 101 (decreasing milepost) since the directional orientation within the study area is closer to east-west than north-south.

The I-5 southbound off-ramp (Exit 104) and the I-5 northbound off-ramp (Exit 104), which cross under I-5 and receives traffic from Deschutes Parkway SW, join to form westbound US 101 (decreasing milepost). The 2nd Avenue SW off-ramp (Exit 103) from southbound I-5 is located just south, approximately 0.2 miles, of the US 101 exit. Southbound I-5 receives traffic from eastbound US 101 (increasing milepost) approximately 0.4 miles south of the 2nd Avenue SW exit.

Traffic on eastbound US 101 has the option to travel south on 2nd Avenue SW, merge with southbound I-5 traffic, or connect to northbound I-5 traffic via a flyover ramp. The flyover ramp from eastbound US 101 also accepts traffic from Deschutes Parkway SW prior to merging with northbound I-5.

I-5/City Center Interchange

Traveling south on I-5, an exit ramp (Exit 105) splits with one lane that connects to Plum Street and the other to 14th Avenue SE. Two on-ramps, one from 14th Avenue SE and one from Henderson Boulevard SE, merge together prior to merging onto southbound I-5. The City Center northbound off-ramp also splits with one lane that merges into Henderson Boulevard SE and Plum Street, which passes under I-5 for local northbound traffic. The other I-5 northbound off-ramp lane merges into 14th Avenue SE, which crosses over I-5 and leads to local westbound traffic and is the main entrance to the capital campus. The northbound I-5 on-ramp stems from the 14th Avenue SE overpass as a loop ramp.

US 101

US 101 is a state highway that predominantly serves regional travel demand and connects the Olympic Peninsula to major activity centers on the east side of Puget Sound. Within the study area, US 101 is a two- to three-lane highway in each direction. US 101 is classified by WSDOT as an Urban-Principal Arterial (U1) and has a posted speed limit of 60 mph. US 101 is also listed as a HSS.

US 101/Mud Bay Road Interchange

This interchange represents the westernmost study interchange along US 101. At this interchange, the US 101 mainline has two westbound and two eastbound lanes. The westbound ramps terminus exhibits a configuration similar to a full diamond; however, the left and right turns are channelized and the through movement (from off-ramp to on-ramp) is restricted. The eastbound ramps terminus has a diamond-style off-ramp and a trumpet on-ramp. This interchange primarily serves low-density residential areas to the west, a few commercial uses to the east, and a connection to the Evergreen Parkway interchange via Mud Bay Road NW.

US 101/Evergreen Parkway Interchange

Direct movements between US 101 and Evergreen Parkway NW are limited at this interchange. Westbound traffic on US 101 is allowed to exit to Evergreen Parkway NW (westbound off-ramp), but there is no direct connection for traffic on Evergreen Parkway NW to enter onto westbound US 101 (westbound on-ramp). Similarly, there is no exit from eastbound US 101 to Evergreen Parkway NW (eastbound off-ramp); however, eastbound US 101 accepts traffic from Evergreen Parkway NW (eastbound on-ramp). Just north of US 101, the westbound off-ramp and eastbound on-ramp connect with Mud Bay Road NW to form a full diamond-style interchange with Evergreen Parkway NW elevated over Mud Bay Road NW. This interchange provides access to low-density residential areas to the west and north and connection to Mud Bay Road NW, which extends eastward towards higher-density commercial, public, and residential areas.

US 101/Black Lake Boulevard Interchange

The Black Lake Boulevard interchange is configured as a single-point urban interchange (SPUI). With this configuration, left- and right-turns to and from the mainline are separated, with the left-turns converging at a single signalized intersection. This interchange provides the primary access to several important regional facilities, including the Capital Medical Center, the Westfield Capital Mall, several commercial developments and parks, and a residential area to the south.

US 101/Crosby Boulevard/Cooper Point Interchange

This interchange is similar to a standard full diamond interchange configuration, except a separate access point on the south side of US 101 from Mottman Road SW to eastbound US 101 is located in the middle of the on-ramp. This interchange primarily serves the Capital Auto Mall and commercial office uses north of the interchange, South Puget Sound Community College, single- and multi-family residences in Tumwater south of the interchange, and is the last interchange before US 101 connects to I-5.

Local Streets and Intersections

This section of the report summarizes the functional classifications and characteristics of the local roadway network within the study area. The City of Olympia currently has four functional classifications: Arterial, Major Collector, Neighborhood Collector, and Local Access Street.

Black Lake Boulevard SW is classified as an arterial spanning from the City of Tumwater north to Harrison Avenue NW. Within the study area, Black Lake Boulevard SW provides access to and from US 101 and serves as a critical four- to five-lane north-south arterial through West Olympia. Several major businesses, including Walgreens, Top Foods, and the Westfield Capital Mall have driveways along the corridor. The posted speed limit varies between 25 and 30 mph throughout the study area.

Cooper Point Road SW provides access from US 101 and continues northwest to the northernmost point of the Cooper Point peninsula. This four- to five-lane arterial provides access to the Capital Auto Mall, the Evergreen Park business park and the Westfield Capital Mall. The posted speed limit is 35 mph in the study area.

Division Street SW is classified by the City of Olympia as an arterial within the study area. This two-lane roadway is the north-south extension of Black Lake Boulevard SW that serves commercial and residential land uses near Harrison Avenue NW. The posted speed limit is 25 mph throughout the study area.

Mud Bay Road NW/Harrison Avenue NW is an arterial roadway that extends from US 101 to W Bay Drive and is the northern study area limit for the WOAS. This roadway operates as a four- to five-lane section between Yauger Way SW and W Bay Drive and has a two-lane cross-section with turn lanes from US 101 to Yauger Way SW. The roadway connects with the 4th and 5th Avenue bridges that cross over Budd Inlet, this roadway provides access between several businesses and residential neighborhoods and serves as the major east-west corridor connecting downtown Olympia to West Olympia. The posted speed limit varies from 30 mph to 35 mph between Division Street SW and the northbound ramps at the US 101/Mud Bay Road interchange. West of the southbound ramps at the US 101/Mud Bay Road interchange, the speed limit along Mud Bay Road NW is 45 mph. Bicycle lanes exist from Evergreen Parkway to Division Street.

7th Avenue SW/Capitol Mall Drive NW is a major collector that begins west of Kaiser Road SW and runs semi-parallel to the north side of US 101. As 7th Avenue SW continues east, this roadway becomes Capitol Mall Drive NW, which fronts Yauger Park and Westfield Capital Mall, and then connects to a residential area as 9th Avenue SW. The western end of 7th Avenue SW begins at Kaiser Road SW as a two-lane roadway that expands to four lanes (one westbound lane, a two-way left-turn lane, and two eastbound lanes) just west of McPhee Road SW and continues with this lane configuration until Black Lake Boulevard SW before reducing down to a two-lane facility again. The posted speed limit is 25 mph. Bicycle lanes exist from McPhee Road SW to Decatur Street.

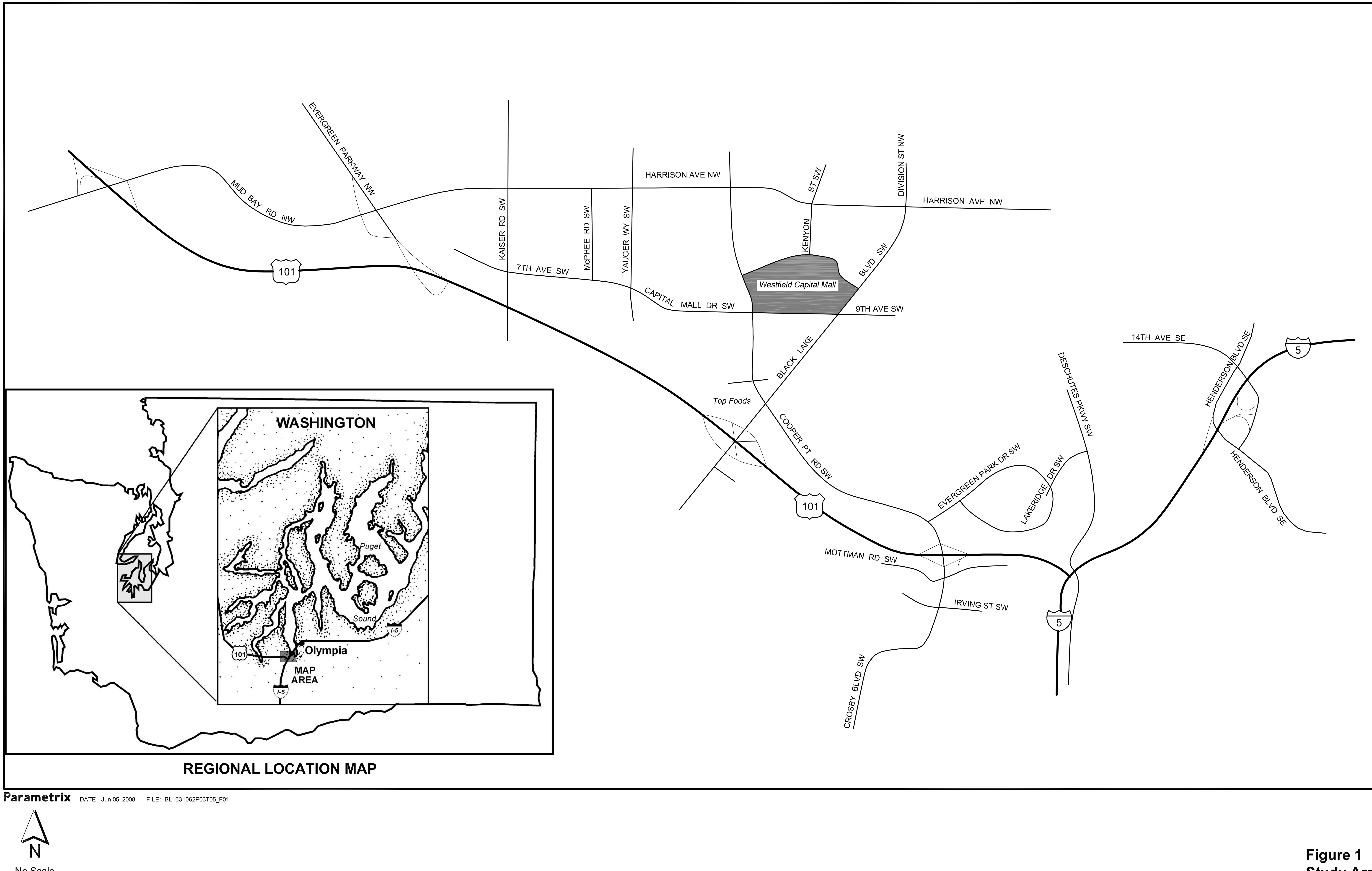

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Figure 1
Study Area

Decatur Street SW is a major collector throughout the study area that begins south of 15th Avenue SW and continues to the northern study area limit at Harrison Avenue NW. This roadway primarily serves residential traffic and a pedestrian/bicycle connection is provided to Caton Way SW. The posted speed limit along Decatur Street SW is 25 throughout the study area.

Yauger Way SW is a major collector that begins at Capital Mall Drive and terminates in a residential subdivision north of Harrison Avenue NW. This two- to three-lane road provides access to major regional points of interest including Yauger Park and the Capital Medical Center, the primary medical facility for West Olympia. The current posted speed limit is 30 mph within the study area.

Kaiser Road SW is classified as a major collector that extends from just south of US 101, over US 101, and continues northward until it terminates several miles north at Cooper Point Road NW. This two-lane roadway provides access to residential land uses on the west side of Olympia. The posted speed limit is 35 mph.

Deschutes Parkway SW is a major collector that begins with a connection to northbound I-5 at the Exit 103 off-ramp, continues north along the east side of I-5, crosses under I-5 near US 101, then travels north along the western edge of Capitol Lake, and ends with a connection to 5th Avenue SW, which crosses Budd Inlet. This two-lane roadway serves north-south travel with a posted speed limit of 35 mph. A parking lane on the east side of the Deschutes Parkway SW is also provided for the majority of the roadway’s length.

Kenyon Street SW is a major collector between Harrison Avenue NW and Westfield Capital Mall. This four-lane roadway primarily serves commercial/industrial land uses within the study area and has a posted speed limit of 25.

Several intersections within the study area were analyzed because they currently or are anticipated in the future to operate poorly, provide access to major regional landmarks, or are ramp terminals for current freeway facilities. In total, 22 locations (24 intersections including the two additional right-turn intersections associated with the Black Lake Boulevard interchange) were studied as part of the WOAS, including:

- Harrison Avenue NW/Division Street NW (Signalized)
- Cooper Point Road SW/Black Lake Boulevard SW (Signalized)
- Black Lake Boulevard SW/US 101 (Signalized)
- Cooper Point Road SW/Harrison Avenue NW (Signalized)
- Black Lake Boulevard SW/9th Avenue SW (Signalized)
- Cooper Point Road/Automall Drive SW/Carriage Street SW (Signalized)
- Cooper Point Road/Automall Drive SW/Evergreen Park Drive SW (Signalized)
- Cooper Point Road SW/Top Food Entrance (Signalized)
- Crosby Boulevard SW/US 101 Westbound Ramps (Signalized)
- Crosby Boulevard SW/US 101 Eastbound Ramps (Signalized)
- Crosby Boulevard SW/Mottman Road SW (Signalized)
- Crosby Boulevard SW/Irving Street SW (Signalized)
- Harrison Avenue NW/Kenyon Street NW (Signalized)
- Black Lake Boulevard SW/Capital Mall Entrance (Signalized)
- Harrison Avenue NW/Yauger Way SW (Signalized)
- Harrison Avenue NW/McPhee Road SW (Unsignalized)
- Harrison Avenue NW /Kaiser Road NW (Unsignalized)
- Mud Bay Road W/Evergreen Parkway NW Eastbound Ramps (Unsignalized)

- Mud Bay Road NW/Evergreen Parkway NW Westbound Ramps (Unsignalized)
- Black Lake Boulevard SW/Top Foods Entrance (Unsignalized)
- Lakeridge Drive SW/Deschutes Parkway SW (Unsignalized)
- Capital Mall Drive SW/Yauger Way SW (Unsignalized)

DATA COLLECTION AND METHODOLOGY

Additional detail on the project's methodology and assumptions is provided in the WOAS Assumptions Document.

A variety of data from different sources were used to develop the traffic analysis models. These data and their sources are identified in Table 1.

Table 1. Data Sources used in the West Olympia Access Study

Source	Data
WSDOT	Freeway ATR traffic count data
WSDOT	Freeway ramp tube counts
WSDOT	Freeway truck classification volumes from past ATRs and the WSDOT 2006 Annual Traffic Report
WSDOT	Freeway speed data
WSDOT	Corridor aerial photos
local.live.com	Intersection geometrics (using bird's eye view)
WSDOT	Freeway grades
WSDOT/Parametrix	Estimated ramp grades
City of Olympia	Signal timing plans
City of Olympia/WSDOT	Local intersection turning movement counts
City of Olympia/WSDOT	Existing conditions Synchro model
Parametrix	Freeway travel times
Parametrix	Field reconnaissance to verify and supplement data, including travel times, queue lengths, and lane channelization
WSDOT	Year 2005, 2010, and Year 2030 travel demand models

Traffic Analysis Tools

Four analysis tools were used for the WOAS traffic analysis. These tools were used to analyze different components of the transportation system, based on the advantages of each tool and WSDOT recommendations. These four analysis tools included:

- VISSIM (freeway operations)
- Synchro (signalized intersection operations)
- HCS+ (unsignalized intersection operations)
- VISUM (travel demand modeling)

VISSIM

VISSIM is a microscopic, behavior-based, multi-purpose traffic simulation program used for signal systems, freeway systems, or a combined signal and freeway system having complex or simple conditions. VISSIM offers a wide variety of urban and highway applications, integrating public and private transportation modes. VISSIM version 4.3 was used to simulate freeway operations along the I-5 and US 101 corridors, including all mainline basic segments, ramps, interchanges, weave sections, and freeway connections. The analysis was conducted for a two-hour PM peak period analysis period between 4:00 and 6:00 PM, but the results are for the peak one-hour. Ramp terminals and a few local intersections were included in the model to simulate the metering and operational effects of these intersections on freeway operations.

Synchro

Synchro is a software application ideal for optimizing traffic signal splits, offsets, and cycle lengths for individual intersections, an arterial, or a transportation system. This application performs intersection capacity and level of service (LOS) analyses using either the intersection capacity utilization (ICU) method or the HCM method. For the WOAS, the HCS Signals module of Synchro version 7 (build 761) was used to calculate the LOS at signalized intersections. The LOS analysis and results are reported for a one-hour PM peak hour (4:30 to 5:30 PM) and are also reported for a two-hour PM peak period consistent with the City of Olympia's transportation concurrency requirements, depending on the intersection (see the Measures of Effectives and Standards section).

HCS+

HCS+ is the latest version of the traffic operations software package co-developed by the Federal Highway Administration (FHWA) and the University of Florida. This analysis tool is the literal electronic translation of methodologies outlined in the Highway Capacity Manual (HCM) and was used to analyze unsignalized intersections. HCS+ was used for a PM peak hour analysis and is also reported for a two-hour PM peak period, depending on the intersection (see the Measures of Effectives and Standards section).

VISUM

VISUM is a comprehensive software application used for transportation planning, travel demand modeling, and network data management. Designed for multi-modal analyses, VISUM integrates all relevant models of transportation into one network model while providing a variety of assignment procedures. VISUM version 9.4 provided the basic travel demand forecasts, which were then post-processed and used as the volume inputs in the freeway and local traffic operation models.

Model Calibration and Validation

Freeway Model

Per FHWA guidelines, the two-hour VISSIM model was calibrated against several parameters, including: matching model throughput volumes with expected and field measured volumes, field observed queue lengths, and field observed travel times. Model inputs and calibration assumptions are provided in Attachment B.

Freeway traffic volumes were determined by using a combination of WSDOT permanent traffic recorders (PTRs) and tube counts on ramps located within the study area. Since only one WSDOT PTR recorder is operational in the study area (R098), freeway volumes were derived by using PTRs outside of the study area, and ramp tube counts were either added or subtracted to produce the expected mainline freeway volume within the study area. The PTRs used to develop freeway volumes include:

- R003 – US 101 at the US 101/SR 8 split
- P4 – I-5 north of the Olympia City Center Interchange
- R097 – I-5 south of Exit 100 in Tumwater
- R098 – US 101 west of the US 101/I-5 Intersection

The derived volume matrix was compared with PTR counts at R098 to verify correct model input volumes, which were developed for 15-minute intervals to account for peaking characteristics. PTR traffic volumes are an average of Tuesday through Thursday volumes taken from October 2006 and ramp tube counts were conducted in January and February 2007. Attachment C shows the expected volumes for each corridor. Figures 2 and 3 illustrate the volume validation at PTR R098, and compare the actual volume, the VISSIM throughput volume, and the derived freeway demand volumes.

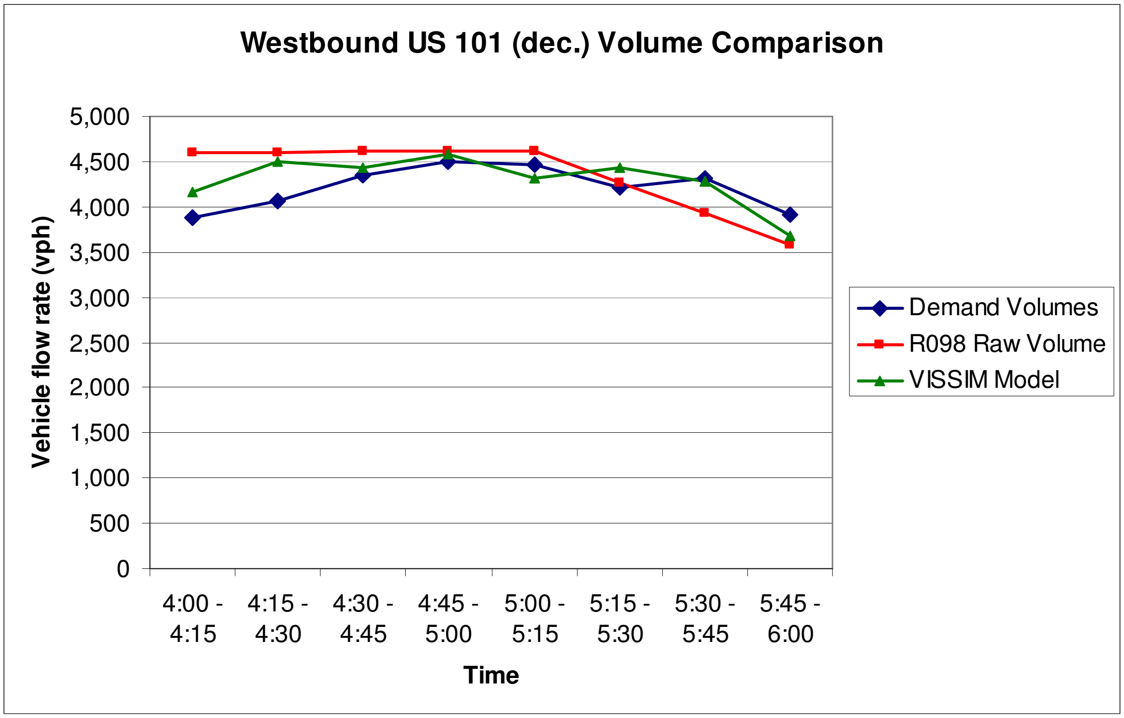


Figure 2. Westbound US 101 Existing and Model Traffic Volumes

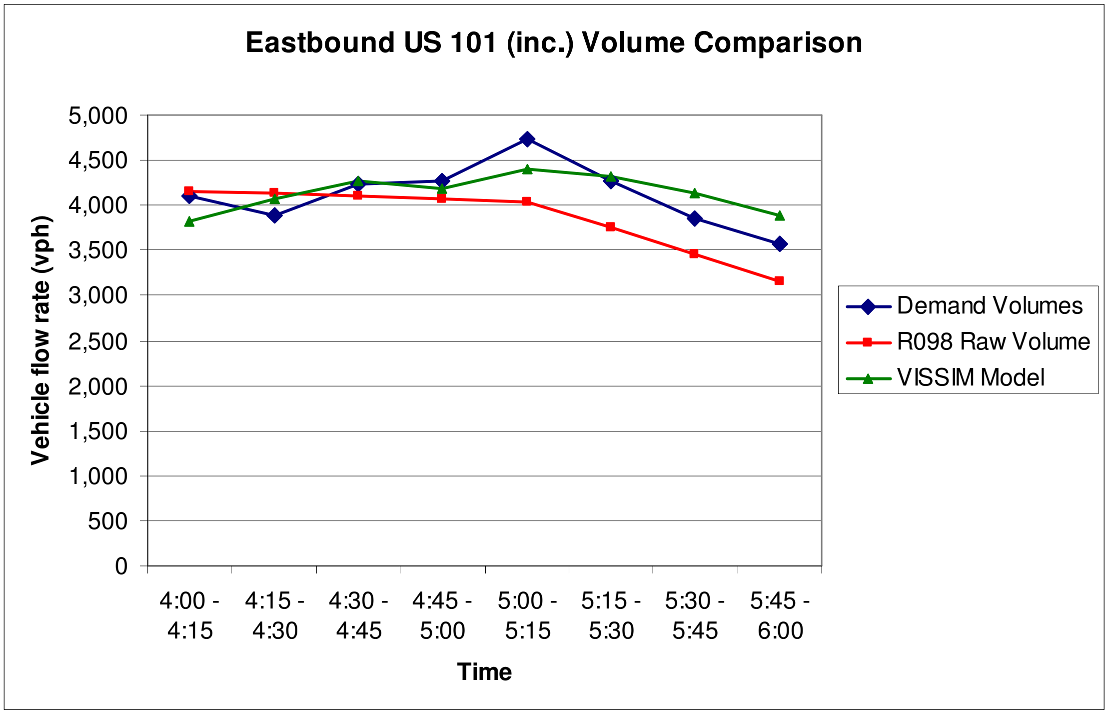


Figure 3. Eastbound US 101 Existing and Model Traffic Volumes

Figure 2 shows a good volume correlation between the observed counts at the R098 PTR and the VISSIM model throughput along westbound US 101. The VISSIM model volume lags the actual counts by approximately 15 minutes; however, by 6:00 PM both the VISSIM model and the PTR counts are approximately equal. Figure 3 indicates the VISSIM model overestimates traffic volumes by about 9 percent during the middle of the peak analysis period. This volume imbalance is partially due to matching freeway ramp volumes to intersection turning movement counts. Although the VISSIM model is conservatively high through this location, comparing the VISSIM model traffic volume against the WSDOT 2006 Peak Hour Report, the traffic volumes are still within the overall range of volumes through the location.

Traffic volumes were calibrated and validated using the Geoff E. Havers (GEH) statistic, which is used to assess the goodness of fit between model results and observed traffic volumes. According to guidelines provided by the FHWA, the model is considered calibrated to observed volumes if the GEH value is less than five for 85 percent or more of the model links and less than four for the sum of all link counts (FHWA 2004). The GEH value is a modified chi-square statistic that incorporates both relative and absolute differences, in comparison of modeled and observed volumes. In the West Olympia model, 100 percent of the links had a GEH value of less than five and the GEH value for the sum of all links was 0.71, suggesting that the model was sufficiently calibrated to FHWA calibration targets. This methodology included measuring all basic freeway sections, ramps, and intersection turning movement counts. Attachment C provides a detailed comparison of the observed field volumes against the model volumes.

Model vehicle queue lengths at selected study locations were visually compared against PM peak period field observations conducted by Parametrix and were used to substantiate model validation. Locations where queues were observed in the field included: southbound I-5 before the US 101 interchange, Black Lake Boulevard SPUI, Black Lake Boulevard/Cooper Point Road SW intersection, and the Cooper Point Road SW/Top Foods/Old Navy intersection. These locations were selected for observation based on known operations and queuing conditions.

Parametrix also conducted a floating car travel time survey during the PM peak period (4:00 PM to 6:00 PM) in August 2007 along I-5 and US 101 to determine existing travel times. Seven travel time runs were conducted for northbound I-5 and eight runs for southbound I-5. Several travel time runs were conducted for eastbound and westbound 101 since both mainlines were observed to operate near free flow conditions, except for westbound US 101 between I-5 and the Crosby Boulevard off-ramp, which operated around 40 mph in the two right-most lanes and slightly higher in the left-most lane. The traffic team observed varied travel times along I-5 throughout the PM peak period, primarily dependant on the travel lane. Typically, the outside southbound I-5 lane north of the US 101 interchange was much slower than the inside two lanes. Since VISSIM cannot measure travel times on a lane-by-lane basis, average vehicle travel times were determined across all lanes for both field measured and model observed travel times. Table 2 compares model travel times against field observed travel times.

Table 2. Modeled and Observed Travel Times

Cross Street	Model Travel Time (sec)	Observed Travel Time (sec)	Percent Difference	Absolute Difference (sec)
NB I-5: Begin at S End of Study Area				
US 101 On-Ramp	31.4	24.0	31%	7.4
14th St Off-Ramp	41.1	55.0	25%	13.9
Total (seconds)	72.5	79.0	8%	6.5
Min (-10% of averaged travel time runs)		71.1		
Max (+10% of averaged travel time runs)		86.9		
SB I-5: Begin at N End of Study Area				
14th St On-Ramp	185.2	145.0	28%	40.2
US 101 Off-Ramp	33.7	47.0	28%	13.3
US 101 On-Ramp	42.6	34.0	25%	8.6
Total (seconds)	261.5	226.0	16%	35.5
Min (shortest travel time run)		207.0		
Max (longest travel time run)		288.0		
EB 101: Begin at E End of Study Area				
Mud Bay Off-Ramp	25.8	29.8	14%	4.0
Mud Bay On-Ramp	16.7	13.9	20%	2.8
EB 101 before Evergreen Prkwy On-Ramp	78.8	85.1	7%	6.3
Evergreen Prkwy On-Ramp	17.1	18.3	6%	1.2
Black Lake Off-Ramp	57.4	67.1	14%	9.7
Black Lake On-Ramp	42.3	32.7	29%	9.6
Crosby Blvd Off-Ramp	25.0	26.2	5%	1.2
Crosby Blvd On-Ramp	25.1	31.6	21%	6.5
101 EB to I-5 Off-Ramp	36.0	28.2	28%	7.8
Total (seconds)	324.2	332.9	3%	8.8
Min (-10% of averaged travel time runs)		299.6		
Max (+10% of averaged travel time runs)		366.1		
WB 101: Begin at W End of Study Area				
Crosby Blvd Off-Ramp	41.5	28.2	47%	13.3
Crosby Blvd On-Ramp	30.6	32.7	6%	2.1
Black Lake Off-Ramp	18.4	24.4	24%	6.0
Black Lake On-Ramp	52.8	43.2	22%	9.6
Evergreen Prkwy Off-Ramp	42.9	60.0	28%	17.1
WB 101 after Evergreen Prkwy Off-Ramp	28.4	32.7	13%	4.3
Mud Bay Off-Ramp	62.9	81.3	23%	18.4
Mud Bay On-Ramp	25.6	21.6	18%	4.0
Model End	32.7	38.2	14%	5.5
Total (seconds)	336.1	362.4	7%	26.3
Min (-10% of averaged travel time runs)		326.1		
Max (+10% of averaged travel time runs)		398.6		

The percent difference for individual travel time segments ranged from five percent to 47 percent; however, the absolute differences in time (seconds) were generally low (less than 10 seconds) for the majority of the travel time segments. These differences were assumed to be attributed to lane utilization since the observed travel times varied substantially depending on the lane of travel. Although observed travel times were averaged for multiple lanes, the data were collected at different times within the peak period; for example, the travel time survey for lane 1 was started at 4:30 PM, while the travel time survey for lane 2 was started at 4:45 PM. This methodology contrasts to VISSIM, which reports an average travel time across all lanes during the same time frame.

Corridor travel times, which are the sum of all travel time segments along a corridor for each direction, estimated by the VISSIM model were within 10 percent of the averaged field observed travel time runs for northbound I-5 and eastbound and westbound US 101. For southbound I-5, the model estimated slightly longer travel times; however, the model results were still within the range of the observed travel times runs. Discrepancies between the observed and modeled travel times could suggest inaccurate levels of congestion; however, modeled traffic volumes were consistent with the expected throughput, which indicates that the cause of travel time differences is likely due to lane utilization. Accordingly, the VISSIM model was assumed to be calibrated to travel times for both I-5 and US 101 for each direction of travel.

Local Streets and Intersections Model

The City of Olympia provided the existing conditions Synchro model that was used for analysis of City streets and freeway ramp terminals. This tool is already used by the City on their local system and works well. In 2005-2006, the City of Olympia worked with WSDOT on updating the model. Existing signal timing and phasing for each of the traffic signals analyzed were collected from City of Olympia. This information was input into the Synchro traffic operations model to update existing signal timing.

Traffic volumes were updated using traffic counts collected within the past three years from WSDOT, City of Olympia, and City of Tumwater. These included 2005-2006 city traffic counts; freeway ramp volumes, and permanent recorder data for US 101 and I-5 located within the study area was collected and provided in early 2007 by the WSDOT Transportation Data Office.

The existing conditions model volumes were compared to 2007 actual counts obtained in May 2007 to ensure that the model data was reflective of the existing field conditions. Some volumes were adjusted in the model based on the 2007 counts analysis, these included the following intersections:

- Harrison Avenue NW/Division Street NW
- Cooper Point Road SW/Black Lake Boulevard SW
- Black Lake Boulevard SW/Capital Mall Entrance
- Black Lake Boulevard SW/Capital Mall Drive SW/9th Avenue SW
- Cooper Point Road/Automall Drive SW/Evergreen Park Drive
- Crosby/US 101 Northbound and Southbound off-ramps
- Crosby Boulevard SW/Mottman Road SW
- Crosby Boulevard SW/Irving Street SW

Field visual observations were made at several of the intersections in the study area during the peak hour including those within the “Triangle” area (area bounded by Harrison Avenue SW/Division Street SW, Cooper Point Road SW/Black Lake Boulevard SW, and Cooper Point Road SW/Harrison Avenue SW intersections) to confirm queue lengths, lane configurations (number of turn lanes) and signal timing in the field.

MEASURES OF EFFECTIVENESS AND STANDARDS

Freeway Traffic

Two primary measures of effectiveness (MOEs) were used to evaluate freeway operations in West Olympia. The MOEs used to analyze freeway conditions are as follows:

- LOS based on density for freeway basic, merge, diverge, and weave locations (each segment based on VISSIM methodology and converted to a HCM analogue). This includes an aggregate MOE based on the sum of all freeway densities along US-101 and I-5 within the study area.
- Travel speeds

WSDOT owns the traffic signals at the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges along US 101, but the City of Olympia operates and maintains them by agreement. WSDOT identifies LOS D or better for freeway segments and ramp terminal intersections along urban state highway facilities and state operated signals as acceptable. WSDOT, in consultation with local governments and agencies, sets the level of service standards for Highways of Statewide Significance (HSS). Though WSDOT consults with agencies and local jurisdictions, WSDOT retains final authority to make decisions regarding level of service for HSS routes (RCW 47.06.140). Both US 101 and I-5 within the study area are considered HSS routes.

One industry standard for evaluating freeway traffic conditions is based on the Transportation Research Board's (TRB) methodology outlined in the Highway Capacity Manual (HCM), Special Report 209 (TRB 2000). Using one of the HCM methodologies, freeway traffic conditions can be assessed with respect to densities along various freeway segments. The letter "A" is used to describe the least amount of congestion and best operations, and the letter "F" indicates the highest amount of congestion and worst operations. Table 3 shows how the HCM relates densities to LOS.

Local Intersection Traffic

The MOEs used to evaluate local intersection operations included:

- Level of service based on average vehicle delay (seconds/vehicle)
- Aggregated MOEs, including:
  - Total number of intersections operating at LOS A, B, or C
  - Total number of intersections operating at LOS D or E
  - Total number of intersections operating at LOS F
  - Total vehicle delay at three critical intersections (the "triangle"), including Black Lake Boulevard SW/Cooper Point Road SW, Harrison Avenue NW/Division Street NW, and Harrison Avenue NW/Cooper Point Road NW

Table 3. Level of Service Criteria for Freeways

Basic Segment		Weave Segment		Merge/Diverge Areas	
Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
0	A	0	A	0	A
11	B	12	B	10	B
18	C	24	C	20	C
26	D	32	D	28	D
35	E	36	E	35	E
45	F	40	F	45[a]	F

Source: HCM 2000, Exhibits 23-2, 24-2, and 25-4.

pc/mi/ln = passenger cars per mile per lane

[a] The HCM does not provide a density for LOS F for merge and diverge areas. A density of 45 pc/mi/ln, which is the same for basic segments, was assumed to distinguish between LOS E and F.

The City of Olympia controls the majority of the study intersections, including all intersections north of US 101. The City has defined LOS E as acceptable through the downtown area and along high-density residential corridors. Study intersections that are south of Harrison Avenue NW, west of Black Lake Boulevard SW, and east of Cooper Point Road SW are considered part of the West Olympia high-density residential corridor; therefore, LOS E or better is defined as acceptable (i.e. LOS E is the acceptable standard for the Harrison Avenue/Division Street, Black Lake Boulevard/Cooper Point Road, and Harrison Avenue/Cooper Point Road study intersections). Throughout the rest of the city, urban growth area, and ramp termini at the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges along US 101, LOS D is defined as acceptable.

Two study intersections, Crosby Boulevard SW/Mottman Road SW and Crosby Boulevard SW/Irving Street SW, fall within the City of Tumwater. The City of Tumwater has adopted LOS D as the minimum acceptable standard for all intersections and roadways within the city and urban growth area.

Similar to freeway traffic operations, the HCM also provides methodologies for evaluating intersection operations. The HCM derives intersection LOS from average vehicle delays for the intersection as a whole or by worst movement. The LOS lettering nomenclature is consistent with the freeway operations naming convention; the letter "A" is used to describe the least amount of delay and best operations and the letter "F" for the highest amount of delay and worst operations. The 2000 HCM level of service criteria for signalized and unsignalized intersections are shown in Table 4.

Table 4. Level of Service Criteria for Signalized and Unsignalized Intersections

LOS Rating	Average Delay for Signalized Intersections (seconds/vehicle)	Average Delay for Unsignalized Intersections (seconds/vehicle)[a]
A	0 – 10	0 – 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

Source: HCM 2000, modified from Exhibits 16-2 and 17-2

[a] LOS ratings for all-way stop-controlled intersections are defined by the intersection operations as a whole; LOS ratings for two-way stop-controlled intersections are defined by the worst lane group.

The City of Olympia uses a slightly modified methodology for estimating intersection LOS for their transportation concurrency requirements. While the general equations and the relationship between delay and LOS grade is consistent with the HCM definitions, the City of Olympia's LOS standards are based on a two-hour peak period, as opposed to a one-hour peak hour. To estimate the two-hour LOS, a volume adjustment factor is applied to one-hour peak hour volumes. This volume adjustment factor can be represented as:

2-Hour Adjustment Factor = (2 hour volume/2) / (peak hour volume)

For example, if 8,500 vehicles entered an intersection over two hours and the peak hour volume within those two hours was 4,500 entering vehicles, the 2-Hour Adjustment Factor would be:

2-Hour Adjustment Factor = (8,500/2)/(4,500)

2-Hour Adjustment Factor = (4,250)/(4,500)

2-Hour Adjustment Factor = 0.94

The 2-Hour Adjustment Factors were provided by the City of Olympia and applied to intersection turning movement volumes to estimate the two-hour LOS at locations where the intersections fall under the City of Olympia's jurisdiction (i.e., all study intersections excluding the Crosby Boulevard SW/Mottman Road SW and Crosby Boulevard SW/Irving Street SW intersections in the City of Tumwater and the Mud Bay interchange in Thurston County).

The ramp termini at the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges along US 101 are operated and maintained by the City of Olympia and therefore have a LOS D standard. However, the 2-Hour Adjustment Factor was not applied to these locations for planning purposes.

EXISTING 2007 TRAFFIC CONDITIONS

Freeway System Volumes

Northbound I-5 traffic volumes vary substantially throughout the study area. During the PM peak hour (4:30 to 5:30 PM), approximately 3,900 vehicles enter the study area. After roughly 900 vehicles exit to westbound US 101, a substantial volume (nearly 3,000 vehicles) enters the northbound I-5 mainline from eastbound US 101 and Deschutes Parkway SW. Approximately 800 vehicles exit northbound I-5 to Plum Street before the northern limit of the study area where 5,100 vehicles per hour travel the I-5 mainline. Figure 4 shows the VISSIM model traffic volumes along different segment types of the northbound I-5 mainline during the existing 2007 PM peak hour.

Approximately 4,600 vehicles enter the southbound I-5 study area during the PM peak hour and, similar to northbound I-5, traffic volumes vary greatly along the corridor. The City Center on-ramp and US 101 off-ramp are approximately 2,000 feet apart, creating a short weave section. Around this weave section, southbound I-5 mainline volumes increase from 4,600 vehicles to 6,200 vehicles, then decrease to 3,200 vehicles just south of the US 101 off-ramp where approximately 3,000 vehicles exit to US 101. Of this volume exiting to westbound US 101 from southbound I-5, 13 percent from the 14th/Plum Street on-ramp, and the remaining 87 percent comes from southbound I-5 north of the City Center interchange. The weave distribution percentages were based on the VISUM model and applied to the expected freeway volumes that were based on balanced PTR data. A relatively small volume exits to 2nd Avenue SW (roughly 200), then the US 101 on-ramp adds approximately 1,300 vehicles to the southbound I-5 mainline. Figure 5 shows the VISSIM model traffic volumes along different segment types of the southbound I-5 mainline during the existing 2007 PM peak hour.

Eastbound traffic volumes on US 101 exhibit relatively little variation around the Mud Bay Road and Evergreen Parkway interchanges, with on- and off-ramp volumes ranging between 100 to 500 vehicles during the PM peak hour. Continuing east, a substantial volume enters the mainline from the Black Lake

Boulevard (approximately 1,400 vehicles) and Crosby Boulevard/Cooper Point (approximately 1,300 vehicles) interchanges. Figure 6 shows the VISSIM model traffic volumes along different segment types of the eastbound US 101 mainline during the existing 2007 PM peak hour.

Off-ramps from southbound I-5 and northbound I-5 converge to create westbound US 101, which has approximately 4,400 vehicles entering the study area during the PM peak hour. Similar to eastbound US 101, the majority of westbound US 101 mainline traffic volume variation occurs between the Crosby Boulevard/Cooper Point and Black Lake Boulevard interchanges, with exiting volumes ranging between 1,200 to 1,400 vehicles. Traffic volumes entering the westbound US 101 mainline from these interchanges are substantially lower, ranging between 200 and 400 vehicles during the PM peak hour. West of the Black Lake Boulevard interchange, traffic volume changes are generally less than 600 vehicles during the PM peak hour to and from Evergreen Parkway NW and Mud Bay Road NW. Figure 7 shows the VISSIM model traffic volumes along different segment types of the westbound US 101 mainline during the existing 2007 PM peak hour.

Freeway System LOS (Densities)

As described above, freeway operations were analyzed using VISSIM version 4.3, which calculates freeway densities in terms of vehicles per mile per lane. These densities were converted into passenger cars per mile per lane based on heavy vehicle percentages and HCM adjustments to determine the freeway LOS. Table 5 identifies the various study segments by type for I-5 and US 101 that are currently operating at LOS E or F.

As shown in Table 5, three segments of I-5 and one segment of US 101 currently operate worse than LOS D during the PM peak hour. In general, LOS D is the acceptable level of service threshold for urban freeway facilities as set by WSDOT in accordance with RCW 47.06.140. Figures 4 through 7 show the mainline densities and LOS for each I-5 and US 101 mainline segment type. An expanded table that shows the densities and LOS for all segments of I-5 and US 101 is provided in Attachment D.

Table 5. Existing 2007 PM Peak Hour Freeway Operations

Mainline Segment	Segment Type	Density (pc/mi/ln)	LOS (HCM Equivalent)
Northbound I-5			
NB I-5 US 101 On-Ramp	Merge	36	E
Southbound I-5			
SB I-5	Basic	73	F
SB I-5 to US 101 Weave	Weave	53	F
Westbound US 101			
WB US 101 e/o Crosby Blvd	Basic	35	E
WB US 101 Crosby Blvd Off-Ramp	Diverge	48	F

pc/mi/ln = passenger cars per mile per lane

Note: The HCM does not provide a density for LOS F for merge and diverge areas. A density of 45 pc/mi/ln, which is the same for basic segments, was assumed to distinguish between LOS E and F.

As described above, a substantial volume (approximately 3,000 vehicles) of traffic is added to the northbound I-5 mainline from the US 101 and Deschutes Parkway on-ramp. This volume, coupled with a three-lane merge condition, results in the existing congestion at this location of I-5.

On southbound I-5, the short weave segment between the City Center on-ramp (1,700 entering vehicles) and the US 101 off-ramp (3,000 exiting vehicles) experiences a high amount of lane changes, which results in high traffic densities in this area and in the upstream segment of southbound I-5.

Congestion near the westbound Crosby Boulevard interchange is related to several factors, including high traffic volumes (4,400 vehicles), weaving, horizontal curves, and steep grades.

Freeway System Speeds

Travel speeds along I-5 and US 101 were also identified as an operational MOE. The existing PM peak period speed conditions along I-5 are shown in Figures 4 and 5, and Figures 6 and 7 display the speeds along US 101. Note that these figures illustrate the operational speeds during the PM peak period (4:00 to 6:00 PM, two hours), but the LOS, densities, and volumes are for the PM peak hour (4:30 to 5:30 PM, one hour).

As shown in Figure 4, above, existing northbound I-5 mainline speeds are generally around free flow conditions. A slight reduction (from 60 to 70 mph to 50 to 60 mph) in speed occurs around the US 101 off-ramp as a result of exiting traffic on operating conditions at the beginning of westbound US 101. Northbound I-5 speeds also experience a slight speed reduction (40 to 60 mph) around the US 101 on-ramp as a result of the high merging traffic volumes.

Southbound I-5 travel speeds are substantially reduced around the I-5/City Center interchange, and range between 30 to 50 mph for the majority of the PM peak period and 10 to 20 mph between 5:00 and 5:30 PM. This reduction in speeds is primarily due to the high volumes of lane changes between the City Center on-ramp and US 101 off-ramp, which is a short weave section approximately 2,000 feet in length and affects upstream traffic flow. South of the City Center interchange, operational speeds increase to free flow conditions (50 to 70 mph). Figure 5 shows the PM peak period travel speeds along southbound I-5.

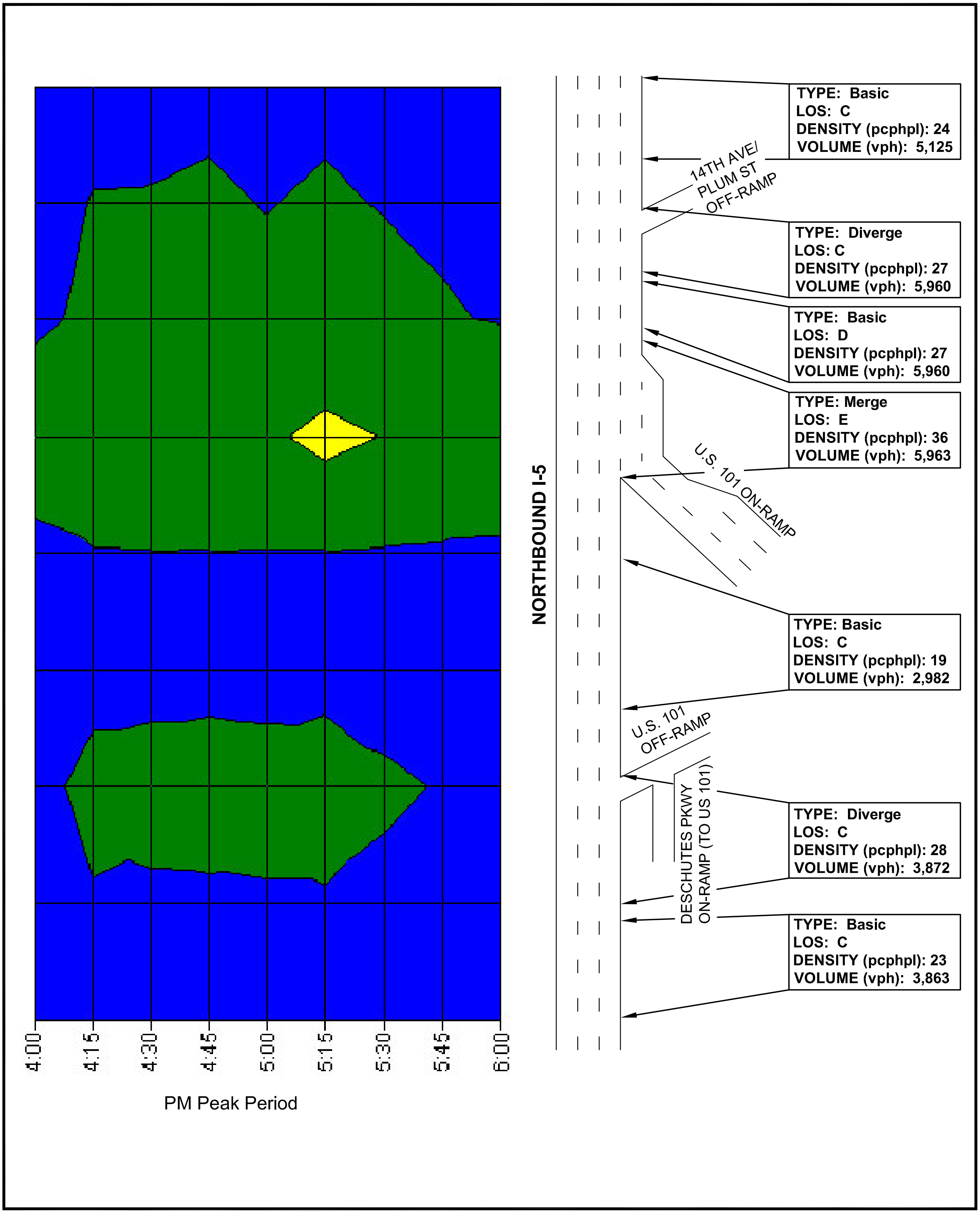
Figure 6 shows the PM peak period travel speeds for eastbound US 101. Eastbound US 101 travel speeds are currently around free flow conditions, with slight decreases (from 60 to 70 mph to 50 to 60 mph) near the Evergreen Parkway, Black Lake Boulevard, and Crosby Boulevard/Cooper Point on-ramps.

Freeway System Travel Times

Freeway travel times are useful for communicating impacts or benefits to freeway mainline operations and can be used to estimate an average travel speed for the freeway as a whole.

Travel times for US 101 and I-5 are provided in Table 2, above. Through the study area, northbound I-5, eastbound US 101, and westbound US 101 all have average travel speeds near free flow conditions. Substantial travel time is added to southbound I-5 around the weave section between the City Center on-ramp and the US 101 off-ramp, which reduces the average travel speed to approximately 29 mph through the study area.

During the PM peak period, travel speeds along westbound US 101 are generally between 40 to 50 mph between I-5 and the Crosby Boulevard interchange. Vertical and horizontal curves, high traffic volumes, and weaving movements all contribute to the speed reductions in this area. Continuing west speeds increase to 50 to 60 mph with a short section operating at 60 to 70 mph near the Evergreen Parkway off-ramp. Figure 7 shows the PM peak period travel speeds along westbound US 101.



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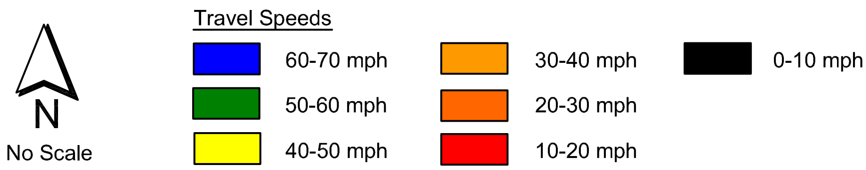
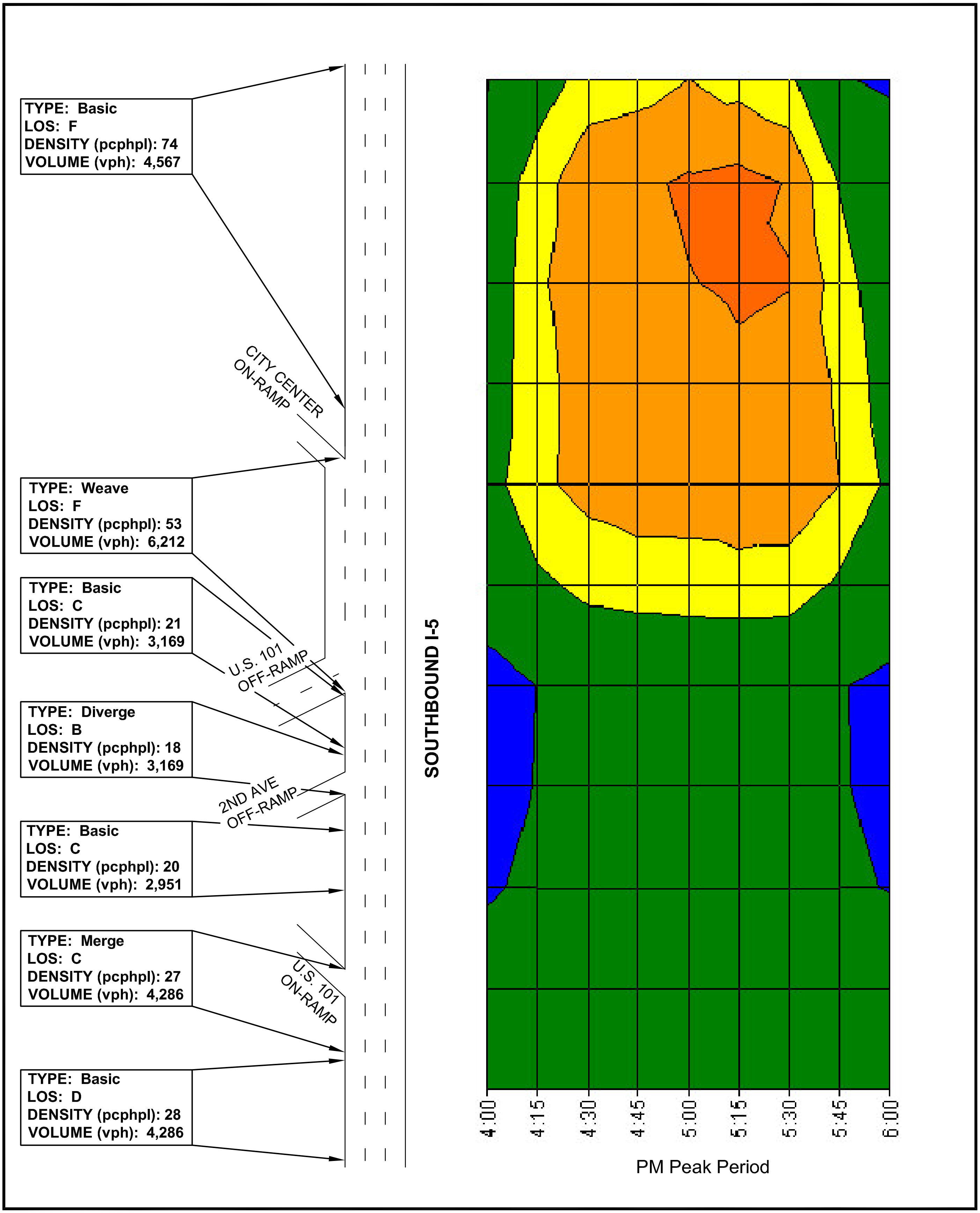


Figure 4
Existing 2007 Northbound I-5 Freeway PM Peak Period Operations



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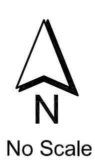

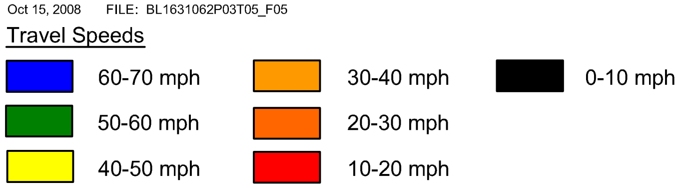

Figure 5
Existing 2007 Southbound I-5 Freeway PM Peak Period Operations

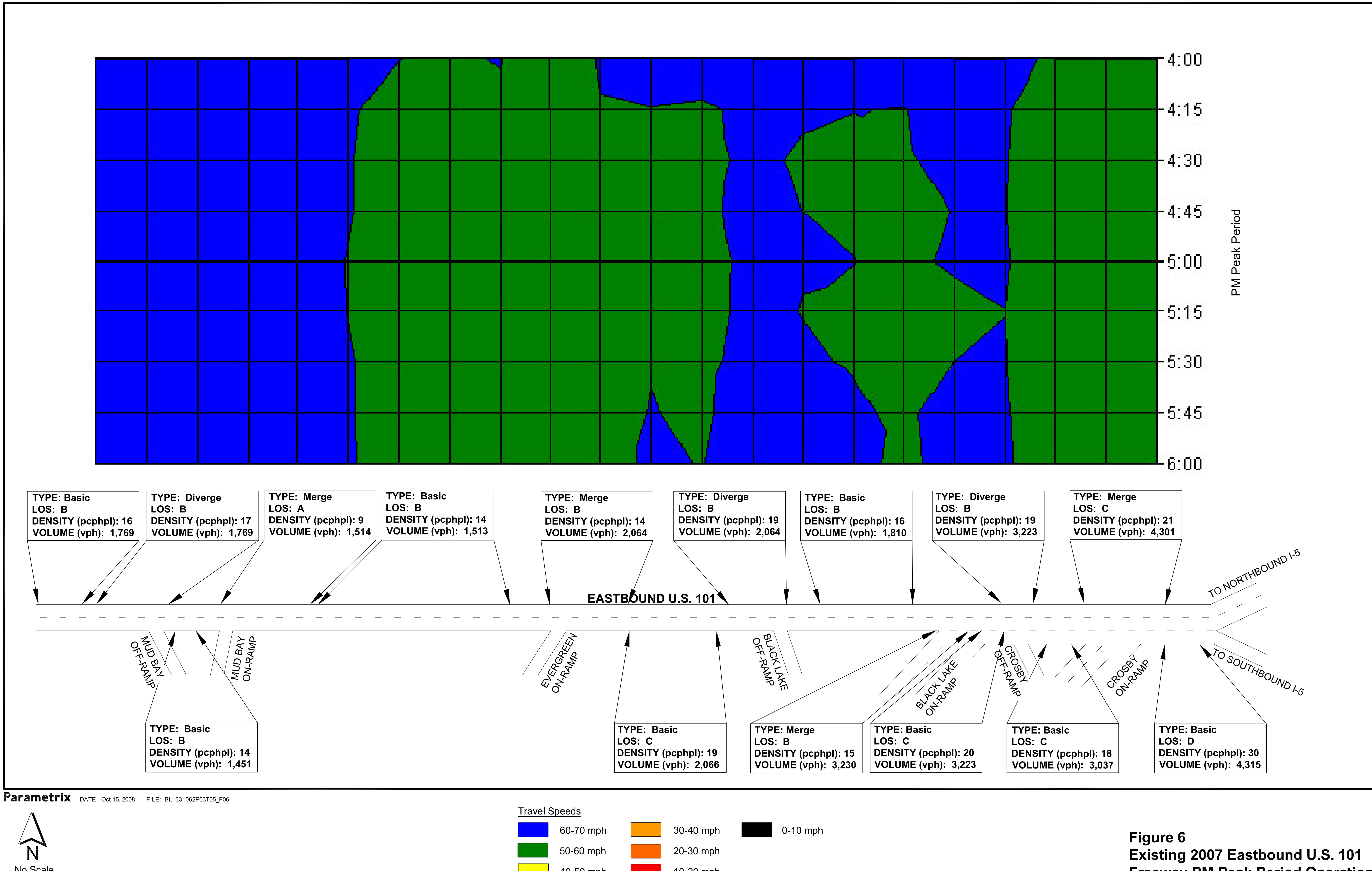

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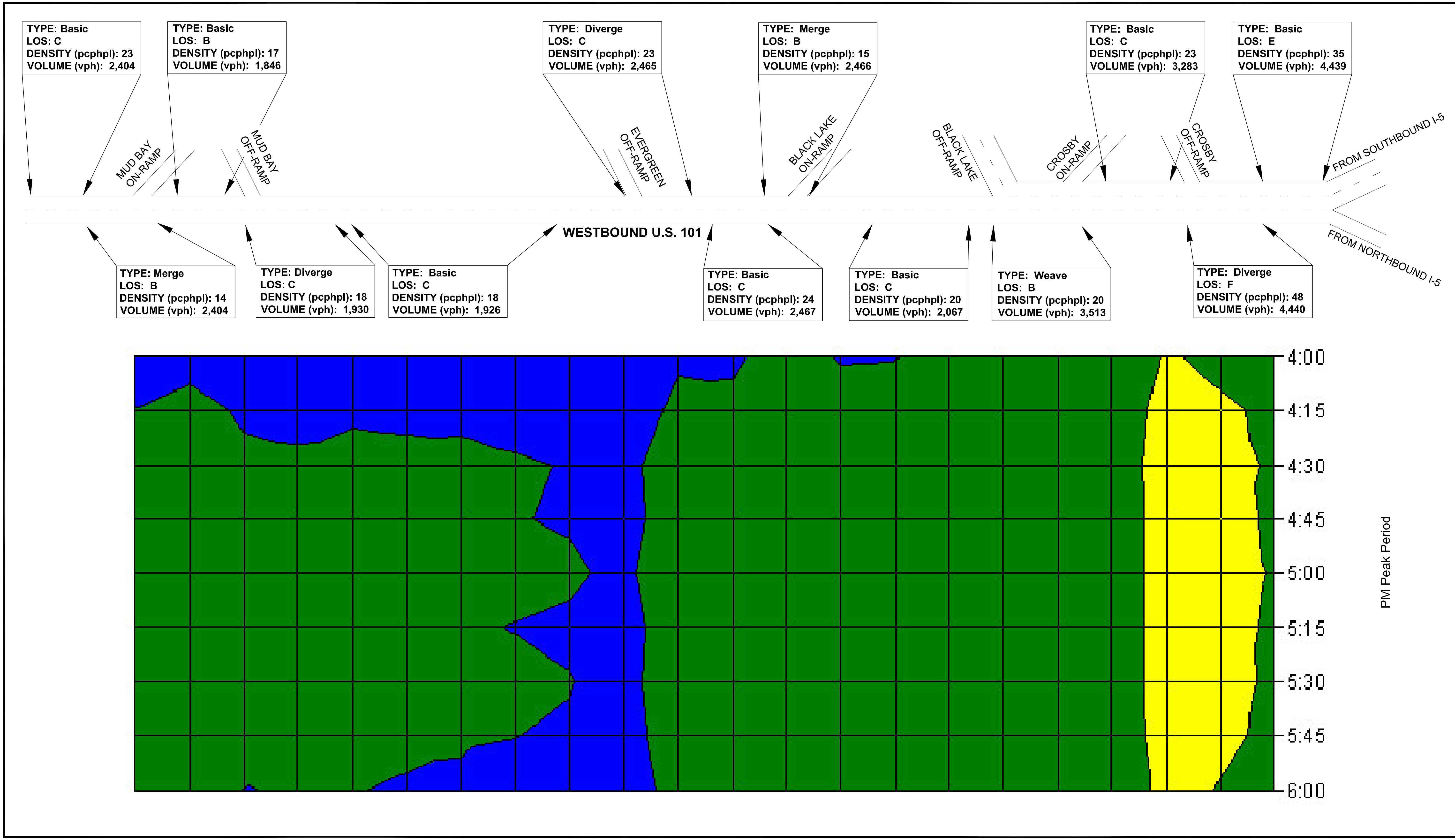
Figure 6
Existing 2007 Eastbound U.S. 101
Freeway PM Peak Period Operations



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F07

N
No Scale

Travel Speeds

- 60-70 mph
- 50-60 mph
- 40-50 mph
- 30-40 mph
- 20-30 mph
- 10-20 mph
- 0-10 mph

Figure 7
Existing 2007 Westbound U.S. 101 Freeway PM Peak Period Operations

Local System Volumes

Local turning movement counts were collected from the WSDOT and the cities of Olympia and Tumwater between 2005 and 2007. These traffic volumes were balanced between intersections, and were used in the local intersection analysis and at US 101 ramp termini. The existing PM peak hour turning movement counts are shown in Figure 8.

