APPENDIX TR-1

TRANSPORTATION IMPACT ANALYSIS

Final Report

CEQA Transportation Impact Analysis for

Upper Westside Specific Plan

Prepared for:
Sacramento County

Revised February 2025
~~March 2022~~

RS20-3945

FEHR PEERS

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1. INTRODUCTION

This chapter describes the purpose of this report and presents an overview of the proposed Upper Westside Specific Plan ("Proposed Project").

Study Purpose

In September 2020, Sacramento County released updated guidance, known as *Transportation Analysis Guidelines* (TAG), for the preparation of transportation analysis studies. The update was necessary to incorporate changes to the way that transportation impacts are measured under the California Environmental Quality Act (CEQA) that resulted from the passage of Senate Bill 743 (SB 743) in 2013. As of July 1, 2020, automobile delay and level of service (LOS) may no longer be used as the performance measure to determine the transportation impacts of land development and transportation projects under CEQA. This requirement did not modify the discretion lead agencies have to develop their own methodologies or guidelines, or to analyze impacts to other components of the transportation system, such as walking, bicycling, transit, and safety. Although SB 743 did not specify the use of a specific metric for transportation analysis, the use of vehicle miles traveled (VMT) has been recommended by the Governor's Office of Planning and Research (OPR).

The County's TAG specifies that the following two distinct types of studies be prepared for proposed land development projects:

- Part I – CEQA Transportation Impact Analysis
- Part II – Local Transportation Analysis (LTA)

This report, which represents Part I of the TAG requirement, focuses on the project's impacts to the transportation system based on its Vehicle Miles Traveled (VMT). It also addresses project impacts to the bicycle/pedestrian systems, transit systems, and safety. However, first, the project's land use and proposed circulation system are presented along with its anticipated travel characteristics. Technical calculations and other supporting information are provided in a separately bound technical appendix.

Part II analyzes project effects on traffic operations at nearby roadways and intersections. Part II is included as a separate report.

Project Description

The Upper Westside Specific Plan would be situated on approximately 2,066 acres north of Interstate 80 (I-80) and west of Interstate 5 (I-5) in unincorporated Sacramento County. **Figure 1** shows the regional setting and the location of the Upper Westside Specific Plan.