Local System LOS (Average Delays)

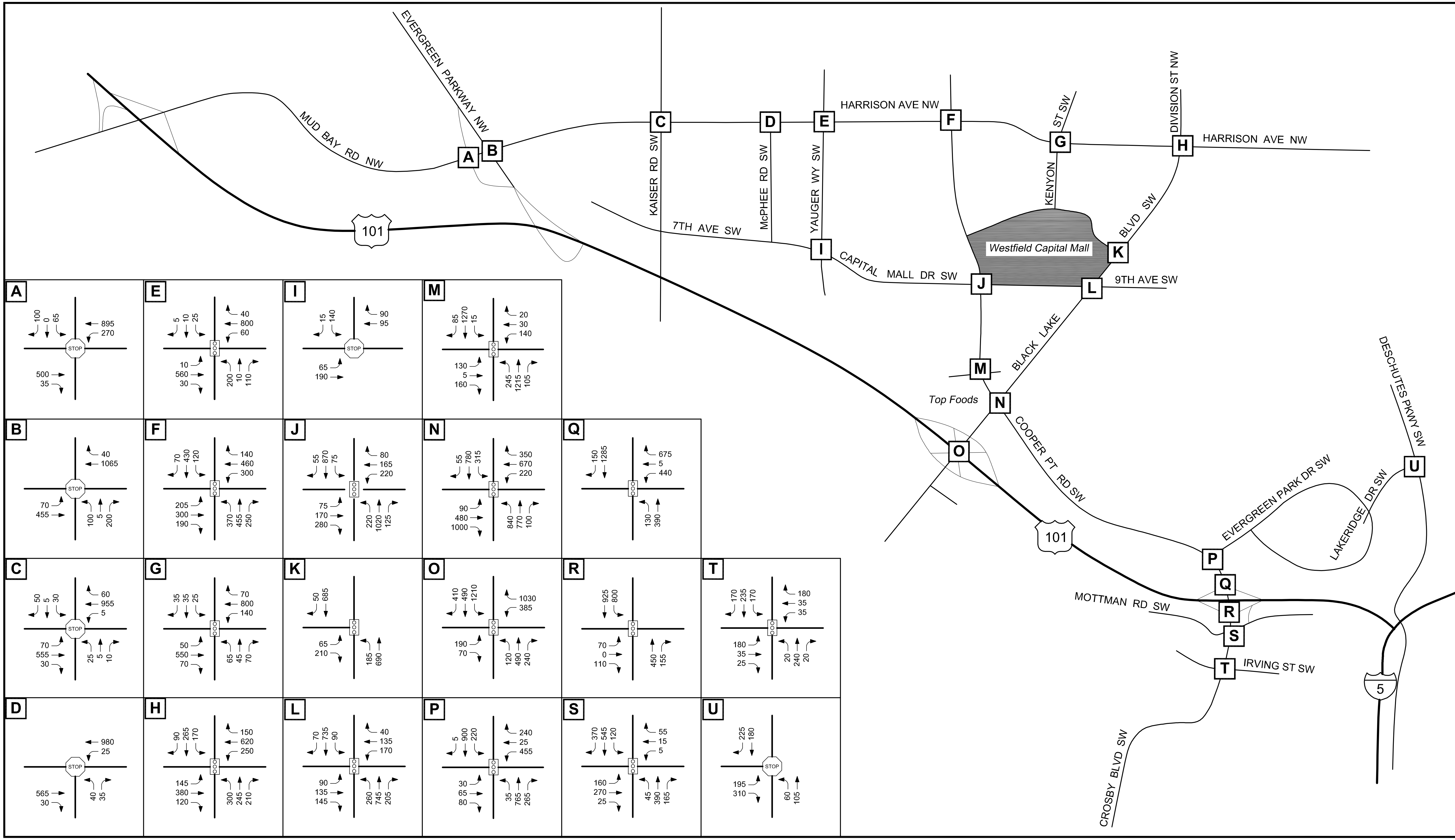
The LOS for local intersections was calculated using the HCS Signals module of Synchro 7 (build 761) for signalized intersections and HCS+ for unsignalized intersections. These traffic analysis software packages were used to measure the total average vehicle delays, which were then equated to LOS grades per the HCM. Table 6 summarizes the existing 2007 local traffic operations and compares the one-hour HCM methodology to the City of Olympia's methodology that incorporates a 2-Hour Adjustment Factor for traffic volumes.

Accounting for the 2-Hour Adjustment Factor, where applicable:

- 16 intersections operate at LOS A, B, or C
- four intersections operate at LOS D or E, and
- four intersections operate at LOS F.

Based on the different LOS standards for WSDOT and the cities of Olympia and Tumwater, this represents five intersections that are currently operating unacceptably below their respective LOS standards.

The "triangle" delay, which is the sum total of intersection delays at the Black Lake Boulevard SW/Cooper Point Road SW, Harrison Avenue NW/Division Street NW, and Harrison Avenue NW/Cooper Point Road NW intersections, is 219.5 seconds/vehicle.



Parametrix DATE: Jul 08, 2008 FILE: BL1631062P03T05_F08

N

No Scale

X Study Intersection

Turning Movement Volume

Stop - Controlled Intersection

Signalized Intersection

Figure 8
2007 Existing
PM Peak Hour
Intersection Volumes

Table 6. Existing 2007 PM Peak Hour Local Traffic Operations

Intersection Description	Intersection Control[a]	One-Hour Analysis[b]			Two-Hour Analysis[b]		
		LOS	Delay (sec/veh)	Max v/c Ratio	LOS	Delay (sec/veh)	Max v/c Ratio
Harrison Ave/Division St	Signalized	F	84.7	1.00	E	73.4	0.96
Black Lake Blvd/Cooper Point Rd	Signalized	F	85.2	1.18	E	74.2	1.12
US 101 SPUI (Through/Lefts)/Black Lake Blvd	Signalized	E	63.2	0.98	E	60.1	0.96
Cooper Point Rd/Harrison Ave/Mud Bay Rd	Signalized	D	49.6	0.81	D	45.0	0.80
Cooper Point Rd/Capitol Mall Blvd	Signalized	D	38.2	0.73	C	34.9	0.70
Black Lake Blvd/9th Ave/Capital Mall Dr	Signalized	C	32.6	0.69	C	31.5	0.66
Cooper Point Rd/Automall Dr/Evergreen Park Dr	Signalized	C	27.6	0.74	C	25.7	0.69
Cooper Point Rd/Top Foods Entrance	Signalized	C	24.5	0.73	C	23.1	0.69
US 101 Westbound Ramps (dec. mp)/Crosby Blvd	Signalized	C	21.0	0.64	B	19.9	0.58
US 101 Eastbound Ramps (inc. mp)/Crosby Blvd	Signalized	B	19.3	0.67	B	18.6	0.62
Crosby Blvd/Mottman Rd	Signalized	B	18.8	0.60	NA	NA	NA
Crosby Blvd/Irving St	Signalized	B	13.9	0.44	NA	NA	NA
Harrison Ave/Kenyon St	Signalized	B	12.4	0.56	B	12.2	0.54
Black Lake Blvd/Capital Mall Entrance	Signalized	B	10.4	0.46	B	10.0	0.43
Harrison Ave/Yauger Wy	Signalized	A	8.6	0.53	A	8.4	0.51
US 101 SPUI Westbound US 101 (dec. mp) Off-Ramp Right Turns/Black Lake Blvd	Signalized	A	8.0	0.73	A	7.8	0.65
US 101 SPUI Eastbound US 101 (inc. mp) Off-Ramp Right Turns/Black Lake Blvd	Signalized	A	2.7	0.35	A	2.7	0.34
Harrison Ave/McPhee Rd	Unsignalized	F	>200	1.16	F	165.7	0.93
Harrison Ave/Kaiser Rd	Unsignalized	F	158.5	0.74	F	104.6	0.61
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	Unsignalized	F	>200	1.30	NA	NA	NA
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	Unsignalized	F	>200	3.44	NA	NA	NA
Black Lake Blvd/Top Foods Entrance	Unsignalized	C	22.7	0.82	C	20.1	0.78
Lakeridge Dr/Deschutes Prkwy	Unsignalized	C	16.9	0.48	B	14.2	0.39
Capital Mall Dr/Yauger Wy	Unsignalized	B	13.6	0.28	B	11.8	0.19

[a] Unsignalized LOS and delay were calculated by HCS+. The LOS and delay for all-way stop-controlled intersections are reported for the intersection as a whole, whereas the LOS and delay for two-way stop-controlled intersections are reported for the worst approach. Signalized intersection LOS and delay were calculated from the HCM Signals Report feature of Synchro 7 (build 761).

[b] The one-hour analysis is based on HCM methodologies and provided the basis for intersection improvements. The two-hour analysis results account for the 2-Hour Adjustment Factor that the City of Olympia uses to define their LOS standards. A “NA” indicates intersections that are not under the jurisdiction of the City of Olympia and therefore a 2-Hour Adjustment Factor is not applicable.

DESCRIPTIONS OF FUTURE SCENARIOS

The scenarios described below include baseline improvements that were initially identified and assumed in the travel demand forecasting model. Other intersection improvements were added to the baseline improvements to meet City of Olympia LOS standards. This approach maximized additional intersection improvements to the fullest extent and was most applicable to the Local System Only Scenarios (Scenario 2 and 3). Even with the full range of possible improvements, this approach was not enough to achieve the City's LOS standard at some intersections. The added improvements are listed in Table 12 of this technical memorandum.

2030 No-Build Scenario 1

Under this scenario, the future conditions of the transportation network would largely be the same as it occurs today, with the exception of five projects that currently have construction funding secured and are expected to be completed prior to this project's design year. These projects are summarized in Table 7.

Table 7. Projects Included in the 2030 No-Build TRPC Demand Model

Project Name	Project Description
4th/5th Avenue Corridor Bridge Project	Project is completed
Harrison Avenue Widening, Phase II	Widen from 2 lanes to 4/5 lanes from Yauger Way to Kaiser Road
Evergreen Parkway Repair and Upgrade	Reduce number of lanes on Evergreen Parkway from 4 lanes to 2 lanes from 17th Avenue to Kaiser Road
College Station Connection	Connection from Mud Bay to Kaiser Road
Harrison Avenue/Kaiser Road Signal	Add a signal to the Harrison Avenue/Kaiser Road intersection and widen Harrison Avenue to five lanes for 300' of either side of the intersection

2030 Local System Only Scenario 2

A few improvements are common to all build scenarios, including:

- East-west connection between McPhee Road SW and Kaiser Road SW south of Mud Bay Road
- North-south connection between Overhulse Road NW and Mud Bay
- Connection from Harrison Avenue NW to 4th Avenue W in the Kenyon Street NW vicinity
- Extend Kaiser Road SW between US 101 and Black Lake Boulevard SW
- Widen Harrison Avenue NW to four lanes from Kaiser Road to Evergreen Parkway

In addition to these improvements common to all build scenarios, Local System Only Scenario 2 also includes:

- Widen Black Lake Boulevard to three lanes from the SPUI to Black Lake Belmore Road
- Intersection improvements at Harrison Avenue/Black Lake Boulevard/Division Street, Harrison Avenue/Cooper Point, and Black Lake Boulevard/Cooper Point Road
- Widen Harrison Avenue NW to five lanes with a two-way left-turn lane from the Black Lake Boulevard/Division Street NW intersection to the West Bay vicinity
- New east-west connection between Yauger Way to the Top Foods vicinity (near Cooper Point Road SW)

2030 Local System Only Scenario 3

This scenario includes all of the local system improvements as Scenario 2, but also includes the Southwest Connections, which include:

- Decatur Street SW connection between Caton Way SW and Decatur Street SW
- Fern Street SW connection to Carriage Loop SW
- 16th Avenue SW connection to Fern Street SW (removal of existing barricade)

2030 Black Lake Interchange Scenario 4

Scenario 4 includes the local system improvements common to all scenarios and the widening of Black Lake Boulevard SW to three lanes from the SPUI to Black Lake Belmore Road, but other local system improvements described under Scenario 2 are not a part of this scenario.

In addition to the local system improvements, this scenario adds an auxiliary westbound off-ramp from the existing Black Lake Boulevard interchange off-ramp to the vicinity of Yauger Way SW and an auxiliary eastbound on-ramp from Yauger Way SW that connects to the existing Black Lake Boulevard interchange eastbound on-ramp.

Scenario 4 does not include the Southwest Connections (Decatur Street SW, Fern Street SW, and 16th Avenue SW) described under Scenario 3.

2030 Black Lake Interchange Scenario 5

Scenario 5 includes the same local system and interchange improvements described under Scenario 4, and also includes the Southwest Connections (Decatur Street SW, Fern Street SW, and 16th Avenue SW) described under Scenario 3.

2030 Evergreen Interchange Scenario 6

Scenario 6 assumes all of the local system improvements common to all scenarios as well as a new east-west connection between Yauger Way SW to the vicinity of Top Foods (Cooper Point Road SW).

This scenario also includes build-out of the existing Evergreen interchange by adding ramps to and from the east and west to create a full-access interchange from all directions. The westbound off-ramp would diverge from the US 101 mainline further east of its current location and intersect Kaiser Road SW. The eastbound on-ramp would also intersect with Kaiser Road SW prior to merging onto US 101 further east of its existing merge area.

Scenario 6 does not include the Southwest Connections (Decatur Street SW, Fern Street SW, and 16th Avenue SW) described under Scenario 3.

2030 Evergreen Interchange Scenario 7

This scenario includes the same local system and interchange improvements described under Scenario 6, but includes the Southwest Connections (Decatur Street SW, Fern Street SW, and 16th Avenue SW) described under Scenario 3.

Modeled Scenarios

The 2030 Thurston Regional Planning Council (TRPC) travel demand model was used to develop traffic volume forecasts for each 2030 design year scenario. Table 8 summarizes the local system and interchange improvements assumed in the travel demand forecasting model with each scenario. Many of the proposed scenarios differ only by the inclusion or exclusion of the Southwest Connections (Decatur, Fern, and 16th Street extensions). The Southwest Connections primarily affect the local transportation system. As a result, the freeway analysis focuses on No-Build Scenario 1 and Scenarios 3, 5, and 7, which are representative of all build scenarios with respect to freeway operations.

Table 8. Improvements Assumed in the Travel Demand Forecasting Model

Improvement	Local System Only w/o SW Connections Scenario 2	Local System Only w/ SW Connections Scenario 3	Black Lake Interchange w/o SW Connections Scenario 4	Black Lake Interchange w/ SW Connections Scenario 5	Evergreen Interchange w/o SW Connections Scenario 6	Evergreen Interchange w/ SW Connections Scenario 7
1	Complete Comprehensive Plan Grid: New connection bearing east-west between McPhee and Kaiser south of Mud Bay	Complete Comprehensive Plan Grid: New connection bearing east-west between McPhee and Kaiser south of Mud Bay	Complete Comprehensive Plan Grid: New connection bearing east-west between McPhee and Kaiser south of Mud Bay	Complete Comprehensive Plan Grid: New connection bearing east-west between McPhee and Kaiser south of Mud Bay	Complete Comprehensive Plan Grid: New connection bearing east-west between McPhee and Kaiser south of Mud Bay	Complete Comprehensive Plan Grid: New connection bearing east-west between McPhee and Kaiser south of Mud Bay
2	New connection bearing east-west between Overhulse north of Mud Bay from 5th to 6th Ave, includes north-south connection to Mud Bay	New connection bearing east-west between Overhulse north of Mud Bay from 5th to 6th Ave, includes north-south connection to Mud Bay	New connection bearing east-west between Overhulse north of Mud Bay from 5th to 6th Ave, includes north-south connection to Mud Bay	New connection bearing east-west between Overhulse north of Mud Bay from 5th to 6th Ave, includes north-south connection to Mud Bay	New connection bearing east-west between Overhulse north of Mud Bay from 5th to 6th Ave, includes north-south connection to Mud Bay	New connection bearing east-west between Overhulse north of Mud Bay from 5th to 6th Ave, includes north-south connection to Mud Bay
3	New connection from Harrison Ave to 4th Ave. vicinity of Kenyon St	New connection from Harrison Ave to 4th Ave. vicinity of Kenyon St	New connection from Harrison Ave to 4th Ave. vicinity of Kenyon St	New connection from Harrison Ave to 4th Ave. vicinity of Kenyon St	New connection from Harrison Ave to 4th Ave. vicinity of Kenyon St	New connection from Harrison Ave to 4th Ave. vicinity of Kenyon St
4	Extend Kaiser Rd E-W between US 101 to Black Lake	Extend Kaiser Rd E-W between US 101 to Black Lake	Extend Kaiser Rd E-W between US 101 to Black Lake	Extend Kaiser Rd E-W between US 101 to Black Lake	Extend Kaiser Rd E-W between US 101 to Black Lake	Extend Kaiser Rd E-W between US 101 to Black Lake
5	Widen Harrison to 4 lanes from Kaiser Road to Evergreen Parkway	Widen Harrison to 4 lanes from Kaiser Road to Evergreen Parkway	Widen Harrison to 4 lanes from Kaiser Road to Evergreen Parkway	Widen Harrison to 4 lanes from Kaiser Road to Evergreen Parkway	Widen Harrison to 4 lanes from Kaiser Road to Evergreen Parkway	Widen Harrison to 4 lanes from Kaiser Road to Evergreen Parkway
6	Widen Black Lake to 3 lanes (Black Lake Interchange to BL Belmore Rd)	Widen Black Lake to 3 lanes (Black Lake Interchange to BL Belmore Rd)	Widen Black Lake to 3 lanes (Black Lake Interchange to BL Belmore Rd)	Widen Black Lake to 3 lanes (Black Lake Interchange to BL Belmore Rd)	Widen Black Lake to 3 lanes (Black Lake Interchange to BL Belmore Rd)	Widen Black Lake to 3 lanes (Black Lake Interchange to BL Belmore Rd)
7	Improve Harrison/Black Lake & Division intersection	Improve Harrison/Black Lake & Division intersection	Improve Harrison/Black Lake & Division intersection	Improve Harrison/Black Lake & Division intersection	Improve Harrison/Black Lake & Division intersection	Improve Harrison/Black Lake & Division intersection
8	Improve Harrison/Cooper Point intersection	Improve Harrison/Cooper Point intersection	Improve Harrison/Cooper Point intersection	Improve Harrison/Cooper Point intersection	Improve Harrison/Cooper Point intersection	Improve Harrison/Cooper Point intersection
9	Improve Black Lake/Cooper Point intersection	Improve Black Lake/Cooper Point intersection	Improve Black Lake/Cooper Point intersection	Improve Black Lake/Cooper Point intersection	Improve Black Lake/Cooper Point intersection	Improve Black Lake/Cooper Point intersection
10	Add signal at McPhee, when warranted	Add signal at McPhee, when warranted	Add signal at McPhee, when warranted	Add signal at McPhee, when warranted	Add signal at McPhee, when warranted	Add signal at McPhee, when warranted
11	Widen Harrison Ave to 5 lanes with TWLTL (Black Lake & Division to vicinity West Bay	Widen Harrison Ave to 5 lanes with TWLTL (Black Lake & Division to vicinity West Bay	Widen Harrison Ave to 5 lanes with TWLTL (Black Lake & Division to vicinity West Bay	Widen Harrison Ave to 5 lanes with TWLTL (Black Lake & Division to vicinity West Bay	Widen Harrison Ave to 5 lanes with TWLTL (Black Lake & Division to vicinity West Bay	Widen Harrison Ave to 5 lanes with TWLTL (Black Lake & Division to vicinity West Bay
12	New connection bearing E-W between Yauger Way to vic. Top Foods (Cooper Point Rd)	New connection bearing E-W between Yauger Way to vic. Top Foods (Cooper Point Rd)			New connection bearing E-W between Yauger Way to vic. Top Foods (Cooper Point Rd)	New connection bearing E-W between Yauger Way to vic. Top Foods (Cooper Point Rd)
13		Decatur St extension		Decatur St extension		Decatur St extension
14		Fern St extension		Fern St extension		Fern St extension
15		16th St extension		16th St extension		16th St extension
16			Add off ramp WB to vicinity of Yauger Way and add on ramp EB from Yauger Way onto US 101	Add off ramp WB to vicinity of Yauger Way and add on ramp EB from Yauger Way onto US 101		
17					Build Out current Evergreen I/C by adding ramps to/from the West and add ramps to/from East at Kaiser Road with frontage road to Evergreen Parkway	Build Out current Evergreen I/C by adding ramps to/from the West and add ramps to/from East at Kaiser Road with frontage road to Evergreen Parkway

DESIGN YEAR 2030 TRAFFIC CONDITIONS

Freeway System Volumes

The 2030 Thurston Regional Planning Council (TRPC) travel demand model was used to develop traffic volume forecasts for each 2030 design year scenario. The 2030 WOAS model included all transportation improvement projects adopted in the Regional Transportation Plan (RTP) for which funds have been secured (see Table 8, above).

The TRPC EMME/2 travel demand model information has been transferred to VISUM to evaluate the West Olympia sub-area. The EMME/2 travel demand model provided a travel demand matrix output that was assigned to the VISUM subarea model. Further VISUM model assumptions, calibration, and validation results are documented in the West Olympia Access Study Model Documentation (PTV America 2007). Table 9 compares the existing 2007 and forecasted 2030 PM peak hour traffic volumes at key locations within the study area.

Table 9. PM Peak Hour Projected Traffic Volume Growths (2007-2030)

Mainline Segment	2007 Volume	2030 Volume	Absolute Difference	Percent Difference	Annual Growth Rate
Westbound US 101					
Northbound I-5 On	1,403	1,888	485	34.6%	1.5%
Southbound I-5 On	2,978	3,707	730	24.5%	1.1%
US 101 WB Mainline	4,381	5,595	1,215	27.7%	1.2%
Crosby Blvd Off	1,120	1,244	123	11.0%	0.5%
US 101 WB Mainline	3,260	4,352	1,092	33.5%	1.5%
Crosby Blvd On	285	604	319	112.1%	4.9%
US 101 WB Mainline	3,545	4,956	1,411	39.8%	1.7%
Black Lake Blvd Off	1,414	1,457	42	3.0%	0.1%
US 101 WB Mainline	2,131	3,499	1,368	64.2%	2.8%
Black Lake Blvd On	530	795	265	50.0%	2.2%
US 101 WB Mainline	2,660	4,294	1,633	61.4%	2.7%
Eastbound US 101					
US 101 EB Mainline	2,080	3,455	1,376	66.1%	2.9%
Black Lake Blvd Off	260	491	231	89.0%	3.9%
US 101 EB Mainline	1,820	2,965	1,145	62.9%	2.7%
Black Lake Blvd on	1,450	1,580	130	9.0%	0.4%
US 101 EB Mainline	3,270	4,545	1,275	39.0%	1.7%
Crosby Blvd Off	180	286	106	58.7%	2.6%
US 101 EB Mainline	3,090	4,258	1,169	37.8%	1.6%
Crosby Blvd On	1,285	1,478	193	15.0%	0.7%
US 101 EB Mainline	4,375	5,736	1,361	31.1%	1.4%
Northbound I-5 Off	2,645	3,253	608	23.0%	1.0%
Southbound I-5 Off	1,340	1,850	510	38.0%	1.7%
Deschutes Pkwy Off	389	633	244	62.6%	2.7%
Southbound I-5					
I-5 SB Mainline	4,585	6,282	1,697	37.0%	1.6%
Plum Avenue/14th On	1,663	1,729	66	4.0%	0.2%
I-5 SB Mainline	6,248	8,010	1,763	28.2%	1.2%
US 101 Off	2,978	3,707	730	24.5%	1.1%
I-5 SB Mainline	3,270	4,303	1,033	31.6%	1.4%
2nd Avenue Off	276	265	-11	-4.1%	-0.2%
I-5 SB Mainline	2,994	4,038	1,044	34.9%	1.5%
US 101 On	1,340	1,850	509	38.0%	1.7%
I-5 SB Mainline	4,334	5,888	1,553	35.8%	1.6%

Table 9. PM Peak Hour Projected Traffic Volume Growths (2007-2030) (continued)

Mainline Segment	2007 Volume	2030 Volume	Absolute Difference	Percent Difference	Annual Growth Rate
Northbound I-5					
I-5 NB Mainline	3,855	5,475	1,619	42.0%	1.8%
US 101 Westbound Off	907	1,233	326	36.0%	1.6%
I-5 NB Mainline	2,949	4,242	1,293	43.8%	1.9%
US 101 WB/Deschutes Pkwy On	3,021	3,671	650	21.5%	0.9%
I-5 NB Mainline	5,970	7,913	1,943	32.5%	1.4%
Plum Street/14th Off	881	1,049	168	19.0%	0.8%
I-5 NB Mainline	5,089	6,864	1,775	34.9%	1.5%
14th Avenue On	700	756	56	8.0%	0.3%
I-5 NB Mainline	5,789	7,620	1,831	31.6%	1.4%

Note: 2030 volumes are for the No-Build Scenario 1

The 2030 traffic volumes provided above represent the balanced travel demand based on the TRPC demand model and do not account for capacity constraints. Actual VISSIM model throughput volumes, which do account for traffic congestion, are depicted graphically on Figures 9 through 12 and are described for each of the scenarios in their respective sections.

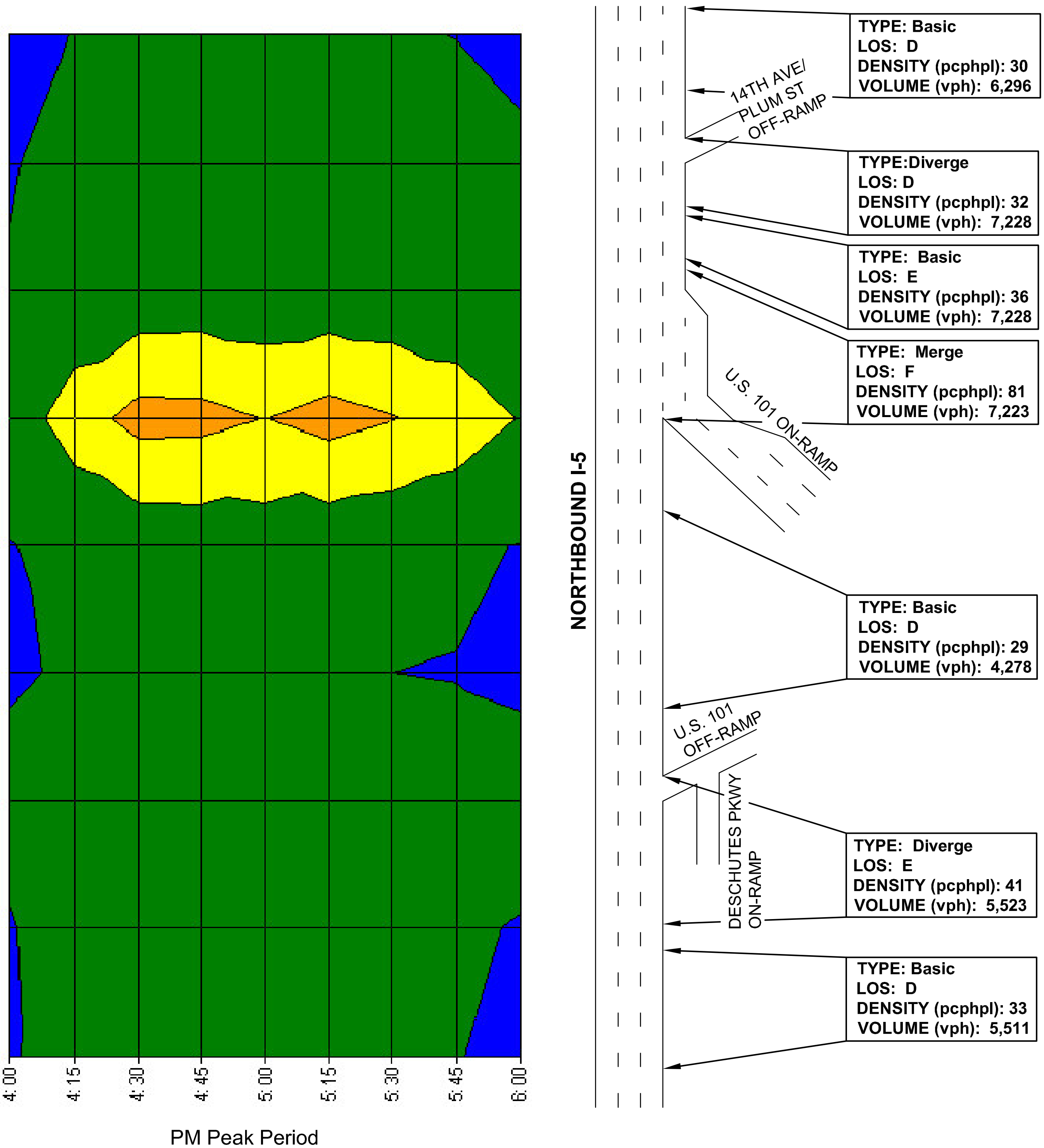
2030 No-Build Scenario 1

Future 2030 No-Build traffic volumes along northbound I-5 are expected to substantially increase by the year 2030. Volumes entering the study area on northbound I-5 are expected to substantially increase from 4,000 vehicles during the PM peak hour to approximately 5,500 vehicles. Similar to the existing conditions, a substantial change in mainline volumes is expected to occur around the US 101 interchange with approximately 1,200 vehicles exiting to US 101 and roughly 3,000 vehicles entering the northbound I-5 mainline from US 101 and Deschutes Parkway SW. Figure 9 shows the VISSIM mainline volumes for northbound I-5 for each of the mainline segment types during the 2030 PM peak hour.

The volume throughput, which is the portion of the demand that is served during a specific time frame, of traffic entering the study area along southbound I-5 is expected to be relatively similar to the existing conditions (4,600 vehicles for existing conditions and 4,700 vehicles for year 2030). Although the demand is expected to be much higher, this portion of southbound I-5 is expected to reach capacity and, therefore, the proportion of the demand that is served (i.e. throughput) will only slightly increase while the unmet demand will increase and be stuck in queue on the mainline or find alternate routes on local streets. Similar to the existing conditions, the short weave section and high volume of lane changes is expected to create a bottleneck and constrain the amount of throughput. South of the US 101 interchange, mainline volumes are expected to slightly increase. Figure 10 shows the modeled volumes for each mainline segment type along southbound I-5 during the 2030 PM peak hour.

From the beginning of the western limit of the study area, eastbound US 101 volumes are expected to substantially increase from approximately 1,800 vehicles per hour to 2,800 vehicles per hour. Substantial changes in mainline traffic volumes are also expected at the Evergreen Parkway on-ramp, Black Lake Boulevard interchange (off- and on-ramps), and Crosby Boulevard/Cooper Point on-ramp. Conversely, the amount of traffic to and from Mud Bay Road SW and to the Crosby Boulevard/Cooper Point off-ramp is expected to experience relatively small changes in traffic volumes compared to the existing conditions. Operations at the Black Lake Boulevard interchange are expected to substantially degrade, causing bottleneck conditions that spill back onto the US 101 mainline up to the Evergreen Parkway interchange. Figure 11 provides the traffic volumes for each mainline segment type along eastbound US 101 during the 2030 PM peak hour.

Traffic volume growth entering the study area for westbound US 101 is expected to be relatively small, largely due to capacity constraints associated with southbound I-5. Continuing west, more pronounced changes in mainline volumes are expected, with volume increases up to 1,200 vehicles per hour around the Black Lake Boulevard and Mud Bay Road interchanges. Westbound US 101 mainline volumes for each segment type during the 2030 PM peak hour are shown in Figure 12



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F09

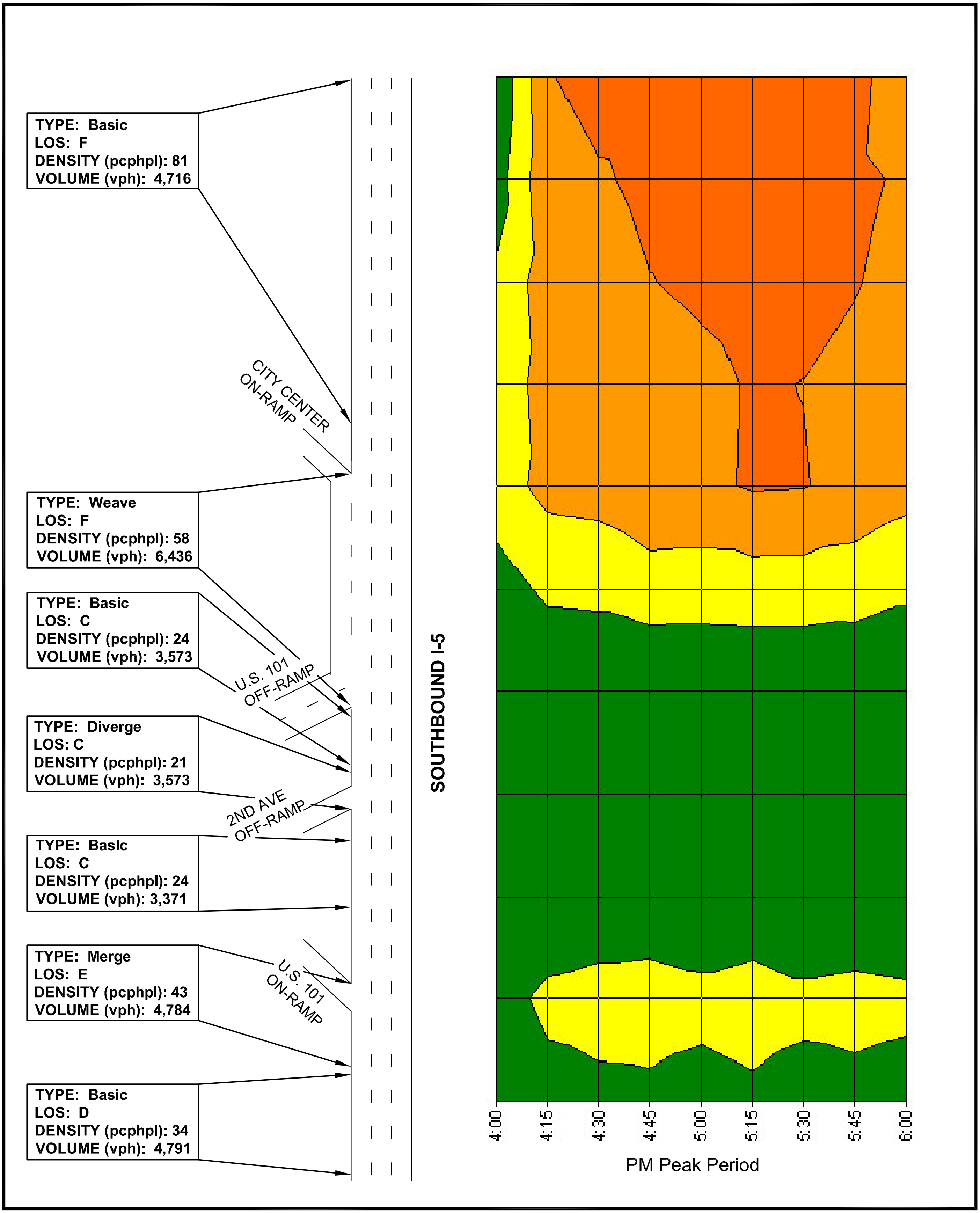
N

No Scale

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 9
2030 No-Build Scenario 1
Northbound I-5 Freeway
PM Peak Period Operations



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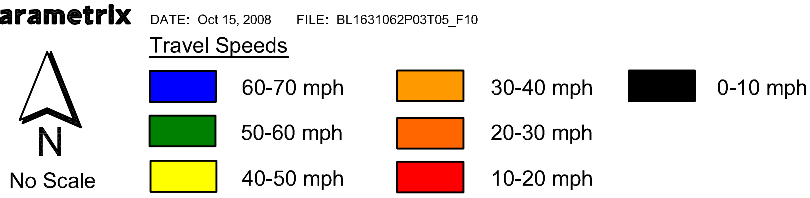
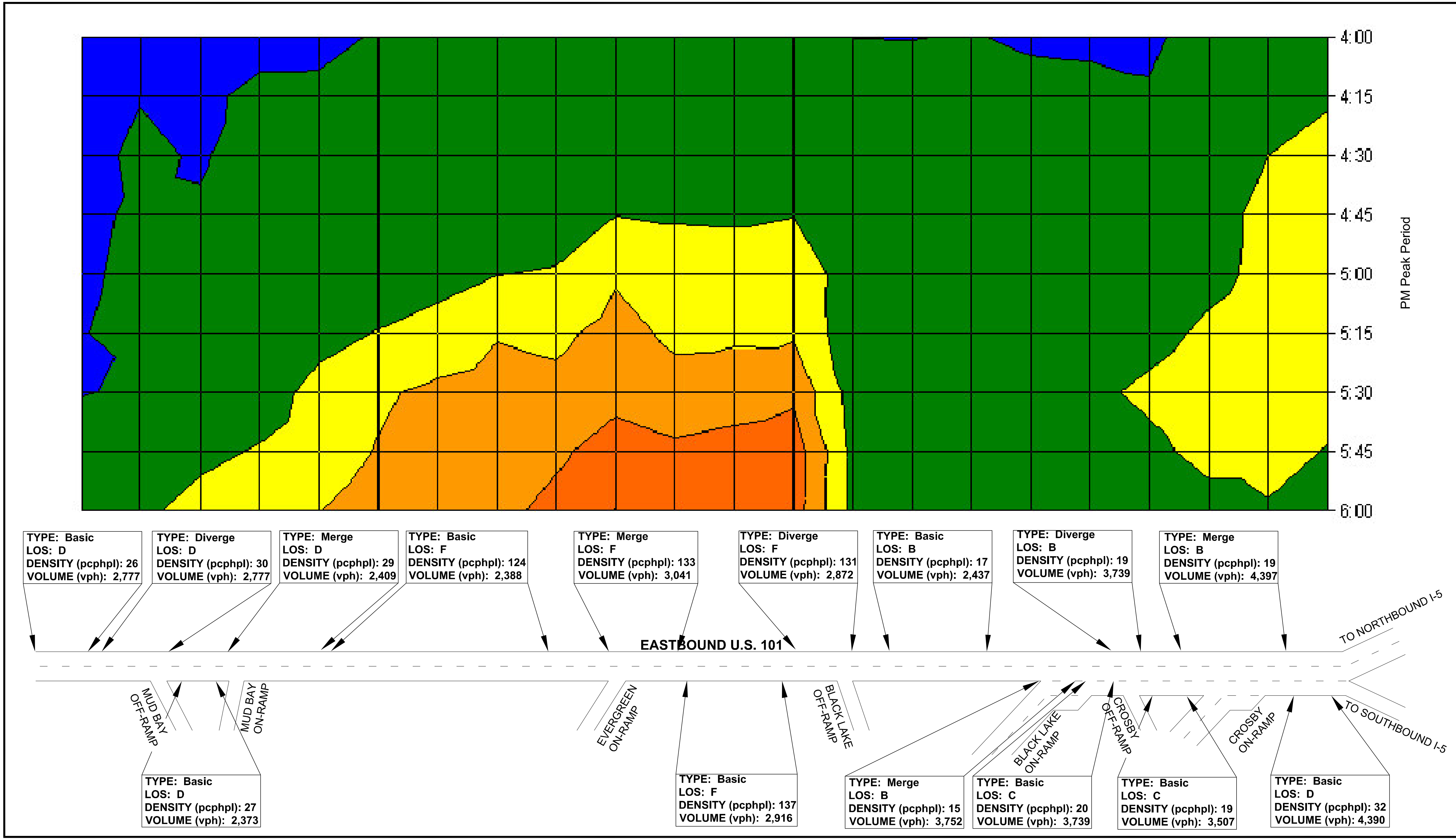


Figure 10
2030 No-Build Scenario 1
Southbound I-5 Freeway
PM Peak Period Operations



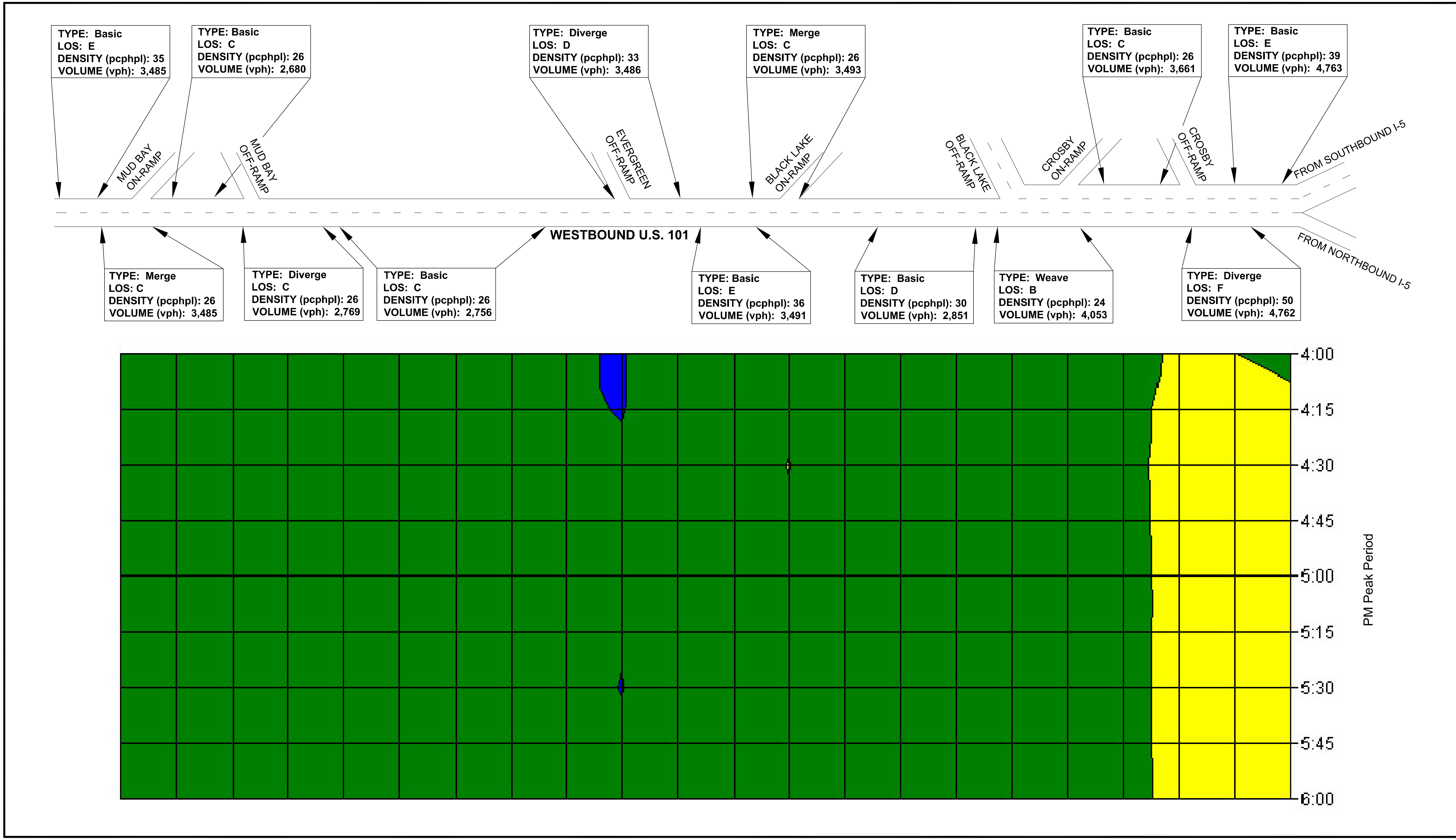
Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F11

N
No Scale

Travel Speeds

60-70 mph	30-40 mph	0-10 mph
50-60 mph	20-30 mph	
40-50 mph	10-20 mph	

Figure 11
2030 No-Build Scenario 1
Eastbound U.S. 101 Freeway
PM Peak Period Operations



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F12

N
No Scale

Travel Speeds

- 60-70 mph
- 50-60 mph
- 40-50 mph
- 30-40 mph
- 20-30 mph
- 10-20 mph
- 0-10 mph

Figure 12
2030 No-Build Scenario 1
Westbound U.S. 101 Freeway
PM Peak Period Operations

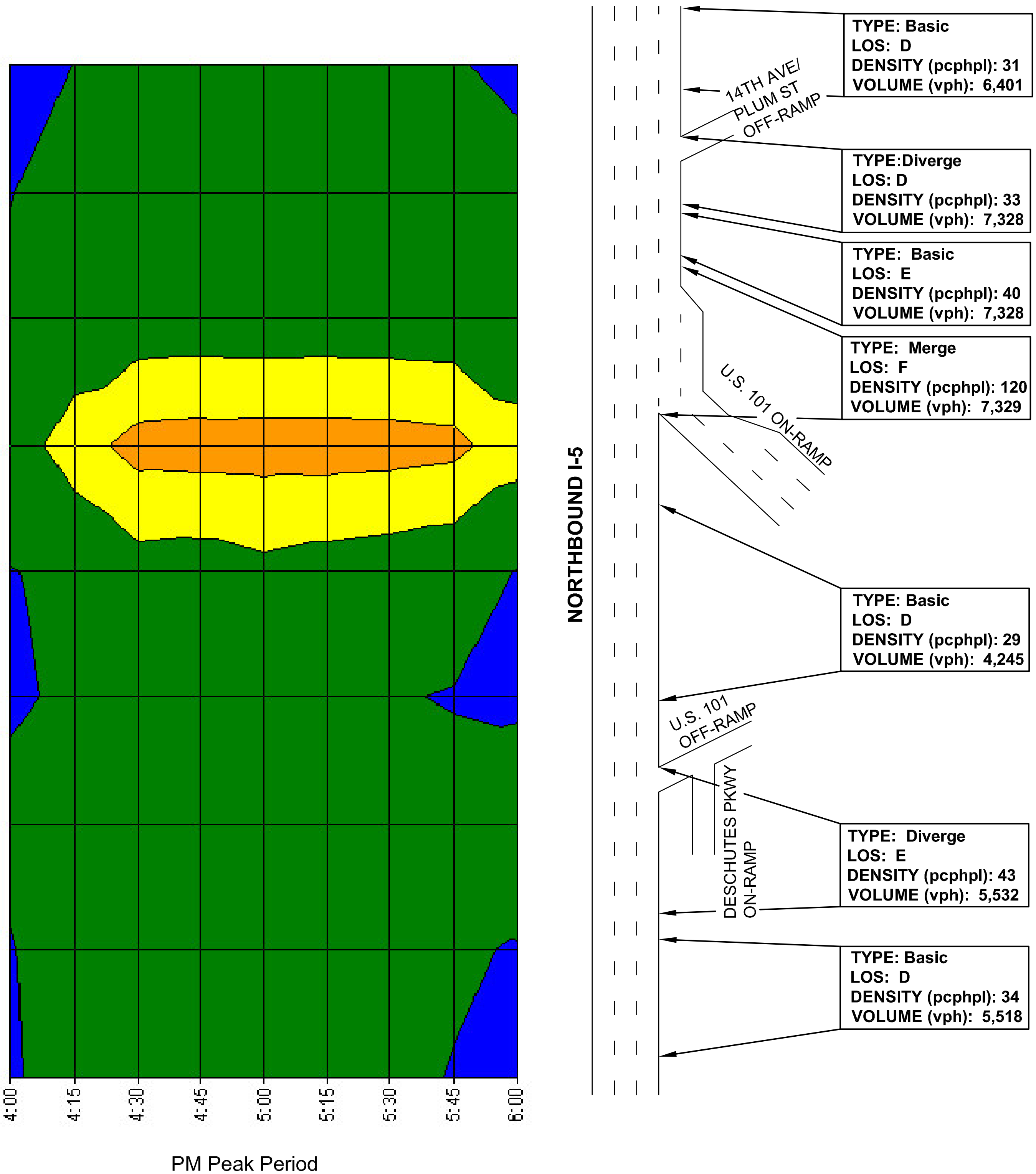
2030 Local System Only Scenario 3

Future 2030 traffic volumes along northbound I-5 under Scenario 3 are fairly similar to No-Build Scenario 1 volumes. Scenario 3 has increased volumes coming onto the northbound I-5 mainline from eastbound US 101, however, this relatively small increase in volume is not the result of additional demand, rather the release of bottleneck conditions at the Black Lake interchange, which is supported by a volume difference of less than 20 vehicles in the travel demand model. Figure 13 shows the 2030 traffic volumes along northbound I-5 under Scenario 3.

Local System Only Scenario 3 and No-Build Scenario 1 traffic volumes on southbound I-5 are comparable. Minor volume differences, less than 150 vehicles during the PM peak hour, suggests that southbound I-5 traffic volumes would be negligibly affected by local system improvements in the West Olympia vicinity since the total demand volumes along some portions of southbound I-5 exceed 6,000 vehicles per hour. Figure 14 shows the 2030 traffic volumes along southbound I-5 under Local System Only Scenario 3.

Approximately 2,800 vehicles enter the western limit of the study area on eastbound US 101 in the PM peak hour, which is the same as the No-Build Scenario 1. The amount of traffic to and from Mud-Bay Road SW is expected to be similar to No-Build. However, substantial changes in traffic volumes along eastbound US 101 are seen at the Evergreen on-ramp, Black Lake interchange and Crosby Boulevard interchange areas. Local improvements at the Black Lake and Crosby Boulevard interchanges substantially improve operations and serve a greater portion of the unmet demand exiting and entering the eastbound US 101 mainline. On- and off-ramp volumes are similar, but US 101 mainline volumes are generally between 450 and 600 vehicles higher with the Local System Only Scenario 3 compared to No-Build Scenario 1 due to the release of bottleneck conditions that precluded vehicles from being served as a result of heavy traffic congestion under No-Build Scenario 1. Figure 15 shows the 2030 traffic volumes along eastbound US 101 under the Local System Only Scenario 3.

Local System Only Scenario 3 is expected to have slightly higher traffic volumes (up to 250 vehicles) along the westbound US 101 mainline compared to No-Build Scenario 1. The demand between these two scenarios is generally the same, however, local improvements associated with the Local System Only Scenario 3 improve ramp termini operations and allow additional traffic volumes (upwards of 150 vehicles) to exit and enter the westbound US 101 mainline at the Crosby Boulevard and Black Lake interchanges. Figure 16 shows the 2030 traffic volumes along eastbound US 101 for the Local System Only Scenario 3.



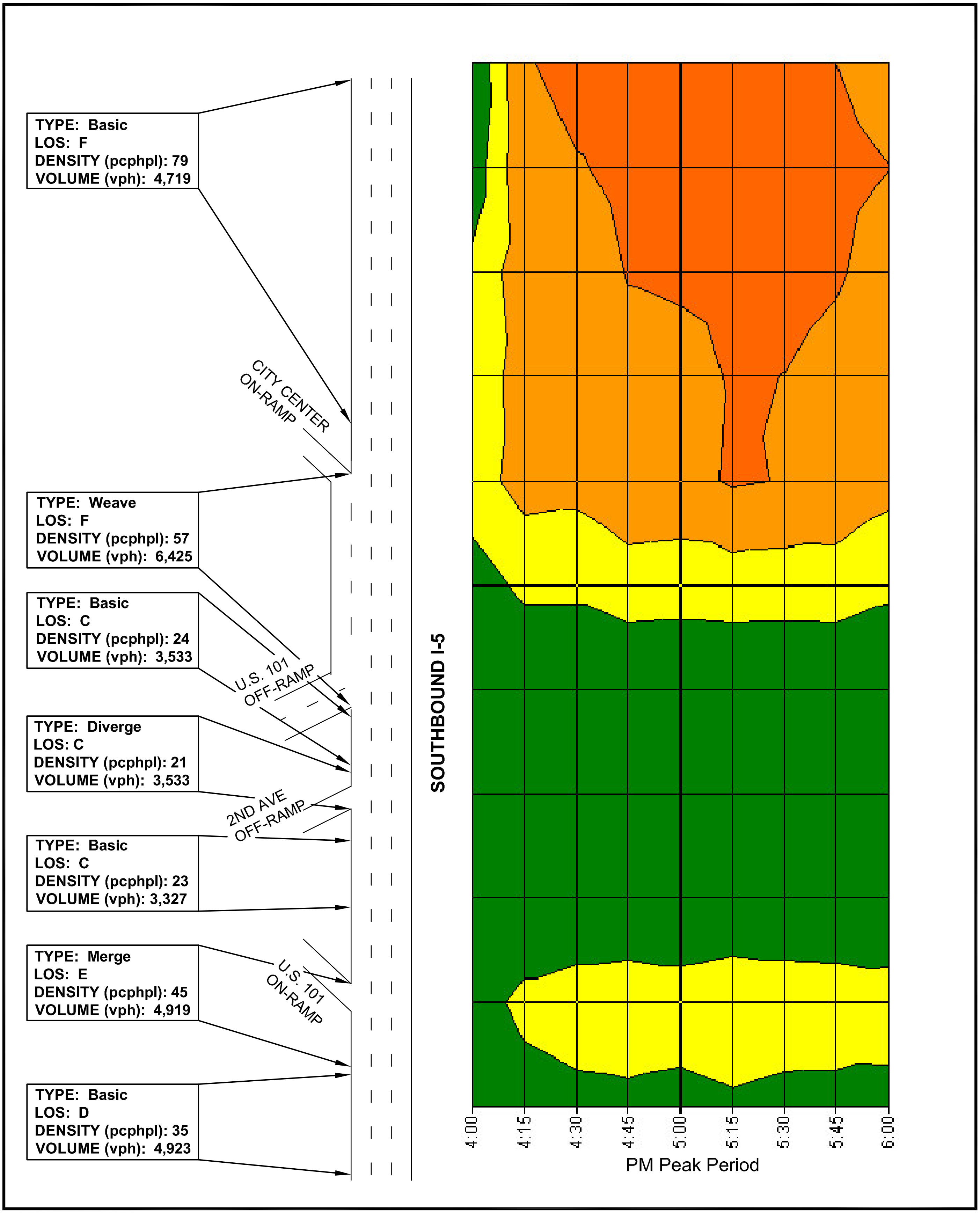
Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F13

Travel Speeds

60-70 mph	30-40 mph	0-10 mph
50-60 mph	20-30 mph	
40-50 mph	10-20 mph	

N
No Scale

Figure 13
2030 Local System Only Scenario 3
Northbound I-5 Freeway
PM Peak Period Operations



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F14

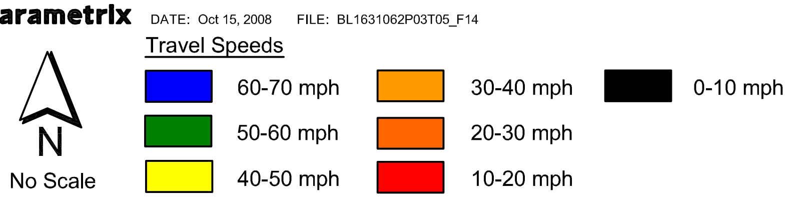
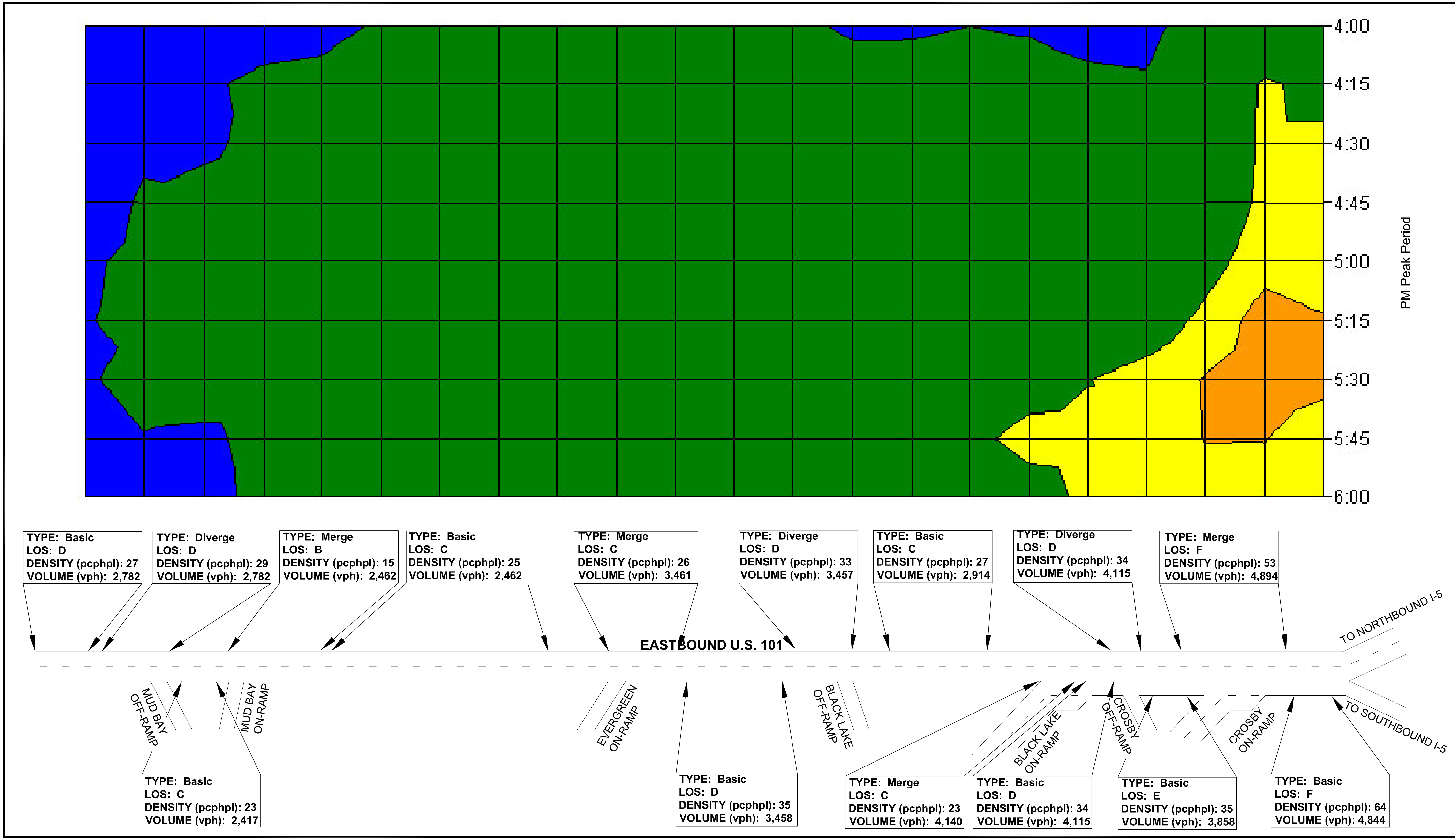


Figure 14
2030 Local System Only Scenario 3
Southbound I-5 Freeway
PM Peak Period Operations



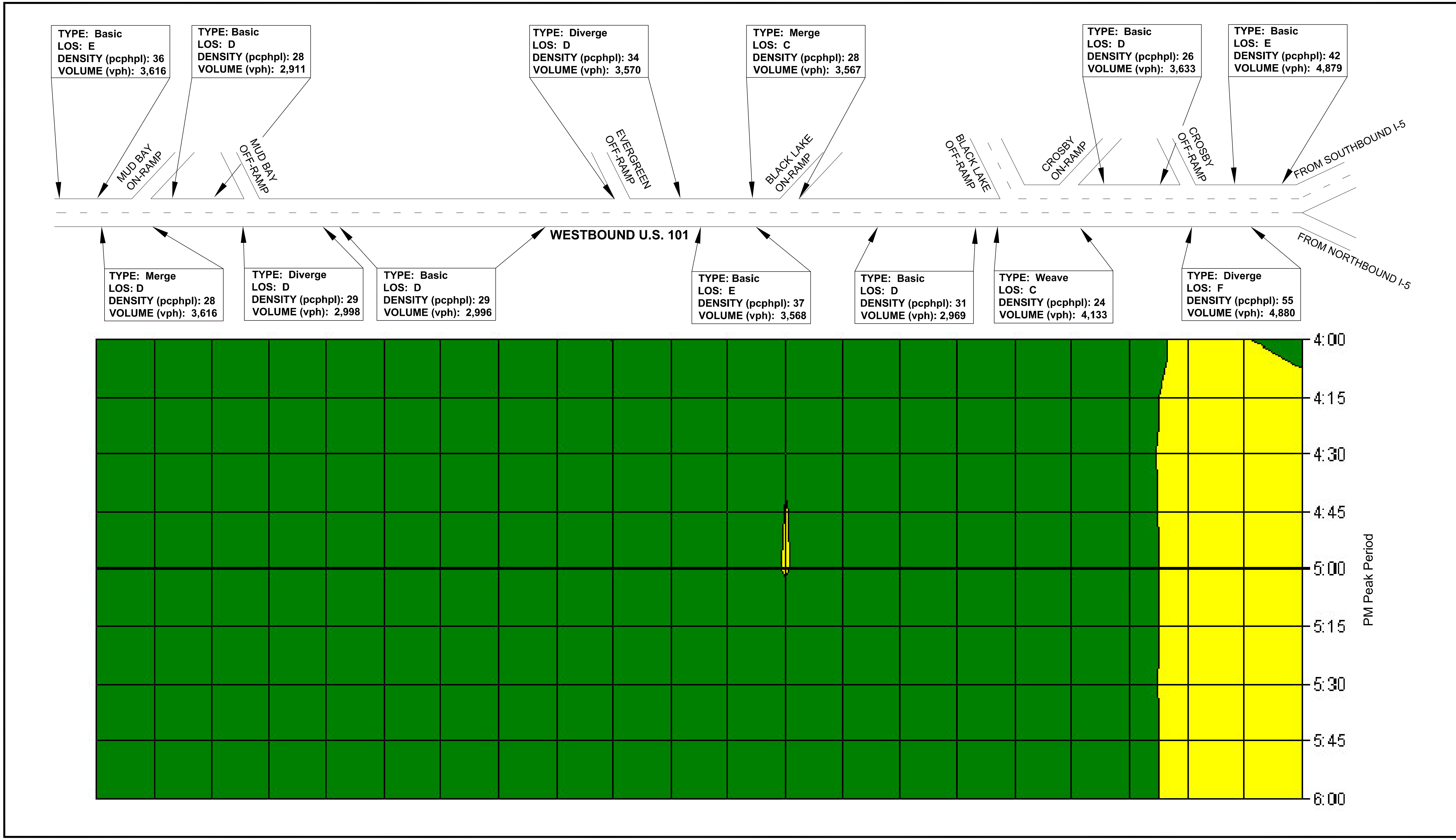
Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F15

N
No Scale

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 15
2030 Local System Only Scenario 3
Eastbound U.S. 101 Freeway
PM Peak Period Operations



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F16

N
No Scale

Travel Speeds

60-70 mph	30-40 mph
50-60 mph	20-30 mph
40-50 mph	10-20 mph
0-10 mph	

Figure 16
2030 Local System Only Scenario 3
Westbound U.S. 101 Freeway
PM Peak Period Operations

2030 Black Lake Interchange Scenario 5

Traffic volumes along northbound I-5 for Scenario 5 are comparable to Local System Only Scenario 3 conditions along all the study segments. Compared to No-Build Scenario 1, Black Lake Scenario 5 has a small volume increase coming from eastbound US 101 to northbound I-5. As previously described, this small increase is attributed to the release of constrained demand at the Black Lake interchange. Figure 17 shows the 2030 traffic volumes along northbound I-5 for Black Lake Scenario 5

Traffic volumes for Scenarios 1, 3, and 5 on southbound I-5 are also generally similar. South of the US 101 on-ramp, the southbound I-5 mainline volume increases slightly as a result of releasing the constrained demand in queue at the Black Lake interchange under No-Build Scenario 1. Figure 18 shows the 2030 traffic volumes along southbound I-5 for Black Lake Scenario 5.

Traffic volumes entering eastbound US 101 under Black Lake Scenario 5 are similar to that of Local System Only Scenario 3 at the beginning of the study area and around the Mud Bay interchange. East of the Mud Bay interchange, US 101 mainline volumes increase with Black Lake Scenario 5 since better operations provide increased demand throughput. Figure 19 shows the 2030 traffic volumes along eastbound US 101 under Black Lake Scenario 5.

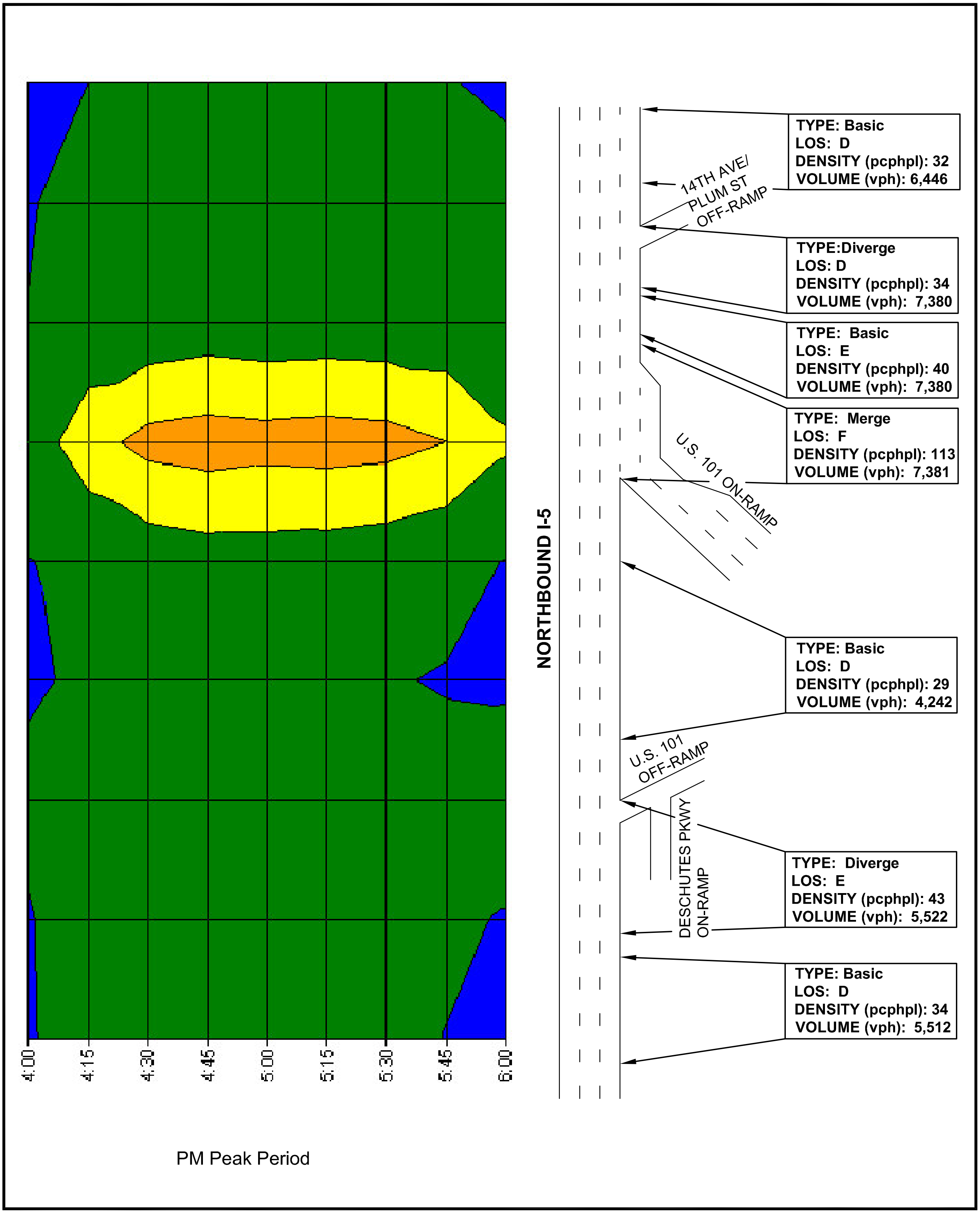
Westbound US 101 mainline volumes for Scenarios 5 and 3 are generally similar, however, a small volume (around 50 vehicles) is diverted from the Evergreen off-ramp to the Black Lake off-ramp. Figure 20 shows the 2030 traffic volumes along westbound US 101 under Black Lake Scenario 5.

2030 Evergreen Interchange Scenario 7

Scenario 7 traffic volumes along northbound and southbound I-5 are similar to those of Local System Only Scenario 3 and Black Lake Scenario 5. As with Scenarios 3 and 5, the Evergreen interchange improvements on US 101 and the local system improvements under Scenario 7 have a small effect on northbound and southbound I-5 traffic volumes. Figure 21 and Figure 22 show the 2030 traffic volumes along northbound I-5 and southbound I-5 under Evergreen Scenario 7.

The traffic volumes entering the western end of the study area on eastbound US 101 for Evergreen Scenario 7 are generally consistent with the traffic volumes of Scenarios 3 and 5. A small volume, approximately 25 vehicles, is expected to utilize the new eastbound Evergreen off-ramp during the PM peak hour. The existing eastbound Evergreen on-ramp volume increases by approximately 200 vehicles compared to Scenarios 3 and 5 as a result of the connection between the on-ramp and Kaiser Road SW. East of Evergreen interchange, eastbound US 101 mainline volumes for Evergreen Scenario 7 are similar to Scenarios 3 and 5. Figure 23 shows the 2030 traffic volumes along eastbound US 101 under Evergreen Scenario 7.

Traffic volumes along westbound US 101 for Evergreen Scenario 7 are generally similar to Scenarios 3 and 5 up to the Black Lake interchange. At the reconfigured westbound Evergreen off-ramp, which connects to Kaiser Road SW, an additional 300 vehicles exit the westbound US 101 mainline under Evergreen Scenario 7. The new westbound Evergreen on-ramp is expected to serve approximately 150 vehicles during the PM peak hour. Figure 24 shows the 2030 traffic volumes along westbound US 101 under Evergreen Scenario 7.

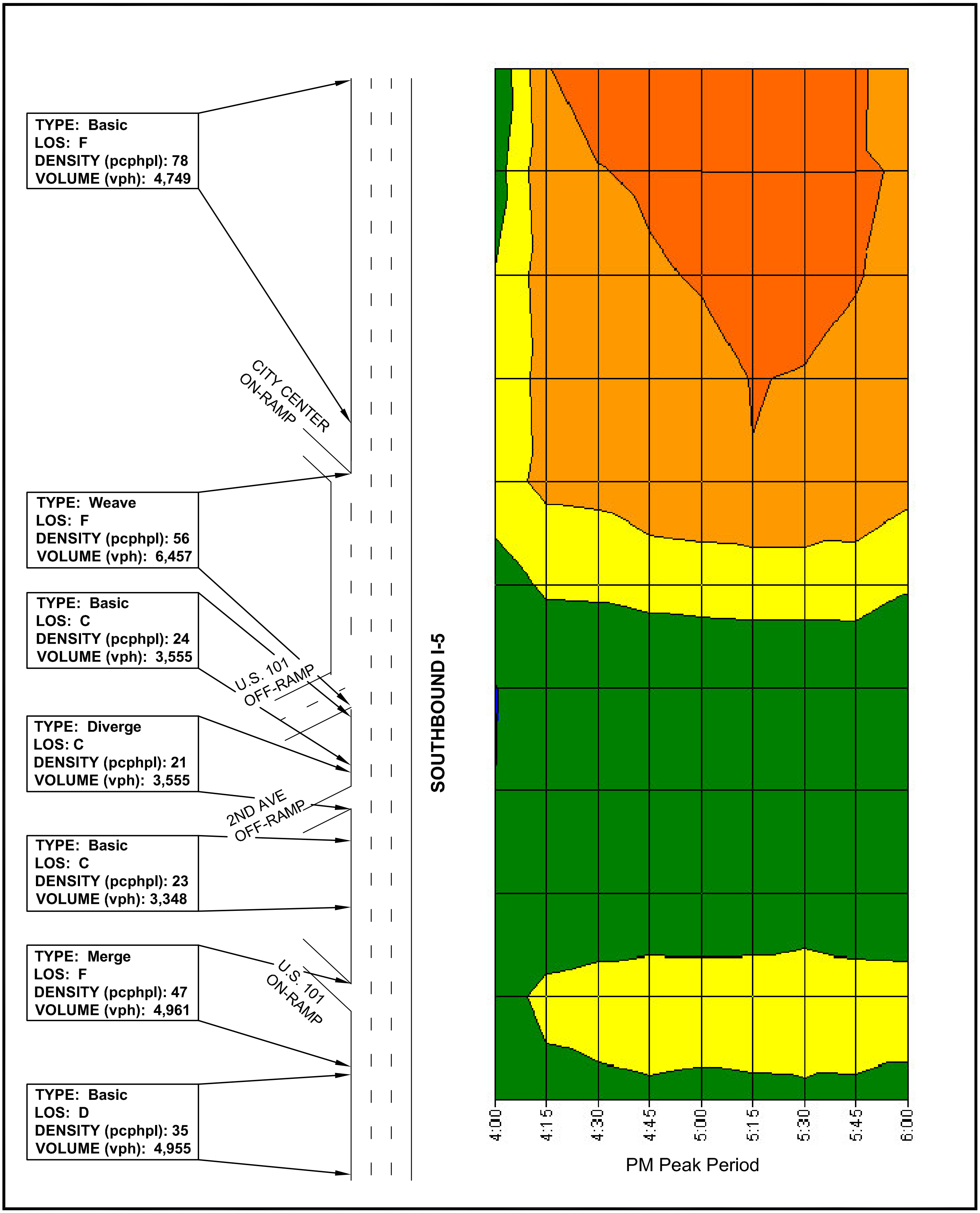


Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F17

Travel Speeds

60-70 mph	30-40 mph	0-10 mph
50-60 mph	20-30 mph	
40-50 mph	10-20 mph	

Figure 17
2030 Black Lake Interchange Scenario 5
Northbound I-5 Freeway
PM Peak Period Operations



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F18

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

N
No Scale

Figure 18
2030 Black Lake Interchange Scenario 5
Southbound I-5 Freeway
PM Peak Period Operations

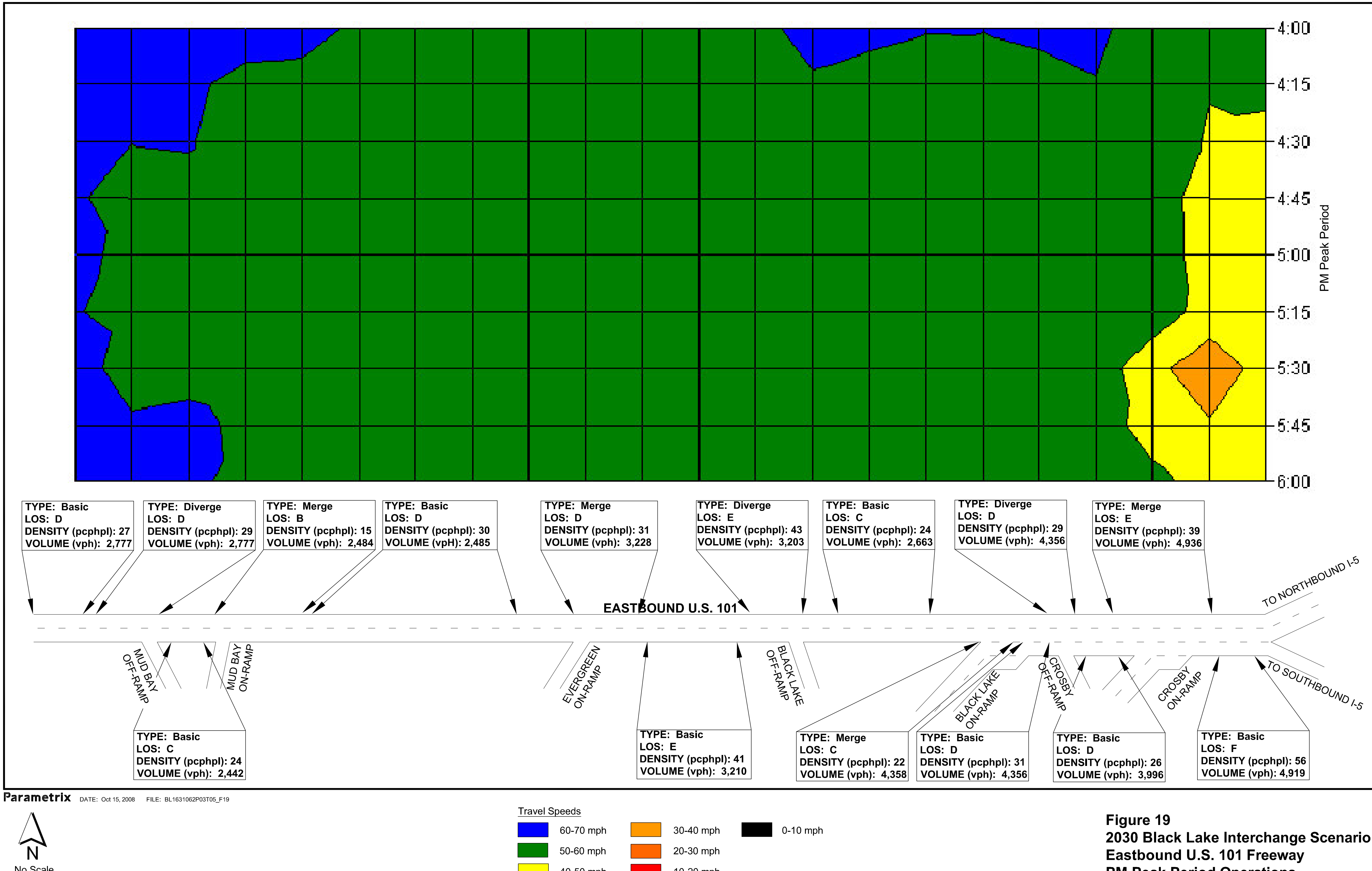
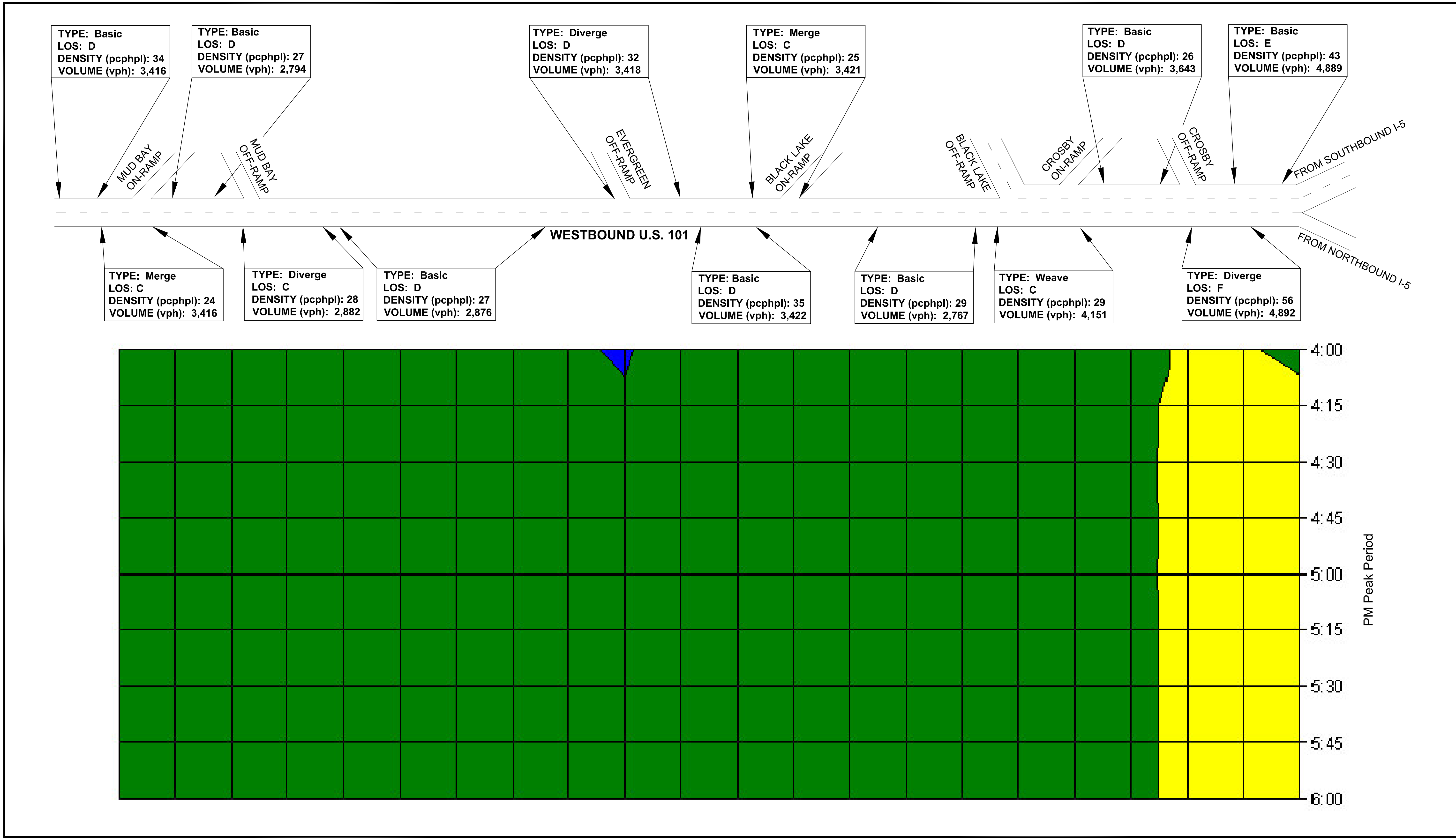


Figure 19
2030 Black Lake Interchange Scenario 5
Eastbound U.S. 101 Freeway
PM Peak Period Operations



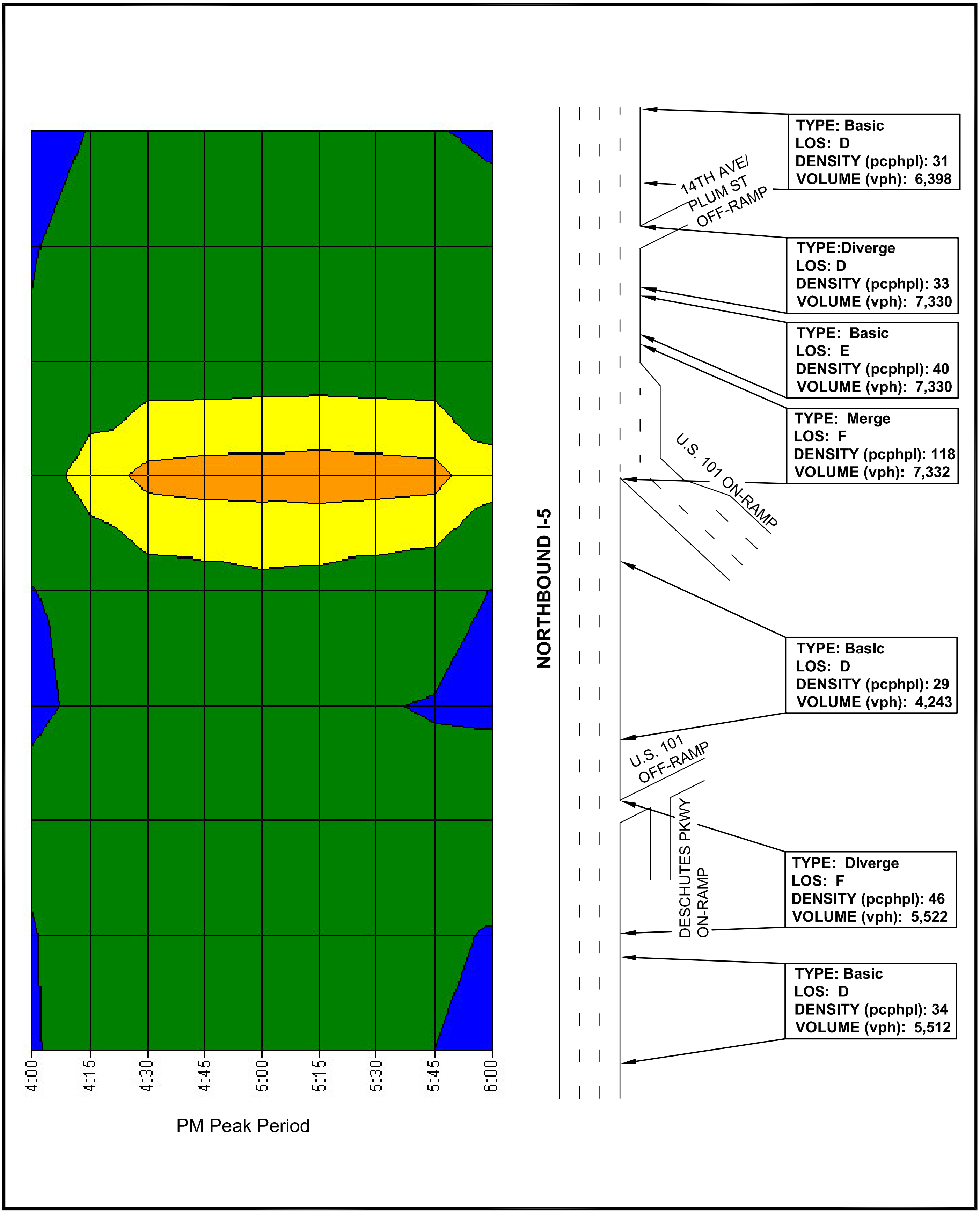
Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F20

N
No Scale

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 20
2030 Black Lake Interchange Scenario 5
Westbound U.S. 101 Freeway
PM Peak Period Operations



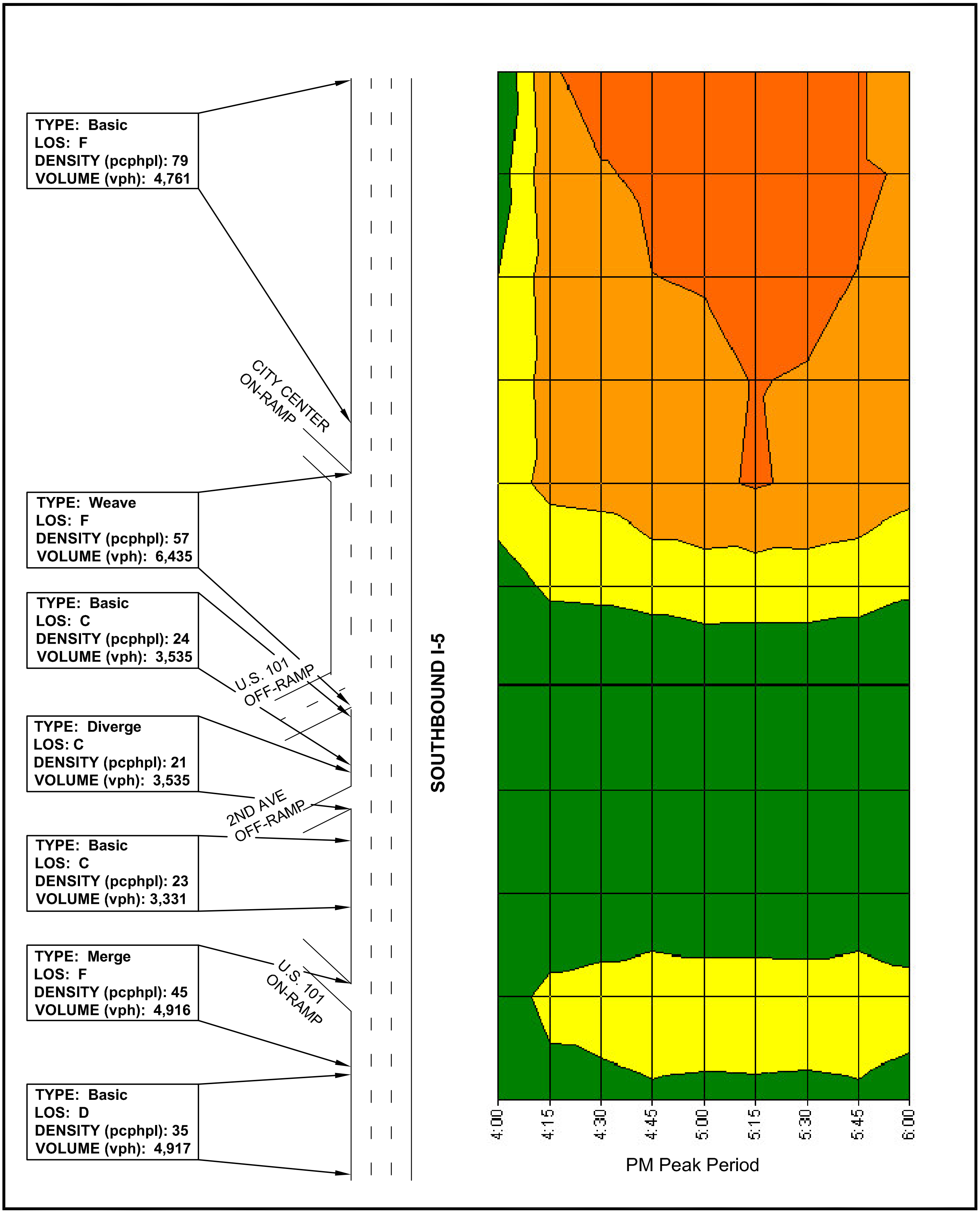
Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F21

N
No Scale

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 21
2030 Evergreen Interchange Scenario 7
Northbound I-5 Freeway
PM Peak Period Operations



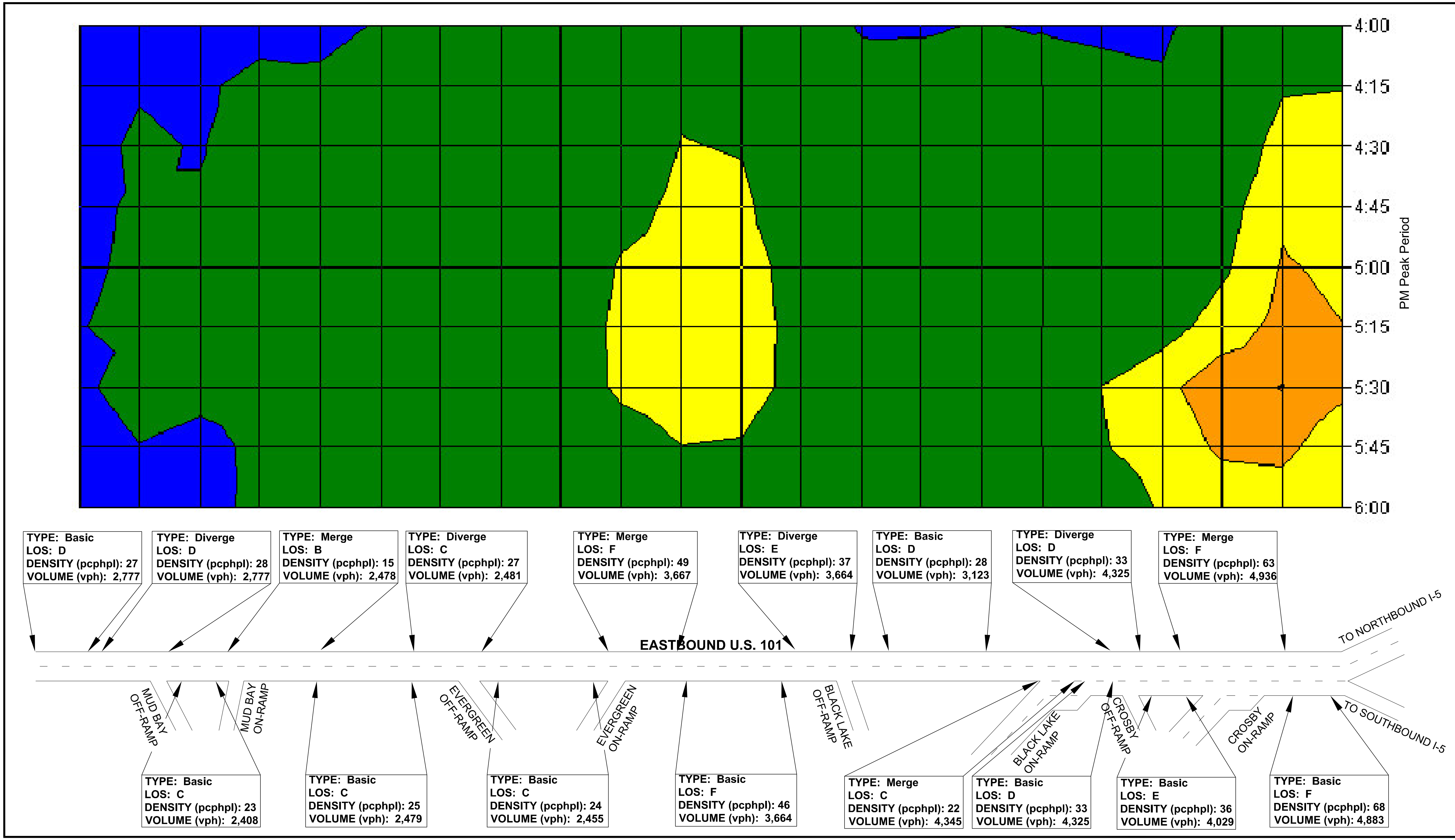
Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F22

N
No Scale

Travel Speeds

60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 22
2030 Evergreen Interchange Scenario 7
Southbound I-5 Freeway
PM Peak Period Operations

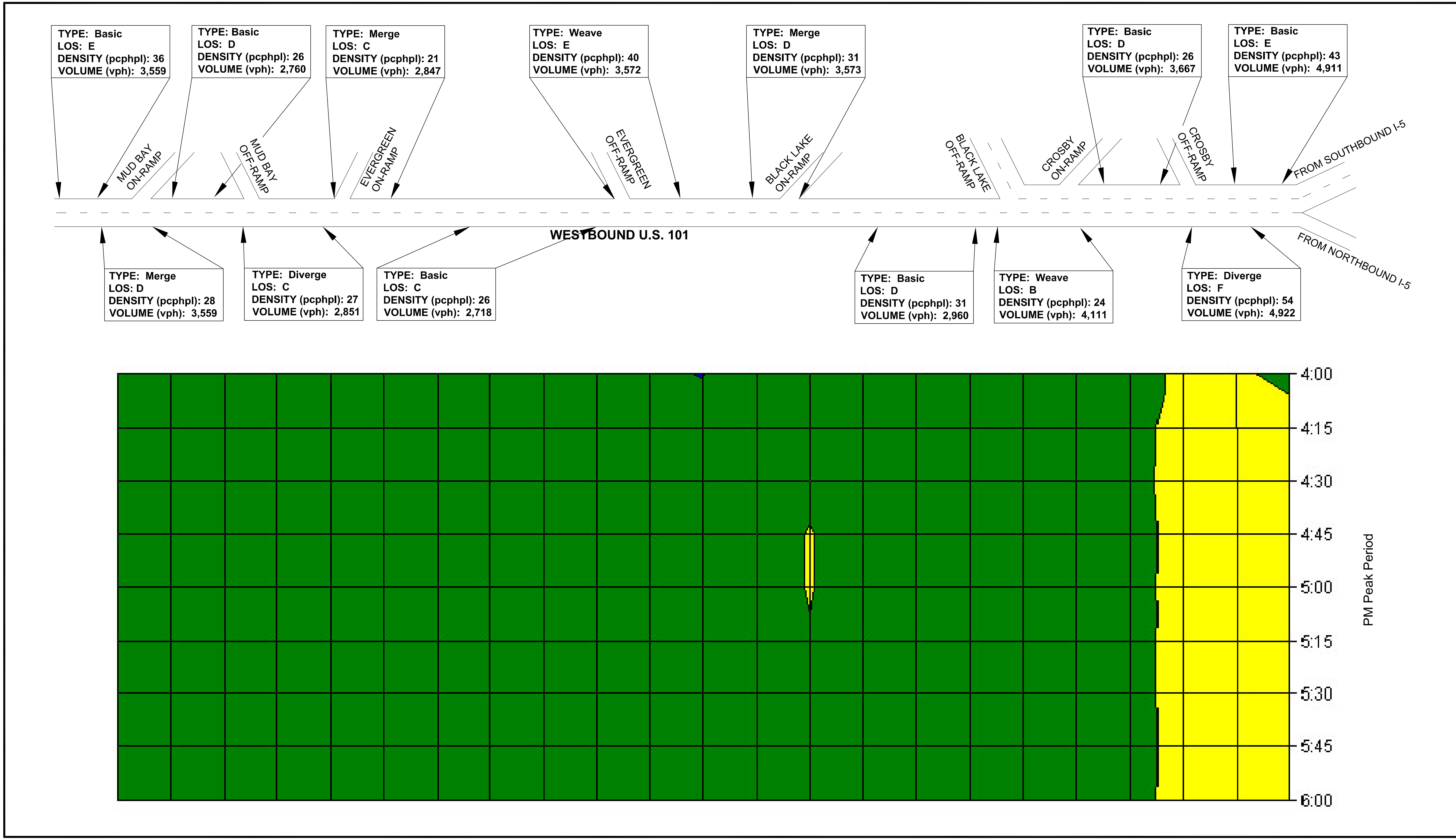


Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F23

N
No Scale

Travel Speeds
60-70 mph
50-60 mph
40-50 mph
30-40 mph
20-30 mph
10-20 mph
0-10 mph

Figure 23
2030 Evergreen Interchange Scenario 7
Eastbound U.S. 101 Freeway
PM Peak Period Operations



Parametrix DATE: Jan 06, 2009 FILE: BL1631062P03T05_F24

N
No Scale

Travel Speeds

60-70 mph	30-40 mph	0-10 mph
50-60 mph	20-30 mph	
40-50 mph	10-20 mph	

Figure 24
2030 Evergreen Interchange Scenario 7
Westbound U.S. 101 Freeway
PM Peak Period Operations

Freeway System LOS (Densities)

Similar to the existing conditions freeway analysis, VISSIM version 4.3 was used to calculate freeway densities in terms of vehicles per mile per lane. Heavy vehicle percentages obtained from the WSDOT and HCM adjustment factors were used to convert vehicles per mile per lane to passenger cars per mile per lane to determine the freeway LOS.

In general, LOS D is the acceptable level of service threshold for urban freeway facilities as set by WSDOT. Table 10 compares existing and future I-5 and US 101 mainline segment types expected to operate at LOS E or F and Attachment D provides an expanded version of this table.

2030 No-Build Scenario 1

As shown in Table 10, three segments each of northbound and southbound I-5, four segments of eastbound US 101, and four segments of westbound US 101 are expected to operate worse than LOS D for No-Build Scenario 1.

The three segments along the northbound I-5 mainline that operate at LOS E/F are around the US 101 off-ramp, US 101 on-ramp, and I-5 mainline north of the US 101 on-ramp. Vehicles exiting to westbound US 101 face horizontal and vertical curves that slow traffic speeds, especially for heavy vehicles. Coupling off-ramp geometrics with high exiting volumes reduces flow and creates high densities in the outside lane of the northbound I-5 mainline. The densities and LOS along the northbound I-5 mainline are shown on Figure 9.

The three segments along the southbound I-5 mainline that operate at LOS E/F are the southbound mainline around Plum Street, US 101 off-ramp, and US 101 on-ramp. Similar to existing conditions, the primary contributor to high traffic densities and LOS E/F congestion in these areas is the short weave section between the Plum Street on-ramp and the US 101 off-ramp, but is exacerbated by higher traffic volumes and more lane change maneuvers. The geometrics of the US 101 off-ramp, which includes horizontal and vertical curves, also contribute to congestion. Figure 10 shows the densities and LOS along the southbound I-5 mainline.

From west of the Evergreen on-ramp to east of the Black Lake off-ramp the eastbound US 101 mainline is expected to experience substantially high densities and LOS F conditions. This is caused due to the bottleneck conditions at the Black Lake interchange that limit the volume of exiting vehicles and causes queues that spillback onto the US 101 mainline. East of the Black Lake interchange the densities substantially decrease as a result of Black Lake bottleneck. Figure 11 shows the LOS and density along the eastbound US 101 mainline.

Westbound US 101, around the Crosby Boulevard interchange, is expected to experience high densities and LOS E/F conditions. This congestion is due to the weaving of vehicles coming from southbound I-5 attempting to move into the left-most lane to bypass the Crosby off-ramp and vehicles coming from northbound I-5 weaving towards the Crosby off-ramp coupled with the steep grade. In addition to the Crosby Boulevard interchange area, the US 101 mainline west of the Evergreen off-ramp is expected to operate at LOS E. Figure 12 shows the LOS and density along the westbound US 101 mainline.

2030 Local System Only Scenario 3

Three segments each of northbound and southbound I-5, three segments of eastbound US 101, and four segments of westbound US 101 operate worse than LOS D for Local System Only Scenario 3.

Density and LOS values along northbound I-5 for Local System Only Scenario 3 are similar to those of No-Build Scenario 1 except at the US 101 on-ramp, where the density increases by a considerable amount. This is attributed to the increase in the traffic volume from eastbound US 101 to northbound I-5 caused by clearing the bottleneck at the Black Lake interchange. The densities and LOS for northbound I-5 under Local System Only Scenario 3 are shown on Figure 13.

Density and LOS values along southbound I-5 for Local System Only Scenario 3 are also similar to No-Build Scenario 1. Near the eastbound US 101 on-ramp to southbound I-5, the density increases slightly as a result of improved operating conditions around the Black Lake interchange. Figure 14 shows the densities and LOS along the southbound I-5 mainline for Local System Only Scenario 3.

Operations along eastbound US 101 for Local System Only Scenario 3 substantially improve in some areas and worsen in other areas compared to No-Build Scenario 1 as a result of the Black Lake bottleneck clearance. Eastbound US 101 operates at or above the LOS standards from the west end of the study area to the Crosby on-ramp. The Crosby Boulevard on-ramp and two mainline segments before and after the on-ramp operate at LOS E/F. This relocation of congestion is caused by the increase in the throughput volumes in the eastbound direction as a result of clearing the Black Lake bottleneck. Overall, the eastbound US 101 mainline operates substantially better with Local System Only Scenario 3 compared to No-Build Scenario 1. Figure 15 shows the LOS and density along the eastbound US 101 mainline for Local System Only Scenario 3.

The densities and LOS along westbound US 101 for Local System Only Scenario 3 are similar to No-Build Scenario 1. Although the densities increase by a small amount (up to 5 pc/mi/ln) in some locations, the overall difference in westbound US 101 densities is only 2 pc/mi/ln and the LOS does not change. These negligible changes are likely the result of the stochastic nature of the model since no improvements to westbound US 101 are included in Local System Only Scenario 3. Figure 16 shows the densities and LOS along the westbound US 101 mainline for Local System Only Scenario 3.

2030 Black Lake Interchange Scenario 5

Three segments each of northbound and southbound I-5, four segments of eastbound US 101, and two segments of westbound US 101 operate worse than LOS D for Black Lake Scenario 5.

Black Lake Scenario 5 densities and LOS values for northbound I-5 are very similar to those of Local System Only Scenario 3. Both Scenarios 3 and 5 slightly increase densities on northbound I-5 around the US 101 on-ramp since traffic volumes at the Black Lake bottleneck are released. Figure 17 shows the densities and LOS for the northbound I-5 mainline for Black Lake Scenario 5.

Southbound I-5 densities and LOS are similar to Scenarios 3; densities increase slightly around the US 101 on-ramp by up to 4 pc/mi/ln. Densities and LOS for the southbound I-5 mainline are shown on Figure 18 for Black Lake Scenario 5.

Differences in eastbound US 101 operations between Black Lake Scenario 5 and Local System Only Scenario 3 are most notable east of the Black Lake on-ramp, where the Scenario 5 densities are higher than Scenario 3. The increase in the density at Black Lake on-ramp is caused by the diversion of traffic from the Evergreen on-ramp to the new Yauger Way on-ramp. The increase in the density at the Black Lake on-ramp causes slight reduction in speeds which in turn reduces densities downstream. Figure 19 shows the densities and LOS along eastbound US 101 mainline for Black Lake Scenario 5.

Westbound US 101 operations in Black Lake Scenario 5 are similar to Local System Only Scenario 3; congestion continues to occur around the Crosby Boulevard interchange, but operates at nearly free flow conditions westward. Westbound US 101 densities and LOS associated with Black Lake Scenario 5 are shown on Figure 20.

2030 Evergreen Interchange Scenario 7

Three segments each of northbound and southbound I-5, six segments of eastbound US 101, and four segments of westbound US 101 operate worse than LOS D for Evergreen Scenario 7.

Evergreen Scenario 7 densities and LOS values for northbound I-5 are similar to those of Local System Only Scenario 3 and Black Lake Scenario 5. Three segments of the northbound I-5 mainline are expected to experience high densities and LOS E/F conditions, including the US 101 merge and diverge areas and a basic segment downstream (north) of the US 101 on-ramp. Figure 21 shows the densities and LOS conditions along the northbound I-5 mainline for Evergreen Scenario 7.

Similar to Scenarios 3 and 5, southbound I-5 densities are expected to result in LOS E/F conditions around the Plum Street/US 101 weave section and around the US 101 on-ramp as a result of heavy lane change maneuvers and high traffic volumes. The southbound I-5 densities and LOS conditions for Evergreen Scenario 7 are shown on Figure 22.

Segments of the eastbound US 101 mainline from the Evergreen on-ramp to the I-5 interchange are expected to have high densities and LOS E/F conditions as a result of increased traffic volumes from the re-aligned eastbound Evergreen on-ramp. These additional volumes (about 200 vehicles during the PM peak hour), as described above, are the result of the connection between the re-align on-ramp and Kaiser Road SW. Figure 23 shows the eastbound US 101 densities and LOS for Evergreen Scenario 7.

Westbound US 101 densities and LOS for Scenario 7 are similar to Scenarios 3 and 5 and the operational characteristics and causes for high densities are generally the same. Figure 24 shows the densities and LOS along the westbound US 101 mainline for Evergreen Scenario 7.

Table 10. 2030 No-Build and Build Scenarios, Failing Densities and LOS

Segment	Type	2030 No-Build Scenario 1		2030 Local System Only w/ SW Connections Scenario 3		2030 Black Lake Interchange w/ SW Connections Scenario 5		2030 Evergreen Interchange w/ SW Connections Scenario 7	
		Density (pc/mi/ln)	LOS (HCM Equivalent)	Density (pc/mi/ln)	LOS (HCM Equivalent)	Density (pc/mi/ln)	LOS (HCM Equivalent)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Northbound I-5									
NB I-5 US 101 Off-Ramp	Diverge	40.7	E	43.0	E	43.3	E	45.6	F
NB I-5 US 101 On-Ramp	Merge	81.4	F	119.5	F	112.7	F	117.5	F
NB I-5	Basic	37.5	E	40.2	E	40.4	E	39.9	E
Northbound I-5 Average [1]		**40.5**		**47.1**		**46.3**		**47.2**	
Southbound I-5									
SB I-5	Basic	80.7	F	78.5	F	78.4	F	79.1	F
SB I-5 US 101 Weave	Weave	57.3	F	57.0	F	56.3	F	57.2	F
SB I-5 US 101 On-Ramp	Merge	42.8	E	45.0	E	47.4	F	45.3	F
Southbound I-5 Average [1]		**40.4**		**40.4**		**40.8**		**40.6**	
Eastbound US 101									
EB US 101	Basic	124.0	F	24.8	C	29.5	D	24.9	C
EB US 101 Evergreen On-Ramp	Merge	133.3	F	25.7	C	30.7	D	48.9	F
EB US 101	Basic	136.9	F	34.7	D	41.2	E	45.7	F
EB US 101 Black Lake Off-Ramp	Diverge	130.6	F	33.2	D	42.9	E	37.4	E
EB US 101	Basic	18.7	C	35.1	E	26.2	D	36.2	E
EB US 101 Crosby Blvd On-Ramp	Merge	19.3	B	52.8	F	38.6	E	62.6	F
EB US 101	Basic	31.6	D	63.6	F	55.9	F	67.6	F
Eastbound US 101 Average [1]		**51.9**		**32.1**		**31.0**		**34.3**	
Westbound US 101									
WB US 101 e/o Crosby Blvd	Basic	38.5	E	42.4	E	42.6	E	43.4	E
WB US 101 Crosby Blvd Off-Ramp	Diverge	49.7	F	54.9	F	55.9	F	54.3	F
WB US 101	Basic	35.6	E	36.6	E	34.6	D	NA	NA
WB US 101 Evergreen Off-Ramp	Weave	32.9	D	34.0	D	32.2	D	40.0	E
WB US 101	Basic	35.2	E	36.4	E	33.9	D	35.9	E
Westbound US 101 Average [1]		**30.8**		**32.9**		**31.8**		**31.5**	
Average of All Densities		**41.7**		**36.2**		**35.4**		**37.6**	
Sum of All Densities		**1710**		**1484**		**1453**		**1542**	

[1] Average of all mainline segments, including segments operating at LOS A, B, C, and D (not shown).

Freeway System Speeds

Travel speeds along I-5 and US 101 were also identified as an operational MOE. Similar to existing conditions, the freeway speeds were collected for every 250 feet along the I-5 and US 101 mainlines.

2030 No-Build Scenario 1

No-Build Scenario 1 PM peak period speed conditions along I-5 are shown in Figures 9 and 10, and Figures 11 and 12 display the speeds along US 101. Note that these figures illustrate the operational speeds during the PM peak period (4:00 to 6:00 PM, two hours), but the densities, LOS, and volumes are for the PM peak hour (4:30 to 5:30 PM, one hour).

As shown in Figure 9, year 2030 northbound I-5 mainline speeds are generally around free flow conditions except at the US 101 on-ramp. High volumes coming from US 101 and a three-lane on-ramp merge area are expected to reduce the operating speeds to 30 to 50 mph around the US 101 on-ramp.

The 2030 No-Build operating speeds for southbound I-5 are shown in the Figure 10. The operational speeds along the mainline north of the City Center on-ramp are expected to be around 20 to 40 mph for most of the PM peak period. Southbound I-5 speeds south of the City Center on-ramp to the US 101 off-ramp are expected to be around 30 to 50 mph for most of the peak period. The reduction in speeds is caused by the weave created between the City Center on-ramp and US 101 off-ramp, which causes the queue to spill back north of the study area limits. Operating speeds at the US 101 on-ramp are also expected to reduce slightly (from 50 to 60 mph to 40 to 50 mph) as a result of high traffic volumes coming from US 101.

Eastbound US 101 travel speeds generally vary between 50 to 70 mph for the first half of the peak period (from 4:00 PM to 5:00 PM). During the second half of the PM peak period (after 5:00 PM) the operational speeds beginning at the west end of the study area are expected to decrease to 40 to 50 mph around the Mud Bay interchange, progressively worsen to 30 to 40 mph just after the Mud Bay Road on-ramp, and continue to decrease to 20 to 30 mph for short segments at the Evergreen on-ramp and Black Lake off-ramp. The worsening of speeds is the result of queues at the Black lake off-ramp spilling back onto the US 101 mainline. Because a substantial volume of traffic is queued behind the Black Lake interchange, volumes that do pass this area operate around 50 to 60 mph. Near the Crosby Boulevard on-ramp, travel speeds are expected to decrease to 40 to 50 mph as a result of high traffic volumes coming onto the US 101 mainline from Crosby Boulevard. Figure 11 shows the travel speeds along eastbound US 101 for No-Build Scenario 1.

The 2030 No-Build Scenario 1 operating speeds along westbound US 101 are shown on Figure 12. Westbound US 101 operates at free flow speeds except for the segment between I-5 and the Crosby Boulevard off-ramp where the speeds vary around 40 to 50 mph. This is caused due to the weaving of vehicles coming from southbound I-5 attempting to move into the left-most lane to bypass the Crosby off-ramp and vehicles coming from northbound I-5 weaving towards the Crosby off-ramp coupled with the steep grade.

2030 Local System Only Scenario 3

Operational speeds along northbound and southbound I-5 for Local System Only Scenario 3 are very similar to No-Build Scenario 1. Scenario 3 northbound I-5 speeds at the US 101 off-ramp are slightly worse than No-Build Scenario 1 because of the increased traffic coming from US 101. As previously mentioned, this increased volume is not additional demand, rather released demand previously queued before the Black Lake interchange. Figure 13 shows the travel speeds along northbound I-5 for Local System Only Scenario 3.

Southbound I-5 travel speeds for Local System Only Scenario 3 are also very similar to No-Build Scenario 1 speeds. The locations, causes for speed differentials, and magnitude of speed changes are also similar. From the northern study area limit, southbound I-5 speeds are substantially reduced, then increase to near free flow conditions after the US 101 on-ramp.

Eastbound US 101 travel speeds for Local System Only Scenario 3 improve compared to No-Build Scenario 1, which is attributed the cleared bottle neck around the Black Lake off-ramp. Speeds along eastbound US 101 generally vary between 50 to 70 mph except east of the Crosby on-ramp. Scenario 3 speeds east of the Crosby on-ramp are lower compared to Scenario 1, which is due to increased throughput at near free flow conditions around Black Lake off-ramp. At the US 101 to I-5 exit, speeds slowdown to 30 to 50 mph for almost the entire PM period of the peak hour. Figure 15 shows the travel speeds along eastbound US 101 for Local System Only Scenario 3.

The westbound US 101 speeds for Local System Only Scenario 3 are shown in the Figure 16 and are very similar to No-Build Scenario 1 speeds.

2030 Black Lake Interchange Scenario 5

Operational speeds along northbound and southbound I-5 for Black Lake Scenario 5 are very similar to No-Build Scenario 1 and Local System Only Scenario 3. Figure 17 and Figure 18 show the travel speeds along northbound and southbound I-5 for Black Lake Scenario 5.

Similar to Scenario 3, speeds along eastbound US 101 for Scenario 5 improve compared to Scenario 1, No-Build. Operational speeds along the eastbound US 101 mainline vary between 60 to 70 mph around the Mud Bay interchange, and 50 to 70 mph until the Black Lake on-ramp. For the last 30 minutes of the PM peak period, the speeds at Black Lake on-ramp drop down to 40 to 50 mph from 50 to 60 mph because of the increased volume from the new Yauger Way on-ramp connection. Similar to Scenario 3, east of the Crosby on-ramp the speeds reduce to 30 to 50 mph before exiting to I-5. Figure 19 shows the travel speeds along eastbound US 101 for Scenario 5.

The westbound US 101 speeds for Scenario 5 are shown in the Figure 20 and are very similar to Scenario 1 and Scenario 3.

2030 Evergreen Interchange Scenario 7

Figure 21 and Figure 22 show the travel speeds along northbound and southbound I-5 for Evergreen Scenario 7, which are similar to Scenarios 1, 3 and 5.

Similar to Scenarios 3 and 5, speeds along eastbound US 101 for Evergreen Scenario 7 increase compared to Scenario 1. Speeds along eastbound US 101 are generally around 50 to 60 mph except near the Evergreen on-ramp where the speeds reduce to 40 to 50 mph as a result of the additional volume (about 200 vph) on the Evergreen on-ramp and at the Crosby on-ramp where the speeds go down to 30 to 50 mph. Figure 23 shows the travel speeds along eastbound US 101 for Scenario 7. The westbound US 101 speeds for Evergreen Scenario 7 are shown on Figure 24 and are very similar to Scenarios 1, 3, and 5.

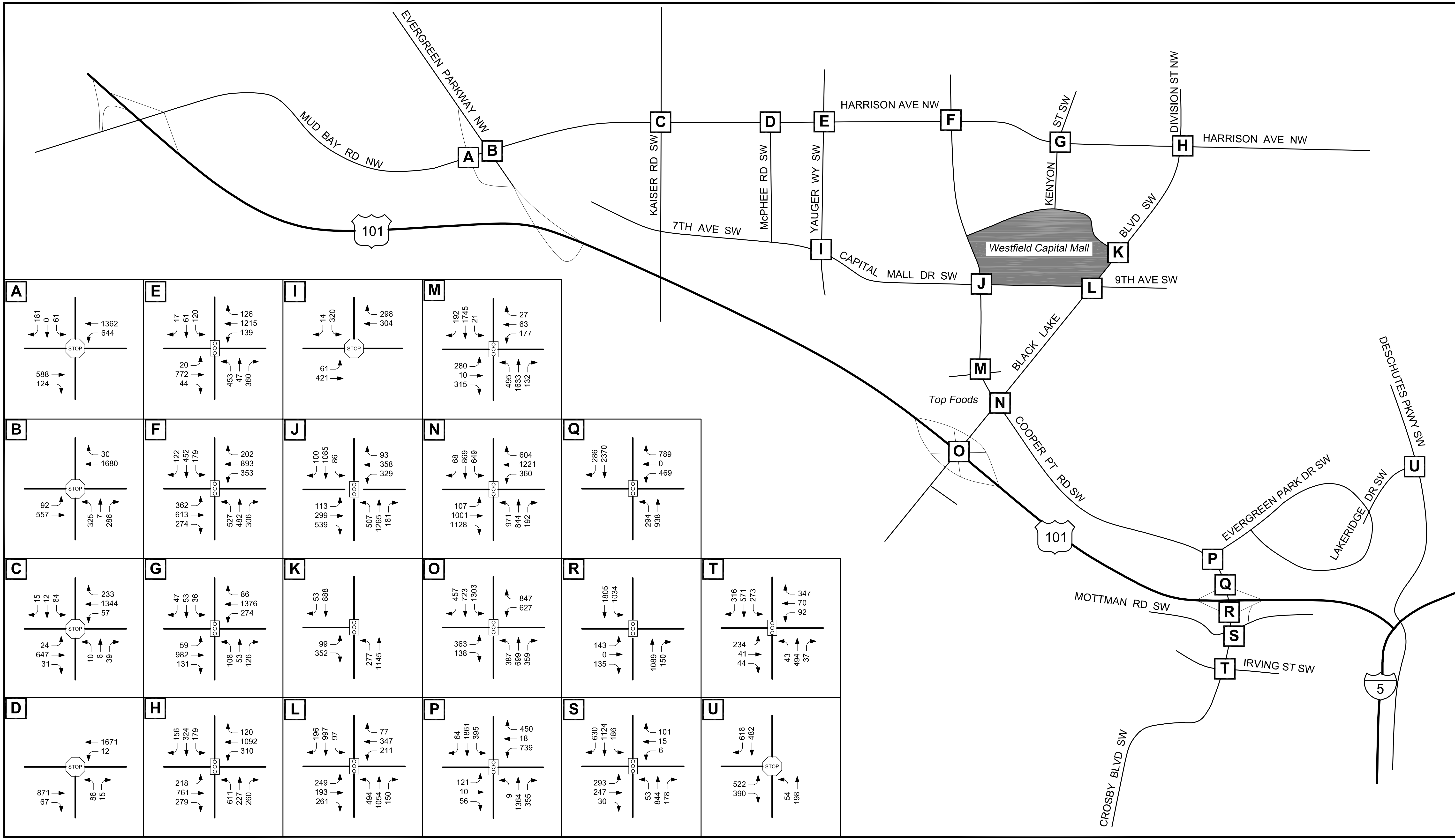
Freeway System Travel Times

PM peak hour travel times along I-5 and US 101 for the No-Build and build scenarios are summarized in Table 11.

As shown in Table 11, the travel times are generally very similar between the No-Build and all build scenarios; however, all build scenarios substantially reduce the travel time along eastbound US 101 compared to No Build Scenario 1. For all build scenarios, the resulting average travel speeds vary by 3 mph or less.