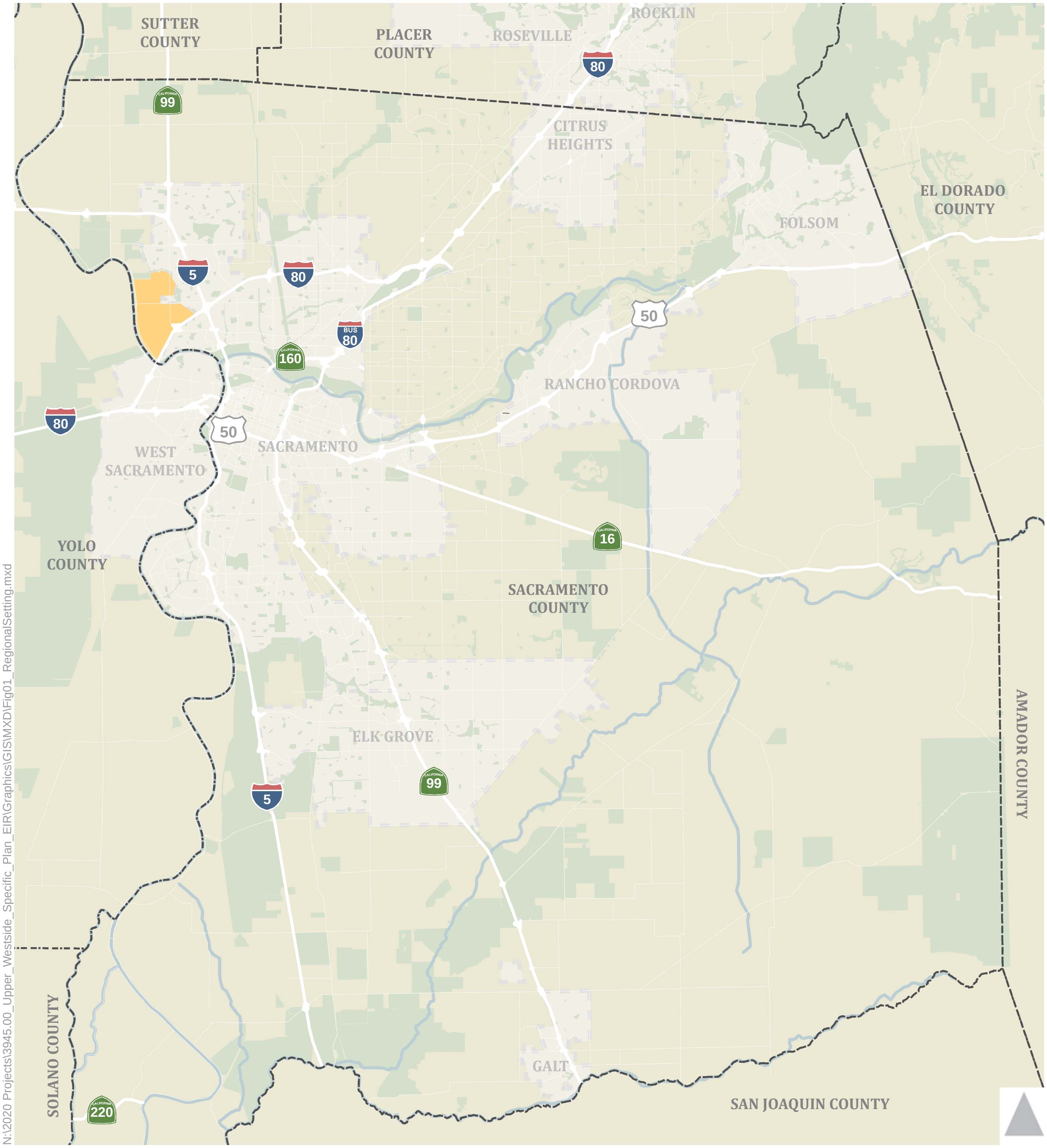
Figure 2 shows the project site plan (*Upper Westside*, Wood Rodgers, May 2021). **Table 1** presents the proposed project land uses based on this site plan. As shown, the proposed project would include 9,356 dwelling units, 3.1 million square feet of business professional/commercial, schools, parks, and various open space elements. Chapter 2 provides a more detailed breakdown of land use types.

As shown on Figure 2, the project would be accessed via several existing roadways including:

- West El Camino Avenue at I-80
- San Juan Avenue west of I-5
- Arena Boulevard west of I-5 via El Centro Road
- Del Paso Boulevard west of I-5 via El Centro Road
- Garden Highway via four connections (existing San Juan Road, improvements to existing Radio Road, and two new connections in the southwest portion of the site)

Figure 3 shows the project's internal roadway network. As shown, West El Camino Avenue would extend westerly from El Centro Road as the main street of the Town Center, which would be a dense, mixed-use environment consisting of a grid-based street system. Other key project roadways include: El Centro Road, Bryte Bend Road, Farm Road, San Juan Road, and Radio Road.

The Town Center would consist of a grid-based street system. North-south streets are labeled Street A through E (from right to left) from West El Camino Avenue to Bryte Bend Road. East-west streets are labeled Street 1 through 7 (from bottom to top) starting south of West El Camino Avenue to San Juan Road. The project would widen parts of El Centro Road and West El Camino Avenue from their current two lanes to the number of lanes shown on Figure 3. Additionally, it is assumed that project buildout would be supported by (and required to help fund) a reconstructed I-80/West El Camino Avenue interchange to provide increased roadway capacity and a more bicycle/pedestrian friendly design. Additional right-of-way would be necessary to support the interchange's reconstruction.