Table 11. Future 2030 PM Peak Hour Travel Times (seconds)

Cross Street	2030 No-Build Scenario 1	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/ SW Connections Scenario 7
Eastbound 101				
Mud Bay Off Ramp	27	27	27	26
Mud Bay On Ramp	18	17	17	17
EB 101 before Evergreen Prkwy On Ramp	164	81	83	82
Evergreen Pky On Ramp	63	18	22	51
Black Lake Off Ramp	199	61	79	35
Black Lake On Ramp	44	44	43	43
Crosby Blvd Off Ramp	29	31	28	29
Crosby Blvd On Ramp	42	40	28	41
101 EB to I-5 Off Ramp	67	71	57	77
Eastbound 101 Total Travel Time	**652**	**389**	**383**	**402**
Eastbound 101 Speed (mph)	**29**	**49**	**50**	**47**
Westbound 101				
Crosby Blvd Off Ramp	44	45	45	45
Crosby Blvd On Ramp	32	31	32	31
Black Lake Off Ramp	21	19	21	19
Black Lake On Ramp	55	55	55	55
Evergreen Prkwy Off Ramp	46	46	45	45
WB 101 after Evergreen Prkwy Off Ramp	29	29	29	29
Mud Bay Off Ramp	64	64	64	64
Mud Bay On Ramp	26	26	26	26
Model End	35	36	35	36
Westbound 101 Total Travel Time	**350**	**351**	**351**	**350**
Westbound 101 Speed (mph)	**55**	**54**	**54**	**55**
Northbound I-5				
US 101 Off Ramp	34	34	32	34
US 101 On Ramp	33	34	33	34
14th St Off Ramp	66	75	71	73
Model End	23	23	23	23
Northbound I-5 Total Travel Time	**155**	**165**	**159**	**163**
Northbound I-5 Speed (mph)	**48**	**45**	**46**	**45**
Southbound I-5				
14th St On Ramp	205	204	202	202
US 101 Off Ramp	35	34	34	34
US 101 On Ramp	43	43	43	43
Southbound I-5 Total Travel Time	**282**	**282**	**279**	**279**
Southbound I-5 Speed (mph)	**27**	**27**	**27**	**27**



Parametrix DATE: Jul 08, 2008 FILE: BL1631062P03T05_F25

N
No Scale

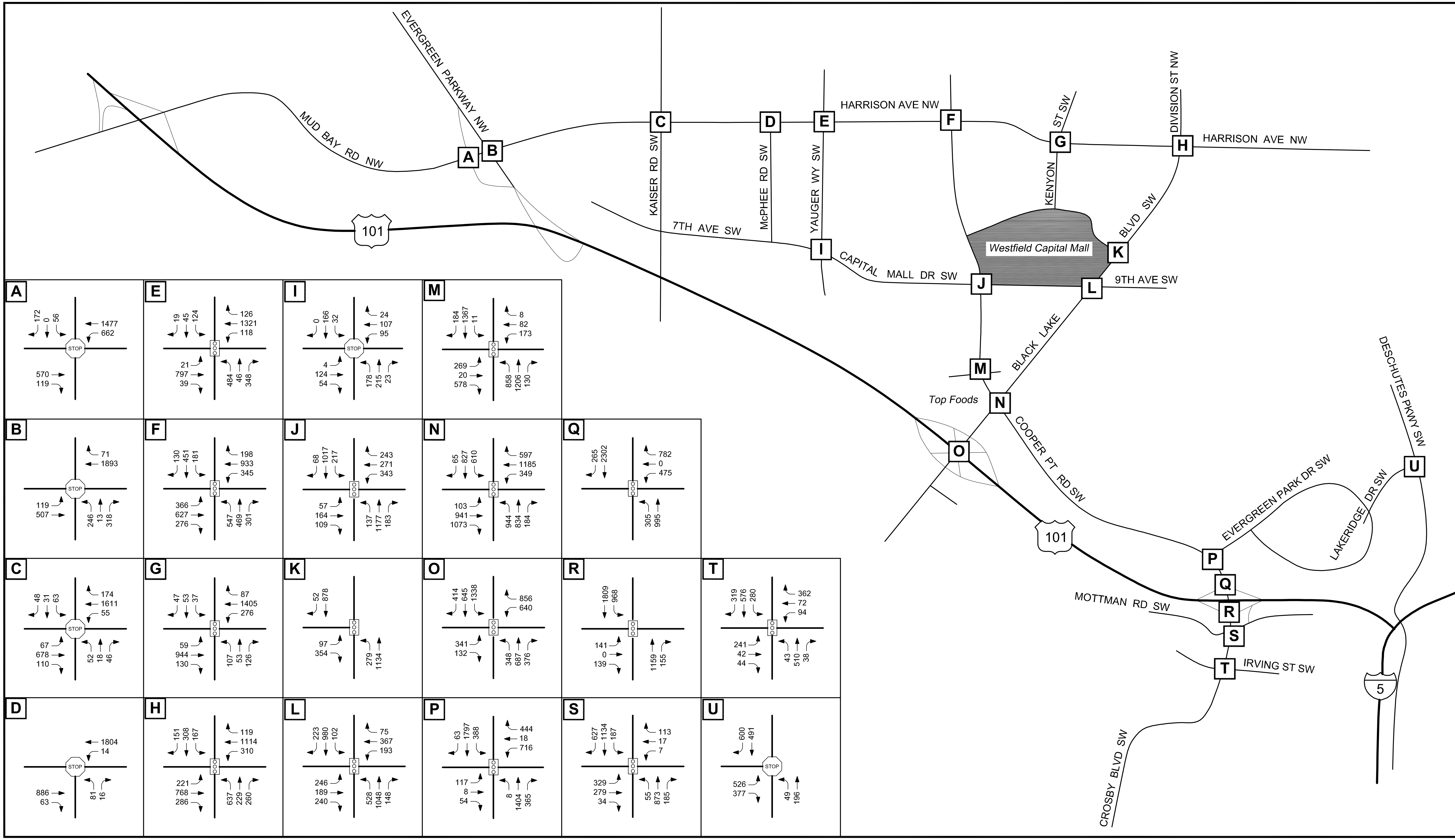
X Study Intersection

Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 25
2030 No-Build Scenario 1
PM Peak Hour Intersection Volumes



Parametrix DATE: Jul 08, 2008 FILE: BL1631062P03T05_F26

N

No Scale

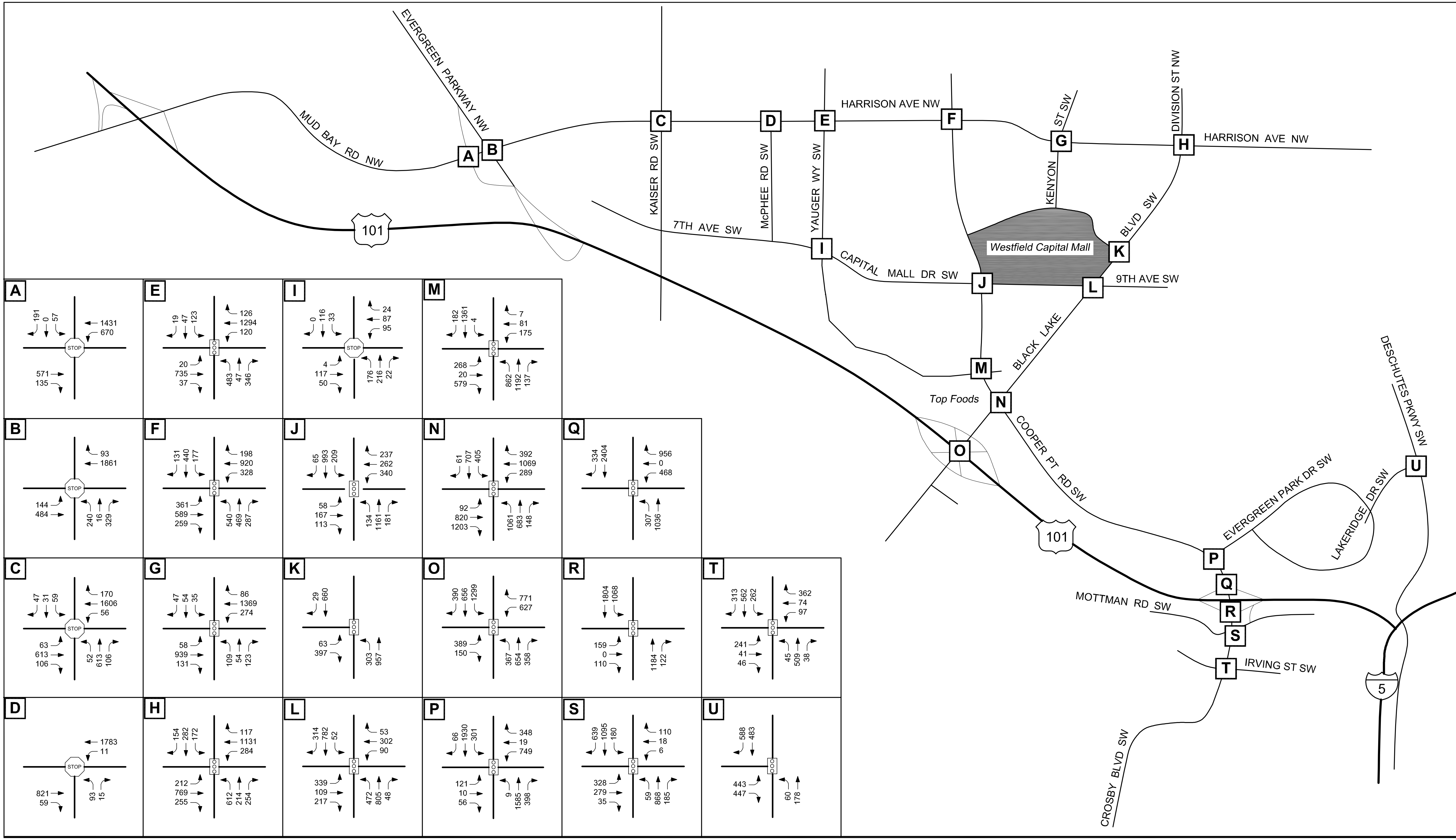
X Study Intersection

Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 26
2030 Local System Only
Without Southwest Connections Scenario 2
PM Peak Hour Intersection Volumes



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F27

N
No Scale

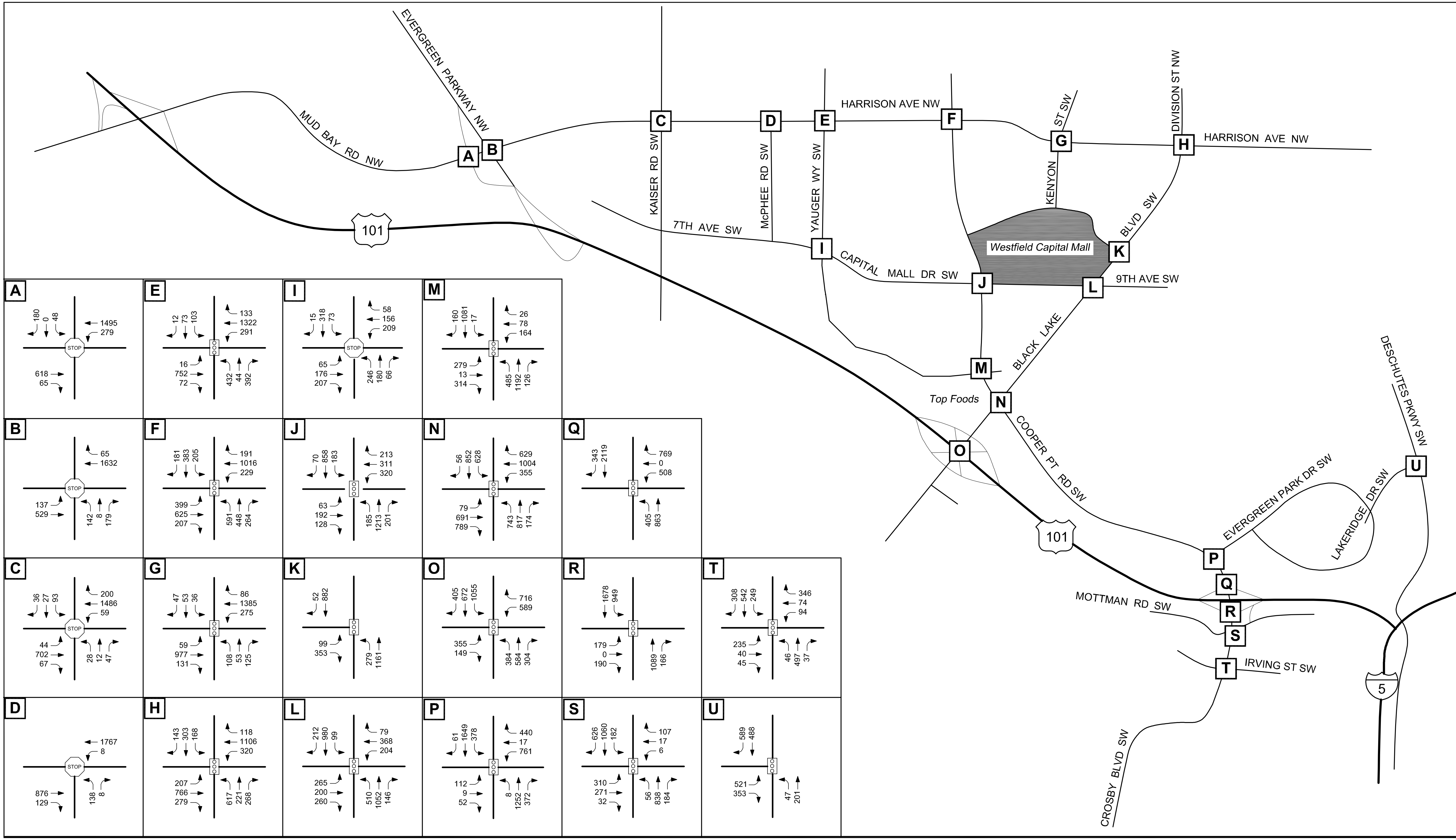
X Study Intersection

Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 27
2030 Local System Only
With Southwest Connections Scenario 3
PM Peak Hour Intersection Volumes



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F28

N
No Scale

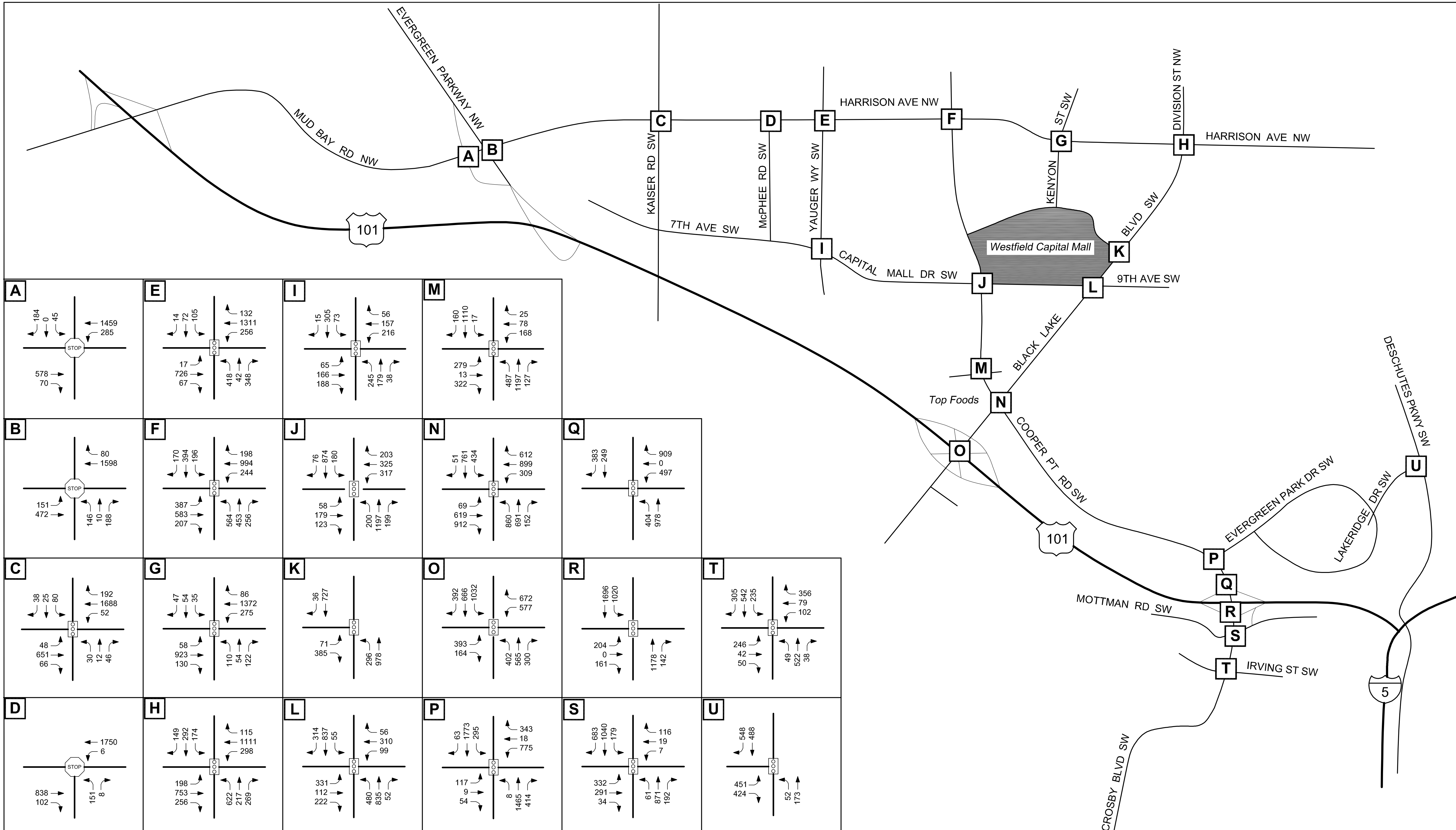
X Study Intersection

Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 28
2030 Black Lake Interchange
Without Southwest Connections Scenario 4
PM Peak Hour Intersection Volumes



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F29

N
No Scale

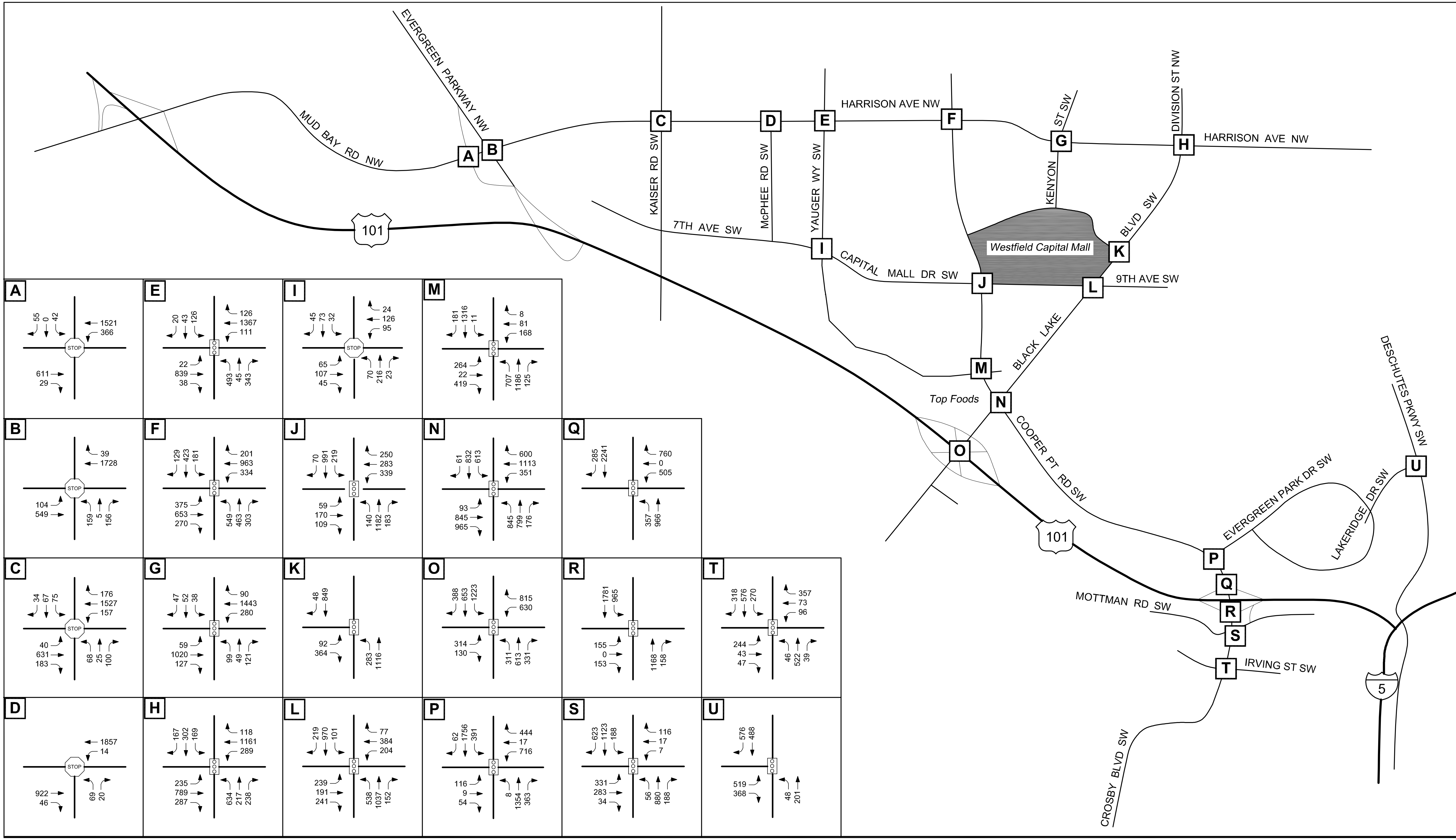
X Study Intersection

Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 29
2030 Black Lake Interchange
With Southwest Connections Scenario 5
PM Peak Hour Intersection Volumes



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F30

N
No Scale

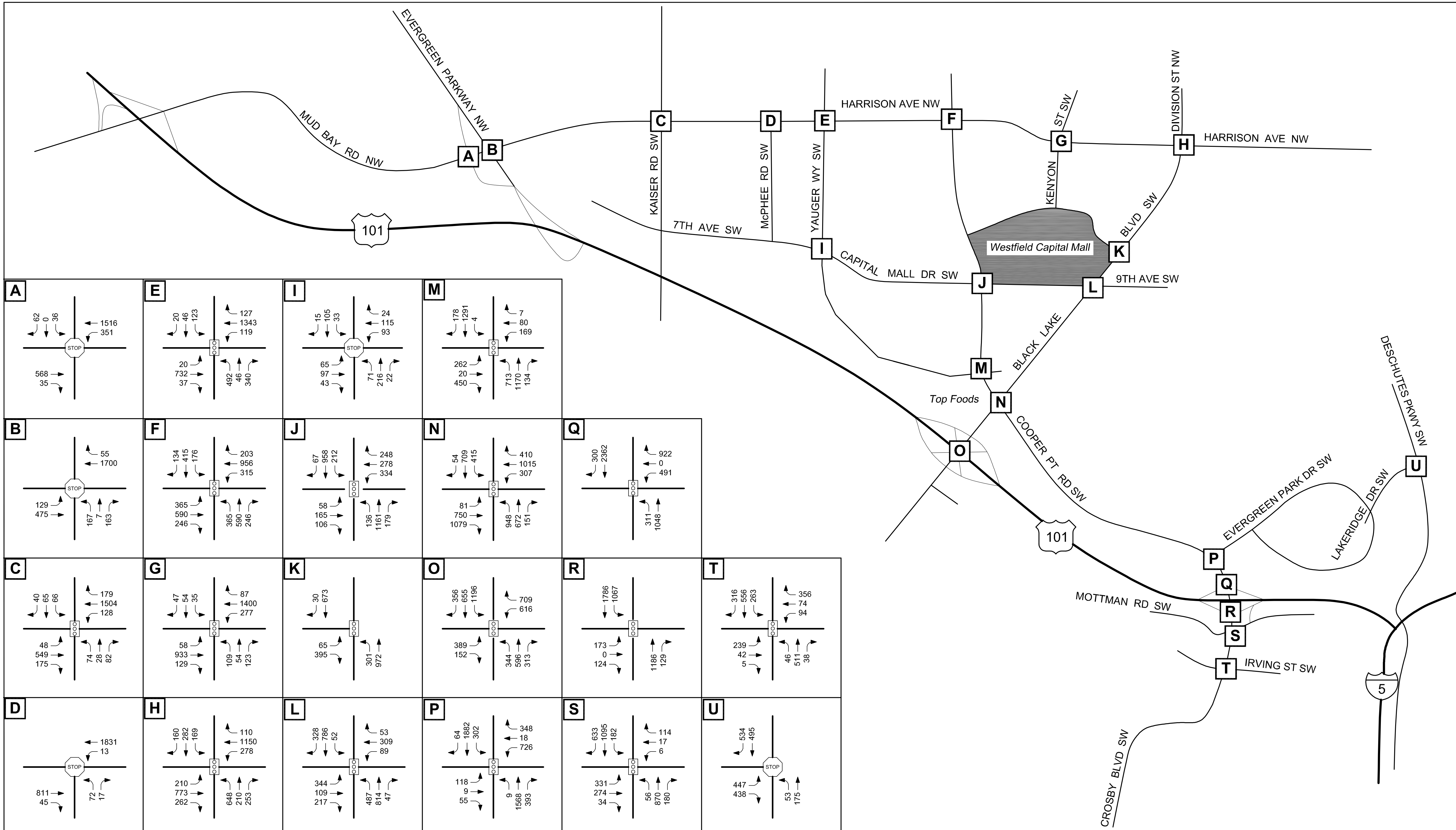
X Study Intersection

Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 30
2030 Evergreen Interchange
Without Southwest Connections Scenario 6
PM Peak Hour Intersection Volumes



Parametrix DATE: Oct 15, 2008 FILE: BL1631062P03T05_F31

N

No Scale

X Study Intersection

xxx Turning Movement Volume

STOP Stop - Controlled Intersection

Signalized Intersection

Figure 31
2030 Evergreen Interchange
With Southwest Connections Scenario 7
PM Peak Hour Intersection Volumes

Summary of Design Year 2030 Freeway System Conditions

For all build scenarios, traffic volumes increase slightly along northbound I-5 at the US 101 on-ramp compared to the No-Build scenario. This increase in volume comes from the release of bottleneck congestion at the Black Lake interchange. Although the densities slightly increase (about 7 pc/mi/ln), the operational effect on travel speeds is negligible.

Although some build scenarios result in traffic volume diversions and cause densities to decrease in some areas and increase in other areas, the overall traffic volumes, densities, and speeds for southbound I-5 and westbound US 101 are generally similar between the No-Build and build scenarios.

For eastbound US 101, all build scenarios substantially improve traffic operations on the mainline. Due to severe congestion at the Black Lake interchange under the No-Build scenario, the eastbound US 101 corridor is expected to have an overall average density of 52 pc/mi/ln, compared to the build scenario densities that range between 31 and 34 pc/mi/ln. Queues formed from poor operations at the Black Lake interchange are expected to extend onto the US 101 mainline and extend west of the Evergreen interchange. Conversely, all build scenarios are expected to experience adequate traffic operations from the western study area limit to the Crosby Boulevard interchange.

When comparing the US 101 and I-5 mainlines as a whole, the sum total of all segment densities for the No-Build scenario is 1,710 pc/mi/ln, compared to a range of 1,453 pc/mi/ln to 1,542 pc/mi/ln for the build scenarios. This indicates that the build scenarios provide more vehicle throughput and the No-Build scenario has more congestion.

Although some build alternatives “relocate” congestion, the traffic volumes, average mainline densities, and speeds are fairly similar among all build scenarios. The similarity in freeway operations among the build alternatives is especially evident when evaluating the PM peak hour travel times and average speeds, which vary by 3 mph or less.

DESIGN YEAR 2030 LOCAL INTERSECTION TRAFFIC OPERATIONS

Local System Volumes

Local turning movement counts were forecasted by the TRPC demand model. The turning movement counts obtained from the demand model were balanced for throughput inconsistencies before using them for analysis. The intersection turning movement counts for the No-Build and build scenarios are shown in Figures 25 through 31.

LOS (Average Delays)

The LOS for local intersections was calculated using the HCS Signals module of Synchro 7 (build 761) for signalized intersections and HCS+ for unsignalized intersections. These traffic analysis software packages were used to measure the total average vehicle delays, which were then equated to LOS grades per the HCM.

An original set of improvements were initially applied to each scenario to achieve applicable LOS standards. However, the City of Olympia identified several of these original improvements as infeasible (see Attachment A). Original and feasible improvements are summarized in Table 12. Descriptions of both sets of analyses are presented.

Based on the feasible improvements shown in Table 12, the LOS results for the No-Build and build scenarios using the traditional one-hour analysis are shown in Table 13, while Table 14 shows the LOS results that account for the City of Olympia’s 2-Hour Adjustment Factor for volumes.

With the original improvement initially identified, Table 15 shows the one-hour LOS results and Table 16 shows the LOS results using the 2-Hour Adjustment Factor.

Table 12. Original [1] and Feasible Intersection Improvements

Intersection	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW connections Scenario 6	2030 Evergreen Interchange w/ SW connections Scenario 7
Harrison Ave/Division St	2 NBL Turn Lanes ~~1 SBL Turn Lane~~	2 NBL Turn Lanes ~~1 SBL Turn Lane~~	2 NBL Turn Lanes ~~1 SBL Turn Lane~~	2 NBLTurn Lanes	2 NBLTurn Lanes ~~1 SBL Turn Lane~~	2 NBLTurn Lanes
Black Lake Blvd/Cooper Point Rd	~~1 NER Turn Lane~~ 1 SER Turn Lane ~~1 SWL Turn Lane~~	~~1 NER Turn Lane~~ 1 SER Turn Lane ~~1 SWL Turn Lane~~	1 SER Turn Lane ~~1 SWL Turn Lane~~		~~1 NER Turn Lane~~ 1 SER Turn Lane ~~1 SWL Turn Lane~~	1 SER Turn Lane
US 101 SPUI (Through/Lefts)/Black Lake Blvd						
Cooper Point Rd/Harrison Ave/Mud Bay Rd	1 NBL Turn Lane	1 NBL Turn Lane	1 NBL Turn Lane	1 NBL Turn Lane	1 NBL Turn Lane	1 NBL Turn Lane
Cooper Point Rd/Capitol Mall Blvd					1 WBR Turn Lane	
Black Lake Blvd/9th Ave/Capital Mall Dr	~~1 EBL Turn Lane~~ 1 SWR Turn Lane	~~1 EBL Turn Lane~~	~~1 EBL Turn Lane~~ 1 SWR Turn Lane	1 SWR Turn Lane	~~1 EBL Turn Lane~~ 1 SWR Turn Lane 1 SWL Turn Lane	1 SWR Turn Lane
Cooper Point Rd/Automall Dr/Evergreen Park Dr	~~1 SEL Turn Lane~~ 1 SWR Turn Lane	~~1 SEL Turn Lane~~ 1 SWR Turn Lane	~~1 SEL Turn Lane~~ 1 SWR Turn Lane	~~1 SEL Turn Lane~~	~~1 SEL Turn Lane~~ 1 SWR Turn Lane	~~1 SEL Turn Lane~~
Cooper Point Rd/Top Foods Entrance	1 EBR Turn Lane	1 EBR Turn Lane			1 EBR Turn Lane	
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	1 NB Through Lane	1 SBR Turn Lane 1 NB Through Lane		1 SBR Turn Lane 1 NB Through Lane		1 SBR Turn Lane 1 NB Through Lane
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd						
Crosby Blvd/Mottman Rd						
Crosby Blvd/Irving St						
Harrison Ave/Kenyon St						
Black Lake Blvd/Capital Mall Entrance						
Harrison Ave/Yauger Wy						
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd						
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd						
Harrison Ave/McPhee Rd						
Harrison Ave/Kaiser Rd						
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	Add Signal 1 NBL Turn Lane	Add Signal 1 NBL Turn Lane	Add Signal	Add Signal	Add Signal	Add Signal
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	Add Signal	Add Signal	Add Signal	Add Signal	Add Signal	Add Signal
Black Lake Blvd/Top Foods Entrance						
Lakeridge Dr/Deschutes Prkwy	Add Signal 1 SBR Turn Lane	Add Signal	Add Signal 1 SBR Turn Lane	Add Signal	Add Signal 1 SBR Turn Lane	Add Signal
Capital Mall Dr/Yauger Wy						
Original Total Turn Lanes Added	14	13	11	6	15	7
Original Total Through Lanes Added	1	1	0	1	0	1
Original Total Signals Added	3	3	3	3	3	3
Feasible Total Turn Lanes Added	9	8	7	5	10	6
Feasible Total Through Lanes Added	1	1	0	1	0	1
Feasible Total Signals Added	3	3	3	3	3	3

[1] Original improvements identified by the City of Olympia as infeasible are indicated by strikeout text format (see Attachment A).

2030 No-Build Scenario 1

Based on the traditional one-hour analysis methodology:

- eight intersections operate at LOS A, B, or C (compared to 15 in 2007),
- three intersections operate at LOS D or E (compared to three in 2007),
- 13 intersections operate at LOS F (compared to six in 2007),
- total triangle and SPUI delay is 684.3 seconds/vehicle (compared to 282.7 seconds in 2007), and
- 15 total intersections would operate below their respective LOS standard (compared to seven in 2007)

Accounting for the 2-Hour Adjustment Factor, where applicable:

- eight intersections operate at LOS A, B, or C (compared to 16 in 2007),
- five intersections operate at LOS D or E (compared to four in 2007),
- 11 intersections operate at LOS F (compared to four in 2007),
- total triangle and SPUI delay is 611.4 seconds/vehicle (compared to 252.7 seconds in 2007), and
- 12 total intersections would operate below their respective LOS standard (compared to five in 2007).

2030 Local System Only Scenario 2

Assuming construction of the feasible improvements and based on the traditional one-hour analysis methodology:

- 11 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- nine intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- four intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 426.5 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- six total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of the feasible improvements and accounting for the 2-Hour Adjustment Factor, where applicable:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- two intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 388.3 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and based on the traditional one-hour analysis methodology:

- 11 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),

- 10 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- three intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 392.7 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- five total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and accounting for the 2-Hour Adjustment Factor, where applicable:

- 13 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- nine intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- two intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 355.7 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- two total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

2030 Local System Only Scenario 3

Assuming construction of the feasible improvements and based on the traditional one-hour analysis methodology:

- nine intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 11 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- four intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 365.3 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- six total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of the feasible improvements and accounting for the 2-Hour Adjustment Factor, where applicable:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- two intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 332.3 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and based on the traditional one-hour analysis methodology:

- 10 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 12 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),

- two intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 339.6 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- four total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and accounting for the 2-Hour Adjustment Factor, where applicable:

- 13 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- one intersection operates at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 308.7 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- one intersection would operate below its respective LOS standard (compared to 12 for No-Build Scenario 1).

2030 Black Lake Interchange Scenario 4

Assuming construction of the feasible improvements and based on the traditional one-hour analysis methodology:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- eight intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- four intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 345.6 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- six total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of the feasible improvements and accounting for the 2-Hour Adjustment Factor, where applicable:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- two intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 308.0 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and based on the traditional one-hour analysis methodology:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 11 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- one intersection operates at LOS F (compared to 13 for No-Build Scenario 1),

- total triangle and SPUI delay is 295.4 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and accounting for the 2-Hour Adjustment Factor, where applicable:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 12 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 264.2 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- one intersection would operate below its respective LOS standard (compared to 12 for No-Build Scenario 1).

2030 Black Lake Interchange Scenario 5

Assuming construction of the feasible improvements and based on the traditional one-hour analysis methodology:

- 13 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 11 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 302.1 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of the feasible improvements and accounting for the 2-Hour Adjustment Factor, where applicable:

- 14 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 271.1 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- two total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and based on the traditional one-hour analysis methodology:

- 13 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 11 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 13 for No-Build Scenario 1),

- total triangle and SPUI delay is 302.1 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- two total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and accounting for the 2-Hour Adjustment Factor, where applicable:

- 14 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 271.1 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- one intersection would operate below its respective LOS standard (compared to 12 for No-Build Scenario 1).

2030 Evergreen Interchange Scenario 6

Assuming construction of the feasible improvements and based on the traditional one-hour analysis methodology:

- 11 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- nine intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- four intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 363.4 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- seven total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of the feasible improvements and accounting for the 2-Hour Adjustment Factor, where applicable:

- 13 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- nine intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- two intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 322.9 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- four total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and based on the traditional one-hour analysis methodology:

- 11 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 12 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- one intersection operates at LOS F (compared to 13 for No-Build Scenario 1),

- total triangle and SPUI delay is 306.6 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- four total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and accounting for the 2-Hour Adjustment Factor, where applicable:

- 14 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 271.1 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- one intersection would operate below its respective LOS standard (compared to 12 for No-Build Scenario 1).

2030 Evergreen Interchange Scenario 7

Assuming construction of the feasible improvements and based on the traditional one-hour analysis methodology:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 10 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- two intersections operate at LOS F (compared to 13 for No-Build Scenario 1),
- total triangle and SPUI delay is 298.2 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of the feasible improvements and accounting for the 2-Hour Adjustment Factor, where applicable:

- 16 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- eight intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 266.8 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- two total intersections would operate below their respective LOS standard (compared to 12 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and based on the traditional one-hour analysis methodology:

- 12 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- 11 intersections operate at LOS D or E (compared to three for No-Build Scenario 1),
- one intersection operates at LOS F (compared to 13 for No-Build Scenario 1),

- total triangle and SPUI delay is 298.2 seconds/vehicle (compared to 684.3 seconds for No-Build Scenario 1), and
- three total intersections would operate below their respective LOS standard (compared to 15 for No-Build Scenario 1).

Assuming construction of all of the originally identified improvements, which the City of Olympia identified some as infeasible, and accounting for the 2-Hour Adjustment Factor, where applicable:

- 16 intersections operate at LOS A, B, or C (compared to eight for No-Build Scenario 1),
- eight intersections operate at LOS D or E (compared to five for No-Build Scenario 1),
- zero intersections operate at LOS F (compared to 11 for No-Build Scenario 1),
- total triangle and SPUI delay is 266.8 seconds/vehicle (compared to 611.4 seconds for No-Build Scenario 1), and
- one intersection would operate below its respective LOS standard (compared to 12 for No-Build Scenario 1).

Table 13. PM Peak Hour LOS Comparison with Feasible Improvements (One-Hour Analysis)

	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7
Intersection Description	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**
Harrison Ave/Division St	F (187.1)	F (84.7)	E (77.9)	F (81.3)	E (76.2)	F (89.4)	E (79.4)
Black Lake Blvd/Cooper Point Rd	F (199.9)	F (126.9)	F (86.6)	F (114.4)	E (78.5)	F (120.4)	E (65.1)
US 101 SPUI (Through/Lefts)/Black Lake Blvd	F (187)	F (140.7)	F (130.8)	E (70.3)	E (72.5)	E (77.9)	F (82.4)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	F (110.3)	E (74.2)	E (70)	E (79.6)	E (74.9)	E (75.7)	E (71.3)
Cooper Point Rd/Capitol Mall Blvd	F (112.8)	E (75)	E (75)	E (77.2)	E (70.8)	E (57.8)	E (69.2)
Black Lake Blvd/9th Ave/Capital Mall Dr	F (101.2)	F (88.5)	F (100.1)	F (102.8)	E (77.5)	F (101.4)	E (78.1)
Cooper Point Rd/Automall Dr/Evergreen Park Dr	F (162.4)	E (71.4)	E (77.4)	E (57.3)	E (71.1)	F (82.5)	F (84.9)
Cooper Point Rd/Top Foods Entrance	F (85.7)	E (77.9)	E (77.8)	D (42.3)	D (41.5)	D (49.8)	E (67.4)
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	E (65.9)	E (64.5)	E (64.8)	F (87)	E (57.5)	E (76.6)	E (58.2)
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd	F (114.5)	C (33.5)	D (36.9)	E (68.5)	C (33.4)	E (69.4)	C (26.2)
Crosby Blvd/Mottman Rd	E (64.4)	D (38.8)	D (38.6)	D (38.7)	C (29.1)	D (42.6)	C (24.9)
Crosby Blvd/Irving St	C (24.7)	D (39.3)	D (39.2)	C (21.7)	C (26.8)	C (25.7)	C (20.5)
Harrison Ave/Kenyon St	C (20.7)	C (20.5)	C (20.4)	C (20.8)	C (20.4)	C (20.9)	C (20.5)
Black Lake Blvd/Capital Mall Entrance	B (12.3)	B (12.3)	B (10.6)	B (12.3)	B (11.1)	B (12.2)	B (10.7)
Harrison Ave/Yauger Wy	C (20.7)	C (25.9)	C (24.7)	C (32.4)	C (28.7)	C (26.8)	C (28.3)
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd	A (6.4)	B (10)	A (9.1)	A (7.9)	A (6.2)	A (8.2)	A (6.7)
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd	A (7.3)	A (3.2)	A (3.4)	A (3.2)	A (3.5)	A (4.2)	A (2.8)
Harrison Ave/McPhee Rd	C (21.7)	C (21.7)	C (20.9)	D (29.6)	D (28.9)	C (21.3)	C (19)
Harrison Ave/Kaiser Rd	A (8.2)	B (13.2)	B (12.2)	B (10.5)	B (11)	B (11.2)	B (11.4)
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	F (>200)	C (30.4)	C (32.5)	C (32.3)	C (34.3)	B (16.6)	C (30.7)
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	F (>200)	B (19.6)	C (20.8)	B (16.7)	B (15.5)	C (22.7)	B (19.2)
Black Lake Blvd/Top Foods Entrance	E (45.8)	E (41.1)	F (55.8)	C (21)	C (23.1)	D (30.1)	D (31.3)
Lakeridge Dr/Deschutes Prkwy	F (>200)	B (14.3)	D (50.3)	B (13.9)	D (43.3)	B (15)	D (41.6)
Capital Mall Dr/Yauger Wy	F (138.4)	D (34)	D (29.6)	B (15.1)	B (15)	D (31.3)	D (29.1)
LOS A, B, C	**8**	**11**	**9**	**12**	**13**	**11**	**12**
LOS D or E	**3**	**9**	**11**	**8**	**11**	**9**	**10**
LOS F	**13**	**4**	**4**	**4**	**0**	**4**	**2**
Total Turn Lanes Added	**NA**	**9**	**8**	**7**	**5**	**10**	**6**
Total Through Lanes Added	**NA**	**1**	**1**	**0**	**1**	**0**	**1**
Total Signals Added	**NA**	**3**	**3**	**3**	**3**	**3**	**3**

Table 14. PM Peak Hour LOS Comparison with Feasible Improvements (2-Hour Adjustment Factor)

	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7
Intersection Description	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**
Harrison Ave/Division St	F (163.6)	E (76.6)	E (70.1)	E (69.5)	E (66.4)	E (77.4)	E (68.2)
Black Lake Blvd/Cooper Point Rd	F (173.5)	F (111)	E (75)	F (100.7)	E (68)	F (104.7)	E (56.8)
US 101 SPUI (Through/Lefts)/Black Lake Blvd	F (178.6)	F (134.8)	F (124.3)	E (67.6)	E (70.2)	E (74)	E (77.9)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	F (95.7)	E (65.9)	E (62.9)	E (70.2)	E (66.5)	E (66.8)	E (63.9)
Cooper Point Rd/Capitol Mall Blvd	F (94.3)	E (62.6)	E (61.6)	E (63.4)	E (59)	D (50.6)	E (59.1)
Black Lake Blvd/9th Ave/Capital Mall Dr	F (89.3)	E (78.4)	F (87.5)	F (91.9)	E (69.1)	F (90.5)	E (69.4)
Cooper Point Rd/Automall Dr/Evergreen Park Dr	F (121.4)	E (57.4)	E (60.7)	D (49.3)	E (59.7)	E (67.5)	E (60.5)
Cooper Point Rd/Top Foods Entrance	E (67.2)	E (67.7)	E (68.6)	D (39.8)	D (38.2)	D (43.5)	E (59.4)
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	D (35.2)	D (38.5)	D (42.3)	D (54.8)	D (38.9)	D (47.6)	C (34.9)
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd	F (86.3)	C (32.4)	C (33.8)	D (50.6)	C (28.3)	D (48.6)	C (22.6)
Crosby Blvd/Mottman Rd	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Crosby Blvd/Irving St	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Harrison Ave/Kenyon St	B (19.7)	B (19.7)	B (19.5)	B (19.7)	B (19.5)	B (19.9)	B (19.6)
Black Lake Blvd/Capital Mall Entrance	B (11.6)	B (11.6)	B (10.2)	B (11.6)	B (10.6)	B (11.7)	B (10.2)
Harrison Ave/Yauger Wy	B (19.1)	C (22.9)	C (22.1)	C (28.9)	C (24)	C (24.1)	C (24)
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd	A (6.2)	A (9.6)	A (8.8)	A (7.8)	A (6.2)	A (8.1)	A (6.5)
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd	A (7.1)	A (3.2)	A (3.4)	A (3.2)	A (3.4)	A (3.9)	A (2.7)
Harrison Ave/McPhee Rd	C (20.3)	C (20.3)	C (19.6)	D (26.6)	D (25.9)	C (20)	C (18)
Harrison Ave/Kaiser Rd	A (7.7)	B (11.5)	B (10.5)	A (9.6)	A (9.3)	B (11.5)	B (10.4)
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Black Lake Blvd/Top Foods Entrance	D (32.8)	D (31.1)	E (38.3)	C (18)	C (19.5)	C (23.8)	C (24.9)
Lakeridge Dr/Deschutes Prkwy	F (>200)	B (11.4)	C (25.5)	B (11.5)	C (23.5)	B (11.5)	C (22.9)
Capital Mall Dr/Yauger Wy	D (32.7)	C (18.1)	C (17.3)	B (11.2)	A (9)	C (18.8)	C (18.1)
LOS A, B, C	**8**	**12**	**12**	**12**	**14**	**13**	**16**
LOS D or E	**5**	**10**	**10**	**10**	**10**	**9**	**8**
LOS F	**11**	**2**	**2**	**2**	**0**	**2**	**0**
Total Turn Lanes Added	**NA**	**9**	**8**	**7**	**5**	**10**	**6**
Total Through Lanes Added	**NA**	**1**	**1**	**0**	**1**	**0**	**1**
Total Signals Added	**NA**	**3**	**3**	**3**	**3**	**3**	**3**

Table 15. PM Peak Hour LOS Comparison with Original Improvements (One-Hour Analysis)

	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7
Intersection Description	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**
Harrison Ave/Division St	F (187.1)	E (70.2)	E (63.2)	E (66.8)	E (76.2)	E (72.7)	E (79.4)
Black Lake Blvd/Cooper Point Rd	F (199.9)	F (108.3)	E (75.6)	E (78.7)	E (78.5)	F (80.3)	E (65.1)
US 101 SPUI (Through/Lefts)/Black Lake Blvd	F (187)	F (140)	F (130.8)	E (70.3)	E (72.5)	E (77.9)	F (82.4)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	F (110.3)	E (74.2)	E (70)	E (79.6)	E (74.9)	E (75.7)	E (71.3)
Cooper Point Rd/Capitol Mall Blvd	F (112.8)	E (75)	E (75)	E (77.2)	E (70.8)	E (57.8)	E (69.2)
Black Lake Blvd/9th Ave/Capital Mall Dr	F (101.2)	E (76.6)	E (75.3)	E (76.3)	E (77.5)	E (78.3)	E (78.1)
Cooper Point Rd/Automall Dr/Evergreen Park Dr	F (162.4)	E (56.4)	E (64.4)	D (49.6)	D (55)	D (51.5)	E (60.1)
Cooper Point Rd/Top Foods Entrance	F (85.7)	E (78.3)	E (77.8)	D (42.3)	D (41.5)	D (49.8)	E (67.4)
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	E (65.9)	E (58)	E (64.6)	F (87)	E (57.5)	E (76.6)	E (58.2)
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd	F (114.5)	C (33.5)	D (36.5)	E (68.5)	C (33.4)	E (69.4)	C (26.2)
Crosby Blvd/Mottman Rd	E (64.4)	D (38.8)	C (34.1)	D (38.7)	C (29.1)	D (42.6)	C (24.9)
Crosby Blvd/Irving St	C (24.7)	D (39.3)	D (38.9)	C (21.7)	C (26.8)	C (25.7)	C (20.5)
Harrison Ave/Kenyon St	C (20.7)	C (20.5)	C (20.4)	C (20.8)	C (20.4)	C (20.9)	C (20.5)
Black Lake Blvd/Capital Mall Entrance	B (12.3)	B (12.3)	B (10.6)	B (12.3)	B (11.1)	B (12.2)	B (10.7)
Harrison Ave/Yauger Wy	C (20.7)	C (25.9)	C (24.7)	C (32.4)	C (28.7)	C (26.8)	C (28.3)
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd	A (6.4)	B (10)	A (9.1)	A (7.9)	A (6.2)	A (8.2)	A (6.7)
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd	A (7.3)	A (3.1)	A (3.4)	A (3.2)	A (3.5)	A (4.2)	A (2.8)
Harrison Ave/McPhee Rd	C (21.7)	C (21.7)	C (20.9)	D (29.6)	D (28.9)	C (21.3)	C (19)
Harrison Ave/Kaiser Rd	A (8.2)	B (13.2)	B (12.2)	B (10.5)	B (11)	B (11.2)	B (11.4)
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	F (>200)	C (30.4)	C (32.5)	C (32.3)	C (34.3)	B (16.6)	C (30.7)
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	F (>200)	B (19.6)	C (20.8)	B (16.7)	B (15.5)	C (22.7)	B (19.2)
Black Lake Blvd/Top Foods Entrance	E (45.8)	F (66.6)	F (55.8)	C (21)	C (23.1)	D (30.1)	D (31.3)
Lakeridge Dr/Deschutes Prkwy	F (>200)	B (14.3)	D (50.3)	B (13.9)	D (43.3)	B (15)	D (41.6)
Capital Mall Dr/Yauger Wy	F (138.4)	D (34)	D (29.6)	B (15.1)	B (15)	D (31.3)	D (29.1)
LOS A, B, C	**8**	**11**	**10**	**12**	**13**	**11**	**12**
LOS D or E	**3**	**10**	**12**	**11**	**11**	**12**	**11**
LOS F	**13**	**3**	**2**	**1**	**0**	**1**	**1**
Total Turn Lanes Added	**NA**	**14**	**13**	**11**	**6**	**15**	**7**
Total Through Lanes Added	**NA**	**1**	**1**	**0**	**1**	**0**	**1**
Total Signals Added	**NA**	**3**	**3**	**3**	**3**	**3**	**3**

Table 16. PM Peak Hour LOS Comparison with Original Improvements (2-Hour Adjustment Factor)

	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7
Intersection Description	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**
Harrison Ave/Division St	F (163.6)	E (61.4)	E (56)	E (58.4)	E (66.4)	E (64.1)	E (68.2)
Black Lake Blvd/Cooper Point Rd	F (173.5)	F (94.6)	E (65.6)	E (68)	E (68)	E (69.7)	E (56.8)
US 101 SPUI (Through/Lefts)/Black Lake Blvd	F (178.6)	F (133.8)	F (124.3)	E (67.6)	E (70.2)	E (74)	E (77.9)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	F (95.7)	E (65.9)	E (62.8)	E (70.2)	E (66.5)	E (66.8)	E (63.9)
Cooper Point Rd/Capitol Mall Blvd	F (94.3)	E (62.6)	E (61.6)	E (63.4)	E (59)	D (50.6)	E (59.1)
Black Lake Blvd/9th Ave/Capital Mall Dr	F (89.3)	E (67.4)	E (65.5)	E (67.2)	E (69.1)	E (69.2)	E (69.4)
Cooper Point Rd/Automall Dr/Evergreen Park Dr	F (121.4)	D (48.2)	D (51.4)	D (44.2)	D (46)	D (45.9)	D (42.5)
Cooper Point Rd/Top Foods Entrance	E (67.2)	E (68.4)	E (68.6)	D (39.8)	D (38.2)	D (43.5)	E (59.4)
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	D (35.2)	C (33.3)	D (42.3)	D (54.8)	D (38.9)	D (47.6)	C (34.9)
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd	F (86.3)	C (32.2)	C (34)	D (50.6)	C (28.3)	D (48.6)	C (22.6)
Crosby Blvd/Mottman Rd	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Crosby Blvd/Irving St	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Harrison Ave/Kenyon St	B (19.7)	B (19.7)	B (19.5)	B (19.7)	B (19.5)	B (19.9)	B (19.6)
Black Lake Blvd/Capital Mall Entrance	B (11.6)	B (11.6)	B (10.2)	B (11.6)	B (10.6)	B (11.7)	B (10.2)
Harrison Ave/Yauger Wy	B (19.1)	C (22.9)	C (22.1)	C (28.9)	C (24)	C (24.1)	C (24)
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd	A (6.2)	A (9.6)	A (8.8)	A (7.8)	A (6.2)	A (8.1)	A (6.5)
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd	A (7.1)	A (3.1)	A (3.4)	A (3.2)	A (3.4)	A (3.9)	A (2.7)
Harrison Ave/McPhee Rd	C (20.3)	C (20.3)	C (19.6)	D (26.6)	D (25.9)	C (20)	C (18)
Harrison Ave/Kaiser Rd	A (7.7)	B (11.5)	B (10.5)	A (9.6)	A (9.3)	B (11.5)	B (10.4)
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Black Lake Blvd/Top Foods Entrance	D (32.8)	E (43.8)	E (38.3)	C (18)	C (19.5)	C (23.8)	C (24.9)
Lakeridge Dr/Deschutes Prkwy	F (>200)	B (11.4)	C (25.5)	B (11.5)	C (23.5)	B (11.5)	C (22.9)
Capital Mall Dr/Yauger Wy	D (32.7)	C (18.1)	C (17.3)	B (11.2)	A (9)	C (18.8)	C (18.1)
LOS A, B, C	**8**	**13**	**13**	**12**	**14**	**13**	**16**
LOS D or E	**5**	**9**	**10**	**12**	**10**	**11**	**8**
LOS F	**11**	**2**	**1**	**0**	**0**	**0**	**0**
Total Turn Lanes Added	**NA**	**14**	**13**	**11**	**6**	**15**	**7**
Total Through Lanes Added	**NA**	**1**	**1**	**0**	**1**	**0**	**1**
Total Signals Added	**NA**	**3**	**3**	**3**	**3**	**3**	**3**

Summary of Design Year 2030 Local System Conditions

Tables 13 through 16 compares the No-Build and build scenarios in terms of the number of intersections operating at particular LOS grade, the "triangle" and Black Lake SPUI delay, and the number of improvements assumed.

Tables 13 through 16 show that the total delay at critical intersections ("triangle" delay plus Black Lake SPUI delay) is expected to be substantially less with the Black Lake and Evergreen interchange scenarios compared to the Local System Only Scenarios. When considering the amount of feasible improvements, the LOS analysis also indicates that the Southwest Connections also result in substantial delay savings at critical intersections. Tables 17 and 18 summarize the one- and two-hour aggregate MOEs assuming construction of the feasible improvements.

The number of local intersection improvements is important because land uses at the intersections needing improvements are generally built out and construction of the improvements would require property acquisition for right-of-way. Full or partial displacement of existing uses can substantially increase project costs, lengthen project schedules and be more difficult to implement. Additionally, increasing the number of turn lanes at intersections also increases pedestrian crossing times, which is less conducive to a pedestrian-friendly environment and inconsistent with the City's Comprehensive Plan.

Based on the number and extent of intersection improvements required to achieve acceptable LOS conditions, the Black Lake and Evergreen interchange scenarios (specifically Scenarios 5 and 7) represent the best alternatives since they are expected to result in the best operations and would likely cost the least to construct within the local transportation system.

The intersection operations analysis demonstrates that the Local Only Scenarios do not meet the purpose of the study to improve access and circulation in West Olympia for the following reasons:

- The US 101 SPUI/Black Lake Boulevard intersection cannot be improved to meet City of Olympia or WSDOT intersection LOS standards. With maximum improvements at this intersection and adjacent intersections, the two Local Only Scenarios cannot achieve better than LOS F conditions with average vehicle delays ranging from 125 to 140 seconds. This results in long vehicle queues on both the eastbound and westbound off-ramps and on Black Lake Boulevard. There is a greater potential for vehicle queues extending back into the US 101 mainline with this scenario due to the higher degree of congestion.
- The two Local Only Scenarios require substantially more intersection turn lane improvements (eight to nine feasible turn lanes) and continue to operate worse than the applicable LOS standards at some locations, compared to either the Black Lake Scenario or Evergreen Scenario (five to six feasible turn lanes respectively). Most of these turn lane improvements would require property acquisition and displace businesses and the costs could be prohibitive.

Recommendations

The recommendations from this study are primarily based on the freeway and local system operations analysis results. Black Lake Scenario has the lowest aggregate densities, which indicate higher throughput and less freeway congestion; however, the system-wide freeway densities and speeds are relatively similar among all build scenarios.

Since freeway operations are comparable for all build scenarios, the recommendations place substantial emphasis on the local system operations. The local system operations for the build scenarios can be summarized as:

- Local System Only Without Southwest Connections Scenario 2 – 11 intersections at LOS A, B, or C and 4 intersections at LOS F

- Local System Only With Southwest Connections Scenario 3 – 9 intersections at LOS A, B, or C and 4 intersections at LOS F
- Black Lake Interchange Without Southwest Connections Scenario 4 – 12 intersections at LOS A, B, or C and 4 intersections at LOS F
- Black Lake Interchange With Southwest Connections Scenario 5 – 13 intersections at LOS A, B, or C and 0 intersections at LOS F
- Evergreen Interchange Without Southwest Connections Scenario 6 – 11 intersections at LOS A, B, or C and 4 intersections at LOS F
- Evergreen Interchange With Southwest Connections Scenario 7 – 12 intersections at LOS A, B, or C and 2 intersections at LOS F

The number of local intersection improvements is important to consider when identifying recommendations because land uses at the intersections needing improvements are generally built out and construction of the improvements would require property acquisition for right-of-way. Full or partial displacement of existing uses substantially increase project costs, lengthens project schedules, and can be more difficult to implement. Additionally, increasing the number of turn lanes at intersections also increases pedestrian crossing times, which is less conducive to a pedestrian-friendly environment and inconsistent with the City's Comprehensive Plan. As described above, Black Lake Scenario 5 and Evergreen Scenario 7 require the least amount of local intersection improvements (also see Table 12, above).

In addition to the best local system operations and least number of intersection improvements, Black Lake Scenario 5 provides the most traffic reduction at the highly congested Black Lake Boulevard SPUI and the Black Lake Boulevard/Cooper Point Road intersections (approximately 800 vph lower than Local System Only Scenario 3) by diverting traffic to the new access ramps at Yauger Way. This is the only scenario that does not require any improvement to the Black Lake Boulevard/Cooper Point Road intersection to meet City of Olympia intersection LOS standards in the year 2030. Black Lake Scenarios 4 and 5, and to a lesser degree, Evergreen Scenarios 6 and 7, also provide important travel time and accessibility benefits to the Capital Medical Center by providing a direct route to and from US 101 for emergency vehicles, avoiding the highly congested Black Lake Boulevard and Cooper Point Road corridors.

Black Lake Scenarios 4 and 5, and to a lesser degree, Evergreen Scenarios 6 and 7 also provide an important secondary route to and from Capital Mall and surrounding retail businesses during peak holiday shopping weekends and seasons. A holiday season peak period traffic analysis was not specifically conducted; however, the new ramp connection to and from Yauger Way would likely improve safety and reduce vehicle queues and congestion that oftentimes extends into the US 101 mainline during these peak shopping days.

In summary, the two study recommendations and reasons for the recommendations are:

1. Eliminate Local System Only Scenarios 2 and 3 from further consideration
    - Local system impacts are substantially higher than other build scenarios
    - There is no traffic volume reduction at the highly congested US 101/Black Lake Boulevard SPUI and Black Lake Boulevard/Cooper Point Road intersections
    - With feasible improvements only, several intersections operate at unacceptable LOS E or F conditions with high delay at US 101/Black Lake Boulevard SPUI, Black Lake Boulevard/Cooper Point Road and 3-4 other intersections
    - There is no accessibility or travel time benefit to Capital Medical Center and other key locations compared to other build scenarios

- There is no benefit during holiday shopping time periods compared to other build scenarios

2. Conduct further evaluation of the Black Lake and Evergreen interchange scenarios

    - Concept design, accident/safety analysis, and an environmental screening evaluation would be initiated to provide more detailed information to select a preferred interchange alternative
    - An Interchange Justification Report (IJR) and NEPA/SEPA environmental document would be prepared after selecting a preferred interchange alternative

Table 17. Summary Comparison of Aggregate MOEs (One-Hour Analysis)

Number of Intersections Operating at	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7
LOS A - C	8	11	9	12	13	11	12
LOS D - E	3	9	11	8	11	9	10
LOS F	13	4	4	4	0	4	2
Triangle Delay (sec/veh)	497.3	285.8	234.5	275.3	229.6	285.5	215.8
Triangle + SPUI Delay (sec/veh)	684.3	426.5	365.3	345.6	302.1	363.4	298.2
Total Turn Pockets Added	NA	9	8	7	5	10	6
Total Through Lanes Added	NA	1	1	0	1	0	1
Total Signals Added	NA	3	3	3	3	3	3
Number Failing	**15**	**6**	**6**	**6**	**3**	**7**	**3**

Table 18. Summary Comparison of Aggregate MOEs (Two-Hour Analysis)

Number of Intersections Operating at	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7
LOS A - C	8	12	12	12	14	13	16
LOS D - E	5	10	10	10	10	9	8
LOS F	11	2	2	2	0	2	0
Triangle Delay (sec/veh)	432.8	253.5	208.0	240.4	200.9	248.9	188.9
Triangle + SPUI Delay (sec/veh)	611.4	388.3	332.3	308.0	271.1	322.9	266.8
Total Turn Pockets Added	NA	9	8	7	5	10	6
Total Through Lanes Added	NA	1	1	0	1	0	1
Total Signals Added	NA	3	3	3	3	3	3
Number Failing	**12**	**3**	**3**	**3**	**2**	**4**	**2**

REFERENCES

FHWA (Federal Highway Administration). 2004. *Traffic Analysis Toolbox, Volume 3, Guidelines for Applying Traffic Microsimulation Modeling Software.*

WSDOT Transportation Planning 2008. *Evaluation Methods and Screening.*

PTV America. 2007. *West Olympia Access Study, Model Documentation*.

TRB (Transportation Research Board). 2000. *Highway Capacity Manual (HCM), Special Report 209.*

STAKEHOLDER ACCEPTANCE

The undersigned parties concur with the assumptions, methodologies, and conclusions of the traffic analysis presented in this document.

WSDOT Assistant Design Engineer

Signature

Asst. State Design Engineer

Title

12/16/08

Date

FHWA

Signature

FHWA – OLYMPIC REGION – AREA ENGINEER

Title

11/18/2008

Date

WSDOT Headquarters

Signature

Access & Hearing Manager

Title

12-15-08

Date

City of Olympia

Randy Wesselman

Signature

Transportation Engineering & Planning Manager

Title

12/17/08

Date

WSDOT Olympic Region

Signature

Olympic Region Traffic

Title

12/12/2008

Date

TRPC

Thera Black.

Signature

Senior Planner.

Title

12.29.08

Date

ATTACHMENT A

City of Olympia Justifications of Infeasible Improvements

City of Olympia
Impacts of WOAS Intersection Improvements Associated with Scenarios
August 22, 2008

Issues of community scale, urban form, pedestrian, and bicycle safety are defined in the *Olympia Comprehensive Plan (see below)*. The additional lanes as proposed with the "local only" scenarios create safety concerns for pedestrians, transit riders and bicyclists, and are detrimental to the urban form Olympia is trying to create. Wide intersections are perceived as unsafe and intimidating to cross as a bicyclist and pedestrian, and can deter a person from walking and biking and using transit. Increasing use of these modes is an important cornerstone of the City's Comprehensive Plan goals and policies. Wide, busy intersections are out of scale with the vision of a pedestrian scale urban environment as defined in the comprehensive plan.

Olympia Comprehensive Plan **Vision, Goals and Policies**

Two of the guiding visions for the comprehensive plan are:

- *Focus on moving people, instead of only moving vehicles. To encourage people to walk, streets, homes and businesses need to be built in a way that makes the streets inviting.*

- *Transportation Demand Management (TDM) is used to reduce the rate of growth of traffic volumes by encouraging commuters to use alternatives to driving alone. TDM is primarily focused on employee travel to and from work because these trips are made at the same time by large numbers of people and are, therefore, easier to replace with alternative modes of travel. TDM is important in maintaining the entire transportation system.*

Supporting policies include:

Policy T 1.15
In downtown and along High Density Corridors, priority shall be given to building pedestrian-friendly streets.

Note: among the City's High Density Corridors are: Cooper Point from Harrison to Black Lake, Black Lake from 101to Harrison, and Harrison Avenue from Budd Inlet to Cooper Point.

T 1.14
The City shall support bicyclists and pedestrians by providing safe, convenient, and inviting routes and walkways between activity centers and in areas where the use of alternatives to driving alone for commuters is encouraged. In these areas, facilities and services needed to support the use of alternatives shall be identified and a funding strategy put into place. Bike and pedestrian facilities shall be included in the multi-modal level of service policy. (See T 2.1)

Excerpt from Policy T 2.1
Road Width and Community Scale: Generally, a road should not be widened beyond two through lanes in each direction with auxiliary turn lanes as appropriate. Roads with more than five lanes are perceived by the public as beyond the scale that is appropriate for this community.
(Resolution #11866, 12/21/98)

Policy T 2.2
Downtown, and along High Density Residential Corridors, level of service E will be acceptable. In these areas road widening should be a last resort since it may discourage the Pedestrians that are to be encouraged and accommodated in these areas and since the results of the Urban Design Strategy indicate a strong preference for narrower roads. Development in these areas may need to contribute funds for improvements that can help the function or safety of the Road (such as signals, bike lanes, turn pockets, special lanes for buses). In the rest of the City and Urban Growth Area LOS D will be acceptable. Higher levels of service may be maintained in Parts of the city because of low traffic demand. Unsolved problem areas are noted on the transportation improvement map. For some intersections, the LOS is F.

Justification for Removal of Infeasible Projects

The width of some intersections described in the original scenarios is out of scale and counter to Olympia's adopted goals and vision defined by the *Olympia Comprehensive Plan*. In order to meet other goals in the comprehensive plan related to vehicle movement, management of congestion and concurrency, it is acknowledged that some additional intersection turn lanes are needed. However, the original scenarios included some excessive intersection widenings. Listed below are reasons why some of the original projects should be deemed infeasible and removed from further consideration in any scenario

1. When comparing local only to connection scenarios, the amount of widening at intersections is doubled or tripled with local only scenarios.
2. Pedestrian crossings are the primary concern of the widening. Pedestrians and transit riders will be exposed to longer crossings and more lanes of turning vehicles.
3. Of the nine intersections affected by the local only scenarios, 8 have transit routes, indicating a relatively high use by pedestrians (see table below).
4. Right on red movements by vehicles and conflicts with pedestrians in this circumstance increase with local only scenarios. Rights on red are one of the top circumstances in which conflict occurs between pedestrians and motorists.
5. Six of the nine intersection affected are considered high density corridors, where special consideration of urban form, and building a pedestrian friendly environment are crucial.
6. Longer signal times will be needed to accommodate pedestrian crossings in the local only scenarios which will increase friction for opposing traffic.
7. Mid blocks crossings and refuge islands would be needed to facilitate pedestrian crossings.
8. The number of conflict points increases which decreases safety and increase potential for vehicular side-swipe collisions as well as vehicle-pedestrian or vehicle-bicyclist collisions.

Based on these principles of we are providing a list of vehicle improvements that are counter intuitive to the City's Comprehensive Plan visions for safe pedestrian environment and the promotion multi-modal facilities. See the following table for those improvements that should be removed from the original list along with associated justification as described above.

As stated on the City's comprehensive plan, roads with more than five lanes are perceived by the public as beyond the scale that is appropriate for this community. Some exception can be made to add auxiliary turn lanes for vehicle level of service consideration and concurrency requirements. The City would have to consider removing the pedestrian crossings of six or seven lanes wide due to increase exposure to traffic and pedestrian crossing times. In these cases alternative designs to cross the street safely would be needed.

Conclusion

Intersection safety for all travelers is the primary concern behind this request to remove the infeasible intersection widenings. These intersection modifications are all related to the "Local Only" alternative improvements that increase intersection crossing distance and conflict points beyond reasonable safety for pedestrians and bicyclists. While the "build scenarios" also include some widening at intersections, the number of widening project and their resulting impact is far less. Subsequent analysis should focus only on those feasible intersection projects.

	2030 Local System Only Scenario		
Intersection	**Original Improvements**	**Feasible Improvements**	**Justification**
Black Lake and Cooper Point	1 NER Turn Lane 1 SER Turn Lane 1 SWL Turn Lane	~~1 NER Turn Lane~~ 1 SER Turn Lane ~~1 SWL Turn Lane~~	• Amount of widening at intersections is doubled or tripled with local only scenarios. • Pedestrians and transit riders will be exposed to longer crossings and more lanes of turning vehicles • Longer signal times will be needed to accommodate pedestrian crossings • Black Lake and Cooper Point intersection accommodates two transit routes, indicating a relatively high use by pedestrians. • Right on red movements by vehicles and conflicts with pedestrians in this circumstance increase with local only scenarios. Rights on red are one of the top circumstances in which conflict occurs between pedestrians and motorists • The intersection is part of a high density corridor, where the city has identified special consideration of urban form, and building a pedestrian friendly environment are crucial • Would have to consider removing the pedestrian crossings of six or seven lanes wide due to increase exposure to traffic and pedestrian crossing times. • The number of conflict points increases which decreases safety and increases potential for side-swipe collisions increase.
Black Lake/9th/Capital Mall Drive	1 EBL Turn Lane 1 SWR Turn Lane	~~1 EBL Turn Lane~~ 1 SWR Turn Lane	• Amount of widening at intersections is doubled or tripled with local only scenarios. • Pedestrians and transit riders will be exposed to longer crossings and more lanes of turning vehicles • Black Lake/9th St/Capital Mall Drive intersection accommodates a transit route, indicating a relatively high use by pedestrians • The intersection is part of a high density corridor, where the city has identified special consideration of urban form, and building a pedestrian friendly environment are crucial. • The number of conflict points increases which decreases safety and increases potential for side-swipe collisions increase.
Cooper Point/Auto Mall/Evergreen Pk	1 SEL Turn Lane 1 SWR Turn Lane	~~1 SEL Turn Lane~~ 1 SWR Turn Lane	• Amount of widening at intersections is doubled or tripled with local only scenarios. • Pedestrians and transit riders will be exposed to longer crossings and more lanes of turning vehicles • Cooper Point/Auto Mall/Evergreen Parkway Drive intersection accommodates a transit route, indicating a relatively high use by pedestrians • Longer signal times will be needed to accommodate pedestrian crossings • The number of conflict points increases which decreases safety and increases potential for side-swipe collisions increase.
Harrison and Division	2 NBL Turn Lanes 1 SBL Turn Lane	2 NBL Turn Lanes ~~1 SBL Turn Lane~~	• Amount of widening at intersections is doubled or tripled with local only scenarios. • Pedestrians and transit riders will be exposed to longer crossings and more lanes of turning vehicles • Harrison and Division intersection accommodates three transit routes, indicating a relatively high use by pedestrians. • The intersection is part of a high density corridor, where the city has identified special consideration of urban form, and building a pedestrian friendly environment are crucial. • The number of conflict points increases which decreases safety and increases potential for side-swipe collisions increase.

Number of Transit Routes	Net additional widening of local scenarios	Description of Improvements	Applicable Scenarios	
			Local Only Scenarios 2 and 3	**Connections to 101 Scenarios 5 and 7**
3	1 lane	Harrison and Division • 2 northbound left-turn lanes • 1 southbound left-turn lane	2 and 3 2 and 3	5 and 7
2	2 lanes	Black Lake and Cooper Point • 1 north/east right-turn lane • 1 south/east right-turn lane • 1 south/west left-turn lane	2 and 3 2 and 3 2 and 3	7
3	None	Cooper Point and Harrison • 1 northbound left-turn lane	2 and 3	5 and 7
1	1 lane	Black Lake/9th/Capital Mall Drive • 1 eastbound left-turn lane • 1 south/west right-turn lane	2 and 3 2 and 3	5 and 7
1	1 lane	Cooper Point/Auto Mall/Evergreen Pk • 1 south/east left-turn lane • 1 south/west left-turn lane	2 and 3 2 and 3	5 and 7
1	1 lane	Cooper Point at Top Foods Entrance • 1 eastbound right-turn lane	2 and 3	
1	None	101 Westbound Ramps and Crosby • 1 northbound turn lane • 1 southbound right-turn lane	2 and 3 3	5 and 7 5 and 7
0	1 lane	Mud Bay Road/Evergreen Park (westbound ramps) • Add signal • 1 northbound turn lane	2, 3, 2 and 3	5 and 7
0	None	Mud Bay Road/Evergreen Park (eastbound ramps) • Add signal	2, 3,	5 and 7
2	1 lane	Lakeridge Drive and Deschutes Pkwy • Add signal • 1 southbound turn lane	2, 3 2	5 and 7

ATTACHMENT B

Model Inputs and Calibration Assumptions

Model Inputs and Calibration Assumptions

Model Input	Data Source(s)	Relevant Values	Remarks
Vehicle Speeds	WSDOT Annual Speed Report for 60 mph facilities Speed group distribution (R097, R003E, and P4)	55-58 mph (7%), 58-60 mph (43%), 60-67 mph (36%), 67-70 mph (12%), 70-75 mph (2%)	Northbound P4 speeds were used as representative of network (best available data)
Vehicle Compositions	Freeway: WSDOT P4 ADC and WSDOT R003E ADC Classification Summaries Annual Traffic Summary Local: City of Olympia Turning Movement Counts	US 101 Heavy Vehicles = 7% I-5 Heavy Vehicles = 9% Local Heavy Vehicles = 3%	PM Peak Period Heavy Vehicle Percentages
Volumes	***Freeway Volumes:*** WSDOT ADC Locations P4, R003E, R097, R098 (October 2006) ***On- and Off-Ramp Volumes:*** WSDOT Tube Counts (January 2007) ***Local Turning Movement Counts***: City of Olympia Existing Conditions Synchro Model (Base 2005) , City of Olympia Turning Movement Counts (2005-2007)	See Figures Tech Memo Figure 2, 3, and 4	Freeway: Average weekday PM peak period (4:00-6:00) counts. Local: Two hour weekday PM peak period(4:00 - 6:00) turning movement counts
Signal Timings	City of Olympia Existing Conditions Synchro Model, Consultant Field Measurements	n/a	Field Verified Signal Timings per field visit
Network Channelization	WSDOT Aerial SID File (Year 2007) local.live.com Consultant Field Visits	n/a	Existing channelization measured from scaled SID file. Number of lanes and channelization verified using local.live.com and consultant field visits

Model Inputs and Calibration Assumptions

Model Input	Data Source(s)	Relevant Values	Remarks
Vehicle Routing	Existing Turning Movement Splits, Existing Conditions VISUM Model	Static Routing	Used VISSIM static routing feature utilizing existing turning movement splits and on-and off-ramp percentages. For SB I-5 from 14th/Plum Avenue, utilized the existing conditions VISUM model to estimate O-D in the I-5/US 101 weave section.
Calibration Parameters	Primary: Lane Change Distances Secondary: Driver Behavior Parameter CC1 (Headway Time)	Modified CC1 on Southbound I-5 between 14th/Plum Avenue On-Ramp and US-101 Off Ramp from 0.9 to 1.3. Lane change distances varied between 2,500' to 7,500'	Modified driver behavior parameters to replicate field measured travel times and speeds. The model would not replicate the queue across all lanes by only changing lane change distances.

ATTACHMENT C

Modeled and Expected Volumes Comparison and GEH Statistics

2007 Existing
PM Peak VISSIM Model Volumes

2007 Existing										
Intersection Name	Expected Volume	Model Volume				Total Volume	Percent Difference	Absolute Difference	GEH
	4:30 - 5:30	4:30	4:45	5:00	5:15	4:30 - 5:30	4:30 - 5:30	4:30 - 5:30	
Freeway Volumes									
Southbound I-5									
Model Entry	4585	1197	1165	1139	1039	4540	1%	45	0.668
SB I-5 Mainline	4585	1167	1174	1112	1114	4567	0%	18	0.265
Plum On/US 101 Off Weave	6248	1560	1567	1544	1541	6212	1%	36	0.452
SB I-5 Mainline	3270	800	779	818	773	3169	3%	101	1.773
2nd Avenue Off	3270	800	779	818	773	3169	3%	101	1.773
SB I-5 Mainline	2994	744	725	760	722	2951	1%	43	0.791
US 101 On	4334	1066	1050	1098	1073	4286	1%	48	0.733
Model Exit	4334	1067	1050	1096	1073	4286	1%	48	0.734
Northbound I-5									
Model Entry	3855	986	978	1007	892	3863	0%	-8	0.135
US 101 Off	3855	987	979	1010	896	3872	0%	-17	0.280
NB I-5 Mainline	2960	767	745	773	697	2982	-1%	-22	0.396
US 101 On-ramp Merge	5958	1495	1446	1563	1459	5963	0%	-5	0.062
US 101/14th Ave Off-ramp Diverge	5958	1497	1446	1555	1462	5960	0%	-2	0.021
NB I-5 Mainline	5077	1290	1242	1333	1261	5125	-1%	-48	0.676
Plum On	5777	1456	1379	1521	1463	5818	-1%	-41	0.536
Model Exit	5789	1456	1379	1521	1463	5818	0%	-29	
Westbound 101									
Model Entry	4381	1106	1147	1078	1108	4439	-1%	-58	0.866
Crosby Blvd Off	4381	1104	1145	1083	1108	4440	-1%	-59	0.887
WB 101 Mainline	3261	819	842	805	817	3283	-1%	-22	0.383
Crosby Blvd/Black Lake Weave	3487	876	896	868	872	3513	-1%	-26	0.433
WB 101 Mainline	2073	514	537	503	512	2067	0%	6	0.125
Black Lake On	2467	603	644	595	624	2466	0%	1	0.020
WB 101 Mainline	2467	600	640	601	626	2467	0%	0	0.004
Evergreen Off	2467	599	641	599	626	2465	0%	2	0.034
WB 101 Mainline	1891	469	502	466	488	1926	-2%	-35	0.797
Mud Bay Off	1891	470	503	474	483	1930	-2%	-39	0.885
WB 101 Mainline	1805	449	484	450	462	1846	-2%	-41	0.948
Mud Bay On	2401	593	623	594	594	2404	0%	-3	0.065
WB 101 Mainline	2401	593	623	594	594	2404	0%	-3	0.065
Model Exit	2401	593	623	594	594	2404	0%	-3	0.065
Eastbound 101									
Model Entry	1773	433	443	455	438	1769	0%	5	0.107
Mudbay Off	1773	433	443	455	438	1769	0%	5	0.107
EB 101 Mainline	1460	357	361	375	359	1451	1%	9	0.236
Mudbay On	1520	376	376	391	371	1514	0%	6	0.159
EB 101 Mainline	1520	375	375	393	370	1513	0%	7	0.175
Evergreen On	2080	511	515	531	507	2064	1%	16	0.354
EB 101 Mainline	2080	511	517	532	506	2066	1%	15	0.318
Black Lake Off	2080	509	517	532	506	2064	1%	16	0.356
EB 101 Mainline	1820	449	452	466	443	1810	1%	10	0.239
Black Lake On	3270	791	801	829	810	3230	1%	41	0.710
EB 101 Mainline	3270	789	788	829	818	3223	1%	47	0.820
Crosby Blvd Off	3270	789	788	829	818	3223	1%	47	0.820
EB 101 Mainline	3090	749	743	770	775	3037	2%	53	0.965
Crosby Blvd On	4375	1057	1037	1117	1090	4301	2%	74	1.120
Model Exit	4375	1067	1047	1112	1089	4315	1%	60	0.910
	85119					**84911**	Comprehensive Model GEH -->		**0.71**

2030 No-Build Scenario 1
PM Peak VISSIM Model Volumes

2030 Scenario 1, No-Build								
Intersection Name	**Expected Volume**	**Model Volume**				**Total Volume**	**Percent Difference**	**Abs Difference**
	4:30 - 5:30	**4:30**	**4:45**	**5:00**	**5:15**	**4:30 - 5:30**	**4:30 - 5:30**	**4:30 - 5:30**
Freeway Volumes								
Southbound I-5								
Model Entry	6282	1249.9	1189	1175	1142	4756	32%	1526
SB I-5 Mainline	6282	1216.5	1204	1160	1137	4716	33%	1566
Plum On/US 101 Off Weave	8011	1617.3	1614	1609	1596	6436	24%	1575
SB I-5 Mainline	4304	898.5	877	912	885	3573	20%	731
2nd Avenue Off	4304	898.5	877	912	885	3573	20%	731
SB I-5 Mainline	4039	850.2	826	862	832	3371	20%	668
US 101 On	5889	1230.7	1169	1221	1163	4784	23%	1105
Model Exit	5889	1237.4	1168	1218	1168	4791	23%	1098
Northbound I-5								
Model Entry	5475	1404.7	1401	1435	1270	5511	-1%	-36
US 101 Off	5475	1408.5	1401	1439	1275	5523	-1%	-48
NB I-5 Mainline	4242	1085	1097	1102	995	4278	-1%	-36
US 101 On-ramp Merge	7913	1847.5	1789	1831	1756	7223	10%	691
US 101/14th Ave Off-ramp Diverge	7913	1851.1	1793	1825	1758	7228	9%	685
NB I-5 Mainline	6864	1613.8	1566	1588	1529	6296	9%	568
Plum On	7620	1792.8	1710	1792	1747	7042	8%	579
Model Exit	7620	1792.8	1710	1792	1747	7042	8%	579
Westbound 101								
Model Entry	5595	1204.1	1213	1175	1171	4763	17%	832
Crosby Blvd Off	5595	1201.8	1215	1180	1166	4762	17%	833
WB 101 Mainline	4337	925.9	929	910	897	3661	18%	676
Crosby Blvd/Black Lake Weave	4917	1030.4	1005	1022	996	4053	21%	864
WB 101 Mainline	3443	729.5	711	713	698	2851	21%	592
Black Lake On	4287	882.6	873	878	860	3493	23%	795
WB 101 Mainline	4287	883.2	868	878	861	3491	23%	797
Evergreen Off	4287	879.6	872	873	862	3486	23%	801
WB 101 Mainline	3406	697.9	693	683	682	2756	24%	650
Mud Bay Off	3406	700	694	691	684	2769	23%	637
WB 101 Mainline	3271	676.1	678	667	660	2680	22%	591
Mud Bay On	4111	883.1	880	876	846	3485	18%	626
WB 101 Mainline	4111	883.1	880	876	846	3485	18%	626
Model Exit	4111	883.1	880	876	846	3485	18%	626
Eastbound 101								
Model Entry	2766	682.9	694	715	685	2777	0%	-11
Mudbay Off	2766	682.9	694	715	685	2777	0%	-11
EB 101 Mainline	2387	587.5	594	609	582	2373	1%	14
Mudbay On	2437	603.9	604	625	577	2409	1%	28
EB 101 Mainline	2437	602.6	601	628	556	2388	2%	49
Evergreen On	3456	834.2	744	756	707	3041	14%	415
EB 101 Mainline	3456	803.4	703	747	662	2916	19%	541
Black Lake Off	3456	779.9	713	749	630	2872	20%	584
EB 101 Mainline	2955	660.8	612	639	525	2437	21%	518
Black Lake On	4617	992.4	942	971	847	3752	23%	865
EB 101 Mainline	4617	996.5	926	965	852	3739	23%	878
Crosby Blvd Off	4617	996.5	926	965	852	3739	23%	878
EB 101 Mainline	4339	946.5	862	893	806	3507	24%	832
Crosby Blvd On	5853	1177.9	1069	1117	1034	4397	33%	1456
Model Exit	5853	1180.8	1073	1092	1044	4390	33%	1463

2030 Local System Only Scenario 3
PM Peak VISSIM Model Volumes

2030 Scenario 3, Local System Only								
Intersection Name	Expected Volume	Model Volume				Total Volume	Percent Difference	Abs Difference
	4:30 - 5:30	4:30	4:45	5:00	5:15	4:30 - 5:30	4:30 - 5:30	4:30 - 5:30
Freeway Volumes								
Southbound I-5								
Model Entry	6282	1257.2	1178	1166	1128	4728	33%	1554
SB I-5 Mainline	6282	1219.1	1193	1135	1172	4719	33%	1563
Plum On/US 101 Off Weave	8011	1626.5	1607	1579	1612	6425	25%	1586
SB I-5 Mainline	4289	903.9	854	890	886	3533	21%	756
2nd Avenue Off	4289	903.9	854	890	886	3533	21%	756
SB I-5 Mainline	4038	856.7	797	844	829	3327	21%	711
US 101 On	5933	1261.1	1213	1236	1209	4919	21%	1014
Model Exit	5933	1263.5	1220	1232	1207	4923	21%	1011
Northbound I-5								
Model Entry	5475	1397.8	1410	1436	1275	5518	-1%	-43
US 101 Off	5475	1399.4	1414	1439	1280	5532	-1%	-57
NB I-5 Mainline	4242	1067.1	1103	1084	991	4245	0%	-3
US 101 On-ramp Merge	7915	1844.7	1850	1820	1814	7329	8%	586
US 101/14th Ave Off-ramp Diverge	7915	1847.7	1847	1819	1814	7328	8%	587
NB I-5 Mainline	6928	1613	1619	1587	1582	6401	8%	527
Plum On	7691	1802.1	1771	1801	1799	7173	7%	518
Model Exit	7691	1802.1	1771	1801	1799	7173	7%	518
Westbound 101								
Model Entry	5696	1229.5	1247	1188	1215	4879	17%	817
Crosby Blvd Off	5696	1217	1254	1199	1210	4880	17%	816
WB 101 Mainline	4272	907	930	886	910	3633	18%	639
Crosby Blvd/Black Lake Weave	4911	1030.1	1055	1012	1036	4133	19%	778
WB 101 Mainline	3513	741.6	763	723	741	2969	18%	544
Black Lake On	4270	893.7	920	868	886	3567	20%	703
WB 101 Mainline	4270	893.7	917	878	880	3568	20%	702
Evergreen Off	4270	891	917	881	882	3570	20%	700
WB 101 Mainline	3534	740.9	779	738	739	2996	18%	538
Mud Bay Off	3534	756.7	766	745	730	2998	18%	536
WB 101 Mainline	3402	732.6	741	727	711	2911	17%	491
Mud Bay On	4078	915.8	917	905	878	3616	13%	462
WB 101 Mainline	4078	915.8	917	905	878	3616	13%	462
Model Exit	4078	915.8	917	905	878	3616	13%	462
Eastbound 101								
Model Entry	2766	676.4	704	707	694	2782	-1%	-16
Mudbay Off	2766	676.4	704	707	694	2782	-1%	-16
EB 101 Mainline	2409	591.8	610	609	606	2417	0%	-8
Mudbay On	2448	606.6	618	622	616	2462	-1%	-14
EB 101 Mainline	2448	605.2	618	623	615	2462	-1%	-14
Evergreen On	3450	859.5	859	885	857	3461	0%	-11
EB 101 Mainline	3450	855.7	855	884	864	3458	0%	-8
Black Lake Off	3450	856.1	854	882	865	3457	0%	-7
EB 101 Mainline	2911	726.4	718	749	721	2914	0%	-3
Black Lake On	4568	1041.9	1034	1059	1005	4140	10%	429
EB 101 Mainline	4568	1042.6	1036	1054	983	4115	11%	453
Crosby Blvd Off	4568	1042.6	1036	1054	983	4115	11%	453
EB 101 Mainline	4299	985.7	974	983	916	3858	11%	441
Crosby Blvd On	5819	1259.4	1249	1216	1170	4894	19%	925
Model Exit	5819	1253.8	1230	1161	1200	4844	20%	975

2030 Black Lake Interchange Scenario 5
PM Peak VISSIM Model Volumes

2030 Scenario 5, Black Lake Interchange								
Intersection Name	Expected Volume	Model Volume				Total Volume	Percent Difference	Abs Difference
	4:30 - 5:30	4:30	4:45	5:00	5:15	4:30 - 5:30	4:30 - 5:30	4:30 - 5:30
Freeway Volumes								
Southbound I-5								
Model Entry	6236	1246.9	1206	1167	1162	4781	30%	1455
SB I-5 Mainline	6236	1207.8	1211	1149	1182	4749	31%	1487
Plum On/US 101 Off Weave	7965	1625.5	1605	1609	1617	6457	23%	1508
SB I-5 Mainline	4273	902	865	903	885	3555	20%	718
2nd Avenue Off	4273	902	865	903	885	3555	20%	718
SB I-5 Mainline	4013	846.2	814	854	834	3348	20%	665
US 101 On	5894	1252.3	1222	1243	1243	4961	19%	933
Model Exit	5894	1253.9	1219	1247	1235	4955	19%	939
Northbound I-5								
Model Entry	5475	1406	1400	1435	1272	5512	-1%	-37
US 101 Off	5475	1407.6	1399	1441	1274	5522	-1%	-47
NB I-5 Mainline	4242	1072.9	1091	1092	987	4242	0%	0
US 101 On-ramp Merge	7886	1851.5	1862	1863	1805	7381	7%	505
US 101/14th Ave Off-ramp Diverge	7886	1844.7	1868	1863	1805	7380	7%	506
NB I-5 Mainline	6899	1612.9	1633	1628	1572	6446	7%	453
Plum On	7669	1796.7	1776	1844	1788	7205	6%	464
Model Exit	7669	1796.7	1776	1844	1788	7205	6%	464
Westbound 101								
Model Entry	5666	1232.8	1241	1205	1210	4889	16%	777
Crosby Blvd Off	5666	1229	1238	1217	1208	4892	16%	774
WB 101 Mainline	4260	913.7	922	906	902	3643	17%	617
Crosby Blvd/Black Lake Weave	5047	1039.3	1053	1019	1039	4151	22%	897
WB 101 Mainline	3378	696.9	702	680	688	2767	22%	611
Black Lake On	4172	869	860	840	852	3421	22%	751
WB 101 Mainline	4172	870.6	858	841	852	3422	22%	750
Evergreen Off	4172	866.9	860	840	851	3418	22%	754
WB 101 Mainline	3516	725.2	732	700	720	2876	22%	640
Mud Bay Off	3516	730.8	728	709	714	2882	22%	634
WB 101 Mainline	3382	708.5	705	691	690	2794	21%	588
Mud Bay On	4037	865.1	867	845	838	3416	18%	622
WB 101 Mainline	4037	865.1	867	845	838	3416	18%	622
Model Exit	4037	865.1	867	845	838	3416	18%	622
Eastbound 101								
Model Entry	2766	682.9	694	715	685	2777	0%	-11
Mudbay Off	2766	682.9	694	715	685	2777	0%	-11
EB 101 Mainline	2427	601.9	608	625	607	2442	-1%	-15
Mudbay On	2468	614.9	616	638	616	2484	-1%	-16
EB 101 Mainline	2468	614	618	636	617	2485	-1%	-17
Evergreen On	3252	801.3	815	833	779	3228	1%	24
EB 101 Mainline	3252	800.2	801	810	798	3210	1%	42
Black Lake Off	3252	802.3	792	808	801	3203	2%	49
EB 101 Mainline	2695	665.2	659	672	667	2663	1%	32
Black Lake On	4647	1101.9	1088	1066	1101	4358	7%	289
EB 101 Mainline	4647	1101.4	1082	1062	1111	4356	7%	291
Crosby Blvd Off	4647	1101.4	1082	1062	1111	4356	7%	291
EB 101 Mainline	4282	1010.5	998	969	1019	3996	7%	286
Crosby Blvd On	5774	1262.1	1227	1211	1236	4936	17%	838
Model Exit	5774	1241.2	1258	1172	1248	4919	17%	855

2030 Evergreen Interchange Scenario 7
PM Peak VISSIM Model Volumes

2030 Scenario 7, Evergreen Interchange								
Intersection Name	Expected Volume	Model Volume				Total Volume	Percent Difference	Abs Difference
	4:30 - 5:30	4:30	4:45	5:00	5:15	4:30 - 5:30	4:30 - 5:30	4:30 - 5:30
Freeway Volumes								
Southbound I-5								
Model Entry	6236	1257.2	1206	1174	1148	4785	30%	1451
SB I-5 Mainline	6236	1214.3	1218	1148	1180	4761	31%	1476
Plum On/US 101 Off Weave	7932	1612.7	1607	1598	1618	6435	23%	1497
SB I-5 Mainline	4269	895.7	861	898	882	3535	21%	734
2nd Avenue Off	4269	895.7	861	898	882	3535	21%	734
SB I-5 Mainline	4023	843.4	814	848	825	3331	21%	692
US 101 On	5922	1238	1217	1235	1226	4916	20%	1006
Model Exit	5922	1239.9	1215	1235	1227	4917	20%	1005
Northbound I-5								
Model Entry	5475	1405.8	1400	1435	1272	5512	-1%	-37
US 101 Off	5475	1403.5	1405	1439	1275	5522	-1%	-47
NB I-5 Mainline	4242	1070.6	1093	1091	988	4243	0%	-1
US 101 On-ramp Merge	7921	1823.5	1848	1837	1824	7332	8%	589
US 101/14th Ave Off-ramp Diverge	7921	1824.1	1851	1832	1823	7330	8%	591
NB I-5 Mainline	6934	1594.3	1611	1603	1589	6398	8%	536
Plum On	7697	1771	1761	1810	1810	7152	8%	545
Model Exit	7697	1771	1761	1810	1810	7152	8%	545
Westbound 101								
Model Entry	5631	1234.7	1248	1207	1223	4911	15%	720
Crosby Blvd Off	5631	1242.4	1246	1215	1218	4922	14%	709
WB 101 Mainline	4218	923.7	930	907	905	3667	15%	551
Crosby Blvd/Black Lake Weave	4829	1029.8	1043	1020	1019	4111	17%	718
WB 101 Mainline	3504	742.2	757	729	732	2960	18%	544
Black Lake On	4204	897.3	907	876	892	3573	18%	632
WB 101 Mainline	4204	896.3	909	875	892	3572	18%	632
Evergreen Off	4204	682.3	696	664	676	2718	55%	1486
WB 101 Mainline	3185	680.6	695	664	676	2716	17%	469
Evergreen On	3315	712	733	699	703	2847	16%	468
WB 101 Mainline	3315	712	733	699	703	2847	16%	468
Mud Bay Off	3315	716.7	726	709	699	2851	16%	465
WB 101 Mainline	3182	692.8	704	683	681	2760	15%	422
Mud Bay On	4016	898.3	904	887	870	3559	13%	457
WB 101 Mainline	4016	898.3	904	887	870	3559	13%	457
Model Exit	4016	898.3	904	887	870	3559	13%	457
Eastbound 101								
Model Entry	2766	682.9	694	715	685	2777	0%	-11
Mudbay Off	2766	682.9	694	715	685	2777	0%	-11
EB 101 Mainline	2409	592	601	616	599	2408	0%	2
Mudbay On	2477	613.2	616	636	613	2478	0%	-1
EB 101 Mainline	2477	612	618	636	613	2479	0%	-2
Evergreen Off	2477	610.2	619	633	619	2481	0%	-4
EB 101 Mainline	2457	606.2	611.4	626.4	610.9	2455	0%	2
Evergreen On	3683	908.5	917	937	904	3667	0%	16
EB 101 Mainline	3683	903.7	920	934	907	3664	1%	19
Black Lake Off	3683	904.5	918	934	907	3664	1%	20
EB 101 Mainline	3142	769.8	777	802	775	3123	1%	19
Black Lake On	4651	1091.5	1063	1125	1065	4345	7%	306
EB 101 Mainline	4651	1091.1	1062	1112	1060	4325	8%	326
Crosby Blvd Off	4651	1091.1	1062	1112	1060	4325	8%	326
EB 101 Mainline	4354	1014.4	1006	1017	992	4029	8%	325
Crosby Blvd On	5880	1252.4	1230	1243	1211	4936	19%	944
Model Exit	5880	1242.5	1216	1208	1216	4883	20%	997

ATTACHMENT D

Expanded Freeway Density and LOS Tables

2007 Existing
PM Peak Freeway Density and LOS

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,519	73.5	F
Southbound I-5 to US 101 Weave	Weave	6,212	53.4	F
Southbound I-5	Basic	3,159	20.9	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,107	17.8	B
Southbound I-5	Basic	2,952	19.8	C
Southbound I-5 US 101 On-Ramp	Merge	3,872	27.2	C
Southbound I-5	Basic	4,285	27.9	D
Northbound I-5	Basic	3,871	22.6	C
Northbound I-5 to US 101 Off-Ramp	Diverge	3,871	27.6	C
Northbound I-5	Basic	2,980	19.2	C
Northbound I-5 US 101 On-Ramp	Merge	5,857	35.6	E
Northbound I-5	Basic	5,957	27.3	D
Northbound I-5 Plum/14th Off-Ramp	Diverge	5,588	26.9	C
Northbound I-5	Basic	5,118	24.1	C
Westbound US 101 e/o Crosby Blvd	Basic	4,411	35.1	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,433	48.4	F
Westbound US 101	Basic	3,244	22.7	C
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,022	19.9	B
Westbound US 101	Basic	2,031	20.2	C
Westbound US 101 Black Lake On-Ramp	Merge	2,278	14.9	B
Westbound US 101	Basic	2,456	23.6	C
Westbound US 101 Evergreen Off-Ramp	Diverge	2,393	22.7	C
Westbound US 101	Basic	1,925	18.0	C
Westbound US 101 Mud Bay Off-Ramp	Diverge	1,922	18.1	C
Westbound US 101	Basic	1,845	17.4	B
Westbound US 101 Mud Bay On-Ramp	Merge	2,218	14.3	B
Westbound US 101	Basic	2,403	22.9	C
Eastbound US 101	Basic	1,768	16.3	B
Eastbound US 101 Mud Bay Off-Ramp	Diverge	1,760	16.5	B
Eastbound US 101	Basic	1,460	13.5	B
Eastbound US 101 Mud Bay On-Ramp	Merge	1,511	8.9	A
Eastbound US 101	Basic	1,513	14.4	B
Eastbound US 101 Evergreen On-Ramp	Merge	2,049	13.5	B
Eastbound US 101	Basic	2,065	19.4	C
Eastbound US 101 Black Lake Off-Ramp	Diverge	2,037	19.1	B
Eastbound US 101	Basic	1,726	15.7	B
Eastbound US 101 Black Lake On-Ramp	Merge	3,136	14.5	B
Eastbound US 101	Basic	3,227	19.6	C
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	3,109	19.2	B
Eastbound US 101	Basic	3,010	18.2	C
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,296	20.6	C
Eastbound US 101	Basic	4,280	30.1	D

2030 No-Build Scenario 1
PM Peak Freeway Density and LOS

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,663	80.7	F
Southbound I-5 to US 101 Weave	Weave	6,432	57.3	F
Southbound I-5	Basic	3,561	24.1	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,513	20.6	C
Southbound I-5	Basic	3,365	23.6	C
Southbound I-5 US 101 On-Ramp	Merge	4,324	42.8	E
Southbound I-5	Basic	4,788	33.6	D
Northbound I-5	Basic	5,518	33.1	D
Northbound I-5 to US 101 Off-Ramp	Diverge	5,519	40.7	E
Northbound I-5	Basic	4,274	28.7	D
Northbound I-5 US 101 On-Ramp	Merge	7,086	81.4	F
Northbound I-5	Basic	7,226	37.5	E
Northbound I-5 Plum/14th Off-Ramp	Diverge	6,813	31.7	D
Northbound I-5	Basic	6,287	30.2	D
Westbound US 101 e/o Crosby Blvd	Basic	4,734	38.5	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,758	49.7	F
Westbound US 101	Basic	3,618	25.8	C
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,436	23.5	B
Westbound US 101	Basic	2,799	29.7	D
Westbound US 101 Black Lake On-Ramp	Merge	3,224	26.4	C
Westbound US 101	Basic	3,476	35.6	E
Westbound US 101 Evergreen Off-Ramp	Diverge	3,387	32.9	D
Westbound US 101	Basic	2,756	26.0	C
Westbound US 101 Mud Bay Off-Ramp	Diverge	2,760	26.4	C
Westbound US 101	Basic	2,680	25.7	C
Westbound US 101 Mud Bay On-Ramp	Merge	3,212	25.5	C
Westbound US 101	Basic	3,484	35.2	E
Eastbound US 101	Basic	2,776	26.2	D
Eastbound US 101 Mud Bay Off-Ramp	Diverge	2,761	29.8	D
Eastbound US 101	Basic	2,383	27.1	D
Eastbound US 101 Mud Bay On-Ramp	Merge	2,406	29.2	D
Eastbound US 101	Basic	2,247	124.0	F
Eastbound US 101 Evergreen On-Ramp	Merge	2,995	133.3	F
Eastbound US 101	Basic	2,936	136.9	F
Eastbound US 101 Black Lake Off-Ramp	Diverge	2,819	130.6	F
Eastbound US 101	Basic	2,364	17.3	B
Eastbound US 101 Black Lake On-Ramp	Merge	3,647	14.9	B
Eastbound US 101	Basic	3,746	20.1	C
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	3,603	19.3	B
Eastbound US 101	Basic	3,480	18.7	C
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,383	19.3	B
Eastbound US 101	Basic	4,353	31.6	D

2030 Local System Only Scenario 3
PM Peak Freeway Density and LOS

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,659	78.5	F
Southbound I-5 to US 101 Weave	Weave	6,421	57.0	F
Southbound I-5	Basic	3,520	23.8	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,473	20.7	C
Southbound I-5	Basic	3,321	23.1	C
Southbound I-5 US 101 On-Ramp	Merge	4,441	45.0	E
Southbound I-5	Basic	4,920	34.6	D
Northbound I-5	Basic	5,527	33.6	D
Northbound I-5 to US 101 Off-Ramp	Diverge	5,528	43.0	E
Northbound I-5	Basic	4,243	28.7	D
Northbound I-5 US 101 On-Ramp	Merge	7,197	119.5	F
Northbound I-5	Basic	7,327	40.2	E
Northbound I-5 Plum/14th Off-Ramp	Diverge	6,914	33.4	D
Northbound I-5	Basic	6,390	31.2	D
Westbound US 101 e/o Crosby Blvd	Basic	4,851	42.4	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,875	54.9	F
Westbound US 101	Basic	3,589	26.2	D
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,501	24.3	C
Westbound US 101	Basic	2,909	31.0	D
Westbound US 101 Black Lake On-Ramp	Merge	3,294	27.8	C
Westbound US 101	Basic	3,553	36.6	E
Westbound US 101 Evergreen Off-Ramp	Diverge	3,491	34.0	D
Westbound US 101	Basic	2,997	28.7	D
Westbound US 101 Mud Bay Off-Ramp	Diverge	2,989	28.8	D
Westbound US 101	Basic	2,910	27.9	D
Westbound US 101 Mud Bay On-Ramp	Merge	3,336	28.3	D
Westbound US 101	Basic	3,612	36.4	E
Eastbound US 101	Basic	2,780	26.7	D
Eastbound US 101 Mud Bay Off-Ramp	Diverge	2,768	29.2	D
Eastbound US 101	Basic	2,427	23.4	C
Eastbound US 101 Mud Bay On-Ramp	Merge	2,458	14.7	B
Eastbound US 101	Basic	2,464	24.8	C
Eastbound US 101 Evergreen On-Ramp	Merge	3,435	25.7	C
Eastbound US 101	Basic	3,459	34.7	D
Eastbound US 101 Black Lake Off-Ramp	Diverge	3,403	33.2	D
Eastbound US 101	Basic	2,772	26.9	D
Eastbound US 101 Black Lake On-Ramp	Merge	4,026	23.0	C
Eastbound US 101	Basic	4,123	33.5	D
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	3,967	33.6	D
Eastbound US 101	Basic	3,832	35.1	E
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,878	52.8	F
Eastbound US 101	Basic	4,825	63.6	F

2030 Black Lake Interchange Scenario 5
PM Peak Freeway Density and LOS

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,684	78.4	F
Southbound I-5 to US 101 Weave	Weave	6,454	56.3	F
Southbound I-5	Basic	3,543	24.0	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,495	21.0	C
Southbound I-5	Basic	3,345	23.3	C
Southbound I-5 US 101 On-Ramp	Merge	4,482	47.4	F
Southbound I-5	Basic	4,954	35.0	D
Northbound I-5	Basic	5,519	33.6	D
Northbound I-5 to US 101 Off-Ramp	Diverge	5,519	43.3	E
Northbound I-5	Basic	4,239	28.8	D
Northbound I-5 US 101 On-Ramp	Merge	7,249	112.7	F
Northbound I-5	Basic	7,381	40.4	E
Northbound I-5 Plum/14th Off-Ramp	Diverge	6,962	33.6	D
Northbound I-5	Basic	6,435	31.5	D
Westbound US 101 e/o Crosby Blvd	Basic	4,862	42.6	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,884	55.9	F
Westbound US 101	Basic	3,601	26.1	D
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,539	28.5	C
Westbound US 101	Basic	2,714	28.6	D
Westbound US 101 Black Lake On-Ramp	Merge	3,158	25.0	C
Westbound US 101	Basic	3,407	34.6	D
Westbound US 101 Evergreen Off-Ramp	Diverge	3,345	32.2	D
Westbound US 101	Basic	2,875	27.3	D
Westbound US 101 Mud Bay Off-Ramp	Diverge	2,873	27.6	C
Westbound US 101	Basic	2,793	26.7	D
Westbound US 101 Mud Bay On-Ramp	Merge	3,152	24.4	C
Westbound US 101	Basic	3,412	33.9	D
Eastbound US 101	Basic	2,776	26.6	D
Eastbound US 101 Mud Bay Off-Ramp	Diverge	2,764	28.7	D
Eastbound US 101	Basic	2,451	23.5	C
Eastbound US 101 Mud Bay On-Ramp	Merge	2,480	14.8	B
Eastbound US 101	Basic	2,467	29.5	D
Eastbound US 101 Evergreen On-Ramp	Merge	3,203	30.7	D
Eastbound US 101	Basic	3,214	41.2	E
Eastbound US 101 Black Lake Off-Ramp	Diverge	3,142	42.9	E
Eastbound US 101	Basic	2,488	23.7	C
Eastbound US 101 Black Lake On-Ramp	Merge	4,234	22.2	C
Eastbound US 101	Basic	4,359	31.4	D
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	4,138	28.7	D
Eastbound US 101	Basic	3,961	26.2	D
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,929	38.6	E
Eastbound US 101	Basic	4,889	55.9	F

2030 Evergreen Interchange Scenario 7
PM Peak Freeway Density and LOS

Segment	Type	Volume (total)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Southbound I-5	Basic	4,703	79.1	F
Southbound I-5 to US 101 Weave	Weave	6,432	57.2	F
Southbound I-5	Basic	3,523	23.8	C
Southbound I-5 Deschutes Pkwy Off-Ramp	Diverge	3,475	20.7	C
Southbound I-5	Basic	3,328	23.1	C
Southbound I-5 US 101 On-Ramp	Merge	4,438	45.3	F
Southbound I-5	Basic	4,916	34.9	D
Northbound I-5	Basic	5,519	33.9	D
Northbound I-5 to US 101 Off-Ramp	Diverge	5,519	45.6	F
Northbound I-5	Basic	4,240	29.1	D
Northbound I-5 US 101 On-Ramp	Merge	7,201	117.5	F
Northbound I-5	Basic	7,330	39.9	E
Northbound I-5 Plum/14th Off-Ramp	Diverge	6,914	33.2	D
Northbound I-5	Basic	6,387	31.2	D
Westbound US 101 e/o Crosby Blvd	Basic	4,886	43.4	E
Westbound US 101 Crosby Blvd Off-Ramp	Diverge	4,915	54.3	F
Westbound US 101	Basic	3,624	26.4	D
Westbound US 101 Crosby Blvd/Black Lake Weave	Weave	3,478	23.9	B
Westbound US 101	Basic	2,903	30.9	D
Westbound US 101 Black Lake On-Ramp	Merge	3,525	31.0	D
Westbound US 101 Evergreen Off-Ramp	Weave	3,505	40.0	E
Westbound US 101	Basic	2,715	25.9	C
Westbound US 101 Evergreen On-Ramp	Merge	1,474	20.6	C
Westbound US 101	Basic	2,862	27.2	D
Westbound US 101 Mud Bay Off-Ramp	Diverge	2,842	27.4	C
Westbound US 101	Basic	2,759	26.4	D
Westbound US 101 Mud Bay On-Ramp	Merge	3,282	28.3	D
Westbound US 101	Basic	3,555	35.9	E
Eastbound US 101	Basic	2,776	26.5	D
Eastbound US 101 Mud Bay Off-Ramp	Diverge	2,764	28.4	D
Eastbound US 101	Basic	2,418	23.2	C
Eastbound US 101 Mud Bay On-Ramp	Merge	2,474	14.8	B
Eastbound US 101	Basic	2,479	24.9	C
Eastbound US 101 Evergreen Off-Ramp	Diverge	2,477	26.8	C
Eastbound US 101	Basic	2,442	24.1	C
Eastbound US 101 Evergreen On-Ramp	Merge	3,635	48.9	F
Eastbound US 101	Basic	3,489	45.7	F
Eastbound US 101 Black Lake Off-Ramp	Diverge	3,557	37.4	E
Eastbound US 101	Basic	2,968	27.9	D
Eastbound US 101 Black Lake On-Ramp	Merge	4,224	21.9	C
Eastbound US 101	Basic	4,333	32.7	D
Eastbound US 101 Crosby Blvd Off-Ramp	Diverge	4,154	33.2	D
Eastbound US 101	Basic	4,001	36.2	E
Eastbound US 101 Crosby Blvd On-Ramp	Merge	4,911	62.6	F
Eastbound US 101	Basic	4,854	67.6	F

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TECHNICAL MEMORANDUM 4

Date:	July 12, 2010
To:	George Kovich, WSDOT Randy Wessleman, City of Olympia
From:	Peter Chen
Subject:	West Olympia Access Study - Alternative Screening Evaluation and Concept Design Technical Memorandum 4
cc:	John Perlic, PE, Parametrix
Project Number:	554-1631-062
Project Name:	West Olympia Access Study

INTRODUCTION

Project Background and Work to Date

Need for Improvements

During the last 5 to 10 years, observed congestion along United States route 101 (US 101) and at local intersections in the West Olympia vicinity has resulted in the need to study the area and identify potential operating deficiencies and transportation facility improvements to improve access and mobility. With the aid of the Thurston Regional Planning Council (TRPC) and the cities of Olympia and Tumwater, existing and future traffic conditions were modeled to confirm operational challenges along the US 101 corridor and the local transportation system in West Olympia.

Short weave sections, frequent lane change maneuvers, and steep grades in some areas currently cause congestion along US 101 in the West Olympia vicinity during peak periods. Additionally, substantial traffic volume increases on US 101 and Interstate 5 (I-5) are expected to worsen congestion in the year 2030 and many sections of US 101 and I-5 are expected to experience unacceptable operating conditions if no improvements are implemented.

In addition to US 101 and I-5 mainline challenges, the local transportation systems in West Olympia and Tumwater are also forecasted to substantially degrade and experience long delays and queues in the year 2030. Of particular concern are the Black Lake Boulevard Single Point Urban Interchange (SPUI), Black Lake Boulevard SW/Cooper Point Road SW intersection, and the Cooper Point Road SW/Top Foods Driveway intersection. The traffic demand at these locations is estimated to substantially exceed capacity and the resulting queues are expected to create bottleneck traffic congestion along eastbound US 101 from the Black Lake off-ramp to west of the Evergreen Parkway interchange.

The high level of interdependency between the freeway and local transportation systems pointed to a need to study improvements to US 101 and local intersections in the cities of Olympia and Tumwater. Without improvements, connectivity between regional activity centers would substantially degrade, congestion could become a detriment to local economic activities, and collision rates and severity would likely increase.

Screening Process

The initial screening process is documented in Technical Memorandum 1, Evaluation and Screening Methods (WSDOT 2007). The first step of the initial screening process included reviewing suggestions during Phase I of the public involvement effort and conducting a fatal flaw analysis. The purpose of the fatal flaw analysis was to eliminate the options that did not meet the objectives of the study.

Based on the initial screening process, options that were selected for further consideration were packaged into scenarios to assess their effectiveness as a system. A more detailed traffic evaluation of the scenarios was conducted in the second screening process, which was documented in Technical Memorandum 2, Existing 2007 and Year 2030 No Build (Parametrix 2008a) and Technical Memorandum 3, Traffic Operations Analysis (Parametrix 2008b). The second screening process focused on reviewing traffic changes and identifying whether the scenarios would relieve traffic congestion at failing intersections and congested freeway locations.

Improvement Scenarios

The result of the initial screening process eliminated potential improvement options with fatal flaws and identified a set of reasonable scenarios (Scenarios 1 through 7) to be carried forward for further consideration. Since that time, the WSDOT and the City of Olympia expressed a desire to conduct an evaluation of an additional interchange improvement (Scenarios 8 and 9). All of these improvement scenarios consisted of:

- **No-Build (Scenario 1)** – The No-Build Scenario 1 accounted for various local and State projects indentified for construction and completion prior to 2030, but did not include any improvements to US 101 or the local transportation system directly related to the build scenarios.
- **Local System Only (Scenarios 2 and 3)** – These scenarios focus on changes to the local transportation system only and do not modify US 101 access. The difference between these scenarios is the inclusion of three street connections between existing roadway facilities in the southwest residential area of West Olympia, collectively referred to as the “Southwest Connections.” Scenario 2 does not include the Southwest Connections and Scenario 3 does include the Southwest Connections.
- **Black Lake Interchange (Scenarios 4 and 5)** – In addition to the improvements included in the Local System Only Scenarios 2 and 3, these scenarios also included modified access to US 101. The existing Black Lake interchange would be modified with an additional lane diverging from the westbound off-ramp that connects to Yauger Way SW, and another lane from Yauger Way SW would connect to the existing eastbound on-ramp prior to merging with the US 101 mainline. Scenario 4 does not include the Southwest Connections and Scenario 5 does include the Southwest Connections.
- **Evergreen Interchange (Scenarios 6 and 7)** – These scenarios also included the arterial network improvements included in the Local System Only Scenarios 2 and 3, but also modified access to US 101. These scenarios included straightening the existing eastbound on-ramp and westbound off-ramp such that both gore points with US 101 would be located further east. Bifurcated ramps to and from Kaiser Road SW would also be added that would connect to the re-aligned on- and off-ramps. Both relocated eastbound and westbound ramps would parallel US 101 under the Kaiser Road SW bridge. Scenario 6 does not include the Southwest Connections and Scenario 7 does include the Southwest Connections.
- **Hybrid Interchange (Scenarios 8 and 9)** – These scenarios are a hybrid of the Black Lake and Evergreen Interchange improvements. Similar to the Black Lake interchange scenarios, a second ramp would be constructed that diverges from the existing Black Lake westbound off-ramp and would connect to Yauger Way SW. Unlike the Black Lake interchange scenarios, this new ramp would continue

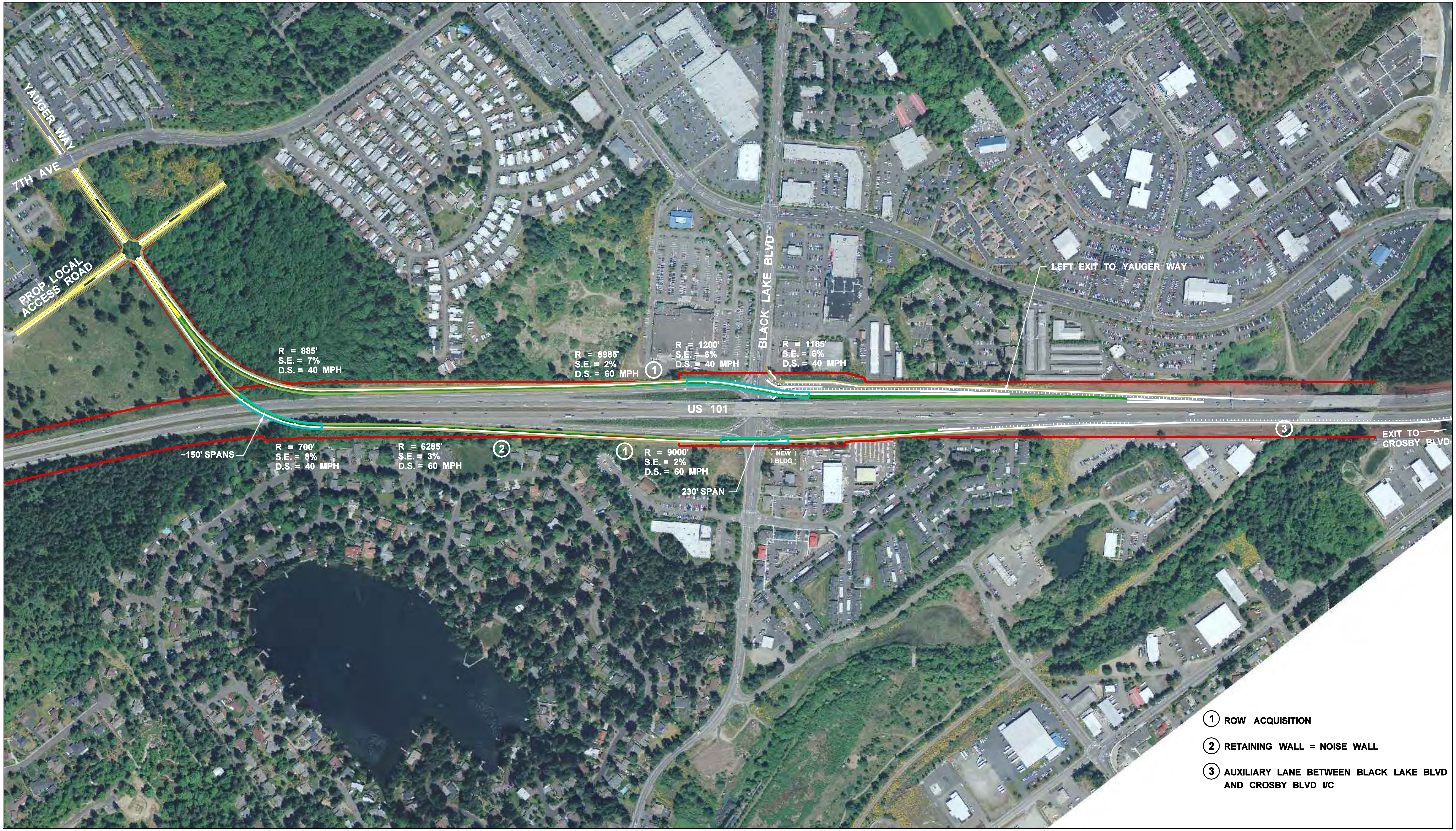
westbound and terminate at Kaiser Road. For the eastbound direction of US 101, an additional eastbound on-ramp from Kaiser Road would be constructed downstream of the existing on-ramp from Evergreen, which would also be straightened and connect to US 101 further east of its current location. The arterial network improvements included in the Local System Only Scenarios 2 and 3 would also be included in the Hybrid Interchange scenarios. Scenario 8 does not include the Southwest Connections and Scenario 9 does include the Southwest Connections.

The Black Lake, Evergreen, and Hybrid interchange configurations are shown on Figures 1, 2, 3a, and 3b.

The traffic analyses for Scenarios 1 through 7 are detailed in Technical Memorandum 2 (Parametrix 2008a) and Technical Memorandum 3 (Parametrix 2008b) and the operational analyses for Scenarios 8 and 9 are provided as an appendix to this technical memorandum. Recommendations from these Technical Memorandums were based on the freeway and local system operations.

Since freeway operations are comparable for all build scenarios, the recommendations place more emphasis on the local system operations. The local system operations (1-hour analysis) for the build scenarios are summarized in Table 1.

Text descriptions and conclusions in this technical memorandum are based on the 1-hour analysis described in Table 1. The City of Olympia uses a slightly different methodology for calculating LOS for concurrency purposes that uses 2 hour peak period volumes. Using the City of Olympia's methodology, the local system operations (2-hour analysis) for the build scenarios are summarized in Table 2.