Upper Westside Specific Plan Boundary

City Boundary

County Boundary

Figure 1

Regional Setting

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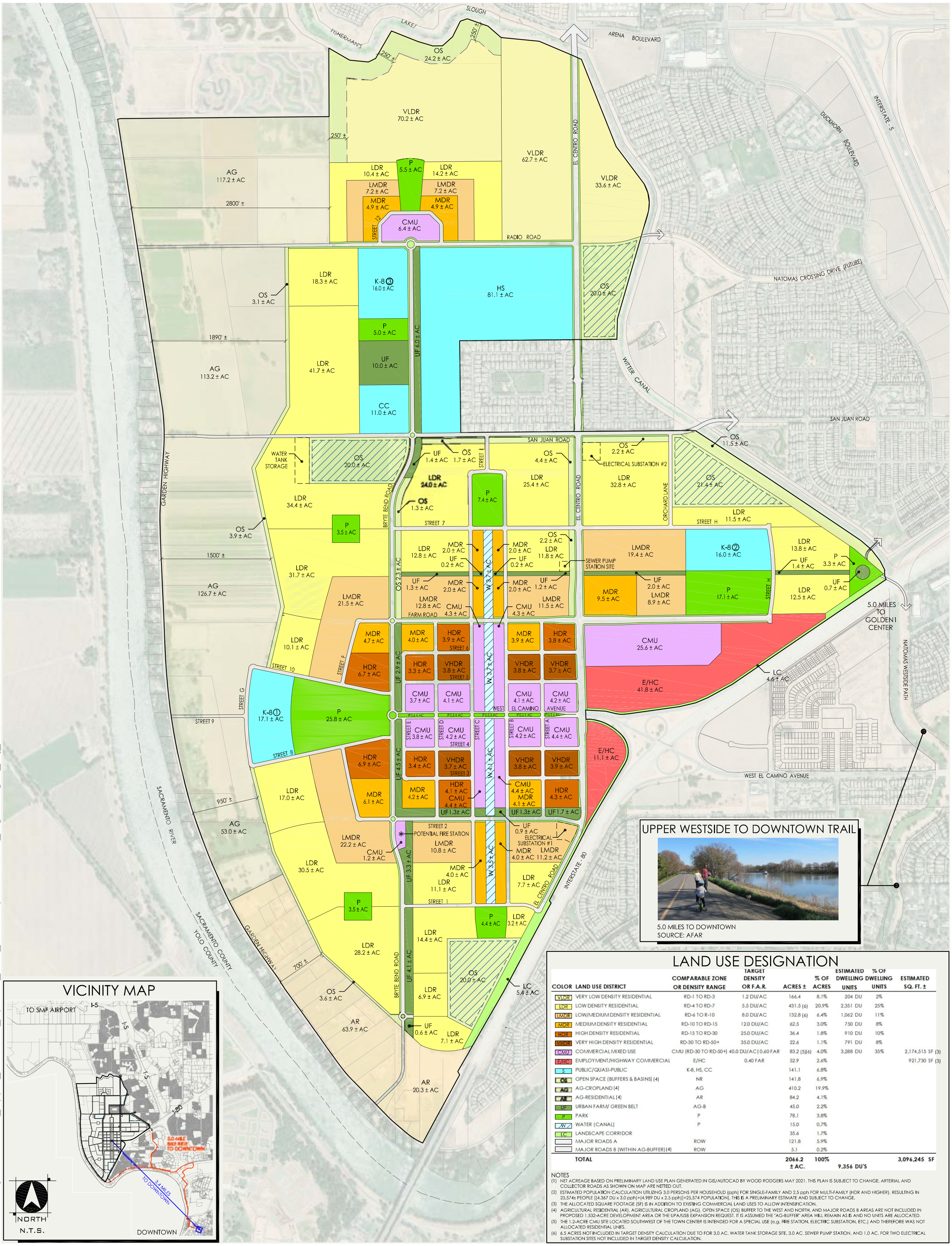


Source: Wood Rodgers

LAND USE DESIGNATION

COLOR	LAND USE DISTRICT	COMPARABLE ZONE OR DENSITY RANGE	TARGET DENSITY OR F.A.R.	ACRES ±	% OF ACRES	ESTIMATED DWELLING UNITS	% OF DWELLING UNITS	ESTIMATED SQ. FT. ±
VLDR	VERY LOW DENSITY RESIDENTIAL	RD-1 TO RD-3	1.2 DU/AC	166.4	8.1%	204 DU	2%	
LDR	LOW DENSITY RESIDENTIAL	RD-4 TO RD-7	5.5 DU/AC	431.5 (6)	20.9%	2,351 DU	25%	
LMDR	LOW/MEDIUM DENSITY RESIDENTIAL	RD-6 TO R-10	8.0 DU/AC	132.8 (6)	6.4%	1,062 DU	11%	
MDR	MEDIUM DENSITY RESIDENTIAL	RD-10 TO RD-15	12.0 DU/AC	62.5	3.0%	750 DU	8%	
HDR	HIGH DENSITY RESIDENTIAL	RD-15 TO RD-30	25.0 DU/AC	36.4	1.8%	910 DU	10%	
VHDR	VERY HIGH DENSITY RESIDENTIAL	RD-30 TO RD-50+	35.0 DU/AC	22.6	1.1%	791 DU	8%	
CMU	COMMERCIAL MIXED USE	CMU (RD-30 TO RD-50+)	40.0 DU/AC | 0.60 FAR	83.2 (5)(6)	4.0%	3,288 DU	35%	2,174,515 SF (3)
E/HC	EMPLOYMENT/HIGHWAY COMMERCIAL	E/HC	0.40 FAR	52.9	2.6%			921,730 SF (3)
S	PUBLIC/QUASI-PUBLIC	K-8, HS, CC		141.1	6.8%			
OS	OPEN SPACE (BUFFERS & BASINS) (4)	NR		141.8	6.9%			
AG	AG-CROPLAND (4)	AG		410.2	19.9%			
AR	AG-RESIDENTIAL (4)	AR		84.2	4.1%			
UF	URBAN FARM/ GREEN BELT	AG-B		45.0	2.2%			
P	PARK	P		78.1	3.8%			
W	WATER (CANAL)	P		15.0	0.7%			
LC	LANDSCAPE CORRIDOR			35.6	1.7%			
	MAJOR ROADS A	ROW		121.8	5.9%			
	MAJOR ROADS B (WITHIN AG-BUFFER) (4)	ROW		5.1	0.2%			
	TOTAL			**2066.2 ± AC.**	**100%**	**9,356 DU'S**		**3,096,245 SF**

NOTES

(1) NET ACREAGE BASED ON PRELIMINARY LAND USE PLAN GENERATED IN GIS/AUTOCAD BY WOOD RODGERS MAY 2021. THIS PLAN IS SUBJECT TO CHANGE. ARTERIAL AND COLLECTOR ROADS AS SHOWN ON MAP ARE NETTED OUT.

(2) ESTIMATED POPULATION CALCULATION UTILIZING 3.0 PERSONS PER HOUSEHOLD (pph) FOR SINGLE-FAMILY AND 2.5 pph FOR MULTI-FAMILY (HDR AND HIGHER), RESULTING IN 25,574± PEOPLE [(4,367 DU x 3.0 pph)+(4,989 DU x 2.5 pph)]=25,574 POPULATION]. THIS IS A PRELIMINARY ESTIMATE AND SUBJECT TO CHANGE.

(3) THE ALLOCATED SQUARE FOOTAGE (SF) IS IN ADDITION TO EXISTING COMMERCIAL LAND USES TO ALLOW INTENSIFICATION.