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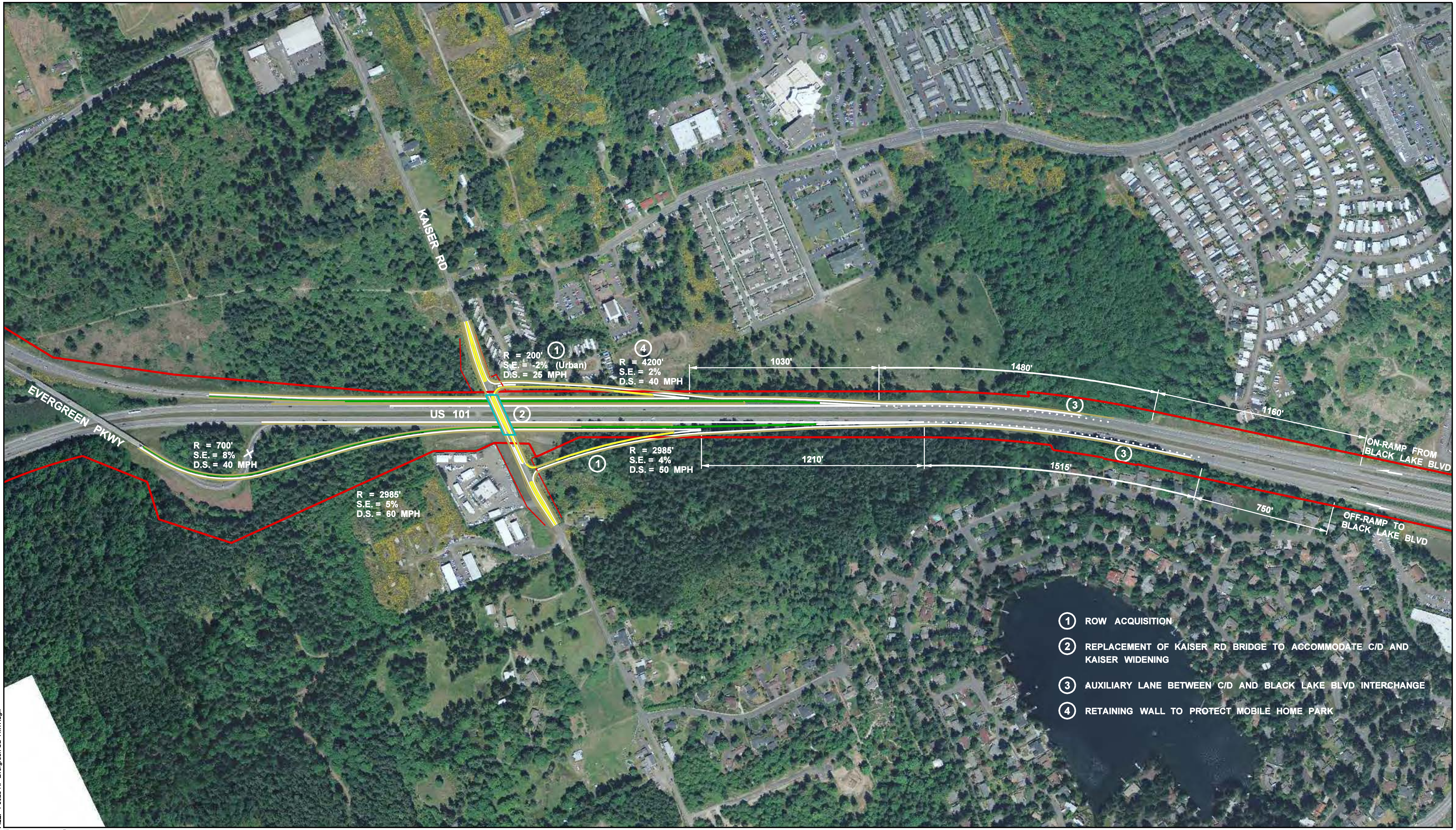
0 500'
SCALE IN FEET

West Olympia Access Study
EB: C/D Outside Black Lake Blvd Interchange Ramps
WB: C/D Braid Over Black Lake Blvd

Figure 1
Black Lake Interchange



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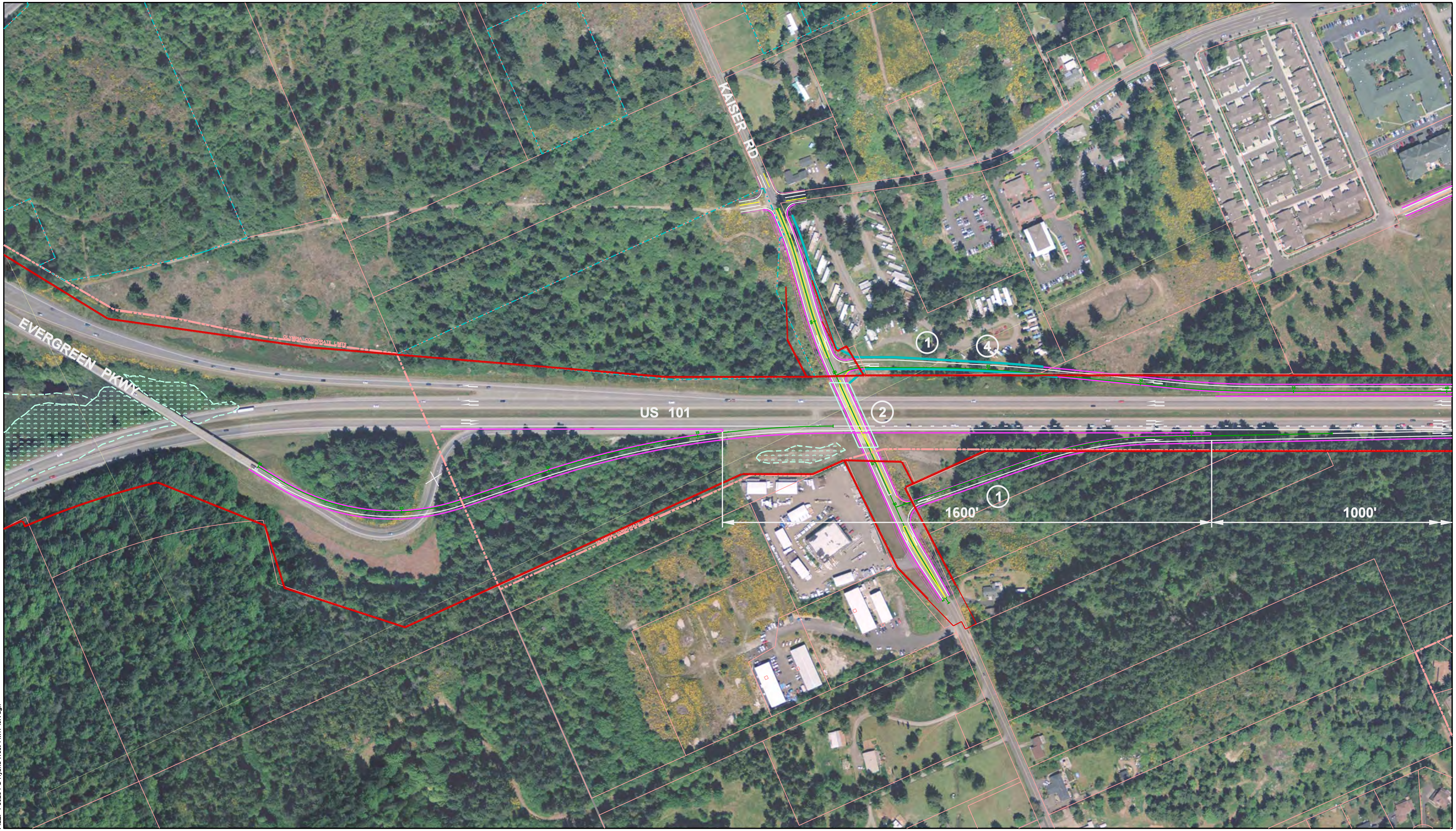
West Olympia Access Study
EB: C/D for On-Ramps from Evergreen Pkwy and Kaiser Rd
WB: C/D for Off-Ramps to Kaiser Rd and Evergreen Pkwy

Figure 2
Evergreen Interchange



FILE: P8028-FG-Hybrid West 11x17 UR.dgn

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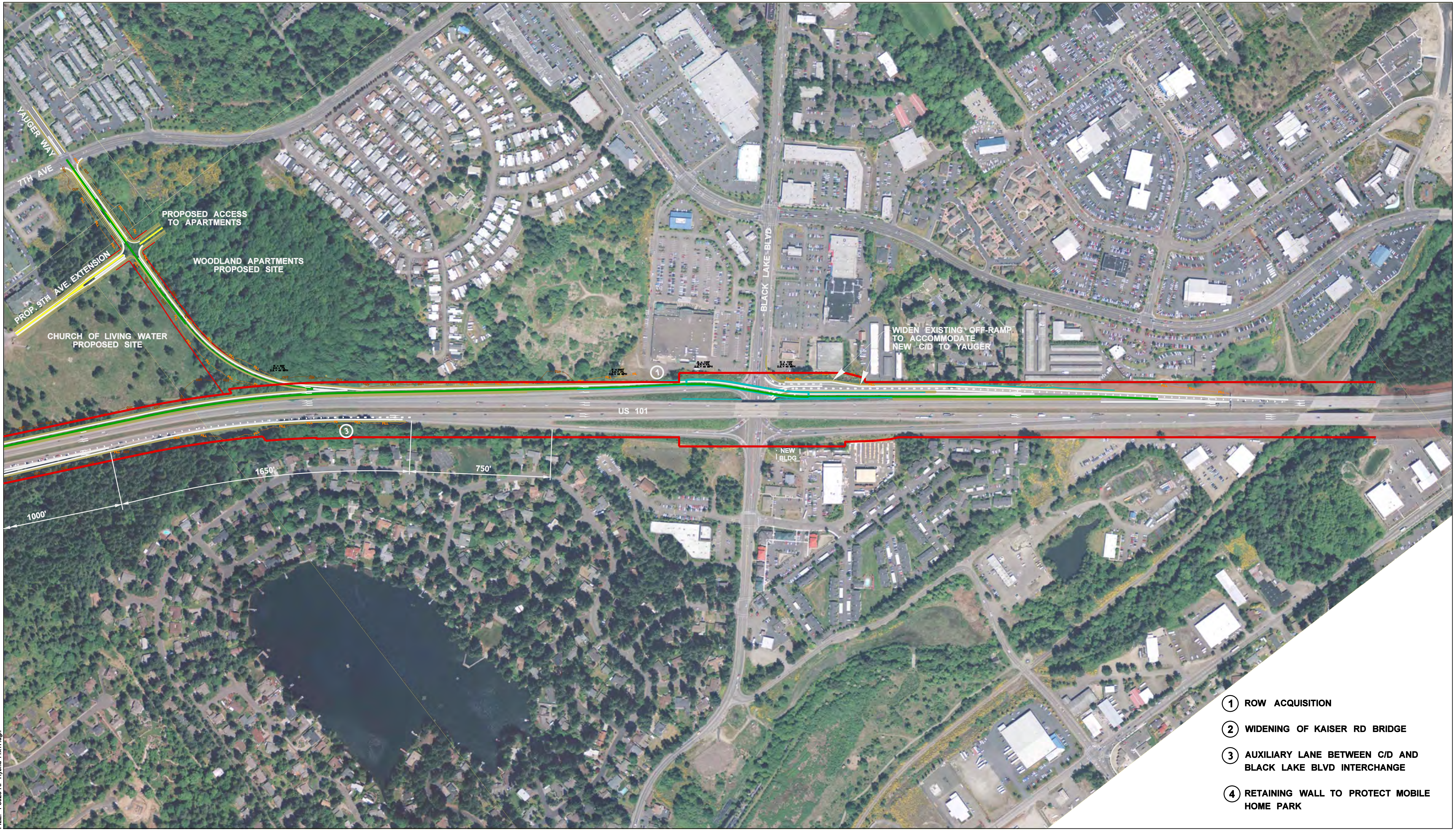
West Olympia Access Study
EB: On-ramps from Evergreen Pkwy and Kaiser Rd
WB: C/D Braid Over Black Lake Blvd Interchange Ramps
C/D Off-ramps to Kaiser Rd and Yauger Way

Figure 3a
Hybrid Interchange (West)



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0 500'
SCALE IN FEET

West Olympia Access Study
EB: On-ramps from Evergreen Pkwy and Kaiser Rd
WB: C/D Braid Over Black Lake Blvd Interchange Ramps
C/D Off-ramps to Kaiser Rd and Yauger Way

Figure 3b
Hybrid Interchange (East)

Table 1. Summary of 2030 PM Peak Hour Local System Operations (1-Hour Analysis)

LOS Range	No-Build Scenario 1	Local System Only Scenario 2	Local System Only Scenario 3	Black Lake Interchange Scenario 4	Black Lake Interchange Scenario 5	Evergreen Interchange Scenario 6	Evergreen Interchange Scenario 7	Hybrid Interchange Scenario 8	Hybrid Interchange Scenario 9
Full Scope [1]									
LOS A, B, C	8	11	9	12	13	11	12	NA	NA
LOS D or E	3	9	11	8	11	9	10	NA	NA
LOS F	13	4	4	4	0	4	2	NA	NA
Reduced Scope [2]									
LOS A, B, C	1	1	1	2	2	1	1	2	2
LOS D or E	0	4	5	4	7	5	7	5	7
LOS F	8	4	3	3	0	3	1	2	0

[1] The original scope analyzed a total of 24 local intersections.

2 The scope of the Hybrid interchange scenarios was reduced to analyze 9 key intersections that were consistent with the original scope. The Kaiser Rd SW/7th Ave SW intersection was also added and would operate at LOS D for both Scenarios 8 and 9.

Table 2. Summary of 2030 PM Peak Local System Operations (2-Hour Analysis)

LOS Range	No-Build Scenario 1	Local System Only Scenario 2	Local System Only Scenario 3	Black Lake Interchange Scenario 4	Black Lake Interchange Scenario 5	Evergreen Interchange Scenario 6	Evergreen Interchange Scenario 7	Hybrid Interchange Scenario 8	Hybrid Interchange Scenario 9
Full Scope [1]									
LOS A, B, C	8	12	12	12	14	13	16	NA	NA
LOS D or E	5	10	10	10	10	9	8	NA	NA
LOS F	11	2	2	2	0	2	0	NA	NA
Reduced Scope [2]									
LOS A, B, C	1	2	2	2	2	2	2	1	1
LOS D or E	2	5	5	5	7	5	7	7	8
LOS F	6	2	2	2	0	2	0	1	0

[1] The original scope analyzed a total of 24 local intersections.

[2] The scope of the Hybrid interchange scenarios was reduced to analyze 9 key intersections that were consistent with the original scope. The Kaiser Rd SW/7th Ave SW intersection was also added and would operate at LOS C and LOS D for Scenarios 8 and 9, respectively.

NOTE: As described above, the 2-hour analysis presented here is for the City of Olympia, which uses a different methodology to calculate LOS for concurrency purposes. The text and conclusions in this report are based on 1-hour analyses.

The local system analysis for the Hybrid Interchange scenarios was based on a scope that reduced the number of arterial intersections analyzed. As a result, including the local operations for the Hybrid Interchange scenarios in the above list or when discussing the total number of local intersection improvements is an inappropriate comparison. However, comparisons among all scenarios are made when appropriate.

The number of local intersection improvements is important to consider when identifying recommendations because land uses at the intersections needing improvements are generally built out and construction of the improvements would require property acquisition for right-of-way. Full or partial displacement of existing uses substantially increase project costs, lengthens project schedules, and can be more difficult to implement. Additionally, increasing the number of turn lanes at intersections also increases pedestrian crossing times, which is less conducive to a pedestrian-friendly environment and inconsistent with the City of Olympia's Comprehensive Plan. Compared to the Local System Only scenarios, Black Lake Scenario 5 and Evergreen Scenario 7 require the least amount of local intersection improvements. For the limited scope of the Hybrid interchange analysis, all interchange improvement scenarios require the same number of turn lanes, but the Hybrid interchange requires one additional signal at the Capital Mall Drive/Yauger Way intersection.

Local intersections that form the "Triangle" and Black Lake SPUI coordinated system are of paramount importance. When these key intersections are mitigated to their LOS standards, the Black Lake and Hybrid interchange scenarios operate approximately the same and provide the most congestion relief. However, the Black Lake scenario requires one less turn lane improvement compared to the Evergreen and Hybrid interchange scenarios. If this turn lane is added, then the Black Lake interchange provides the best congestion relief.

Black Lake Scenarios 4 and 5, and to a lesser degree the Hybrid Scenarios 8 and 9, also provide important travel time and accessibility benefits to the Capital Medical Center by providing a direct route to and from US 101 for emergency vehicles, avoiding the highly congested Black Lake Boulevard and Cooper Point Road corridors. In a similar fashion, the Black Lake and Hybrid Scenarios also provide an important secondary route to and from Capital Mall and surrounding retail businesses during peak holiday shopping weekends and seasons. A holiday season peak period traffic analysis was not specifically conducted; however, the new ramp connection to and from Yauger Way would likely improve safety and reduce vehicle queues and congestion that oftentimes extends into the US 101 mainline during these peak shopping days.

Based on this information, the two initial study recommendations and reasons for the recommendations were:

1. Eliminate Local System Only Scenarios 2 and 3 from further consideration
    - Local system impacts are substantially higher than other build scenarios
    - There is no traffic volume reduction at the highly congested US 101/Black Lake Boulevard SPUI and Black Lake Boulevard/Cooper Point Road intersections
    - With feasible improvements only, several intersections operate at unacceptable LOS E or F conditions with high delay at US 101/Black Lake Boulevard SPUI, Black Lake Boulevard/Cooper Point Road and three to four other intersections
    - There is no accessibility or travel time benefit to Capital Medical Center and other key locations compared to other build scenarios
    - There is no benefit during holiday shopping time periods compared to other build scenarios

2. Conduct further evaluation of the interchange scenarios
    - Concept design, accident/safety analysis, and an environmental screening evaluation to provide more detailed information to select a preferred interchange alternative
    - Prepare an Interchange Justification Report (IJR) and NEPA/SEPA environmental document

From these recommendations, the interchange improvement scenarios have been evaluated with respect to five evaluation criteria and are described below.

Purpose

Previous efforts have eliminated potential improvement options based on fatal flaws and analyzed several improvement scenarios from the traffic operations perspective. The purpose of this Technical Memorandum 4 is to build on the conclusions and recommendations of the previous traffic operations analyses and evaluate the Black Lake, Evergreen, and Hybrid interchange improvement scenarios with respect to other factors that should be taken into consideration during the decision-making process. This “second-level” screening analysis will become part of subsequent environmental review and documentation to comply with NEPA and SEPA for a preferred alternative.

SCREENING CRITERIA DESCRIPTIONS

The WSDOT has identified five screening criteria, each with two or more elements, to assess the relative advantages and disadvantages of the interchange improvements. Table 3 summarizes the five screening criteria, and their elements and measurements for evaluation.

The scoring system for these five screening criteria is shown in Table 4.

Table 3. Screening Criteria

Element	Evaluation Measurement
Criterion 1: Built Environmental Impacts	
Disruptions and Displacements How many commercial and residential properties will be displaced?	Quantitative estimate of the net number of properties adversely affected and an initial assessment of full or partial acquisitions.
Right-of-Way How much additional ROW is required?	Quantitative estimate of the additional right-of-way required.
Criterion 2: Natural Environmental Impacts	
Wetlands/Shorelines How will implementation of an option impact known wetland resources?	Planning-level estimate of impact and quality of impacted wetlands and/or buffers.
Water Resources (Stormwater) What are the impacts on surface and groundwater?	Quantitative estimate of additional impervious surface. Planning-level estimate of impact and quality of impacted water basins.
Criterion 3: Constructibility	
Constructibility How easy and lengthy would it be to implement the option during construction?	Qualitative judgments based on the potential overall construction schedule, impacts to traffic operations, ability to sequence and phase project delivery, etc.
Probable Construction Cost How much to build the full project?	Probable construction cost estimate based on INROADS footprint cut/fill volumes and typical markups for similar projects.
Criterion 4: Safety	
Compatibility with Freeway Safety How does the option impact safety on the freeway?	The projected number of congested conflict zones (ramp merge and diverge segments) as a function of Level of Service (LOS).
Compatibility with Local Street Safety How does the option impact safety on the local streets?	Impact on key intersections based on number of collisions per year as a function of traffic volumes.
Ability to Meet Design Standards How well does the option adhere to WSDOT design standards?	Nominal safety is examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures.
Criterion 5: Transportation Benefits	
Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) How does the option affect distribution of vehicle trips within the local transportation system?	This will show the daily amount of vehicle travel and the total daily hours of travel for vehicles on the study area road system. VMT and VHT are an output of the travel forecasting model.
Compatibility with Freeway Operations How does the option impact the freeway mainline?	The projected number of poorly operating mainline segments. For this evaluation, "poorly operating" is defined by the number of mainline and ramp segments operating at Level of Service "LOS = D, E, or F" and mainline travel speeds.
Compatibility with Local System Operations How does the option impact key local intersections?	Based on the potential for increases or decreases in LOS at key intersection ("Triangle" + Black Lake SPUI intersections)

Table 4. Scoring System Descriptions

Qualitative Description	Score	Description
Worst	1	Most impact or no benefit
	2	High impact or low benefit
	3	Moderate impact or benefit
	4	Low impact or high benefit
Best	5	No impact or highest benefit

SCREENING CRITERIA EVALUATIONS

This section describes the potential impacts and benefits of the interchange scenarios and then provides a quantitative scoring of each interchange.

Criterion 1: Built Environmental Impacts

The Built Environmental Impacts are composed of two elements: Disruptions and Displacements and Right-of-Way.

Disruptions and Displacements

The Black Lake interchange improvements would add new ramps to Yauger Way from the existing ramps connecting to Black Lake Boulevard. A portion of these new ramps would be located in existing WSDOT right-of-way, while the other portion would extend over undeveloped areas. No business or residential displacements are expected.

Most of the Evergreen interchange improvements would occur within existing WSDOT right-of-way or in undeveloped areas. However, Kaiser Road would need to be widened at its intersection with the US 101 westbound ramps and three mobile homes may need to be relocated in the northeast quadrant of the interchange. No commercial displacements are expected.

Similar to the Black Lake interchange, the Hybrid interchange improvements would add a new westbound ramp to Yauger Way that would primarily be located within existing WSDOT right-of-way and undeveloped areas and would not require any displacements. However, the Hybrid interchange improvements also include a westbound ramp to Kaiser Road, which could displace three mobile homes, similar to the Evergreen interchange scenarios.

None of the interchange improvements are expected to result in commercial displacements. The Evergreen and Hybrid interchange improvements could require three residential displacements, but these residences could be relocated within the same mobile home park. Nonetheless, the Evergreen and Hybrid interchange improvements receive a lower (worse) score with respect to disruptions and displacements.

Right-Of-Way

The right-of-way estimates described below for the interchange improvements do not include stormwater needs.

Although the Black Lake interchange improvements would not require displacements, approximately 147,000 square feet (3.4 acres) of right-of-way would be required and some property acquisition (partial takes) would be needed. Of the 147,000 square feet of right-of-way needed:

- 129,000 square feet is from vacant land (undeveloped),
- 15,700 square feet is from commercial land (15,000 square feet from Top Foods and 700 square feet from a lumber distribution facility), and
- 2,300 square feet is from an apartment complex.

The Evergreen interchange improvements would require roughly 240,000 square feet of right-of-way and potential displacement of three mobile homes (see Disruptions and Displacements section above). Of the 240,000 square feet (5.5 acres) of right-of-way needed:

- 199,000 square feet is from vacant land (undeveloped), and
- 41,000 square feet is from residential properties along Kaiser Road and would result in the displacement of three mobile homes.

The Hybrid interchange improvements would require roughly 310,000 square feet of right-of-way and potentially displace three mobile homes. Of the 310,000 square feet (7.1 acres) of right-of-way needed:

- 269,000 square feet is from vacant land (undeveloped), and
- 41,000 square feet is from residential properties along Kaiser Road and would result in the displacement of three mobile homes.

The Black Lake interchange improvements require less acquisition area compared to the Evergreen and Hybrid improvements, but the areas needed from platted developments and existing commercial properties is higher. Although the Hybrid interchange requires the most right-of-way, the additional area is in vacant (undeveloped) land. As a result, all interchange scenarios were equally rated as having moderate impacts for the right-of-way criterion.

Criterion 2: Natural Environmental Impacts

The Natural Environmental Impacts are composed of two elements: Wetlands/Shorelines and Water Resources (Stormwater).

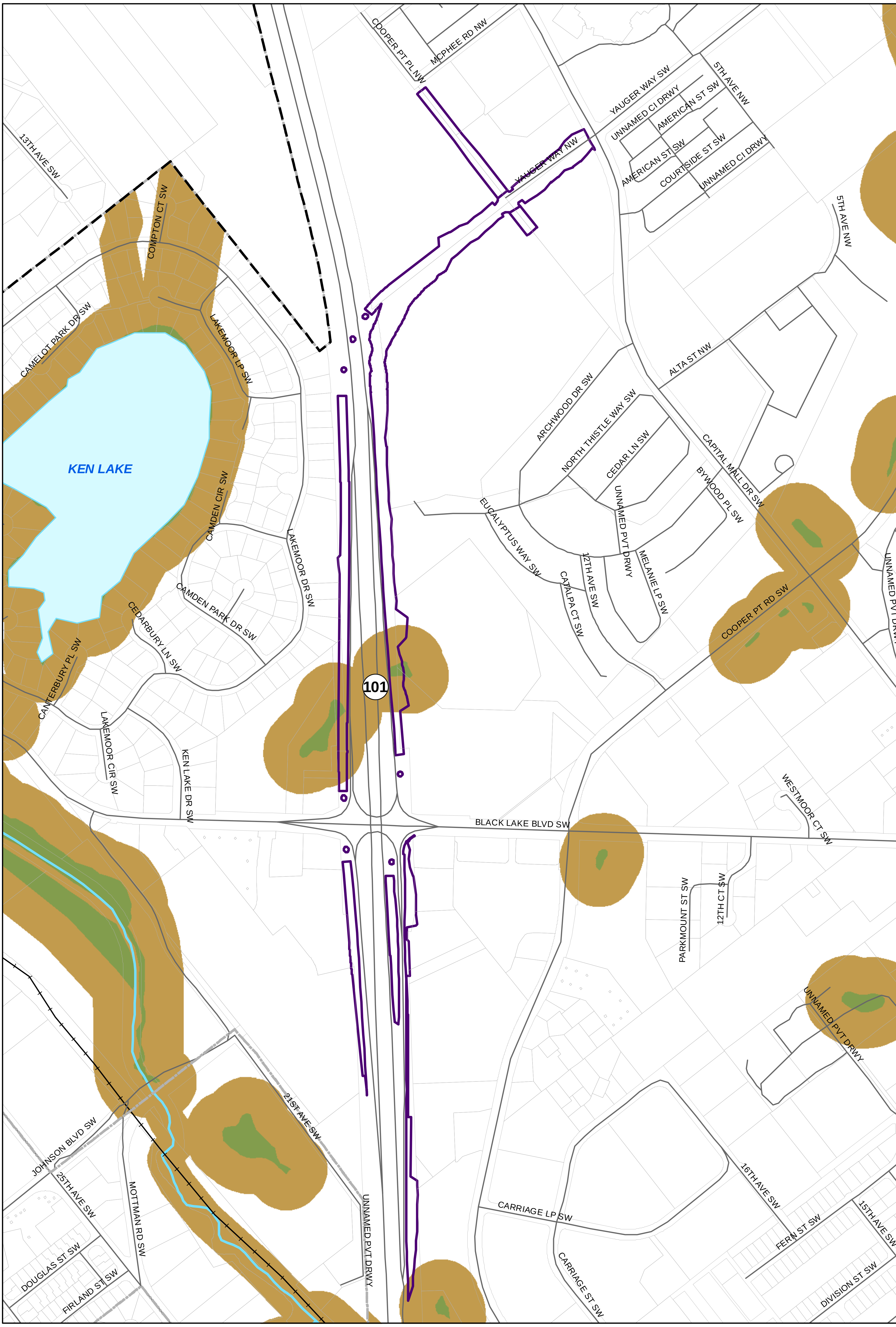
Wetlands/Shorelines

Three relatively small palustrine forested (PFO) wetlands exist near the Black Lake interchange; one to the north side of the westbound on-ramp, one on the south side of the eastbound off-ramp, and one near the westbound off-ramp near the gore point. Construction of the Black Lake interchange improvements would impact a total of 0.2 acres of wetlands and a total of 1.5 acres of wetland buffers. These wetland and buffer impacts are shown on Figure 4.

One palustrine emergent (PEM) wetland occurs on the south side of US 101 in the vicinity of Kaiser Road and the associated buffer extends to the north and south sides of US 101. Construction of the Evergreen interchange improvements would impact a total of 0.1 acres of wetlands and a total of 2.4 acres of wetland buffers. These wetland and buffer impacts are shown on Figure 5.

Since the Hybrid interchange improvements are similar to the Black Lake and Evergreen interchanges, the impacts would be similar to those described above except that the Hybrid interchange would impact only 2.0 buffer acres compared to 2.4 buffer acres under the Evergreen interchange. The Hybrid interchange would impact a total of 0.1 acres of wetlands and a total of 2.0 acres of wetland buffers, which are shown on Figure 6.

Because the total acreage of wetlands and buffer areas are similar among all three interchange scenarios, each scenario received the same score of “moderate impact.”



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Yauger Critical Area Buffer Impacts

- Yauger Wetland Impacts
- Yauger Buffer Impacts
- Wetland
- Buffer
- Yauger Alignment
- Parcels
- Streams
- Waterbody
- Railroads
- Roads
- City Boundary
- UGA Boundary

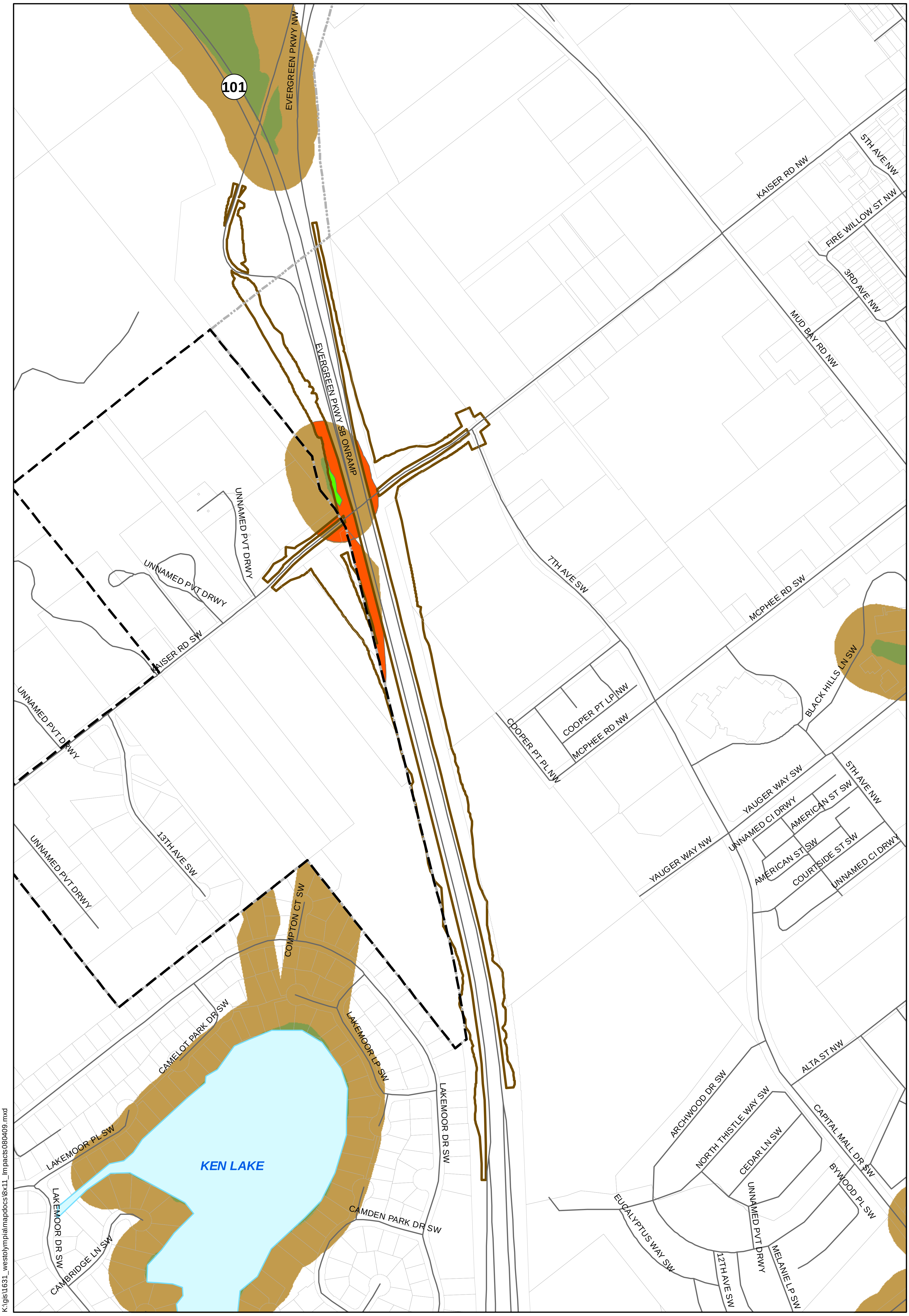
N

0 500

Scale in Feet

Note: The data displayed on this map are critical area indicators only. Critical areas have not been field verified.
Data Sources: Thurston Regional Planning Council, Thurston County

Figure 4
Black Lake Interchange Wetland and Buffer Impacts



Parametrix

Evergreen Critical Area Buffer Impacts

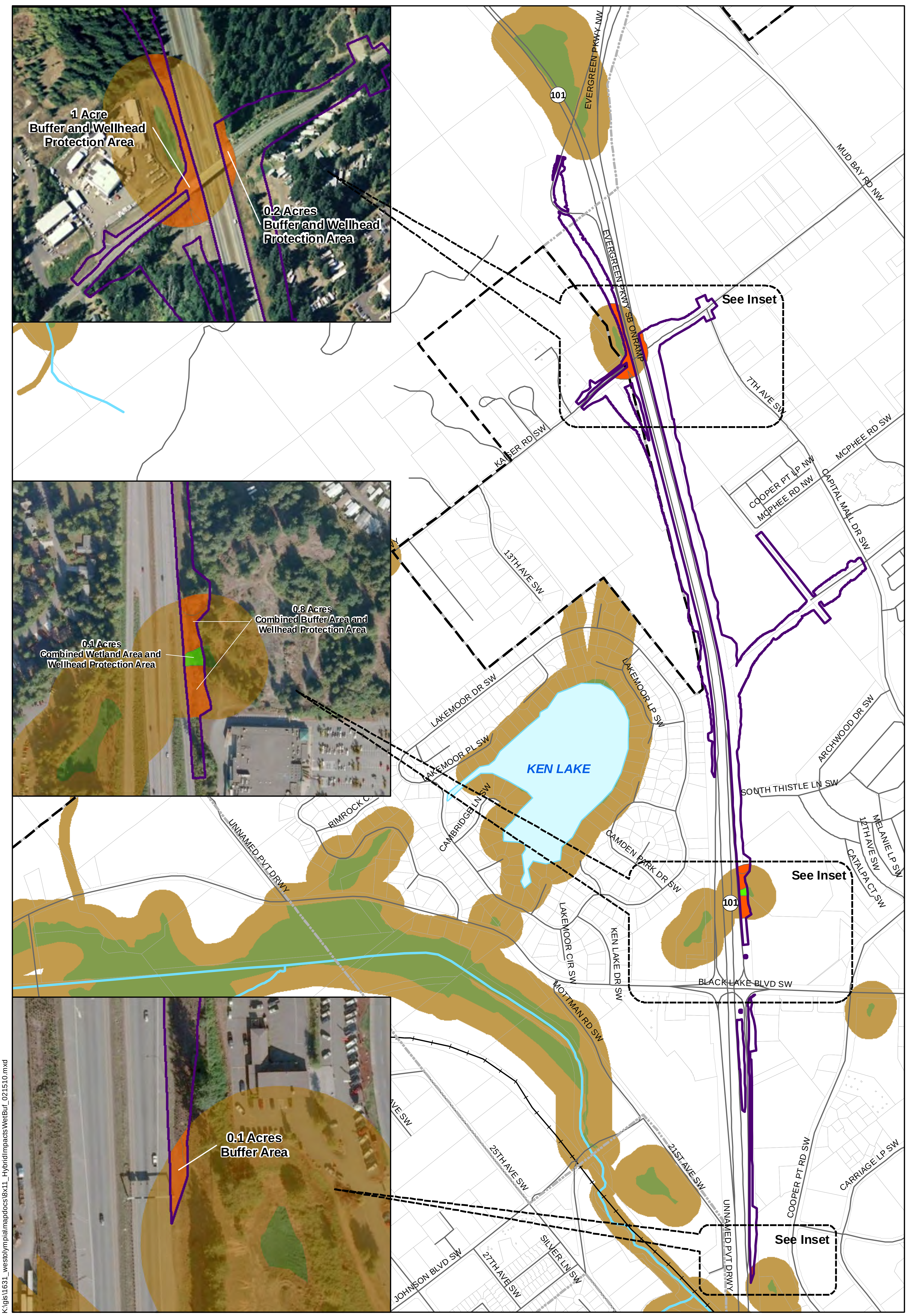
- Evergreen Wetland Impacts
- Evergreen Buffer Impacts
- Wetland
- Buffer
- Evergreen Alignment
- Parcels
- Streams
- Waterbody
- Railroads
- Roads
- City Boundary
- UGA Boundary

N

0 500
Scale in Feet

Note: The data displayed on this map are critical area indicators only. Critical areas have not been field verified.
Data Sources: Thurston Regional Planning Council, Thurston County

Figure 5
Evergreen Interchange
Wetland and Buffer Impacts



Note: The data displayed on this map are critical area indicators only. Critical areas have not been field verified.
Data Sources: Thurston Regional Planning Council, Thurston County

Figure 6
Hybrid Interchange
Wetland and Buffer Impacts

Water Resources (Stormwater)

The Allison Springs Wells 13 and 19 are located south of Mud Bay Road NW and west of Delphi Road SW. These wells would be affected by all three interchange improvements.

The Black Lake interchange improvements are located within the 10-year Allison Springs wellhead protection area. If the new Yauger Way ramps are constructed, approximately 11.7 acres would be impacted. Figure 7 shows the impacted areas associated with the Black Lake improvements.

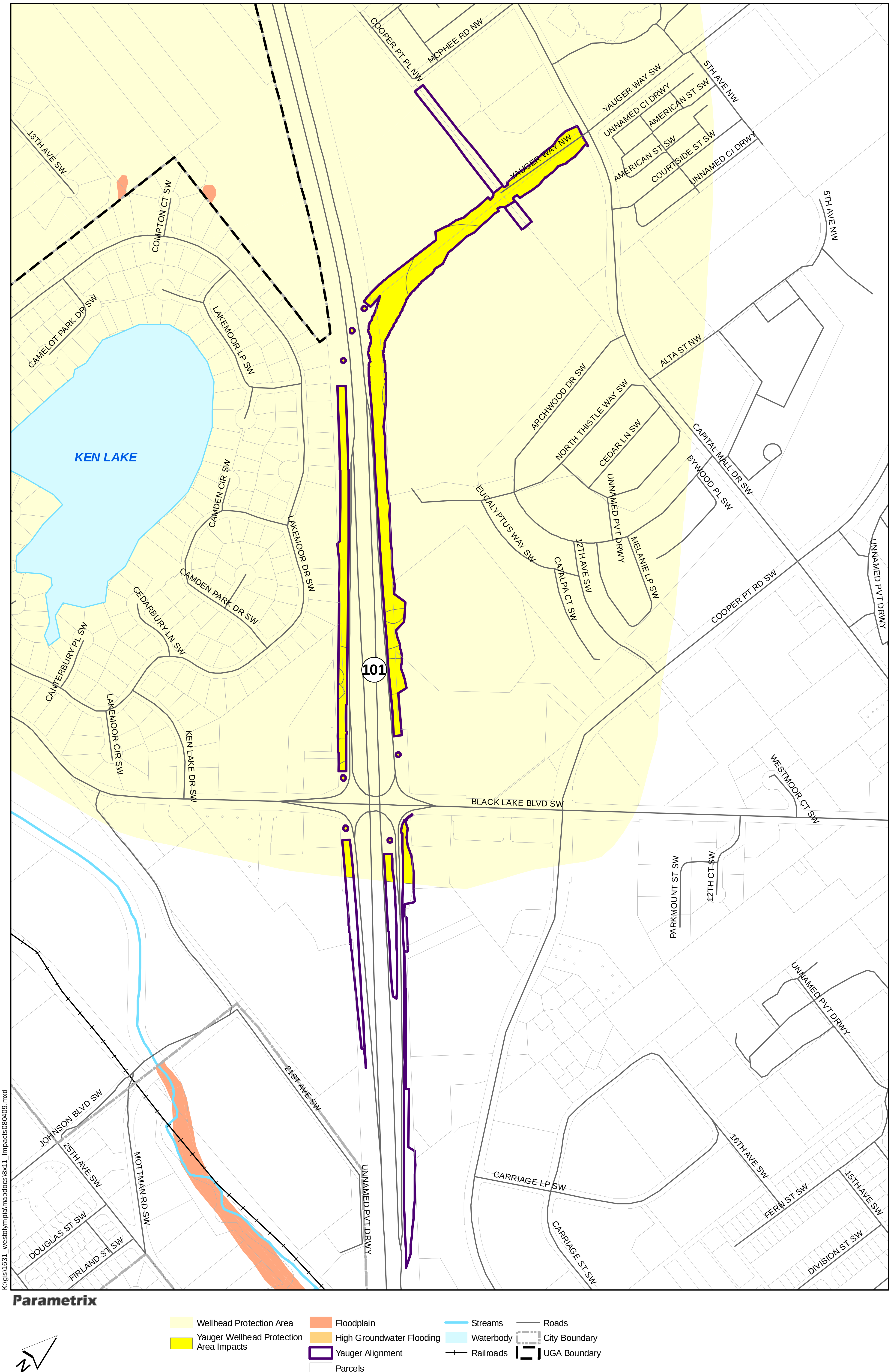
As shown in Figure 8, improvements at the Evergreen interchange would also impact the Allison Springs wellhead protection area for Wells 13 and 19. However, since the Evergreen improvements are much closer to these wells, a total of 21.4 acres would be impacted, consisting of:

- 0.1 acres in the 1-year wellhead protection area,
- 18.2 acres in the 5-year wellhead protection area, and
- 3.1 acres in the 10-year wellhead protection area.

The Hybrid interchange improvements, shown on Figure 9, would be similar to the combined impacts associated with the Black Lake and Evergreen interchange improvements. A total of 30.8 acres would be impacted, consisting of:

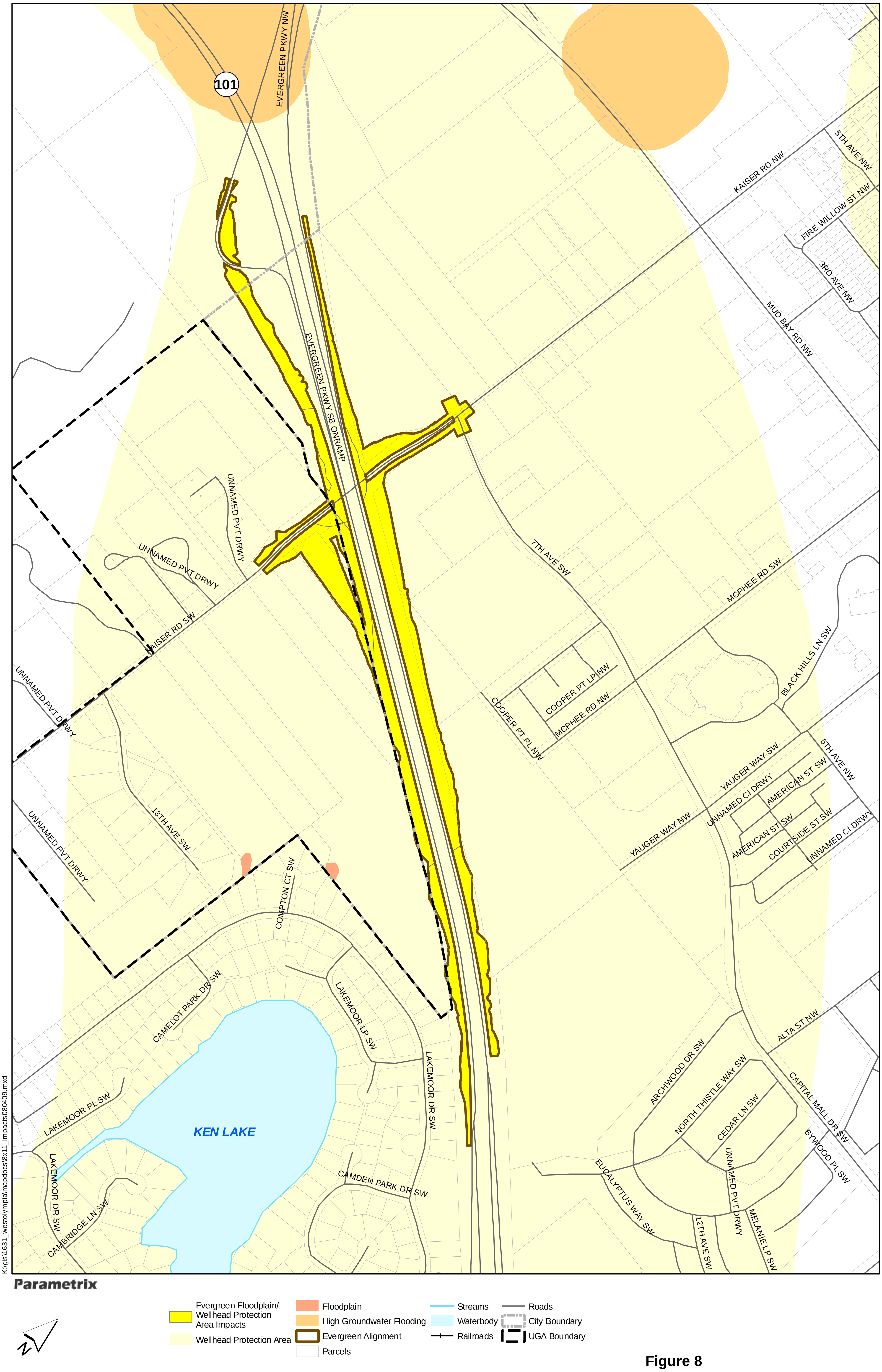
- 16.8 acres in the 5-year wellhead protection area, and
- 14.1 acres in the 10-year wellhead protection area.

The total wellhead protection area acreage impacted by the Black Lake improvements is less than the Evergreen and Hybrid interchange impacts (11.7 acres compared to 21.4 acres and 30.8 acres). Additionally, while the Black Lake interchange improvement impacts on the wellhead protection area are all within the 10-year travel time zone, the majority of impacts associated with the Evergreen (18.2 of 21.4 acres) and Hybrid (16.8 of 30.8 acres) interchange improvements are within the 5-year travel time zone. As a result, the Black Lake interchange received a “low impact” rating compared to a “high impact” rating for the Evergreen interchange and “most impact” rating for the Hybrid Interchange.



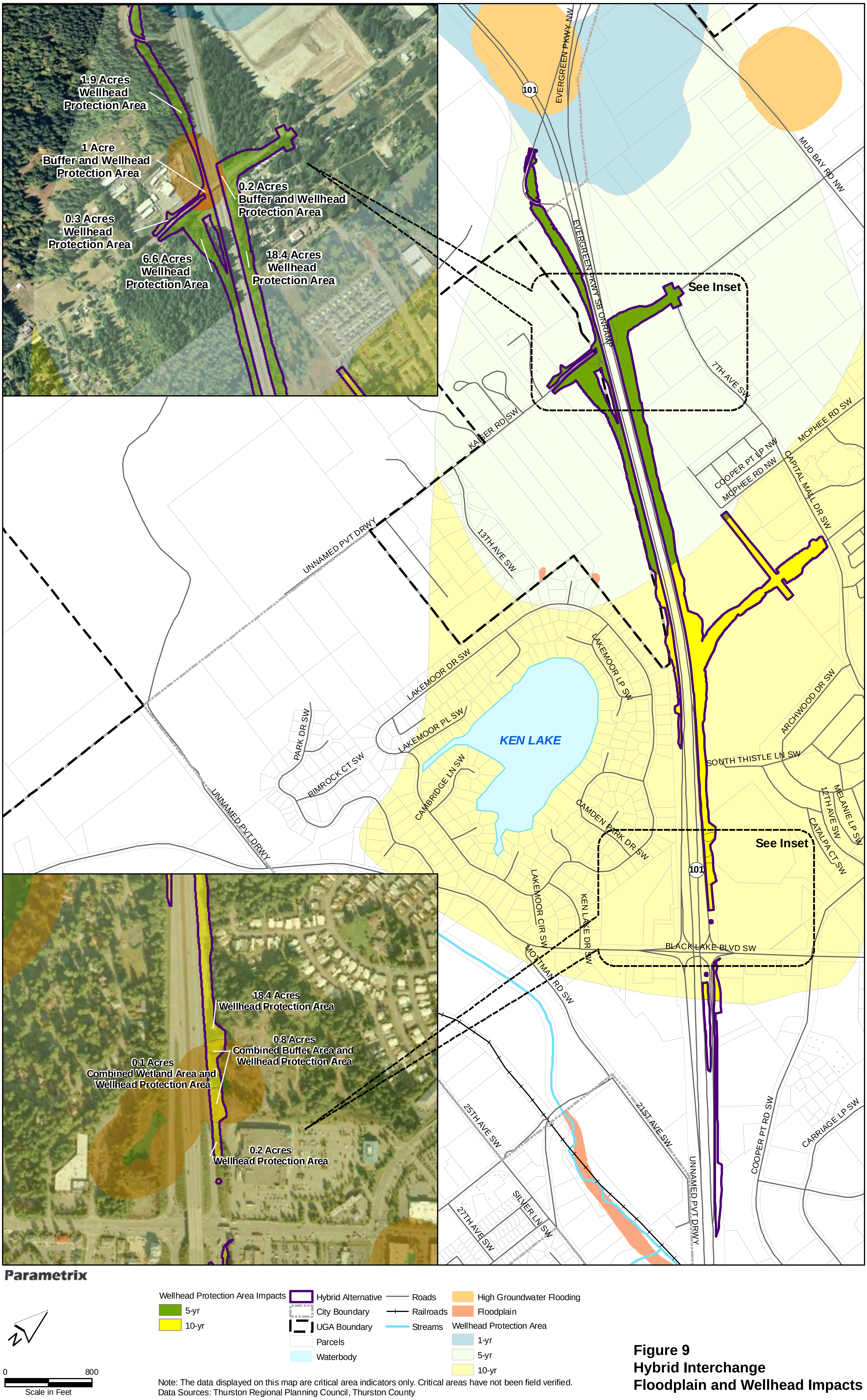
Note: The data displayed on this map are critical area indicators only. Critical areas have not been field verified.
Data Sources: Thurston Regional Planning Council, Thurston County

Figure 7
Black Lake Interchange
Floodplain and Wellhead Impacts



Note: The data displayed on this map are critical areas indicators only. Critical areas have not been field verified.
Data Sources: Thurston Regional Planning Council, Thurston County

Figure 8
Evergreen Interchange
Floodplain and Wellhead Impacts



Note: The data displayed on this map are critical area indicators only. Critical areas have not been field verified.
Data Sources: Thurston Regional Planning Council, Thurston County

Figure 9
Hybrid Interchange
Floodplain and Wellhead Impacts

Criterion 3: Constructibility

The Constructibility criterion is composed of two elements: Constructibility and Probable Construction Cost.

Constructibility

Constructibility challenges associated with the Black Lake interchange improvements are relatively high:

- Disruptions to traffic operations along Black Lake Boulevard, US 101 westbound off-ramp, and eastbound on-ramp during construction of bridge overcrossings, collector/distributor ramps, and revised ramp connections to mainline. However, most work can be staged to minimize roadway or lane closures.
- The Yauger Way extension and collector/distributor ramps west of Black Lake can be constructed with minimal disruption to existing roadways.

Constructibility challenges associated with the Evergreen interchange improvements are relatively low:

- Disruption to Kaiser Road traffic operations during bridge reconstruction.
- Occasional shoulder and outside lane closure on US 101 during construction of auxiliary lanes between Kaiser Road and Black Lake interchange.
- Collector/distributor ramps can be constructed without disruption to US 101.

Constructibility challenges associated with the Hybrid interchange improvements are relatively moderate:

- Disruptions to traffic operations along Black Lake Boulevard, US 101 westbound off-ramp, bifurcated ramps, and revised ramp connections to mainline.
- The Yauger Way extension and collector/distributor ramps west of Black Lake can be constructed with minimal disruption to existing roadways.
- Disruption to Kaiser Road traffic operations during bridge reconstruction.
- Occasional shoulder and outside lane closure on US 101 during construction of auxiliary lanes between Kaiser Road and Black Lake interchange.

The constructibility challenges with the Black Lake interchange improvements are considered higher (worse) than the Hybrid and Evergreen interchange improvements as a result of the magnitude of improvements and high traffic volumes that are expected to result in higher construction delays. Therefore, the Black Lake interchange received a “high impact” constructibility rating compared to a “moderate impact” rating for the Hybrid interchange and “low impact” rating for the Evergreen interchange.

Probable Construction Cost

Planning level conceptual cost estimates were prepared using information from the conceptual designs for each alternative. These planning level cost estimates only account for the construction costs and excludes the following items:

- Right-of-way
- Wetland mitigation and environmental permitting
- Preliminary engineering costs
- Risk and inflation factors

The cost estimates were based on conceptual design alignments, channelization, profiles, and rough earthwork generated in INROADS. Specific bid items were consolidated into generalized items due to the conceptual design level at this stage of the project. The unit prices for most of these generalized items are based on square footage costs calculated from the 30 percent PS&E construction cost estimate for the SR 522 Snohomish River Bridge to US 2 Project. The calculated square footage cost for each generalized item was multiplied by the new pavement area to yield the total item cost. Costs per cubic yard, ton, and linear foot are based on general knowledge of recent bid costs.

The planning level conceptual cost estimates totaled $86,268,000 for Black Lake interchange, $34,419,000 for Evergreen, and $84,762,000 for the Hybrid interchange. Tables 5, 6, and 7 summarize the cost estimates and Appendix A provides a more detailed breakdown.

Table 5. Black Lake Interchange Cost Estimate ($2009)

	Westbound Collector / Distributor Ramp	Eastbound Collector / Distributor Ramp	Yauger Way	Total Base Cost
Area (SF)	146,000	126,000	73,000	
Preparation and Grading	$1,336,120	$1,570,620	$688,760	$3,595,500
Structures	$10,770,500	$18,614,500	$0	$29,385,000
Surfacing and Paving	$1,065,800	$919,800	$532,900	$2,518,500
Roadside Development and Drainage	$2,851,000	$2,331,000	$1,510,500	$6,692,500
Traffic Services and Safety	$2,073,000	$2,090,500	$1,978,500	$6,142,000
Subtotal	$18,096,420	$25,526,420	$4,710,660	$48,333,500
Other Items [1]	$14,202,926	$20,034,926	$3,698,198	$37,934,050
Total	$32,299,000	$45,561,000	$8,409,000	**$86,268,000**

[1] Includes allowance for Miscellaneous Bid Items, Mobilization, Sales Tax (8.5%), Contingencies during construction, and Construction Engineering.

Table 6. Evergreen Interchange Cost Estimate ($2009)

	Evergreen EB ramp w/ US101 Widening	Kaiser Road Widening	WB Off-Ramp to Kaiser Road	EB On-Ramp from Kaiser Road	Total Base Cost
Area (SF)	92,000	14,600	36,000	111,000	
Preparation and Grading	$543,040	$564,952	$441,120	$806,820	$2,355,932
Structures	$450,000	$2,133,000	$2,420,000	$525,000	$5,528,000
Surfacing and Paving	$671,600	$106,580	$262,800	$810,300	$1,851,280
Roadside Development and Drainage	$1,882,000	$435,100	$666,000	$2,163,500	$5,146,600
Traffic Services and Safety	$1,181,000	$1,347,300	$456,500	$1,328,500	$4,313,300
Subtotal	$4,727,640	$4,586,932	$4,246,420	$5,634,120	$19,195,112
Other Items [1]	$3,749,360	$3,639,068	$3,366,580	$4,467,880	$15,223,888
Total	$8,477,000	$8,226,000	$7,613,000	$10,102,000	**$34,419,000**

[1] Includes allowance for Miscellaneous Bid Items, Mobilization, Sales Tax (8.5%), Contingencies during construction, and Construction Engineering.

Table 7. Hybrid Interchange Cost Estimate ($2009)

	Evergreen EB On-Ramp	Kaiser EB On-Ramp	Kaiser Road Widening	WB Off-Ramp to Yauger Way Extension	WB Off-Ramp CD Extension to Kaiser	Black Lake WB Off-Ramp	Total Base Cost
Area (SF)	92000	111000	14600	262000	117000	49000	
Preparation and Grading	$543,040	$806,820	$564,952	$1,823,840	$991,140	$81,380	$4,811,172
Structures	$450,000	$525,000	$2,133,000	$7,969,800	$3,220,000	$0	$14,297,800
Surfacing and Paving	$671,600	$810,300	$106,580	$1,912,600	$854,100	$357,700	$4,712,880
Roadside Development and Drainage	$1,882,000	$2,163,500	$435,100	$5,142,000	$2,314,500	$931,500	$12,868,600
Traffic Services and Safety	$1,181,000	$1,328,500	$1,347,300	$4,327,000	$1,486,000	$1,129,500	$10,799,300
Subtotal	$4,727,640	$5,634,120	$4,586,932	$21,175,240	$8,865,740	$2,500,080	$47,489,752
Other Items [1]	$3,710,360	$4,421,880	$3,600,068	$16,618,760	$6,957,260	$1,963,920	$37,272,248
Total	$8,438,000	$10,056,000	$8,187,000	$37,794,000	$15,823,000	$4,464,000	**$84,762,000**

[1] Includes allowance for Miscellaneous Bid Items, Mobilization, Sales Tax (8.5%), Contingencies during construction, and Construction Engineering.

The primary contributors to the higher costs associated with the Black Lake and Hybrid interchanges are the additional structures and generalized items that include allowances for Miscellaneous Bid Items, Mobilization, Sales Tax (8.5%), Contingencies during construction, and Construction Engineering. The higher probable costs associated with the Black Lake and Hybrid interchange improvements resulted in lower ratings compared to the Evergreen interchange.

Criterion 4: Safety

NOTE: Under 23 United States Code-Section 409, this data cannot be used in discovery or as evidence at trial in any action for damages against the WSDOT, or any jurisdictions involved in the data.

The Safety criterion is composed of three elements: Compatibility with Freeway Safety, Compatibility with Local Street Safety, and Ability to Meet Design Standards. A general evaluation was conducted for a relative comparison of the alternatives. A more detailed analysis of the collision history for the Preferred Alternative is necessary for the IJR. The collision history of the area is described first since it is applicable to existing conditions and all interchanges.