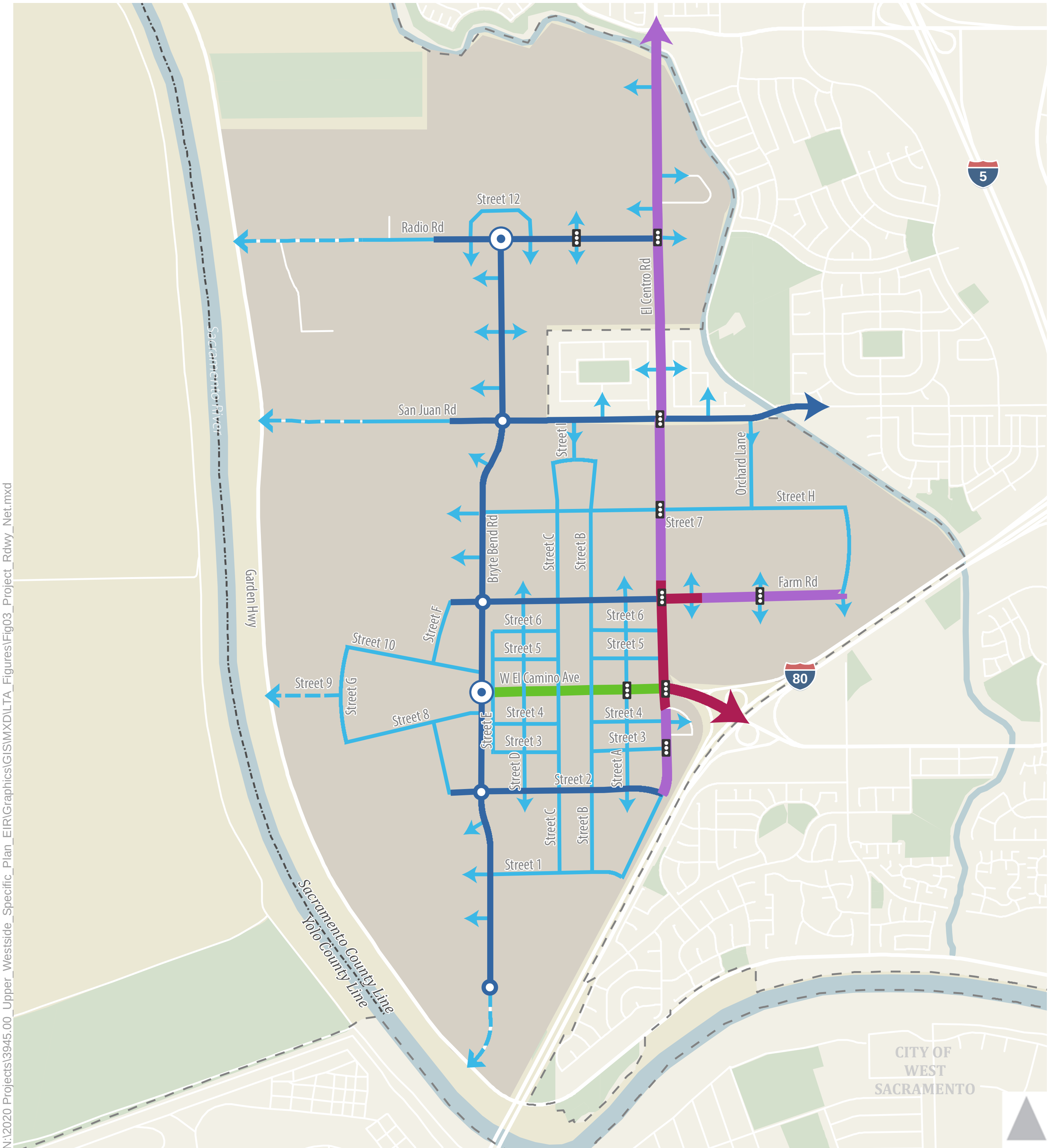
(4) AGRICULTURAL RESIDENTIAL (AR), AGRICULTURAL CROPLAND (AG), OPEN SPACE (OS) BUFFER TO THE WEST AND NORTH, AND MAJOR ROADS B AREAS ARE NOT INCLUDED IN PROPOSED 1,532-ACRE DEVELOPMENT AREA OR THE UPA/USB EXPANSION REQUEST. IT IS ASSUMED THE "AG-BUFFER" AREA WILL REMAIN AS IS AND NO UNITS ARE ALLOCATED.

(5) THE 1.2-ACRE CMU SITE LOCATED SOUTHWEST OF THE TOWN CENTER IS INTENDED FOR A SPECIAL USE (e.g. FIRE STATION, ELECTRIC SUBSTATION, ETC.) AND THEREFORE WAS NOT ALLOCATED RESIDENTIAL UNITS.

(6) 6.5 ACRES NOT INCLUDED IN TARGET DENSITY CALCULATION DUE TO FOR 3.0 AC. WATER TANK STORAGE SITE, 3.0 AC. SEWER PUMP STATION, AND 1.0 AC. FOR TWO ELECTRICAL SUBSTATION SITES NOT INCLUDED IN TARGET DENSITY CALCULATION.

Figure 2

Project Site Plan



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Roundabout
Traffic Signal
Traffic Circle
6-Lane Thoroughfare
4-Lane Arterial
2-Lane Arterial/Collector
Modified Primary Residential
Garden Highway Connector Road
Smart Growth Street
Median Break
City Boundary
County Boundary
Upper Westside Specific Plan Boundary

Figure 3

Project Roadway Network

Table 1: Upper Westside Specific Plan Land Use Summary				
Land Use	**Acres**	**Percent of Project**	**Dwelling Units**	**Square Feet**
Very Low Density Residential	166.1	8.1%	204	-
Low Density Residential	431.5	20.9%	2,351	-
Low/Medium Density Residential	132.8	6.4%	1,062	-
Medium Density Residential	62.5	3.0%	750	-
High Density Residential	36.4	1.8%	910	
Very High Density Residential	22.6	1.1%	791	-
Commercial Mixed Use	83.2	4.0%	3,288	2,174,515
Employment / Highway Commercial	52.9	2.6%	-	921,730
Community College, High School, K-8 School	141.1	6.8%	-	-
Parks, Urban Farm/Greenbelt, and Canal	136.1	6.5%		
Open Space / Agriculture,	674.1	32.6%		
Proposed Major Circulation	126.9	6.1%		
Total Upper Westside Specific Plan	**2,066.2**	**100%**	**9,356**	**3,096,245**

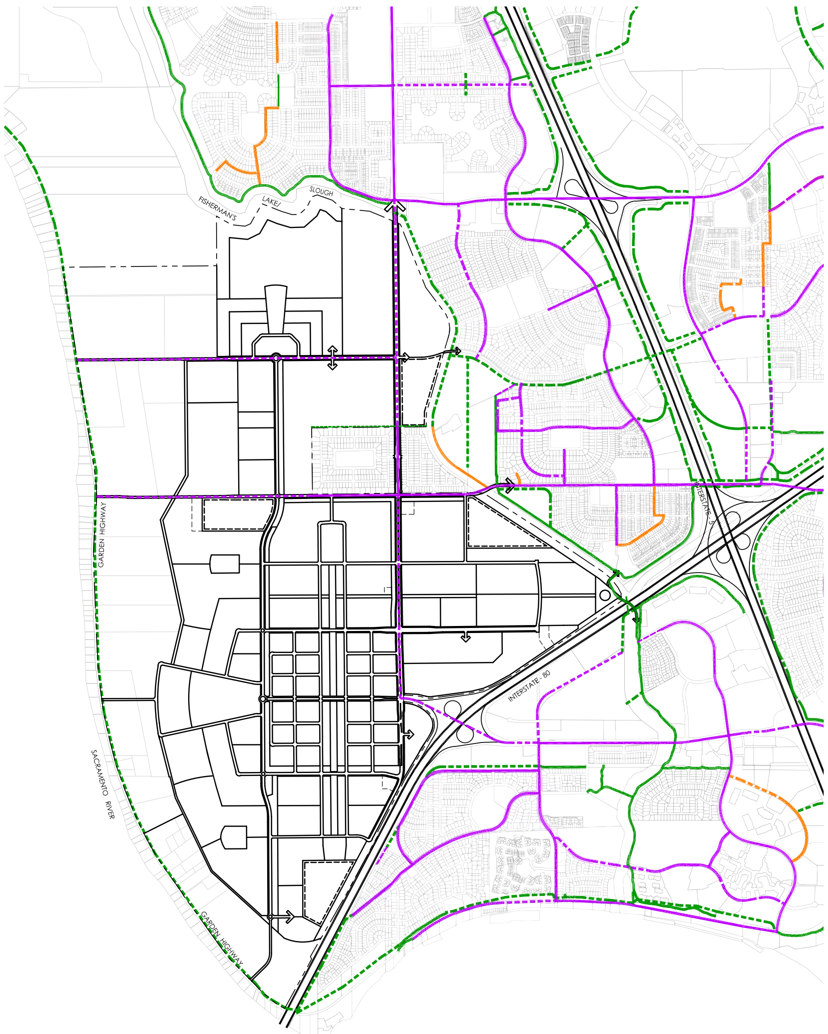
Source: *Upper Westside Site Plan*, Wood Rodgers, May 2021.