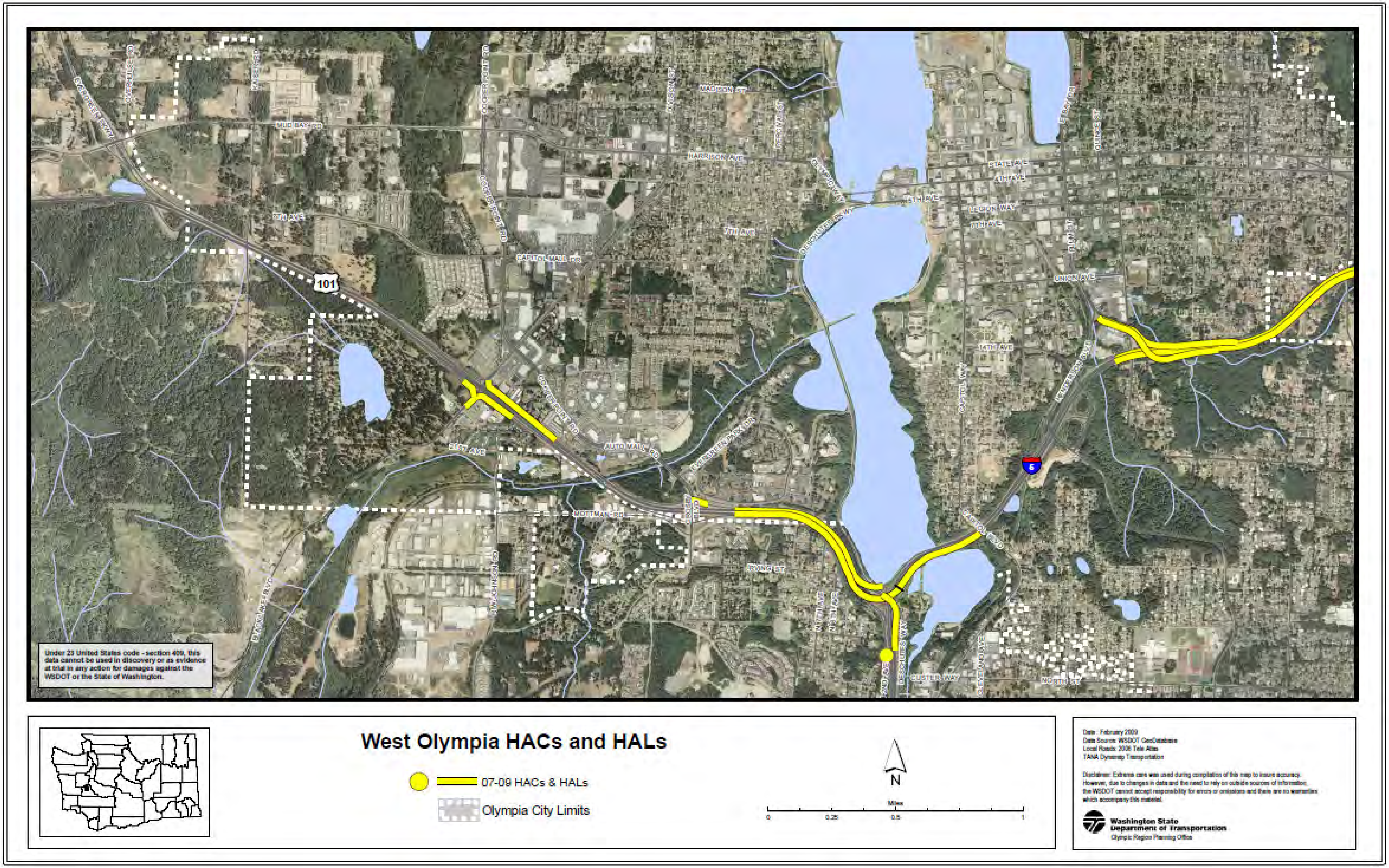
Collision History

The following subsection is applicable when considering both interchange improvements. Additional detail on the collision history analysis is provided in Appendix B.

Collision data were obtained for the three most recent, complete, and consecutive years (January 1, 2005 through December 31, 2007) at the time when the analysis was conducted. Collision data were provided by the WSDOT Transportation Data Office and the City of Olympia.

Within the study area and timeframe described above, the following findings summarize the collision history analysis:

- **Freeway Collision History**
  - 471 collisions along 4.8 miles of US 101
  - 61 percent of US 101 collisions occurred on the mainline and the remaining 39 percent occurred at interchanges
  - 2 High Accident Corridors (HACs) are located within the study area and are shown on Figure 10



Under 23 United States Code-Section 409, this data cannot be used in discovery or as evidence at trial in any action for damages against the WSDOT, or any jurisdictions involved in the data.

Figure 10
WSDOT 2007-2009 HAC and HAL Locations

        - Westbound US 101 mainline (MP 366.59 to MP 367.41) from I-5 to Cooper Point Road/Crosby Boulevard interchange
        - Eastbound US 101 mainline (MP 366.90 to MP 367.41) from I-5 to Cooper Point Road/Crosby Boulevard interchange
    - 4 High Accident Locations (HALs) are located within the study area and are also shown on Figure 10
        - 1 HAL within the Cooper Point Road/Crosby Boulevard interchange
        - 3 HALs within the Black Lake interchange
    - The most common collision type was rear ends (41 percent), followed by fixed objects (25 percent) and sideswipes (14 percent)
    - The most frequent collision severity was property-damage only (67 percent), followed by possible injuries (25 percent) and evident injuries (7 percent)
    - Based on the most frequent collision type and severity, the majority of collisions are likely attributed to congested traffic conditions

- **Local Street Collision History**
    - 887 collisions at 35 intersections within the local street system of West Olympia
    - 54 percent of local system collisions occurred at intersections and the remaining 46 percent occurred along the roadways (between intersections)
    - The City of Olympia has identified 35 HALs city-wide; 8 of the 35 HALs are located along the three principal arterials (Black Lake Boulevard SW, Cooper Point Road SW, and Harrison Avenue NW) within the study area
    - The most common collision type was rear ends (46 percent), followed by right angle (22 percent) and sideswipes (15 percent)
    - The most frequent collision severity was property-damage only (72 percent), followed by possible or evident injuries (28 percent)
    - Based on the most frequent collision type and severity, the majority of collisions are likely attributed to congested traffic conditions

Compatibility with Freeway System

Analyzing nominal safety (design standards) and substantive safety (collision data) elements provides a basis for evaluating potential benefits of alternatives.

Although the Black Lake and Hybrid interchanges have potential design challenges, these challenges would not necessarily result in design deviations. Since the Black Lake and Hybrid interchange improvements are expected to have slightly better operations compared to the Evergreen interchange, these scenarios were rated better for the freeway safety element.

The Evergreen interchange improvements decrease interchange spacing in both directions. Shorter interchange spacing typically results in worse operating conditions, which may lead to more frequent collisions. For the Evergreen interchange scenarios, the spacing between the westbound Black Lake on ramp and Evergreen off ramp is reduced and creates a weaving segment on the US 101 mainline. This weaving segment is expected to operate with a density of 40.0 passenger cars per mile per lane (pcpmpl) for the Evergreen interchange scenario, compared to 34.6 and 36.6 pcpmpl under the Black Lake and Hybrid interchange scenarios. As a result, the Evergreen interchange received the slightly worse rating of “moderate impact.”

Compatibility with Local Street System

All interchange scenarios include a variety of local intersection improvements. At this time, all potential intersection improvements identified are expected to meet design standards and all of the interchange improvements are expected to decrease the collision potential relative to the No-Build.

The “Triangle” intersections are of particular interest since they experience the highest traffic volumes and delays. Table 8, summarizes potential collision occurrences at these locations based on the methods outlined in FHWA’s *Statistical Models of At-Grade Intersection Accidents—Addendum* (FHWA 2000).

Table 8. WSDOT Annual Collision Projections at Triangle Intersections

	Black Lake Interchange			Evergreen Interchange			Hybrid Interchange		
Intersection	**Collisions**	**ADT**	**LOS (Delay)**	**Collisions**	**ADT**	**LOS (Delay)**	**Collisions**	**ADT**	**LOS (Delay)**
Black Lake Blvd/Cooper Point Rd	10	79,613	E (78.5)	10	82,388	E (65.1)	8	55,750	E (78.6)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	8	58,075	E (74.9)	8	57,513	E (71.3)	8.4	59,188	E (73.3)
Harrison Ave/Division St	8	55,675	E (76.2)	8	56,313	E (79.4)	10.3	79,438	E (63.9)
Total	**26**			**26**			**27**		

NOTE**:** Under 23 United States Code-Section 409, this data cannot be used in discovery or as evidence at trial in any action for damages against the WSDOT, or any jurisdictions involved in the data.

Based on the FHWA methodology, the total number of collisions that could potentially occur for all interchange improvements are expected to be similar at the “Triangle” intersections and therefore, all interchanges were rated the same as “moderate impact” for local street safety.

Ability to Meet Design Standards

For the Black Lake interchange improvements, deviation for superelevation runoff distance may be needed on the new westbound bridge crossing over Black Lake Boulevard. Unique design considerations, but not necessarily deviations, include:

- Weaving distance westbound between Black Lake and Crosby interchanges,
- Advance signing of westbound off-ramp to Black Lake Boulevard and new collector/distributor to Yauger Way, and
- Westbound collector/distributor transition from ramp into local roadway (Yauger Way) and new intersection at 9th Avenue.

No deviations are identified for the Evergreen interchange improvements. Unique design considerations, but not necessarily deviations, include:

- Weaving distance for both directions of US 101 between Kaiser and the Black Lake interchange,

- If a tight diamond configuration is proposed for the westbound off-ramp to Kaiser Road, the off-ramp may be tying into a steep cross-grade on Kaiser Road, which is not ideal for large trucks turning against the steep cross-grade.

The Hybrid interchange would have the same one deviation and three potential design challenges as the Black Lake interchange described above. It would also share one of the potential design challenges with the Evergreen interchange; a short weaving distance on eastbound US 101 between the Kaiser on ramp and the Black Lake interchange.

As described above, all three interchange improvements are expected to meet design standards for local improvements. However, since the Black Lake and Hybrid interchange improvements have a larger number of design challenges, the Evergreen interchange scenario was rated slightly higher as “no impact” compared to a “low impact” for the Black Lake and Hybrid interchanges for this evaluation element.

Criterion 5: Transportation Benefits

The Transportation Benefit is composed of three elements: VMT and VHT, Compatibility with Freeway Operations, and Compatibility with Local System Operations.

Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)

The VMT and VHT for all interchange improvements are summarized in Tables 9 and 10. This information was extracted from the TRPC regional travel demand model.

Table 9. US 101 VMT and VHT (2030)

	Vehicle Miles Traveled			Vehicle Hours Traveled		
Scenario	**VMT**	**Change**	**% Change**	**VHT**	**Change**	**% Change**
2030 No-Build	36,190			880		
2030 Black Lake	35,750	-440	-1.20%	850	-30	-3.40%
2030 Evergreen	35,920	-270	-0.70%	860	-20	-2.30%
2030 Hybrid	35,000	-1,190	-3.30%	860	-20	-2.30%

Table 10. US 101/Black Lake/Cooper Point VMT and VHT (2030)

	Vehicle Miles Traveled			Vehicle Hours Traveled		
Scenario	**VMT**	**Change**	**% Change**	**VHT**	**Change**	**% Change**
2030 No-Build	44,870			1,330		
2030 Black Lake	42,910	-1,960	-4.40%	1,160	-170	-12.80%
2030 Evergreen	43,260	-1,610	-3.60%	1,200	-130	-9.80%
2030 Hybrid	42,330	-2,540	-5.66%	1,190	-140	-10.53%

Although relatively similar, the Black Lake and Hybrid interchanges are expected to result in the most VMT and VHT reduction and have been rated as a “high benefit” compared to a “moderate benefit” for the Evergreen interchange.

Compatibility with Freeway Operations

US 101 freeway operations were analyzed using VISSIM and were primarily assessed with respect to two measures of effectiveness: LOS (as defined by densities) and operating speed. Table 11 summarizes the LOS and densities along US 101 at key locations where the operations change between scenarios. Table 12 presents the LOS summary.

Table 11. PM Peak Hour US 101 Densities and LOS (2030)

	No-Build		Black Lake/Yauger**		Evergreen***		Hybrid Interchange***	
Segment	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**
Westbound US 101								
Crosby/Black Lake Weave	24	C	28	C	24	C	24	C
Mainline	30	D	29	D	31	D	27	D
Black Lake On-Ramp	26	C	25	C	31	D	23	C
Eastbound US 101								
Evergreen On-Ramp	133	**F**	31	D	49	**F**	20	C
Mainline	137	**F**	41	**E**	NA	NA	20	C
Kaiser On-Ramp	NA	NA	NA	NA	NA	NA	15	B
Black Lake Off-Ramp/ Kaiser On-Black Lake Off Weave*	131	**F**	43	E	37	E	26	C
Mainline W/o Crosby Blvd On-Ramp	19	C	26	D	29	D	32	D
Crosby Blvd On-Ramp	19	B	39	E	48	**F**	58	**F**
Mainline	32	D	56	**F**	62	**F**	65	**F**

* Diverge segment for the Black Lake interchange. Weave segment for the Evergreen and Hybrid interchanges.

** Eastbound Yauger on-ramp is metered.

*** Eastbound Black Lake and Crosby on-ramps are metered.

Table 12. PM Peak Hour LOS Summary (2030)

All Scenarios	No Build	Black Lake Interchange	Evergreen Interchange	Hybrid Interchange
Total # of Segments Operating at LOS D or better	28	28	30	31
Total # of Segments Operating at LOS E	6	8	4	5
Total # of Segments Operating at LOS F	8	8	10	7
Average of All Densities [1]	42	36	36	35
Sum of All Densities	1710	1459	1458	1454

[1] Averages are for the corridor as a whole, including portions not shown in this table, but that are in the study area.

All interchange scenarios change travel patterns and redistribute traffic volumes. As a result, while the US 101 corridor as a whole is expected to operate relatively similar among all interchange scenarios, changes in densities are evident along specific segments of the corridors. These changes in densities at different locations affect the number of freeway segments that operate unacceptably:

- Black Lake Interchange – two segments at LOS E and two segments at LOS F
- Evergreen Interchange – one segment at LOS E and three segments at LOS F
- Hybrid Interchange – two segments at LOS F

VISSIM was also used to estimate average operating speeds along the US 101 corridor and the results are shown in Table 13.

Table 13. US 101 Operating Speeds (mph) (2030)

	No Build	Black lake Interchange*	Evergreen Interchange**	Hybrid Interchange**
Westbound US 101				
Mud Bay Interchange	59	59	58	59
Evergreen Pkwy On Ramp	NA	NA	59	NA
Evergreen Pkwy Off Ramp	59	59	58	59
Black Lake On Ramp	55	56	55	57
Black Lake Off Ramp	57	57	57	58
Crosby Blvd/Cooper Point Off Ramp	43	42	43	43
US 101/I-5	48	47	46	47
Average Westbound US 101 [1]	**56**	**56**	**56**	**56**
Eastbound US 101				
Mud Bay Interchange	57	59	59	59
Evergreen Pkwy Off Ramp	NA	NA	57	NA
Evergreen Pkwy On Ramp	47	56	50	59
Kaiser On Ramp	NA	NA	NA	59
Black Lake Off Ramp	59	59	59	59
Black Lake On Ramp	58	59	59	59
Crosby Blvd/Cooper Point On Ramp	50	51	51	49
US 101/I-5	45	45	43	44
Average Eastbound US 101 [1]	**54**	**57**	**56**	**56**

[1] Inclusive of all measurement points between areas listed
* EB Yauger on-ramp is metered
** EB Black Lake and Crosby on-ramps are metered

As shown in Table 13, the operating speeds at key locations for all interchanges are expected to be similar.

Although the US 101 corridor speeds as a whole are expected to be similar for all build scenarios, the Evergreen interchange would have the most segments operating unacceptably at LOS E and LOS F and, therefore, was assigned a lower (worse) rating compared to the Black Lake and Hybrid interchanges.

Compatibility with Local System Operations

The local system analysis was conducted using Synchro 7 (build 761) and evaluated 24 intersections within the cities of Olympia and Tumwater. Table 14 summarizes the traffic analysis (1-hour) at key locations within the study area and an expanded LOS table with all of the study intersections is provided in Appendix C. Table 15 provides the LOS analysis using the City of Olympia's 2-hour methodology for calculating LOS.

Table 14. Aggregated Local System Operations (2030) (1-Hour Analysis)

Intersection	No Build	Black Lake Interchange	Evergreen Interchange	Hybrid Interchange
Harrison Avenue/Division Street	F (187.1)	E (76.2)	E (79.4)	E (78.6)
Harrison Avenue/Cooper Point Road	F (110.3)	E (74.9)	E (71.3)	E (73.3)
Black Lake Boulevard/Cooper Point Road	F (199.9)	E (67.7)*	E (65.1)	E (63.9)
Cooper Point Rd/Top Foods Entrance	F (85.7)	D (41.5)	E (67.4)	D (48.5)
Black Lake Boulevard SPUI	F (187.0)	E (72.5)	F (82.4)	E (79.0)
Total Delay (sec/veh)	770.0	332.8	365.6	343.3
LOS A, B, C	0	0	0	0
LOS D	0	1	0	1
LOS E	0	4	4	4
LOS F	5	0	1	0

* Includes second southeast right turn lane

Table 15. Aggregated Local System Operations (2030) (2-Hour Analysis)

Intersection	No Build	Black Lake Interchange	Evergreen Interchange	Hybrid Interchange
Harrison Avenue/Division Street	F (163.6)	E (66.4)	E (68.2)	E (72.9)
Harrison Avenue/Cooper Point Road	F (95.7)	E (66.5)	E (63.9)	E (63.8)
Black Lake Boulevard/Cooper Point Road	F (173.5)	E (60.1)*	E (56.8)	E (58.0)
Cooper Point Rd/Top Foods Entrance	E (67.2)	D (38.2)	E (59.4)	D (40.0)
Black Lake Boulevard SPUI	F (178.6)	E (70.2)	E (77.9)	E (79.6)
Total Delay (sec/veh)	678.6	309.3	326.2	314.3
LOS A, B, C	0	0	0	0
LOS D	0	1	0	1
LOS E	1	4	5	4
LOS F	4	0	0	0

* Includes second southeast right turn lane

NOTE: As described above, the 2-hour analysis presented here is for the City of Olympia, which uses a different methodology to calculate LOS for concurrency purposes. The text and conclusions in this report are based on 1-hour analyses.

As shown in Table 14, all three interchange improvements reduce the total delay at the key intersections by a similar magnitude compared to the No-Build. At these key intersections, the amount of mitigation is also the same. As a result, all three interchanges received the same rating for this evaluation criterion.

EVALUATION SUMMARY

Table 16 provides a brief description and summary of the impacts for all interchange scenarios with respect to the five evaluation criteria.

The advantages and disadvantages of these interchanges identified in Table 16 were quantified according to the scoring system identified in Table 4, which included:

- Score of 1: Most impact or no benefit (Worst)
- Score of 2: High impact or low benefit
- Score of 3: Moderate impact or high benefit
- Score of 4: Slight impact or high benefit
- Score of 5: No impact or highest benefit (Best)

Based on this scoring system, Table 17 provides a quantitative comparison of impacts and benefits for all interchange improvements.

The scoring shown in Table 17 represents the consensus of the project stakeholders. The total combined ratings of the interchange scenarios exhibited small differences, but those differences became more pronounced with the weighting of the evaluation criteria and the Black Lake interchange had the highest (best) score.

STUDY RECOMMENDATIONS

It is important to note that the quantitative scoring matrix shown in Table 17 was used only as a guide during decision making. There are other factors that are less tangible and difficult to quantify and were therefore not included as evaluation criteria. Furthermore, scores and weighting are subjective and should not be interpreted as or used for final judgment.

Concurrent with this study, the WSDOT, City of Olympia, and TRPC have conducted extensive coordination efforts and the following recommendations have resulted:

- Eliminate the stand-alone Black Lake interchange alternative from further consideration; this recommendation is based on the high eastbound on-ramp traffic volume with a short weave section, high construction costs, and impacts to the Ken Lake neighborhood (e.g., aesthetic and noise)
- Advance the Hybrid interchange into the next phase of project development, which includes:
  - Completion of the Interchange Justification Report (IJR) process (Engineering and Operational Acceptability)
  - Complete environmental documentation to comply with the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA), and obtain final IJR approval, and
  - Preliminary engineering
- Phase the Hybrid interchange in the next phase of work

Table 16. Summary of Impacts

Criteria	Element	Black Lake Interchange	Evergreen Interchange	Hybrid Interchange
1. Built Environmental Impacts	*Disruptions and Displacements*	• No displacements • No disruptions of access identified	• Potential relocation of 3 mobile homes • Potential disruption of access to residential and commercial properties in the US 101/Kaiser interchange area	• Potential relocation of 3 mobile homes • Potential disruption of access to residential and commercial properties in the US 101/Kaiser interchange area
	Right-of-Way	• Less right-of-way acquisition (147,000 SF) • Impacts to platted developments and existing commercial developments (15,700 SF)	• More right-of-way acquisition (240,000 SF) • No impacts to platted developments or existing commercial developments	• More right-of-way acquisition (310,000 SF) • No impacts to platted developments or existing commercial developments
2. Natural Environmental Impacts	*Wetlands/Shorelines*	• Slightly less wetland and buffer impacts (1.7 acres)	• Slightly more wetland and buffer impacts (2.5 acres)	• Slightly more wetland and buffer impacts (2.1 acres)
	Water Resources (Stormwater)	• Less water resource impacts based on proximity to Allison Springs (11.7 acres) • Slightly more impervious surface (8 acres)	• More water resource impacts based on proximity to Allison Springs (21.4 acres) • Slightly less impervious surface (7 acres)	• More water resource impacts based on proximity to Allison Springs (30.8 acres) • Slightly less impervious surface (14.2 acres)
3. Constructibility	*Constructibility*	• Most difficult to construct: periodic and major disruptions to traffic during construction • Most bridge structures and retaining wall required	• Least difficult to construct: periodic disruptions to traffic during construction, can be built mostly outside of roadway • Least bridge structures and less retaining wall required	• Moderately difficult to construct: periodic disruptions to traffic during construction, can be built mostly outside of roadway • Fewer bridge structures and less retaining wall required
	Probable Construction Cost	• Higher estimated construction cost ($86M)	• Lower estimated construction cost ($34M)	• Lower estimated construction cost ($85M)
4. Safety	*Compatibility with Freeway Safety*	• Slightly better than Evergreen operations • Does not affect interchange spacing	• Essentially worse operations than Black Lake and Hybrid • Shortens interchange spacing in both directions	• Slightly better than Evergreen operations • Shortens interchange spacing in one direction
	Compatibility with Local Street Safety	• Essentially equal with other scenarios	• Essentially equal with other scenarios	• Essentially equal with other scenarios
	Ability to Meet Design Standards	• Potential design deviation and more design issues	• No design deviations identified and fewer design issues	• Potential design deviation and more design issues
5. Transportation Benefits	*VMT and VHT*	• Slightly less VMT and VHT	• Slightly more VMT and VHT	• Slightly less VMT and VHT
	Compatibility with Freeway Operations	• Slightly better at key locations	• Slightly worse at key locations	• Slightly worse at key locations
	Compatibility with Local System Operations	• Essentially equal with other scenarios at key intersections • 0 intersections operating at LOS F at key locations • 4 new turn pockets at key locations (“Triangle” intersections and coordinated system)	• Essentially equal with other scenarios at key intersections • 1 intersections operating at LOS F at key locations • 4 new turn pockets at key locations (“Triangle” intersections and coordinated system)	• Essentially equal with other scenarios at key intersections • 0 intersections operating at LOS F at key locations • 4 new turn pockets at key locations (“Triangle” intersections and coordinated system)

Table 17. Quantitative Scoring

	Black Lake Interchange	Evergreen Interchange	Hybrid Interchange	Weight	Black Lake Interchange	Evergreen Interchange	Hybrid Interchange
1. Built Environment Impacts	**8**	**7**	**7**	**16.7**	**13**	**12**	**12**
Displacement	5	4	4				
Right of Way	3	3	3				
2. Natural Environment Impacts	**7**	**5**	**4**	**20**	**14**	**10**	**8**
Wetland/Shorelines	3	3	3				
Water Resources	4	2	1				
3. Constructibility	**4**	**8**	**5**	**6.7**	**3**	**5**	**3**
Constructibility	2	4	3				
Estimated Construction Cost (Planning Level)	2	4	2				
4. Safety	**11**	**11**	**11**	**30**	**22**	**22**	**22**
Ability to meet Design Standards	4	5	4				
Compatibility with Local System Safety	3	3	3				
Compatibility with Freeway Safety	4	3	4				
5. Transportation Benefits	**10**	**8**	**10**	**26.6**	**18**	**14**	**18**
Vehicle Miles Traveled (VMT)/Vehicle Hours Traveled (VHT)	4	3	4				
Compatibility with Local System Operations	2	2	2				
Compatibility with Freeway Operations	4	3	4				
TOTAL SCORE	**40**	**39**	**37**	**100**	**70**	**63**	**63**

Recommended Hybrid Interchange Phasing

Phasing of the Hybrid interchange is recommended and could consist of:

- Phase 1 – Kaiser on- and off-ramps
- Phase 2 – Westbound Yauger Way off-ramp
- Phase 3 – Evergreen eastbound on-ramp re-alignment

Phase 3, which is an independent project that consists of improving the ramp design speed and geometry, could be constructed at any time depending on funding availability. The planning level cost estimate for the re-alignment is approximately $8,500,000.

By using a phased approach for the Hybrid interchange it does not cost any more to complete the IJR than just moving forward with the Evergreen Parkway-Kaiser.

Phase 1, which consists of the Kaiser Road on- and off-ramps, would:

- Provide a cost-effective and timely solution to current and future access and circulation needs, and
- Serve existing land use and planned future land uses.

These ramps are recommended to be the first phase of this long-term project because it provides both on- and off-ramps to US 101 as compared to Yauger Way, which would only provide an off-ramp.

Phase 2, which consists of the Yauger Way off-ramp, would:

- Allow even greater distribution of traffic serving both current commercial and future uses, as growth occurs as planned,
- Further alleviate growing traffic volumes at the intersection of Black Lake Boulevard and Cooper Point Road, and
- Potentially provide access and circulation to the proposed development land use changes for Friendly Village.

REFERENCES

WSDOT 2007. Washington State Department of Transportation, West Olympia Access Study, *Technical Memorandum 1, Evaluation and Screening Methods*. 2007.

Parametrix 2008a. Parametrix, West Olympia Access Study, *Existing 2007 and Year 2030 No-Build Technical Memorandum 2*. July 2, 2008.

Parametrix 2008b. Parametrix, West Olympia Access Study, *Traffic Operations Analysis Technical Memorandum 3*. November 10, 2008.

FHWA 2000. Federal Highway Administration, *Statistical Models of At-Grade Intersection Accidents—Addendum*. March 2000.

STAKEHOLDER ACCEPTANCE

The undersigned parties concur with the conclusions and recommendations for the West Olympia Access Study as presented in this document.

WSDOT Assistant Design Engineer	FHWA
Signature	Signature
Asst. State Design Engr.	Area Engineer
Title	Title
6/28/10	6/30/2010
Date	Date

WSDOT Access and Hearings	City of Olympia
Signature	Signature
Development Svcs & Access Mgr.	Transportation Engineering & Planning Manager
Title	Title
July 1, 2010	7/6/10
Date	Date

WSDOT Olympic Region	Thurston Regional Planning Council
Signature	Signature
Region Traffic Engr	Senior Planner
Title	Title
July 6, 2010	7 July 2010
Date	Date

APPENDIX A

Planning Level Cost Estimates

Parametrix ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

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MEMORANDUM

Date:	May 26, 2010
To:	John Perlic
From:	Owen Kikuta, P.E.
Subject:	Planning Level Construction Cost Estimate for Alternative Screening Analysis
cc:	Project File
Project Number:	554-1631-062
Project Name:	West Olympia Access Study

This memorandum summarizes the process used to create the attached construction cost estimates for the three conceptual alternatives of the West Olympia Access Study. Alternatives include the Black Lake, Evergreen (modified), and Hybrid interchange improvements. These are planning level cost estimates that compare the three conceptual alternatives to provide input for the alternatives screening analysis. The cost estimates only account for the construction costs and excludes the following items:

- Right-of-way
- Wetland mitigation and environmental permitting
- Preliminary engineering costs
- Risk and inflation factors

The cost estimates are based on conceptual design alignments, channelization, profiles, and rough earthwork generated in Inroads. Specific bid items are consolidated into generalized items for this cost estimate due to the conceptual design level of the project. The unit prices for most of these generalized items are based on square footage costs calculated from the 30% PS&E construction cost estimate for the SR 522 Snohomish River Bridge to US 2 project. The calculated square footage cost for each generalized item is multiplied by the new pavement area to yield the total item cost. Costs per cubic yard, ton, and linear foot are based on general knowledge of recent bid costs.

WSDOT completed a planning level cost estimate in July 2008. Due a to differing methodology, the WSDOT and Parametrix estimates cannot be compared directly on a dollar to dollar basis. However, a comparison of the cost ratio between the Black Lake and Evergreen alternatives can be made. In the WSDOT estimate, the Black Lake alternative is approximately 46 percent higher compared to the Evergreen alternative. In the attached Parametrix estimate, the Black Lake and Hybrid alternatives are around double the cost of the Evergreen alternative.

If you have any questions about the cost estimate, please contact Owen Kikuta at 253-501-1066.

Black Lake Alternative

Prepared by OSK 7-10-09, Checked by KW 7-13-09

This estimate is for comparison purposes only between conceptual alternatives. Additional risk and inflation factors are needed for this estimate to be used for budgeting purposes.

R/W, Wetland Mitigation, Permitting, and Preliminary Engineering costs are not included

Costs are expressed in 2009 dollars.

		WB C/D Ramp	EB C/D Ramp	Yauger Way	Total Base Cost	Check	
I. CONSTRUCTION							
1. PREPARATION AND GRADING							
Area (SF)		146000	126000	73000			
Mobilization (See below)							
Clearing and Grubbing ($5,000/AC=$0.12/SF)	0.12	$17,520	$15,120	$8,760	$41,400		
General Removal Items ($2/SF)	2	$292,000	$252,000	$146,000	$690,000		
Embankment ($12/Ton)	12	$780,000	$1,200,000	$432,000	$2,412,000		
Roadway Ex.($12/CY)	12	$21,600	$36,000	$12,000	$69,600		
Special ground improvements ($45/SF)	45	$225,000	$67,500	$90,000	$382,500		Assume for roadway in wetland areas
subtotal		**$1,336,120**	**$1,570,620**	**$688,760**	**$3,595,500**	**$3,595,500**	
2. STRUCTURES							
Concrete Precast Girder Bridge ($220/SF)	220	$0	$3,366,000	$0	$3,366,000		
Steel Plate Girder Bridge ($310/SF)	310	$6,448,000	$3,751,000	$0	$10,199,000		
Retaining Walls ($100/SF)	100	$3,705,000	$9,405,000	$0	$13,110,000		
SEW Moment slab traffic barrier ($250/LF)	250	$617,500	$1,567,500	$0	$2,185,000		
Noise Walls ($75/SF)	75	$0	$525,000	$0	$525,000		
subtotal		**$10,770,500**	**$18,614,500**	**$0**	**$29,385,000**	**$29,385,000**	
3. SURFACING AND PAVING							
Surfacing incl. HMA and CSBC ($7.30/SF)	7.3	$1,065,800	$919,800	$532,900	$2,518,500		Assume 1' HMA@$80+$8/Ton, 0.5'CSBC@$16/Ton
subtotal		**$1,065,800**	**$919,800**	**$532,900**	**$2,518,500**	**$2,518,500**	
4. ROADSIDE DEVELOPMENT AND DRAINAGE							
Landscaping- outside roadway ($50/LF/side)	50	$150,000	$0	$80,000	$230,000		
Planter Strips ($50/LF)	50	$0	$0	$80,000	$80,000		
Temp. Water Pol. Control ($6.50/SF)	6.5	$949,000	$819,000	$474,500	$2,242,500		
Drainage incl. Det./Treatment ($12.00/SF)	12	$1,752,000	$1,512,000	$876,000	$4,140,000		
subtotal		**$2,851,000**	**$2,331,000**	**$1,510,500**	**$6,692,500**	**$6,692,500**	
5. TRAFFIC SERVICES AND SAFETY							
Intersection Control ($500K each)		$0	$0	$1,000,000	$1,000,000		
Illumination ($65/LF/side, 1 side C/D ramps, 2 on	65	$390,000	$487,500	$130,000	$1,007,500		
Signing		$150,000	$80,000	$50,000	$280,000		
Sidewalk ($20/LF)	20	$0	$0	$32,000	$32,000		
Traffic Safety items (striping, guardrail, etc: $7/SF)	7	$1,022,000	$882,000	$511,000	$2,415,000		
Traffic Control ($3.50/SF)	3.5	$511,000	$441,000	$255,500	$1,207,500		
ITS/Ramp metering		$0	$200,000	$0	$200,000		Assuming one ramp meter signal, no other ITS equipment
subtotal		**$2,073,000**	**$2,090,500**	**$1,978,500**	**$6,142,000**	**$6,142,000**	
SUB TOTAL		**$18,096,420**	**$25,526,420**	**$4,710,660**	**$48,333,500**	**$48,333,500**	
6. Allowance for misc. bid items ***(30%)***		$5,428,926	$7,657,926	$1,413,198	$14,500,050		For bid items not covered by general items above
7. Construction Sub-total		$23,525,000	$33,184,000	$6,124,000	$62,834,000		
8. Mobilization ***(11% of line 7))***		$2,588,000	$3,650,000	$674,000	$6,912,000		
9. Subtotal (lines 7 and 8)		$26,113,000	$36,834,000	$6,798,000	$69,746,000		
10. Sales Tax (8.5%)		$2,220,000	$3,131,000	$578,000	$5,928,000		Olympia rate as of 7/10/09
11. Other Environmental Permits & Mit.(not incl.)							
12. Subtotals (lines 9 thru 11)		$28,333,000	$39,965,000	$7,376,000	$75,674,000		
13. Contingencies during Construction (4%)		$1,133,000	$1,599,000	$295,000	$3,027,000		
14. Construction Engineering ***(10%)***		$2,833,000	$3,997,000	$738,000	$7,567,000		
CONSTRUCTION		**$32,299,000**	**$45,561,000**	**$8,409,000**	**$86,268,000**		

Evergreen Alternative

Prepared by OSK 2-15-10

This estimate is for comparison purposes only between conceptual alternatives. Additional risk and inflation factors are needed for this estimate to be used for budgeting purposes.

R/W, Wetland Mitigation, Permitting, and Preliminary Engineering costs are not included

Costs are expressed in 2009 dollars.

Item	Unit rate	Evergreen EB ramp w/ US101 Widening	Kaiser Road	WB Off-Ramp to Kaiser Road	EB On-Ramp from Kaiser Road	Total Base cost	Check	Notes
I. CONSTRUCTION								
1. PREPARATION AND GRADING								
Area (SF)		92000	14600	36000	111000			
Mobilization (See below)						$0		
Clearing and Grubbing ($5,000/AC=$0.12/SF)	0.12	$11,040	$1,752	$4,320	$13,320	$30,432		
General Removal Items ($2/SF)	2	$184,000	$29,200	$72,000	$222,000	$507,200		
Embankment ($12/Ton)	12	$22,200	$432,000	$360,000	$480,000	$1,294,200		
Roadway Ex.($12/CY)	12	$100,800	$12,000	$4,800	$24,000	$141,600		
Special ground improvements ($45/SF)	45	$225,000	$90,000	$0	$67,500	$382,500		Assume for roadway in wetland areas
subtotal		**$543,040**	**$564,952**	**$441,120**	**$806,820**	**$2,355,932**	**$2,355,932**	
2. STRUCTURES								
Concrete Precast Girder Bridge ($220/SF)	220	$0	$924,000	$0	$0	$924,000		
Retaining Walls ($100/SF)	100	$300,000	$1,209,000	$2,070,000	$0	$3,579,000		
SEW Moment slab traffic barrier ($250/LF)	250	$150,000	$0	$350,000	$0	$500,000		
Noise Walls ($75/SF)	75	$0	$0	$0	$525,000	$525,000		
subtotal		**$450,000**	**$2,133,000**	**$2,420,000**	**$525,000**	**$5,528,000**	**$5,528,000**	
3. SURFACING AND PAVING								
Surfacing incl. HMA and CSBC ($7.30/SF)	7.3	$671,600	$106,580	$262,800	$810,300	$1,851,280		Assume 1' HMA@$80+$8/Ton, 0.5'CSBC@$16/Tor
subtotal		**$671,600**	**$106,580**	**$262,800**	**$810,300**	**$1,851,280**	**$1,851,280**	
4. ROADSIDE DEVELOPMENT AND DRAINAGE								
Landscaping- outside roadway ($50/LF/side)	50	$180,000	$90,000	$0	$110,000	$380,000		
Planter Strips ($50/LF)	50	$0	$75,000	$0	$0	$75,000		
Temp. Water Pol. Control ($6.50/SF)	6.5	$598,000	$94,900	$234,000	$721,500	$1,648,400		
Drainage incl. Det./Treatment ($12.00/SF)	12	$1,104,000	$175,200	$432,000	$1,332,000	$3,043,200		
subtotal		**$1,882,000**	**$435,100**	**$666,000**	**$2,163,500**	**$5,146,600**	**$5,146,600**	
5. TRAFFIC SERVICES AND SAFETY								
Intersection Control ($500K each)		$0	$1,000,000	$0	$0	$1,000,000		
Illumination ($65/LF/side, 1 side on ramps, 2 on	65	$195,000	$117,000	$58,500	$143,000	$513,500		
Signing		$20,000	$20,000	$20,000	$20,000	$80,000		
Sidewalk ($20/LF)	20	$0	$57,000	$0	$0	$57,000		
Traffic Safety items (striping, guardrail, etc: $7/SF)	7	$644,000	$102,200	$252,000	$777,000	$1,775,200		
Traffic Control ($3.50/SF)	3.5	$322,000	$51,100	$126,000	$388,500	$887,600		
subtotal		**$1,181,000**	**$1,347,300**	**$456,500**	**$1,328,500**	**$4,313,300**	**$4,313,300**	
SUB TOTAL		**$4,727,640**	**$4,586,932**	**$4,246,420**	**$5,634,120**	**$19,195,112**	**$19,195,112**	
6. Allowance for misc. bid items ***(30%)***		$1,418,292	$1,376,080	$1,273,926	$1,690,236	$5,758,534		For bid items not covered under general items abov
7. Construction Sub-total		$6,146,000	$5,963,000	$5,520,000	$7,324,000	$24,954,000		
8. Mobilization ***(11% of Line 7)***		$676,000	$656,000	$607,000	$806,000	$2,745,000		
9. Subtotal (lines 7 and 8)		$6,822,000	$6,619,000	$6,127,000	$8,130,000	$27,699,000		
10. Sales Tax (8.5%)		$614,000	$596,000	$551,000	$732,000	$2,493,000		Olympia rate as of 7/10/09
11. Other Environmental Permits & Mit.(not incl.)								
12. Subtotals (lines 9 thru 11)		$7,436,000	$7,215,000	$6,678,000	$8,862,000	$30,192,000		
13. Contingencies during Construction ***(4%)***		$297,000	$289,000	$267,000	$354,000	$1,208,000		
14. Construction Engineering ***(10%)***		$744,000	$722,000	$668,000	$886,000	$3,019,000		
CONSTRUCTION		**$8,477,000**	**$8,226,000**	**$7,613,000**	**$10,102,000**	**$34,419,000**		

Hybrid Alternative

Prepared by ES 2-12-10, Checked by OK 2-12-10

This estimate is for comparison purposes only between conceptual alternatives. Additional risk and inflation factors are needed for this estimate to be used for budgeting purposes.

R/W, Wetland Mitigation, Permitting, and Preliminary Engineering costs are not included

Costs are expressed in 2009 dollars.

Item	Unit	Evergreen EB On-Ramp	Kaiser EB On-Ramp	Kaiser Road Widening	WB Off-Ramp to Yauger Way Extension	WB Off-Ramp CD Extension to Kaiser	Black Lake WB Off-Ramp	Total Base Cost	Check		
I. CONSTRUCTION											
1. PREPARATION AND GRADING											
Area (SF)		92000	111000	14600	262000	117000	49000			645600	14.82
Mobilization (See below)											
Clearing and Grubbing ($5,000/AC=$0.12/SF)	0.12	$11,040	$13,320	$1,752	$31,440	$14,040	$5,880	$77,472			
General Removal Items ($2/SF)	2	$184,000	$222,000	$29,200	$524,000	$234,000	$5,000	$1,198,200			
Embankment ($12/Ton)	12	$22,200	$480,000	$432,000	$984,000	$516,000	$12,000	$2,446,200			
Roadway Ex.($12/CY)	12	$100,800	$24,000	$12,000	$194,400	$159,600	$36,000	$526,800			
Special ground improvements ($45/SF)	45	$225,000	$67,500	$90,000	$90,000	$67,500	$22,500	$562,500		Assume for roadway in wetla	
subtotal		**$543,040**	**$806,820**	**$564,952**	**$1,823,840**	**$991,140**	**$81,380**	**$4,811,172**	**$4,811,172**		
2. STRUCTURES											
Concrete Precast Girder Bridge ($220/SF)	220	$0	$0	$924,000	$4,557,300	$0	$0	$5,481,300			
Retaining Walls ($100/SF)	100	$300,000	$0	$1,209,000	$2,925,000	$2,760,000	$0	$7,194,000			
SEW Moment slab traffic barrier ($250/LF)	250	$150,000	$0	$0	$487,500	$460,000	$0	$1,097,500			
Noise Walls ($75/SF)	75	$0	$525,000	$0	$0	$0	$0	$525,000			
subtotal		**$450,000**	**$525,000**	**$2,133,000**	**$7,969,800**	**$3,220,000**	**$0**	**$14,297,800**	**$14,297,800**		
3. SURFACING AND PAVING											
Surfacing incl. HMA and CSBC ($7.30/SF)	7.3	$671,600	$810,300	$106,580	$1,912,600	$854,100	$357,700	$4,712,880		Assume 1' HMA@$80+$8/To	
subtotal		**$671,600**	**$810,300**	**$106,580**	**$1,912,600**	**$854,100**	**$357,700**	**$4,712,880**	**$4,712,880**		
4. ROADSIDE DEVELOPMENT AND DRAINAGE											
Landscaping- outside roadway ($50/LF/side)	50	$180,000	$110,000	$90,000	$270,000	$150,000	$25,000	$825,000			
Planter Strips ($50/LF)	50	$0	$0	$75,000	$25,000	$0	$0	$100,000			
Temp. Water Pol. Control ($6.50/SF)	6.5	$598,000	$721,500	$94,900	$1,703,000	$760,500	$318,500	$4,196,400			
Drainage incl. Det./Treatment ($12.00/SF)	12	$1,104,000	$1,332,000	$175,200	$3,144,000	$1,404,000	$588,000	$7,747,200			
subtotal		**$1,882,000**	**$2,163,500**	**$435,100**	**$5,142,000**	**$2,314,500**	**$931,500**	**$12,868,600**	**$12,868,600**		
5. TRAFFIC SERVICES AND SAFETY											
Intersection Control ($500K each)		$0	$0	$1,000,000	$1,000,000	$0	$500,000	$2,500,000			
Illumination ($65/LF/side, 1 side C/D ramps, 2 on	65	$195,000	$143,000	$117,000	$455,000	$227,500	$65,000	$1,202,500			
Signing		$20,000	$20,000	$20,000	$100,000	$30,000	$50,000	$240,000			
Sidewalk ($20/LF)	20	$0	$0	$57,000	$21,000	$0	$0	$78,000			
Traffic Safety items (striping, guardrail, etc: $7/SF)	7	$644,000	$777,000	$102,200	$1,834,000	$819,000	$343,000	$4,519,200			
Traffic Control ($3.50/SF)	3.5	$322,000	$388,500	$51,100	$917,000	$409,500	$171,500	$2,259,600			
subtotal		**$1,181,000**	**$1,328,500**	**$1,347,300**	**$4,327,000**	**$1,486,000**	**$1,129,500**	**$10,799,300**	**$10,799,300**		
SUB TOTAL		**$4,727,640**	**$5,634,120**	**$4,586,932**	**$21,175,240**	**$8,865,740**	**$2,500,080**	**$47,489,752**	**$47,489,752**		
6. Allowance for misc. bid items ***(30%)***		$1,418,292	$1,690,236	$1,376,080	$6,352,572	$2,659,722	$750,024	$14,246,926		For bid items not covered by	
7. Construction Sub-total		$6,146,000	$7,324,000	$5,963,000	$27,528,000	$11,525,000	$3,250,000	$61,737,000			
8. Mobilization ***(11% of line 7))***		$676,000	$806,000	$656,000	$3,028,000	$1,268,000	$358,000	$6,791,000			
9. Subtotal (lines 7 and 8)		$6,822,000	$8,130,000	$6,619,000	$30,556,000	$12,793,000	$3,608,000	$68,528,000			
10. Sales Tax (8.5%)		$580,000	$691,000	$563,000	$2,597,000	$1,087,000	$307,000	$5,825,000		Olympia rate as of 7/10/09	
11. Other Environmental Permits & Mit.(not incl.)											
12. Subtotals (lines 9 thru 11)		$7,402,000	$8,821,000	$7,182,000	$33,153,000	$13,880,000	$3,915,000	$74,353,000			
13. Contingencies during Construction (4%)		$296,000	$353,000	$287,000	$1,326,000	$555,000	$157,000	$2,974,000			
14. Construction Engineering ***(10%)***		$740,000	$882,000	$718,000	$3,315,000	$1,388,000	$392,000	$7,435,000			
CONSTRUCTION		**$8,438,000**	**$10,056,000**	**$8,187,000**	**$37,794,000**	**$15,823,000**	**$4,464,000**	**$84,762,000**			
ROW ACQUISITION (Not including stormwater needs)		0 SF	70000 SF	40000 SF	90000 SF	110000 SF	0 SF				
Phase 1--WB off-ramp to Yauger Way		$42,258,000									
Phase 2--Kaiser EB On-ramp		$26,681,000									
Phase 3--Kaiser WB Off-ramp		$15,823,000									

APPENDIX B

Collision Analysis Technical Memorandum

West Olympia Access Study Collision History Summary and Analysis

Prepared by: WSDOT Olympic Region

Date: August 28, 2009

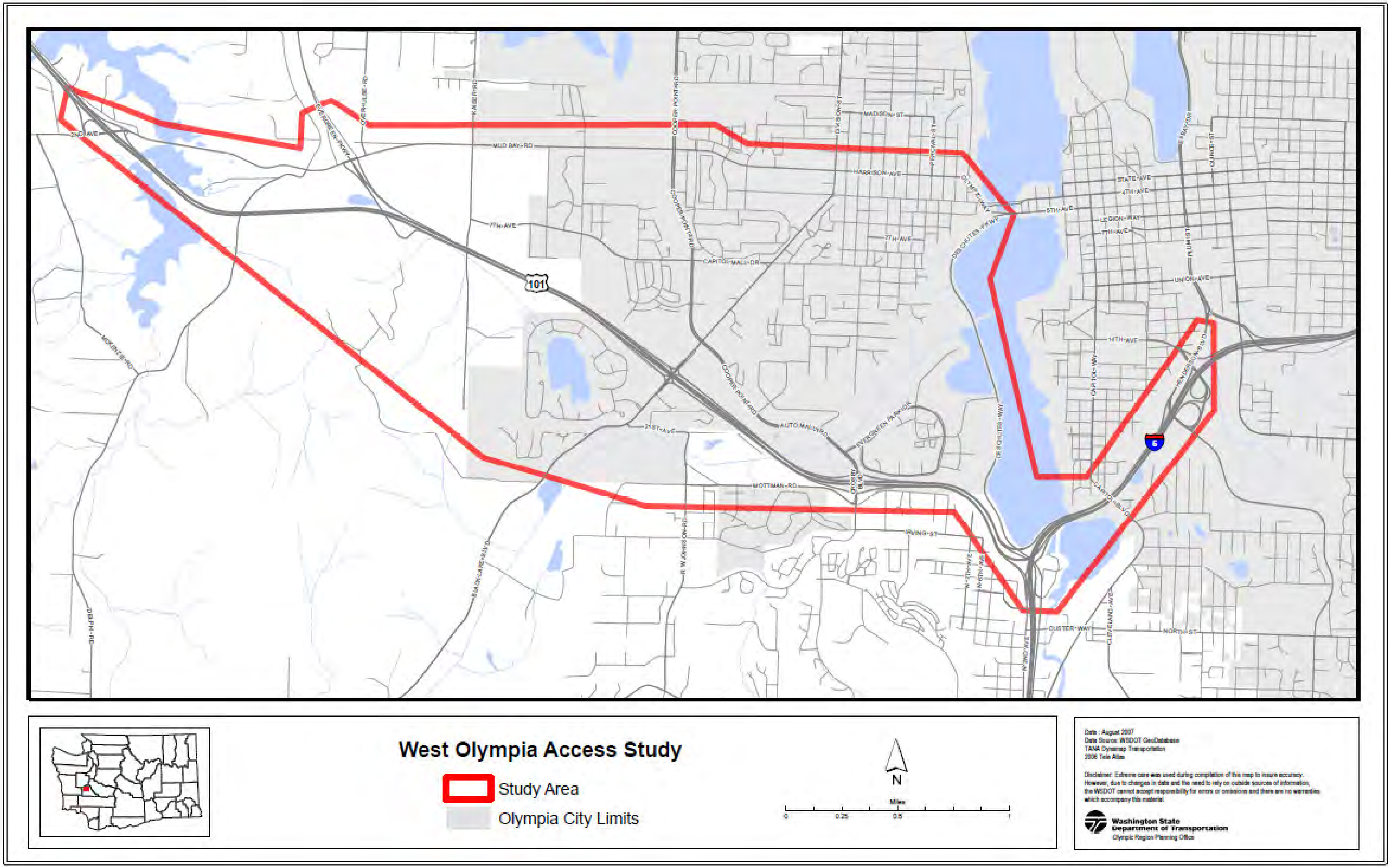
Introduction

The purpose of this technical memorandum is to provide a summary and analysis of collision data for the West Olympia Access Study. This documentation summarizes collisions that occurred on those portions of US 101, I-5 and city and county streets within the West Olympia Access Study (WOAS) limits. It also includes a planning level collision analysis of the two alternatives that are in consideration.

The study area for the WOAS, shown in Figure 1, can be broadly categorized from a traffic operations perspective as two systems: freeway corridors (I-5 and US 101) and the local transportation system in the cities of Olympia and Tumwater. The study area along the I-5 corridor is approximately 2.81 miles long and includes interchanges with US 101 and the southern half of the City Center interchange. The portion of the US 101 corridor within the study area is approximately 4.82 miles long and contains four interchanges, including Mud Bay Road, Evergreen Parkway, Black Lake Boulevard, and Crosby Boulevard/Cooper Point. The study area for the local transportation system is in the cities of Olympia and Tumwater and is located to the north and south of US 101. The local network segments which were considered are:

- Mud Bay Road beginning at 2nd Avenue to Harrison Avenue ending at West Bay Drive
- Evergreen Parkway beginning at Mud Bay Road ending at 17th Avenue
- Overhulse Road beginning at Mud Bay Road ending at 17th Avenue
- Kaiser Road SW beginning at Mud Bay Road to the end of the road
- McPhee Street beginning at Mud Bay Road ending at 7th Ave./Capital Mall Dr.
- Yauger Way beginning at Mud Bay Road ending at Capital Mall Drive
- Cooper Point Road beginning at Harrison Avenue, turns into Automall Drive and ending at Crosby Boulevard
- Black Lake Boulevard beginning at Harrison Avenue ending at 21st Avenue
- 7th Avenue/Capital Mall Drive beginning at Kaiser Road ending at Blake Lake Boulevard
- Mottman Road beginning at RW Johnson Road ending at Crosby Boulevard
- Crosby Boulevard beginning at Irving Street ending at Automall Road
- Evergreen Park Drive beginning at Automall Road ending at Lakeridge Way
- Lakeridge Drive beginning at Evergreen Park Drive ending at Deschutes Parkway

Figure 1
Study Area



Note: For the purpose of the report, northbound US 101 will be referred to as eastbound US 101 (increasing milepost) and southbound US 101 will be referred to as westbound US 101 (decreasing milepost) since the directional orientation within the study area is closer to east-west than north-south.

Collision Information Collection

Collision Data was obtained and compiled for a three year period. The most current information available at the beginning of this study was obtained from the Washington State Department of Transportation's Transportation Data Office (TDO) and the City of Olympia. Collision data used in this memorandum was for the period January 1, 2005, to December 31, 2007.

Summary of Collision History

State Highway Collisions History

The history of collisions helps to determine areas within the project limits which could be a potential hazard. Within the study area during the three-year timeframe, there were a total of 1035 collisions on the state highway system (471 collisions on US 101 and 564 collisions on I-5).

Forty-four percent of all state highway collisions were rear end type crashes. The most common contributing factor in half of the collisions was drivers exceeding a reasonable safe speed for driving conditions. This is a very common contributing factor for highways that are congested.

US 101 Collision History Summary

<u>Statistical Analysis</u>

Statistical analysis of the collision history for the period of January 1, 2005, to December 31, 2007 in the study area along US 101 concludes the following:

- 471 collisions were recorded within the 4.8 mile stretch of US 101.
- This segment averaged 33 collisions per mile per year
- Collisions most frequently occurred between the hours of 5pm and 6pm.
- Non-injury collisions accounted for 70% of all collisions.
- Fatal collisions accounted for 0.2% of all collisions.
- Rear end collisions accounted for 41% of all collisions.
- Fixed object collisions accounted for 25% of all collisions.
- Sideswipe collisions accounted for 14% of all collisions.

<u>Collisions by Type and Severity</u>

The following table summarizes the type of collisions that occurred in the study area along US 101. The collision information includes collisions that occurred on mainline US 101 and at the associated interchanges. Interchange collisions include those that occurred at on ramps, off ramps and over/undercrossing.

Table 1 US 101 Collisions by Type					
				3-Year Total	
Collision Type	**2005 Collisions**	**2006 Collisions**	**2007 Collisions**	**Collisions**	**Percent**
Animal	3	4	6	13	2.8%
Head on	0	0	1	1	0.2%
Front end (NOT HEAD ON)	2	2	3	7	1.5%
Angle collision	12	17	18	47	10.0%
Sideswipe	**14**	**25**	**25**	**64**	**13.6%**
Bicycle	0	0	2	2	0.4%
Vehicle overturned	1	6	8	15	3.2%
Fixed object	**27**	**42**	**48**	**117**	**24.8%**
Rear end	**45**	**66**	**81**	**192**	**40.8%**
Other	2	2	9	6	2.8%
Total	**106**	**164**	**201**	**471**	

The collision rate within the project limits on US 101 is 1.47 collisions per million vehicle miles. This is less than the 2007 statewide collision rate of 2.55 for urban principal arterials.

The number of collisions per year by severity is summarized in the following table:

Table 2 US 101 Collisions by Severity					
				3-Year Total	
Collision Type	**2005 Collisions**	**2006 Collisions**	**2007 Collisions**	**Collisions**	**Percent**
Fatal Collisions	1	0	0	1	0.2%
Serious Injury Collisions	0	0	2	2	0.4%
Evident Injury Collisions	4	16	13	33	7.0%
Possible Injury Collisions	30	38	36	104	22.1%
Non-injury Collisions	71	110	150	331	70.3%
Total	**106**	**164**	**201**	**471**	

The type of collision typically corresponds with the severity of the collision. For example, opposite direction head-on crashes tend to be much more severe than rear end type crashes. This area does not have a significant number of serious or fatal injury type crashes, as nearly-three quarters (70%) of the collisions that occurred on US 101 within the West Olympia study area were non-injury collisions. General observation of traffic operations and the collision data indicate that the majority of crashes are due in part to congested conditions and are typically occurring at lower speeds. The collisions are primarily a mix of rear end (vehicles following too closely), sideswipe (typically due to merging vehicles colliding with vehicles on the mainline freeway or vehicles changing lanes), and fixed objects (hitting median barrier, guard rail, sign posts, etc.).

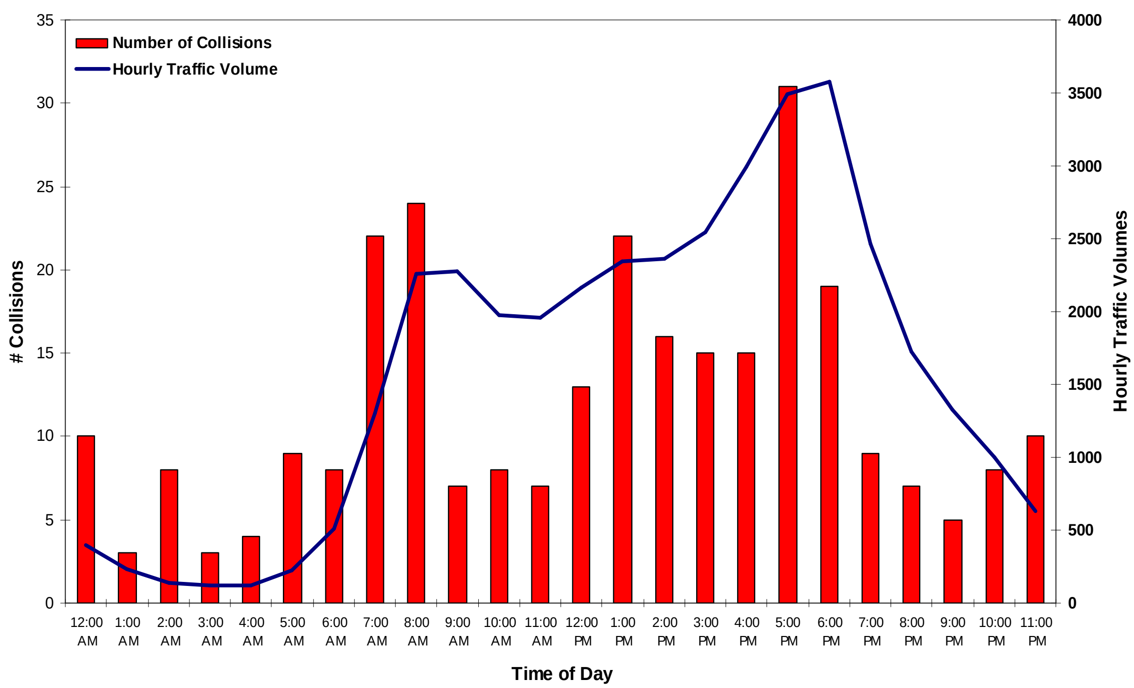
The fatality rate on US 101 is below the 2007 statewide average. During the three year analysis period, there was one fatal collision on US 101 (0.2% of all collisions). This was a single vehicle crash and involved a vehicle striking a fixed object. The operation of a vehicle while under the influence of alcohol was the major contributing factor in this crash.

There were two serious injury collisions (0.4% of all collisions), one of which involved a bicyclist.

Collision Relationship to Traffic Volume
It is fairly common that collisions have a direct correlation to volume and congestion. Figure 2 below provides a graphical representation for the study area along US 101. As shown in the Figure 2, US 101 experienced the highest number of collisions during the evening, morning, and afternoon with the most collisions occurring between the hours of 5pm and 6pm, which happens to be during the evening peak period. The next highest number of crashes occurred between the hours of 7am and 8am. The fact that the majority of crashes were rear end type collisions most of which occurred during the times of the heaviest traffic volumes, suggests that the collisions are primarily congestion related.

The figure below shows the number of collisions as related to the time of day and traffic volumes.

Figure 2
US 101 Collisions by Time of Day

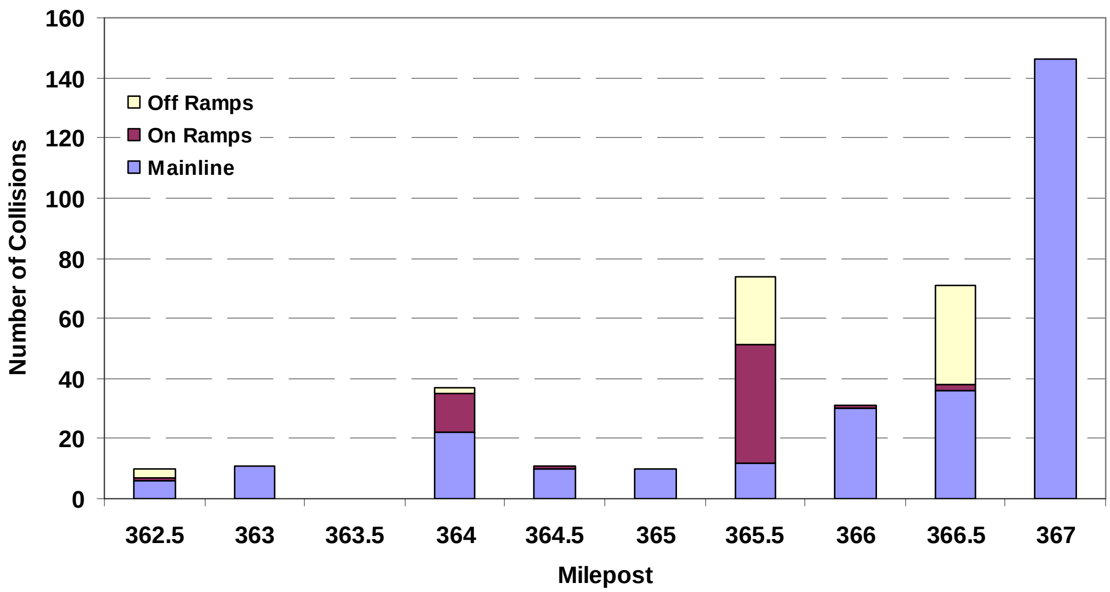


Under 23 United States Code-Section 409, this data cannot be used in discovery or as evidence at trial in any action for damages against the WSDOT, or any jurisdictions involved in the data.

Collisions per Mile

To determine the locations within the study area that had the highest collision rate the collision data was evaluated at half mile intervals. Figure 3 provides a graphical representation of collisions occurrence on the mainline and at the on and off ramps along US 101. By far, the most crashes occurred at the Milepost 367 segment. Most of these collision occurred on the mainline near the terminus of US 101 in the vicinity of the US 101/I-5 interchange

Figure 3
US 101 Collisions by Milepost



Collisions at Interchanges

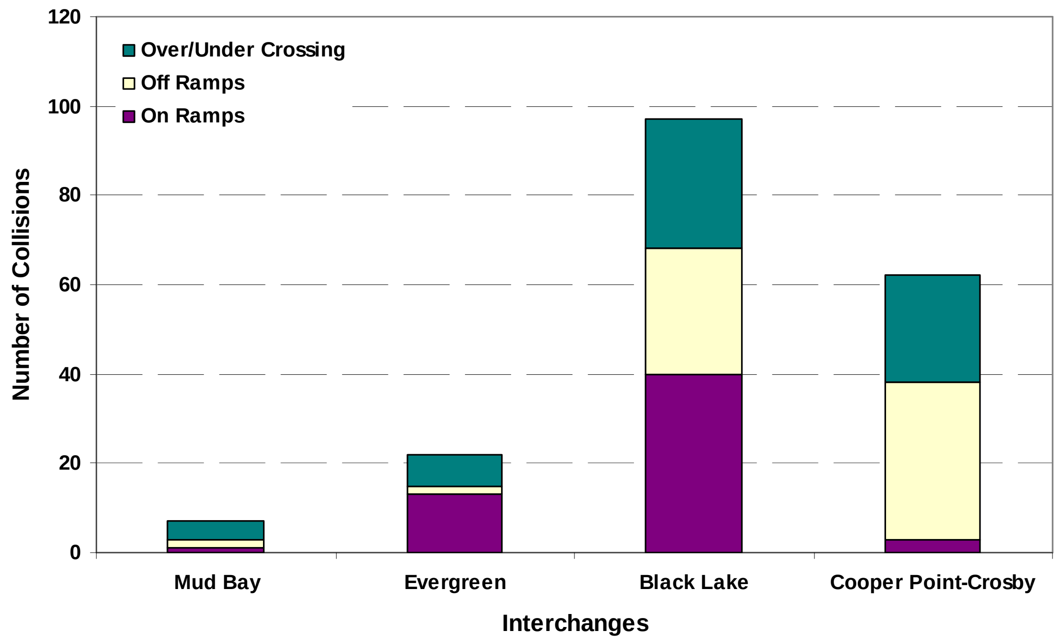
Higher collisions rates at ramp locations are usually expected because drivers experience significantly more decisions points than what they experience on the mainline freeway. Figure 4 below depicts the collision occurrences at the US 101 interchange on and off ramps as well as the interchange over and under crossings within the study area. The four US 101 interchanges accounted for 188 collisions. Seventy percent of the collisions were non-injury collisions.

The Black Lake and Crosby/Cooper Point interchanges accounted for 85% of the collisions that occurred at the four US 101 interchanges. The westbound off and eastbound on ramps accounted for most of the Black Lake ramp collisions, while the westbound off ramp accounted for most collisions at the Cooper Point/Crosby interchange.

For the Black Lake Interchange, at the off ramps, 93% of the crashes were rear end type collisions. For the on ramps, the collisions were fairly evenly spread amongst 3 types of crashes, 35% rear end crashes, 35% sideswipe crashes, and 28% run off the road striking a fixed object.

At the Cooper Point/Crosby Interchange, 86% of the crashes were rear end type collisions, with most occurring at the westbound off ramp. Only three collisions occurred on the Cooper Point/Crosby on ramps, two rear end and one angle collisions. The collisions that occurred on the over/under crossings at both interchanges are primarily located in the vicinity of the intersections at the end of the ramp terminals.

Figure 4
Collisions at US 101 Interchanges



Interstate 5 Collision History Summary

<u>Statistical Analysis</u>
Statistical analysis of the collision history between January 1, 2005, to December 31, 2007 in the study area along Interstate (I-5) concludes the following:

- Over 560 collisions were recorded within the 2.8 mile stretch of I-5.
- This segment averaged 67 collisions per mile per year
- Collisions most frequently occurred between the hours of 5pm and 6pm.
- Non-injury collisions accounted for 65% of all collisions.
- Fatal collisions accounted for 0.4% of all collisions.
- Rear end collisions accounted for 47% of all collisions.
- Fixed object collisions accounted for 21% of all collisions.
- Sideswipe collisions accounted for 15% of all collisions.

<u>Collisions by Type and Severity</u>
The following table summarizes the type of collisions that occurred in the study area along Interstate (I-5). The collision information includes collisions that occurred on mainline I-5 and at interchanges. Interchange collisions include those at on ramps, off ramps and over/undercrossing.

Table 3 I-5 Collisions by Type					
				3-Year Total	
Collision Type	2005 Collisions	2006 Collisions	2007 Collisions	Collisions	Percent
Animal	2	1	1	4	0.7%
Bicycle	0	0	1	1	0.2%
Pedestrian	0	0	1	1	0.2%
Hitting construction	1	1	0	2	0.4%
Roadway ditch	1	0	1	2	0.4%
Head on	1	0	0	1	0.2%
Front end (not head on)	2	3	5	10	1.8%
Angle collision	15	12	11	39	6.7%
Sideswipe	**24**	**29**	**32**	**83**	**15.1.9%**
Vehicle overturned	3	4	5	12	2.1%
Fixed object	**30**	**45**	**45**	**120**	**21.3%**
Rear end	**81**	**81**	**102**	**264**	**46.8%**
Other	12	8	4	23	4.3%
Total	**172**	**184**	**208**	**564**	

Much like the study segment on US 101, rear end type collisions were the predominant collision type on I-5, followed by striking a fixed object and then sideswiping another vehicle. As noted in Table 3 above, 564 collisions were recorded along stretch of I-5 during the three-year period, of which 368 (65%) occurred on the mainline. The collision rate within the project limits on I-5 is 1.71 collisions per million vehicle miles. This is slightly higher than the 2007 statewide collision rate of 1.46 for urban interstates.

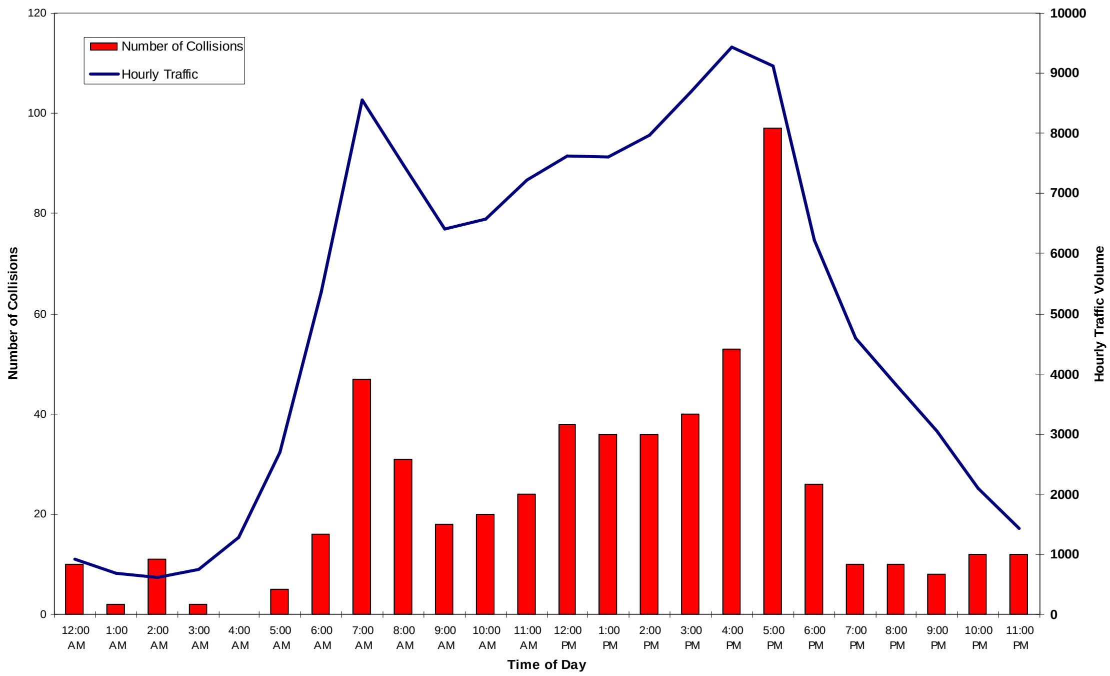
Nearly two-thirds (65%) of the interstate collisions were non-injury collisions. Again as on US 101 the remaining collisions are a primarily mix of sideswipe, angle and hitting fixed objects. The number of collisions per year by severity is summarized in the following table:

Table 4 I-5 Collisions by Severity					
				3-Year Total	
Collision Type	2005 Collisions	2006 Collisions	2007 Collisions	Collisions	Percent
Fatal Collisions	1	0	1	2	0.4%
Serious Injury Collisions	0	2	0	2	0.4%
Evident Injury Collisions	13	17	9	39	7%
Possible Injury Collisions	38	52	65	155	27%
Non-injury Collisions	120	113	133	366	65%
Total	**172**	**184**	**208**	**564**	

During the 3 year analysis period, there were two collisions that involved fatal injuries. Both of these crashes involved motorcycles. One crash involved a motorcycle striking guardrail, while the other was a sideswipe crash with another vehicle. Also, there were two crashes that resulted in serious injuries. One crash involved an overturned vehicle and the other was a sideswipe involving a motorcycle. Both were in the vicinity of the Capitol/Port of Olympia interchange.

<u>Collision Relationship to Traffic Volume</u>
As seen in the analysis of US 101 mainline, there is correlation between the collisions that occur on I-5 mainline and traffic volumes and congestion. Figure 5 below provides a graphical representation of the study area along I-5.

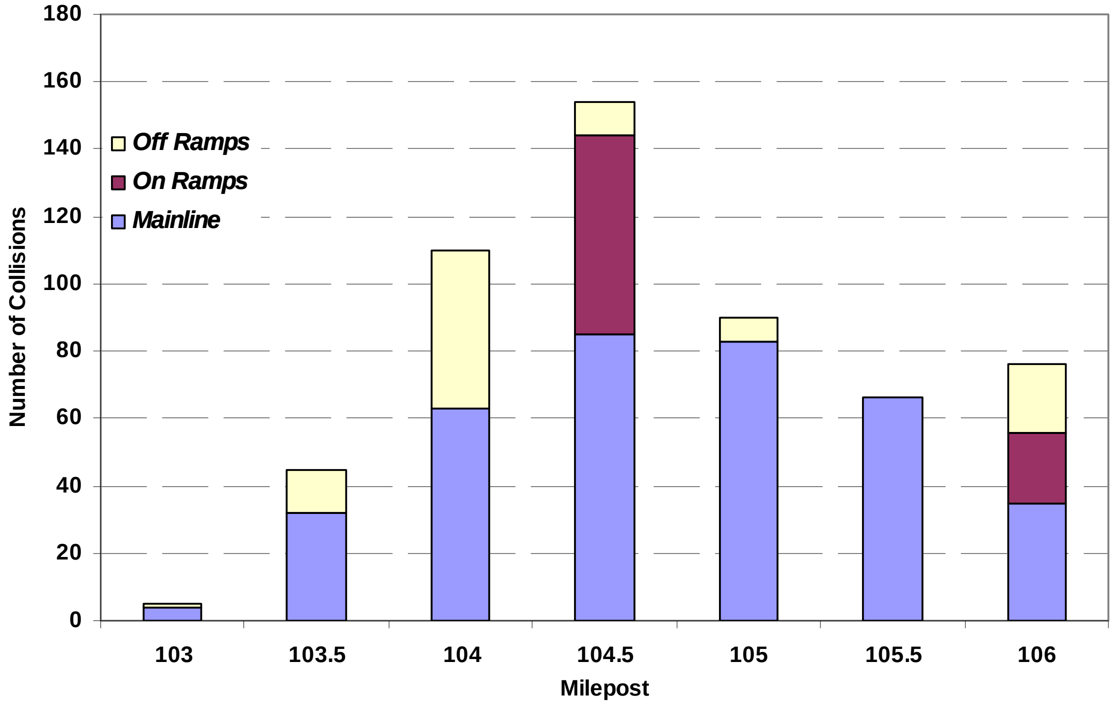
Figure 5
I-5 Collisions by Time of Day



As shown in the Figure 5 the highest number of collisions on I-5 mainline occurred during the evening peak period, between 5pm and 6pm. Again as with US 101 the highest type of collisions along I-5 in the study area being rear end collisions and the highest number of collisions occur during peak traffic periods.

<u>Collisions per Mile</u>
To determine which segments within the study area had the highest number of collisions collision data was evaluated at half mile intervals. Figures 6 provide a graphical representation. On average I-5 within the study area had 67 collisions per mile per year. As represented in Figure 6 the highest number of collisions was in the vicinity of the US 101/I-5 interchange (milepost 104.5).

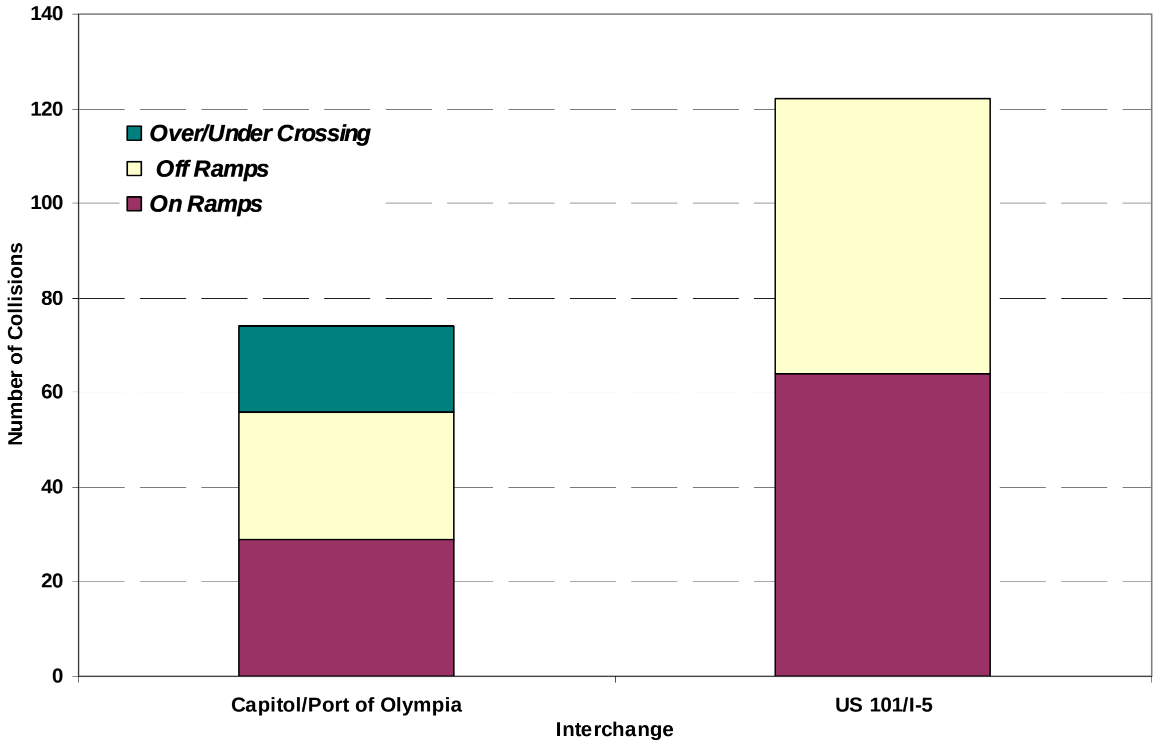
Figure 6
I-5 Collisions by Milepost



Collisions at Interchanges

Figure 7 below depicts the collision occurrences at the I-5 interchange on and off ramps as well as the interchange over and under crossings within the study area. The two I-5 interchanges within the study area accounted for 196 of all I-5 collisions. As with US 101, non-injury collisions accounted for 67% of the I-5 interchanges collisions. Though rear ends collisions was still the predominate type of collision at the I-5 interchanges, striking fixed objects, sideswipe and angle collisions were also prevalent at these locations. In general, the northbound ramps had more collisions ~~occur~~ than the southbound ramps.

Figure 7
Collisions at I-5 Interchanges



WSDOT Accident history - High Accident Locations (HAL) and Corridors (HAC)
Washington State Department of Transportation (WSDOT) regularly reviews the accident history of all state highways to look for problem locations. The two main approaches used in these reviews are identifying High Accident Locations (HALs) and High Accident Corridors (HACs).

High Collision Locations (HAL) - spot locations less than a mile long which have experienced a higher than average rate of severe accidents during the previous two years

High Collision Corridors (HAC) – are sections of state highway one or more miles long, which have a higher than average number of severe accidents over a continuous period of time.

Table 5 below lists the designated locations of the HACs and HALs on I-5 and US 101 within the West Olympia study area.

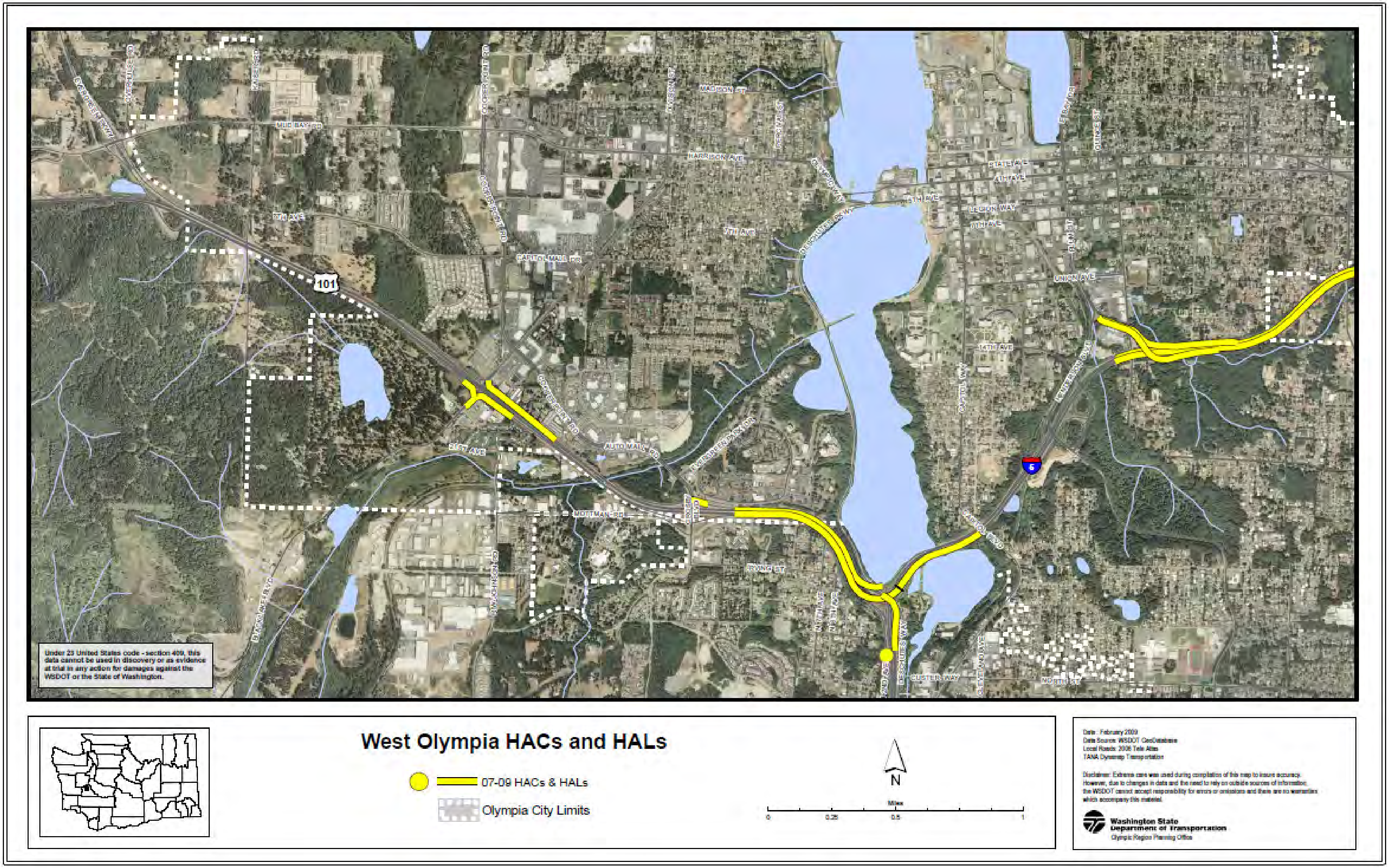
Table 5 HAC and HAL within Study Area					
State Route	**HAC/HAL**	**Begin MP**	**End MP**	**Travel Direction**	**Description**
I-5	HAC	105.62	107.61	I-5	Mainline from State Capitol/Port of Olympia Interchange to Pacific Avenue ramps. Two HALs are located within this HAC.
I-5	HAL	106.10		I-5 Southbound	HAL located on Plum Street off ramp
I-5	HAL	106.23		I-5 Northbound	HAL located on Plum Street on ramp
I-5	HAL	104.02		I-5 Northbound	HAL located on the off ramp to US 101
I-5	HAL	104.35		I-5 Southbound	HAL located on the end of 2nd Avenue off ramp with intersection of DeSoto Street
I-5	HAL	104.81		I-5 Northbound	HAL located on the on ramp from US 101
US 101	HAC	366.59	367.41	US 101	Mainline US 101 from I-5 to Cooper Point Road/Crosby Road Interchange.
US 101	HAC	366.90	367.41	US 101	Mainline US 101 from Cooper Point Road/Crosby Road HAL is within this HAC.
US 101	HAL	366.68		US 101 Westbound	HAL located on the Cooper Point Off Ramp
US 101	HAL	365.03		US 101 Eastbound	HAL located on the Black Lake Off Ramp
US 101	HAL	365.91		US 101 Eastbound	HAL located on the Black Lake On Ramp
US 101	HAL	365.98		US 101 Westbound	HAL located on the Black Lake Off Ramp

Source: WSDOT 2007-2009 HAC & HAL List

On the US 101 corridor there are two HACs, both of which are located within the last mile of US 101. While on I-5 there is one HAC which is located at the north end of the study area and extends beyond the study boundary.

There are four HALs located on US 101 within the study limits. Each of these HALs was situated on highway on and off ramps. One HAL was within the Crosby Road/Cooper Point Road Interchange, while the other three HALs were within the Black Lake Interchange. On I-5 all of the HALs identified in the study area were located on highway on and off ramps. Two HALs were located at the State Capitol/Port of Olympia Interchange while the other three HALs were within the US 101/I-5 Interchange.

Figure 8
WSDOT 2007-2009 HAC & HAL Locations



Local Road Collisions History
An analysis was performed of collisions that occurred on city and county streets within the West Olympia Access Study limits. Only the collision data for the segment of streets that are within the study limits was considered. Within study area during the three-year timeframe, there were a total of 887 collisions on roads that made up the local system in the study area.

Local Road Collision History Summary

Statistical Analysis
Statistical analysis of the collision history for the period January 1, 2005, to December 31, 2007 on the local system in the study area concludes the following:

- Intersection related collisions accounted for 54% of all collisions.
- The highest number of collisions occurs between 3pm and 6pm.
- Non-injury collisions accounted for 72% of all collisions.
- Fatal collisions accounted for 0.1% of all collisions.
- Rear end collisions accounted for 46% of all collisions.
- Right Angle collisions accounted for 22% of all collisions.
- Sideswipe collisions accounted for 15% of all collisions.
- Eight of the 35 City of Olympia High Collision Locations are in West Olympia

Collisions by Type and Severity
The following table summarizes the type of collisions that occurred on the local network in the study area US 101. The collision information includes collisions that occurred on the roadway mainline and at the associated intersections.

Table 6
Local Roads Collisions by Type

				3-Year Total	
Collision Type	2005 Collisions	2006 Collisions	2007 Collisions	Collisions	Percent
Animal	0	1	0	1	0.1%
Approach Turns	23	15	25	63	7.6%
Backing	3	4	2	9	1.1%
Fixed object	19	13	18	50	6.0%
Head On	3	1	1	5	0.6%
Pedestrian/Cyclist	12	8	24	44	5.3%
Rear end	122	126	137	385	46.4%
Right Angle	52	69	60	181	21.8%
Sideswipe	30	42	51	123	14.8%
Front end	0	0	0	0	0.0%
Roadway Ditch/Over Embankment	4	0	1	5	0.6%
Vehicle overturned	3	1	1	5	0.6%
Other	5	7	4	16	1.9%
Total	**276**	**287**	**324**	**887**	

As with the collisions that occurred on the state system rear end collisions were the primary collision type accounting for 46% of all collisions that occurred on the local system; followed by right angle collisions and sideswiping another vehicle. Right angle collisions as defined by the City of Olympia are collisions in which one vehicle is turning right and is struck by another vehicle, this type of collision is predominately intersection or driveway related collisions.

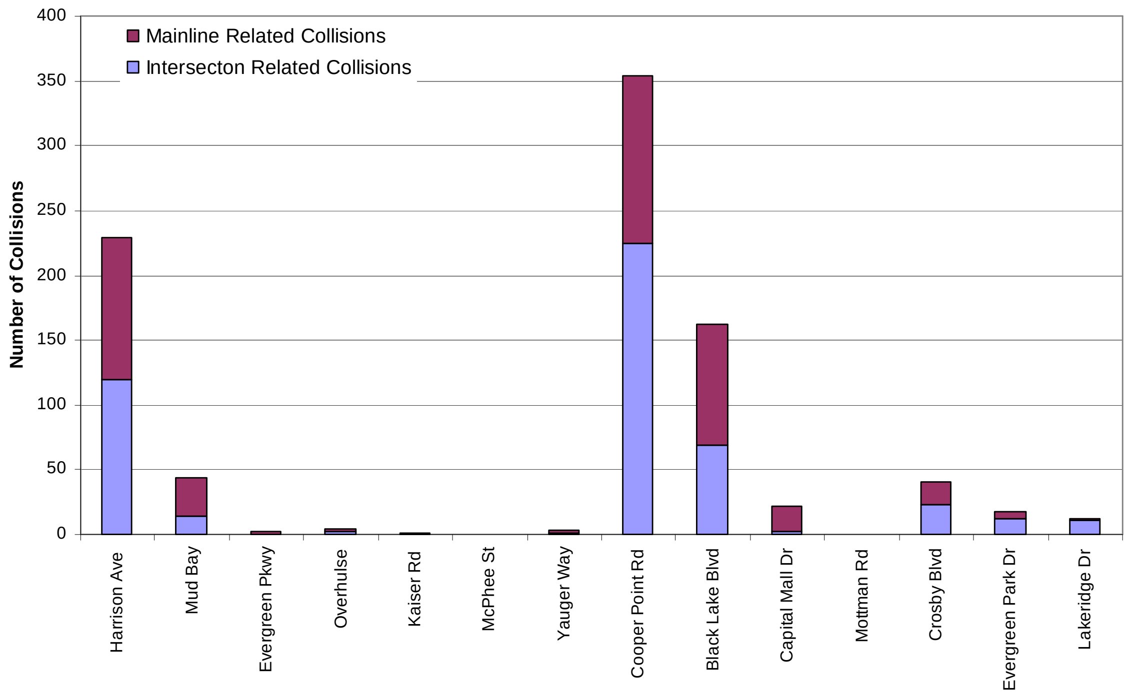
The number of collisions a year by severity is summarized in the following table. Non-injury collisions accounted for approximately 72% of the local network collisions. Only one fatal collision occurred within the study area on the local network during the three-year period. The fatal collision involved a bicyclist not granting right of way to a vehicle on the Mud Bay Road mainline.

Table 7
Local Roads Collisions by Severity

				3-Year Total	
Collision Type	**2005**	**2006**	**2007**	**Collisions**	**Percent**
Fatal Collisions	0	0	1	1	0.1%
Injury Collisions	87	73	90	250	28.2%
Non-injury Collisions	189	214	233	636	71.7%
Total	**276**	**287**	**324**	**887**	

The following figure depicts the number of collisions that occurred on the individual local network roads. Intersection related collisions accounted for 54% of the collisions on the local network in the study area. Facilities with the highest number of collisions coincide with the three principal arterials in the study area; Cooper Point Road with 354 collisions, Harrison Avenue with 229 collisions and Black Lake Boulevard with 162 collisions. Adding the county segment of Mud Bay Road to Harrison Avenue collision totals, the Harrison/Mud Bay corridor accounts for 273 collisions for the three-year period. These three arterials account for approximately 90% of all the local network collisions within the study area.

Figure 9
Local Network Collisions



On each of the three arterials, almost 46% of the collisions were the result of rear end type collisions. Following rear collisions the most common collisions that occurred on these three arterials include, right angle (19%), and sideswipe (15%). Table 8 summarizes the most common types of collisions that occurred on these three arterials. Combining this with the fact that property damage only collisions are the primary severity type collision highly suggest that congestion is a contributing factor to collisions. The time of the day that had the most traffic collisions was between 3 pm and 6 pm.

Table 8
Common Collision Types on Arterials

	Rear End	Right Angle	Sideswipe	Approach Turns
Black Lake Blvd	71	20	39	10
Harrison Ave/Mud Bay	88	76	29	28
Cooper Point Rd	203	53	50	16
Total	362	149	186	54

Source: City of Olympia

Intersections are frequent location of collisions, 54% of the collisions on the local network in the study area were at intersections. As anticipated the common type of collisions that occurred at intersections were rear end, sideswipe and right angle collisions. The City of Olympia identifies their High Collision Locations where a significant number of intersection-related collisions occurred and ranked by the collision rate of each intersection. All of the High Collision Locations identified by the city are intersection related. Of the 35 intersections identified as High Collision Locations in the City of Olympia for the period 2005-2007 eight were located in West Olympia. Table 9 shows these eight high collision location intersections; all of which are related to one of the three key arterials, Cooper Point Road, Harrison Avenue, and Black Lake.

Table 9
West Olympia High Collision Locations

Ranking	Location	Number of Collisions	Collision Rate
14	Black Lake Blvd at Cooper Point Rd	58	0.9
17	Black Lake Blvd at Capital Mall/9th Ave	25	0.77
19	Capital Mall at Cooper Point Rd	27	0.75
21	12th Ave at Cooper Point Rd	22	0.71
22	Harrison at West Bay Dr	21	0.65
24	Division at Harrison Ave	21	0.58
26	Harrison Ave at Perry St	15	0.58
34	Cooper Point Rd at Harrison Ave	14	0.37

Source: City of Olympia

Alternative Safety Comparison

A comparative statistical safety analysis of the two alternatives carried forward for additional analysis was performed. This analysis considered potential for collisions at intersections and along the US 101 segments as associated with each improvement alternative in 2030. The two alternatives considered are:

Black Lake Interchange: The existing Black Lake interchange would be modified with an additional lane diverging from the westbound off-ramp that connects to Yauger Way SW, and another lane from Yauger Way SW would connect to the existing eastbound on-ramp prior to merging with the US 101 mainline. The option includes local system improvements to local intersections.

Evergreen Interchange: The Evergreen interchange primarily consist of adding an eastbound off-ramp and a westbound on-ramp, which would provide full access to and from all directions of travel at the Evergreen interchange. The existing eastbound on-ramp and westbound off-ramp would also be re-aligned to provide an at-grade connection with Kaiser Road SW prior to merging/after diverging from the US 101 mainline. The option also includes local system improvements to local intersections.

Intersection Collisions

An analysis of intersections was based on statistical models as identified in FHWA PUBLICATION NO. FHWA-RD-99-094*, Statistical Models of At-Grade Intersection Accidents—Addendum*, (MARCH 2000). This is an addendum to the work published in FHWA publication FHWA-RD-96-125 titled *Statistical Models of At-Grade Intersections*. The objective of both research studies was to develop statistical models of the relationship between traffic accidents and highway geometric elements for at-grade intersections. The addendum presents predictive models based on all collision types including both multiple-vehicle and single-vehicle accidents.

Specifically the analysis used the research report charts which depict number of collisions per year as a function of traffic volumes. The charts provide the variation of the annual number of intersection accidents with major road and crossroad average daily traffic

(ADT) to predict the number of collisions per year. Intersection types considered were urban, four-leg, stop-controlled intersections; urban, three-leg, stop-controlled intersections; and urban, four-leg, signalized intersections (Attachment A).

The analysis used the 2030 intersection traffic volumes for each option as identified in the study's *Traffic Operations Analysis Technical Memorandum 3* (Attachment B). After determining the ADT for each intersection these values were applied to the appropriate chart to arrive at an "order of magnitude" estimate of collisions at each intersection for each interchange option. Based on the predictive models the following is the resulting estimated total number of intersection related collisions that could be expected to occur in a year at study area intersections.

Black Lake Interchange	Evergreen Interchange
129	130

The total average number of intersection related collisions that occurred during the three-period (2005-2007) was approximately 159.7.

For screening purposes the analysis focused on key intersections that were identified on the arterials making up the 'triangle', these included the Cooper Point Road Harrison Avenue, Division at Harrison Avenue, and Black Lake Blvd at Cooper Point Road intersections. The analysis, summarized in Table 10, indicates that for each option the total number of intersection related collisions that could be expected to occur is similar.

Table 10
Annual Collision Projections

	Black Lake Interchange			Evergreen Interchange		
Intersection Description	**Accidents**	**ADT**	**LOS (Delay)**	**Accidents**	**ADT**	**LOS (Delay)**
Black Lake Blvd/Cooper Point Rd	10.2	79613	E (78.5)	10.3	82388	E (65.1)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	8	58075	E (74.9)	7.9	57513	E (71.3)
Harrison Ave/Division St	7.9	55675	E (76.2)	7.9	56313	E (79.4)
	26.1			**26.1**		

Freeway Segments

The collision history for US 101 within the study area indicates that most of the collisions have been congestion related. As noted in Section 1.5.3 Safety of FHWA, *Freeway Management and Operations Handbook*, though the details of the relationship between congestion and safety are not well defined, it is generally accepted congestion and collisions are directly related. Collisions increase as congestion increases, but the severity of the crashes is generally lower. Also, crashes in congestion tend to lead to secondary crashes.

The statistical analysis of the two interchange alternatives considered the freeway PM Period traffic volumes as identified in the study's *Traffic Operations Analysis Technical Memorandum 3* as well as the collision rate based on the three-year collision data (2005-2007) for the same freeway segments of US 101. The 2005-2007 collision rate was applied to the 2030 volumes in order to project future collision numbers.

Based on the premise that additional congestion leads to additional crashes, the collision projections were modified for the segments of freeway that are expected to experience a decrease in level of service (LOS). The analysis assumed that each step of degradation in LOS leads to a 5% increase in crashes during the peak period (i.e. A to B = 5% B to C =5%, A to C = 10%, B to D = 10%, etc.) This factor was only applied to crashes that occurred during the peak period, since the worse LOS will predominately occur during the peak period.

Adding access to a freeway introduces additional conflict points which also tend to lead to more crashes. Taking this into account the freeway segment analysis considered the number of mainline conflict points as an indicator of mainline safety. In essence these are defined as the number of access points, which could impact the overall safety record of the freeway system within the study area. These include ramp merge and diverges and assume that design criteria has been met by the design. In addition the analysis considered the LOS that is expected at these congested conflict zones. The basic relationship between LOS and accidents is increases in vehicle delay result in a decrease in LOS performance and decrease in LOS performances could typically result in an increase in collisions.

The analysis also considered safety by evaluating each option in reference to ability to meet design standards, guidelines and sanctioned design procedures. Whenever a deviation or the differences from the design level specified in the *Design Manual* is needed to implement a design increases the possibility for a potential collision to occur. The analysis compared each option as to their ability to meet design standards according the *WSDOT Design Manual* by considering the number of potential deviations that could be required to gain endorsement of each design. A summary of the analysis is shown in Table 11.

Table 11
Conflict Points and Design Standard Considerations

Black Lake Interchange			Evergreen Interchange		
Conflict Points		**Ability to meet standards**	**Conflict Points**		**Ability to meet standards**
• two weaves (eastbound Black Lake -Crosby, westbound Crosby-Black Lake) • two merges (eastbound Evergreen on-ramp, westbound Black Lake on-ramp) • two diverges (eastbound Black Lake off-ramp, westbound Evergreen off-ramp)	• three are LOS D or better • two are LOS E • one is LOS F	• one deviation for superelevation runoff distance, which may be needed on new westbound bridge crossing over Black Lake Blvd. • three potential design issues, but not necessarily deviations which include: o weaving distance westbound between Black Lake interchange and Crosby interchange o advance signing of westbound off-ramp to Black Lake Blvd and new collector-distributor to Yauger o westbound collector-distributor transition from ramp into local roadway (Yauger Way) and new intersection at 9th	• four weaves (eastbound Black Lake–Crosby & Evergreen-Black Lake, westbound Crosby-Black Lake & Black Lake-Evergreen) • two merges (eastbound Evergreen on-ramp, westbound Black Lake on-ramp) • two diverges (eastbound Black Lake off-ramp, westbound Evergreen off-ramp)	• four conflict points are LOS D or better • two are LOS E • two are LOS F	• no deviations currently identified. • two potential design issues, but not necessarily deviations include; o weaving distance both directions of SR 101 between Kaiser interchange and Black Lake interchange o westbound off-ramp to Kaiser. If tight diamond configuration, the off-ramp may be tying into a steep cross-grade on Kaiser Road. This is not ideal for large trucks turning against the steep cross-grade.

APPENDIX C

Operational Analysis Comparison

Travel Time (4:30-5:30)

Segment	2007 Existing Conditions	2030 No-Build Scenario 1	2030 Black Lake Interchange Scenario 5	2030 Evergreen Interchange Scenario 7	2030 Hybrid Interchange Scenario 9
Eastbound 101					
Start of model to Mud Bay On Ramp	42	44	43	43	43
Mud Bay On Ramp to Black Lake On Ramp	196	470	211	211	201
Black Lake On Ramp to Crosby On Ramp	50	71	61	58	61
Crosby On Ramp to I-5 Off Ramp	36.02	67	57	65	71
Eastbound 101 Total Travel Time	**324**	**652**	**372**	**378**	**376**
Eastbound 101 Speed (mph)	**59**	**29**	**51**	**51**	**51**
Westbound 101					
I-5 On Ramp to Crosby On Ramp	72	76	81	76	76
Crosby On Ramp to Black Lake On Ramp	71	76	77	74	73
Black Lake On Ramp to Mud Bay Off Ramp	134	138	138	138	137
Mud Bay Off Ramp to Model End	58	61	61	61	61
Westbound 101 Total Travel Time	**336**	**350**	**357**	**350**	**347**
Westbound 101 Speed (mph)	**57**	**55**	**54**	**55**	**55**
Northbound I-5					
Start of model to US 101 Off Ramp	32	34	34	35	34
US 101 Off Ramp to US 101 On Ramp	31	33	33	34	33
US 101 On Ramp to 14th St Off Ramp	41	66	73	71	73
14th St Off Ramp to Model End	22	23	23	23	23
Northbound I-5 Total Travel Time	**127**	**155**	**163**	**163**	**164**
Northbound I-5 Speed (mph)	**58**	**48**	**45**	**45**	**45**
Southbound I-5					
Start of model to 14th St On Ramp	185	205	201	200	201
14th St On Ramp to US 101 Off Ramp	34	35	34	34	34
US 101 Off Ramp to US 101 On Ramp	43	43	43	43	43
Southbound I-5 Total Travel Time	**261**	**282**	**278**	**278**	**278**
Southbound I-5 Speed (mph)	**29**	**27**	**28**	**28**	**28**

Speeds

	2007 Existing Conditions	2030 No-Build Scenario 1	2030 Black Lake Interchange Scenario 5	2030 Evergreen Interchange Scenario 7	2030 Hybrid Interchange Scenario 9
Southbound I-5	(4:30-5:30)	(4:30-5:30)	(4:30-5:30)	(4:30-5:30)	(4:30-5:30)
City Center Off Ramp	35	29	29	29	29
City Center On Ramp	33	32	33	33	33
I-5/US 101 Weave	46	46	47	46	46
US 101 Off Ramp	59	58	59	59	58
US 101 On Ramp	53	49	48	48	48
Average Southbound I-5 [1]	**46**	**43**	**43**	**42**	**42**
Northbound I-5					
City Center Off Ramp	60	58	58	58	58
US 101 On Ramp	57	51	50	50	50
US 101 Off Ramp	60	57	57	56	57
Average Northbound I-5 [1]	**59**	**56**	**55**	**56**	**56**
Westbound US 101					
Mud Bay Interchange	60	59	59	58	59
Evergreen Pkwy On Ramp	NA	NA	NA	59	NA
Evergreen Pkwy Off Ramp	60	59	59	58	59
Black Lake On Ramp	59	55	56	55	57
Black Lake Off Ramp	59	57	57	57	58
Crosby Blvd/Cooper Point Off Ramp	45	43	42	43	43
US 101/I-5	51	48	47	46	47
Average Westbound US 101 [1]	**58**	**56**	**56**	**56**	**56**
Eastbound US 101					
Mud Bay Interchange	60	57	59	59	59
Evergreen Pkwy Off Ramp	NA	NA	NA	57	NA
Evergreen Pkwy On Ramp	59	47	57	50	59
Kaiser On Ramp	NA	NA	NA	NA	59
Black Lake Off Ramp	60	59	59	59	59
Black Lake On Ramp	60	58	58	59	59
Crosby Blvd/Cooper Point On Ramp	56	50	50	51	49
US 101/I-5	55	45	45	43	44
Average Eastbound US 101 [1]	**59**	**54**	**57**	**56**	**56**

[1] Inclusive of all measurement points between areas listed

Freeway LOS and Densities

Segment	Type	2030 No-Build Scenario 1		2030 Black Lake Interchange Scenario 5		2030 Evergreen Interchange Scenario 7		2030 Hybrid Interchange Scenario 9	
		Density (pc/mi/ln)	LOS (HCM Equivalent)	Density (pc/mi/ln)	LOS (HCM Equivalent)	Density (pc/mi/ln)	LOS (HCM Equivalent)	Density (pc/mi/ln)	LOS (HCM Equivalent)
Westbound US 101									
WB US 101 e/o Crosby Blvd	Basic	38	E	43	E	43	E	42	E
WB US 101 Crosby Blvd Off-Ramp	Diverge	50	**F**	57	**F**	54	**F**	56	**F**
WB US 101 Mainline	Basic	26	C	28	D	26	D	27	D
WB US 101 Crosby Blvd/Black Lake Weave	Weave	24	C	30	C	24	C	24	C
WB US 101 Mainline	Basic	30	D	29	D	31	D	27	D
WB US 101 Black Lake On-Ramp	Merge	26	C	26	C	31	D	23	C
WB US 101 Mainline	Basic	36	E	35	E	NA	NA	34	D
WB US 101 Evergreen Off-Ramp/ Black lake Off-Evergreen On Weave**	Diverge/ Weave	33	D	32	D	40	**F**	32	D
WB US 101 Mainline	Basic	NA	NA	NA	NA	26	C	NA	NA
WB US 101 Evergreen On-Ramp	Merge	NA	NA	NA	NA	21	C	NA	NA
WB US 101 Mainline	Basic	26	C	27	D	27	D	28	D
WB US 101 Mud Bay Off-Ramp	Diverge	26	C	28	C	27	C	29	D
WB US 101 Mainline	Basic	26	C	27	D	26	D	28	D
WB US 101 Mud Bay On-Ramp	Merge	26	C	24	C	28	C	26	C
WB US 101 Mainline	Basic	35	E	34	D	36	E	35	E
Westbound US 101 Average		**31**		**32**		**31**		**32**	
Eastbound US 101									
EB US 101 Mainline	Basic	26	D	27	D	27	D	26	D
EB US 101 Mud Bay Off-Ramp	Diverge	30	D	29	D	28	D	29	D
EB US 101 Mainline	Basic	27	D	24	C	23	C	23	C
EB US 101 Mud Bay On-Ramp	Merge	29	D	15	B	15	B	15	B
EB US 101 Mainline	Basic	124	**F**	26	D	25	C	25	C
EB US 101 Evergreen Off-Ramp	Diverge	NA	NA	NA	NA	27	C	NA	NA
EB US 101 Mainline	Basic	NA	NA	NA	NA	24	C	NA	NA
EB US 101 Evergreen On-Ramp	Merge	133	**F**	26	C	49	**F**	20	C
EB US 101 Mainline	Basic	137	**F**	38	E	NA	NA	20	C
EB US 101 Kaiser On-Ramp	Merge	NA	NA	NA	NA	NA	NA	15	B
EB US 101 Black Lake Off-Ramp/ Kaiser On-Black Lake Off Weave*	Diverge/ Weave	131	**F**	37	E	37	E	26	C
EB US 101 Mainline	Basic	17	B	24	C	28	D	28	D
EB US 101 Black Lake On-Ramp	Merge	15	B	24	C	21	C	21	C
EB US 101 Mainline	Basic	20	C	35	D	30	D	29	D
EB US 101 Crosby Blvd Off-Ramp	Diverge	19	B	31	D	29	D	29	D
EB US 101 Mainline	Basic	19	C	27	D	29	D	32	D
EB US 101 Crosby Blvd On-Ramp	Merge	19	B	39	E	48	**F**	58	**F**
EB US 101 Mainline	Basic	32	D	58	**F**	62	**F**	65	**F**
Eastbound US 101 Average		**52**		**31**		**31**		**29**	
Northbound I-5									
NB I-5 Mainline	Basic	33	D	33	D	34	D	33	D
NB I-5 US 101 Off-Ramp	Diverge	41	E	44	E	46	**F**	43	E
NB I-5 Mainline	Basic	29	D	29	D	29	D	29	D
NB I-5 US 101 On-Ramp	Merge	81	**F**	117	**F**	115	**F**	117	**F**
NB I-5 Mainline	Basic	38	E	40	E	40	E	40	E
NB I-5 Plum/14th Off-Ramp	Diverge	32	D	33	D	33	D	34	D
NB I-5 Mainline	Basic	30	D	31	D	31	D	32	D
Northbound I-5 Average		**40**		**47**		**47**		**47**	
Southbound I-5									
SB I-5 Mainline	Basic	81	**F**	78	**F**	79	**F**	78	**F**
SB I-5 US 101 Weave	Weave	57	**F**	56	**F**	57	**F**	56	**F**
SB I-5 Mainline	Basic	24	C	24	C	24	C	24	C
SB I-5 Deschutes Pkwy Off-Ramp	Diverge	21	C	21	C	21	C	21	C
SB I-5 Mainline	Basic	24	C	23	C	23	C	23	C
SB I-5 US 101 On-Ramp	Merge	43	E	48	**F**	46	**F**	49	**F**
SB I-5 Mainline	Basic	34	D	35	E	35	D	35	E
Southbound I-5 Average		**40**		**41**		**41**		**41**	
LOS A			0		0		0		0
LOS B			4		1		1		2
LOS C			12		11		13		12
LOS D			12		16		16		17
Total # of Segments Operating at LOS E			**6**		**8**		**4**		**5**
Total # of Segments Operating at LOS F			**8**		**6**		**10**		**7**
Average of All Densities		**42**		**36**		**36**		**35**	
Sum of All Densities		**1710**		**1459**		**1458**		**1454**	

*Diverge segment for Scenario 5. Weave Segment for scenarios 7 and 9

** Diverge segment for Scenarios 5 and 9. Weave segment for Scenario 7

West Olympia Access Study
Intersection Level of Service

1-Hour Analysis

		2007 Existing Conditions	2030 No-Build Scenario 1	2030 Local System Only w/o SW Connections Scenario 2	2030 Local System Only w/ SW Connections Scenario 3	2030 Black Lake Interchange w/o SW Connections Scenario 4	2030 Black Lake Interchange w/ SW Connections Scenario 5	2030 Evergreen Interchange w/o SW Connections Scenario 6	2030 Evergreen Interchange w/ SW Connections Scenario 7	2030 Hybrid Interchange w/o SW Connections Scenario 8	2030 Hybrid Interchange w/ SW Connections Scenario 9
Intersection Description	**Intersection Control[a]**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**	**LOS (Delay)**
Harrison Ave/Division St	Signalized	F (84.7)	F (187.1)	F (84.7)	E (77.9)	F (81.3)	E (76.2)	F (89.4)	E (79.4)	F (82.3)	E (78.6)
Black Lake Blvd/Cooper Point Rd	Signalized	F (85.2)	F (199.9)	F (126.9)	F (86.6)	F (114.4)	E (67.7)*	F (120.4)	E (65.1)	F (108.3)	E (63.9)
US 101 SPUI (Through/Lefts)/Black Lake Blvd	Signalized	E (63.2)	F (187)	F (140.7)	F (130.8)	E (70.3)	E (72.5)	E (77.9)	F (82.4)	E (75.1)	E (79)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	Signalized	D (49.6)	F (110.3)	E (74.2)	E (70)	E (79.6)	E (74.9)	E (75.7)	E (71.3)	E (74.3)	E (73.3)
Cooper Point Rd/Capitol Mall Blvd	Signalized	D (38.2)	F (112.8)	E (75)	E (75)	E (77.2)	E (70.8)	E (57.8)	E (69.2)	E (75.4)	E (74.3)
Black Lake Blvd/9th Ave/Capital Mall Dr	Signalized	C (32.6)	F (101.2)	F (88.5)	F (100.1)	F (102.8)	E (77.5)	F (101.4)	E (78.1)	E (74.8)	E (75)
Cooper Point Rd/Automall Dr/Evergreen Park Dr	Signalized	C (27.6)	F (162.4)	E (71.4)	E (77.4)	E (57.3)	E (71.1)	F (82.5)	F (84.9)		
Cooper Point Rd/Top Foods Entrance	Signalized	C (24.5)	F (85.7)	E (77.9)	E (77.8)	D (42.3)	D (41.5)	D (49.8)	E (67.4)	D (52.9)	D (48.5)
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	Signalized	C (21)	E (65.9)	E (64.5)	E (64.8)	F (87)	E (57.5)	E (76.6)	E (58.2)		
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd	Signalized	B (19.3)	F (114.5)	C (33.5)	D (36.9)	E (68.5)	C (33.4)	E (69.4)	C (26.2)		
Crosby Blvd/Mottman Rd	Signalized	B (18.8)	E (64.4)	D (38.8)	D (38.6)	D (38.7)	C (29.1)	D (42.6)	C (24.9)		
Crosby Blvd/Irving St	Signalized	B (13.9)	C (24.7)	D (39.3)	D (39.2)	C (21.7)	C (26.8)	C (25.7)	C (20.5)		
Harrison Ave/Kenyon St	Signalized	B (12.4)	C (20.7)	C (20.5)	C (20.4)	C (20.8)	C (20.4)	C (20.9)	C (20.5)		
Black Lake Blvd/Capital Mall Entrance	Signalized	B (10.4)	B (12.3)	B (12.3)	B (10.6)	B (12.3)	B (11.1)	B (12.2)	B (10.7)		
Harrison Ave/Yauger Wy	Signalized	A (8.6)	C (20.7)	C (25.9)	C (24.7)	C (32.4)	C (28.7)	C (26.8)	C (28.3)		
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd	Signalized	A (8)	A (6.4)	B (10)	A (9.1)	A (7.9)	A (6.2)	A (8.2)	A (6.7)		
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd	Signalized	A (2.7)	A (7.3)	A (3.2)	A (3.4)	A (3.2)	A (3.5)	A (4.2)	A (2.8)		
Harrison Ave/McPhee Rd	Unsignalized	F (>200)	C (21.7)	C (21.7)	C (20.9)	D (29.6)	D (28.9)	C (21.3)	C (19)		
Harrison Ave/Kaiser Rd	Unsignalized	F (158.5)	A (8.2)	B (13.2)	B (12.2)	B (10.5)	B (11)	B (11.2)	B (11.4)	B (10.7)	B (13.2)
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	Unsignalized	F (>200)	F (>200)	C (30.4)	C (32.5)	C (32.3)	C (34.3)	B (16.6)	C (30.7)		
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	Unsignalized	F (>200)	F (>200)	B (19.6)	C (20.8)	B (16.7)	B (15.5)	C (22.7)	B (19.2)		
Black Lake Blvd/Top Foods Entrance	Unsignalized	C (22.7)	E (45.8)	E (41.1)	F (55.8)	C (21)	C (23.1)	D (30.1)	D (31.3)		
Lakeridge Dr/Deschutes Prkwy	Unsignalized	C (16.9)	F (>200)	B (14.3)	D (50.3)	B (13.9)	D (43.3)	B (15)	D (41.6)		
Kaiser Rd/7th Ave	Unsignalized		NA				NA		NA	D (29.4)	D (29.1)
Capital Mall Dr/Yauger Wy	Unsignalized/Signalized	B (13.6)	F (138.4)	D (34)	D (29.6)	B (15.1)	B (15)	D (31.3)	D (29.1)	A (7.6)	B (14)

LOS A, B, C		**15**	**8**	**11**	**9**	**12**	**13**	**11**	**12**	**2**	**2**
LOS D or E		**3**	**3**	**9**	**11**	**8**	**11**	**9**	**10**	**6**	**8**
LOS F		**6**	**13**	**4**	**4**	**4**	**0**	**4**	**2**	**2**	**0**
Sum Check		**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**

Total Turn Pockets Added		**NA**	**NA**	**9**	**8**	**7**	**5**	**10**	**6**	**5**	**5**
Total Through Lanes Added		**NA**	**NA**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**
Total Signals Added		**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**
Number Failing		**7**	**15**	**6**	**6**	**7**	**3**	**7**	**3**	**3**	**1**

[a] Unsignalized LOS and delay were calculated by HCS+. The LOS and delay for all-way stop-controlled intersections are reported for the intersection as a whole, whereas the LOS and delay for two-way stop-controlled intersections are reported for the worst

[b] The one-hour analysis is based on HCM methodologies and provided the basis for intersection improvements. The two-hour analysis results account for the 2-Hour Adjustment Factor that the City of Olympia uses to define their LOS standards. A "NA" indicate

* Without additional SER turn pocket the LOS (Delay) is - E (78.5)

NOTE: All scenarios mitigated to acceptable LOS conditions based on the standard one-hour LOS methodology except where improvements are inconsistent with the Olympia Comprehensive Plan

West Olympia Access Study
Intersection Level of Service

2-Hour Analysis

Intersection Description	Intersection Control[a]	2007 Existing Conditions LOS (Delay)	2030 No-Build Scenario 1 LOS (Delay)	2030 Local System Only w/o SW Connections Scenario 2 LOS (Delay)	2030 Local System Only w/ SW Connections Scenario 3 LOS (Delay)	2030 Black Lake Interchange w/o SW Connections Scenario 4 LOS (Delay)	2030 Black Lake Interchange w/ SW Connections Scenario 5 LOS (Delay)	2030 Evergreen Interchange w/o SW Connections Scenario 6 LOS (Delay)	2030 Evergreen Interchange w/ SW Connections Scenario 7 LOS (Delay)	2030 Hybrid Interchange w/o SW Connections Scenario 8 LOS (Delay)	2030 Hybrid Interchange w/ SW Connections Scenario 9 LOS (Delay)
Harrison Ave/Division St	Signalized	E (73.4)	F (163.6)	E (76.6)	E (70.1)	E (69.5)	E (66.4)	E (77.4)	E (68.2)	E (80)	E (72.9)
Black Lake Blvd/Cooper Point Rd	Signalized	E (74.2)	F (173.5)	F (111)	E (75)	F (100.7)	E (68)	F (104.7)	E (56.8)	F (92.5)	E (58)
US 101 SPUI (Through/Lefts)/Black Lake Blvd	Signalized	E (60.1)	F (178.6)	F (134.8)	F (124.3)	E (67.6)	E (70.2)	E (74)	E (77.9)	E (69)	E (79.6)
Cooper Point Rd/Harrison Ave/Mud Bay Rd	Signalized	D (45)	F (95.7)	E (65.9)	E (62.9)	E (70.2)	E (66.5)	E (66.8)	E (63.9)	E (65.4)	E (63.8)
Cooper Point Rd/Capitol Mall Blvd	Signalized	C (34.9)	F (94.3)	E (62.6)	E (61.6)	E (63.4)	E (59)	D (50.6)	E (59.1)	E (62.4)	E (61.7)
Black Lake Blvd/9th Ave/Capital Mall Dr	Signalized	C (31.5)	F (89.3)	E (78.4)	F (87.5)	F (91.9)	E (69.1)	F (90.5)	E (69.4)	E (74.7)	E (67.4)
Cooper Point Rd/Automall Dr/Evergreen Park Dr	Signalized	C (25.7)	F (121.4)	E (57.4)	E (60.7)	D (49.3)	E (59.7)	E (67.5)	E (60.5)		
Cooper Point Rd/Top Foods Entrance	Signalized	C (23.1)	E (67.2)	E (67.7)	E (68.6)	D (39.8)	D (38.2)	D (43.5)	E (59.4)	D (41)	D (40)
US 101 Westbound Ramps (dec. MP)/Crosby Blvd	Signalized	B (19.9)	D (35.2)	D (38.5)	D (42.3)	D (54.8)	D (38.9)	D (47.6)	C (34.9)		
US 101 Eastbound Ramps (inc. MP)/Crosby Blvd	Signalized	B (18.6)	F (86.3)	C (32.4)	C (33.8)	D (50.6)	C (28.3)	D (48.6)	C (22.6)		
Crosby Blvd/Mottman Rd	Signalized	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)		
Crosby Blvd/Irving St	Signalized	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)		
Harrison Ave/Kenyon St	Signalized	B (12.2)	B (19.7)	B (19.7)	B (19.5)	B (19.7)	B (19.5)	B (19.9)	B (19.6)		
Black Lake Blvd/Capital Mall Entrance	Signalized	B (10)	B (11.6)	B (11.6)	B (10.2)	B (11.6)	B (10.6)	B (11.7)	B (10.2)		
Harrison Ave/Yauger Wy	Signalized	A (8.4)	B (19.1)	C (22.9)	C (22.1)	C (28.9)	C (24)	C (24.1)	C (24)		
US 101 SPUI Westbound US 101 (dec. MP) Off-Ramp Right Turns/Black Lake Blvd	Signalized	A (7.8)	A (6.2)	A (9.6)	A (8.8)	A (7.8)	A (6.2)	A (8.1)	A (6.5)		
US 101 SPUI Eastbound US 101 (inc. MP) Off-Ramp Right Turns/Black Lake Blvd	Signalized	A (2.7)	A (7.1)	A (3.2)	A (3.4)	A (3.2)	A (3.4)	A (3.9)	A (2.7)		
Harrison Ave/McPhee Rd	Unsignalized	F (165.7)	C (20.3)	C (20.3)	C (19.6)	D (26.6)	D (25.9)	C (20)	C (18)		
Harrison Ave/Kaiser Rd	Unsignalized	F (104.6)	A (7.7)	B (11.5)	B (10.5)	A (9.6)	A (9.3)	B (11.5)	B (10.4)	B (11.4)	B (11.5)
Mud Bay Rd/Evergreen Prkwy Westbound Ramp	Unsignalized	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)		
Mud Bay Rd/Evergreen Prkwy Eastbound Ramp	Unsignalized	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)		
Black Lake Blvd/Top Foods Entrance	Unsignalized	C (20.1)	D (32.8)	D (31.1)	E (38.3)	C (18)	C (19.5)	C (23.8)	C (24.9)		
Lakeridge Dr/Deschutes Prkwy	Unsignalized	B (14.2)	F (>200)	B (11.4)	C (25.5)	B (11.5)	C (23.5)	B (11.5)	C (22.9)		
Kaiser Rd/7th Ave	Unsignalized									C (25)	C (24.7)
Capital Mall Dr/Yauger Wy	Unsignalized/Signalized	B (11.8)	D (32.7)	C (18.1)	C (17.3)	B (11.2)	A (9)	C (18.8)	C (18.1)	D (33)	D (30.5)

LOS A, B, C		**16**	**8**	**12**	**12**	**12**	**14**	**13**	**12**	**2**	**2**
LOS D or E		**4**	**5**	**10**	**10**	**10**	**10**	**9**	**11**	**7**	**8**
LOS F		**4**	**11**	**2**	**2**	**2**	**0**	**2**	**1**	**1**	**0**
Sum Check		**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**	**ok**

Total Turn Pockets Added		**NA**	**NA**	**9**	**8**	**7**	**5**	**10**	**6**	**5**	**5**
Total Through Lanes Added		**NA**	**NA**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**
Total Signals Added		**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**
Number Failing		**5**	**12**	**3**	**3**	**3**	**2**	**4**	**3**	**0**	**0**

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[b] The one-hour analysis is based on HCM methodologies and provided the basis for intersection improvements. The two-hour analysis results account for the 2-Hour Adjustment Factor that the City of Olympia uses to define their LOS standards. A "NA" indicate

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