Figure 4 shows the project's planned bicycle network. Key components of the bicycle network include:

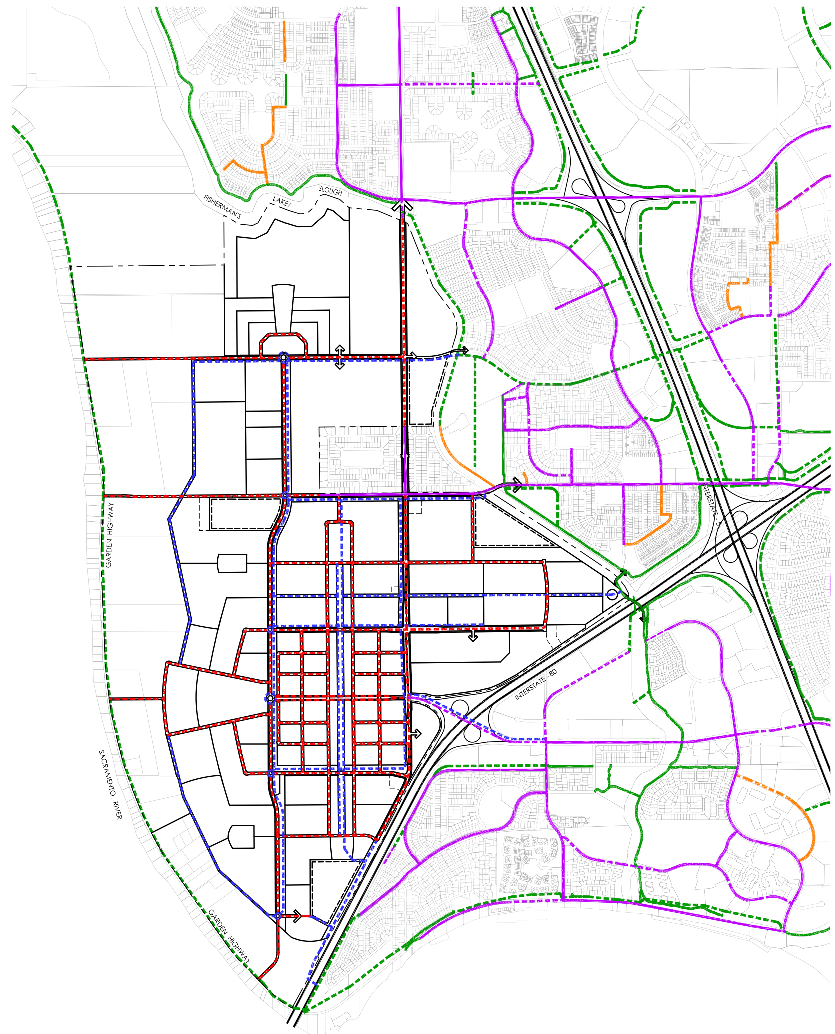
- A set of north-south and east-west Class I (off-street) bicycle/pedestrian paths would be constructed. The north-south path would extend southerly from San Juan Road through the Town Center to Garden Highway. The east-west path would extend parallel and north of Farm Road from Bryte Bend Road easterly to connect to an existing Class I network (near Peregrine Park), which includes an overcrossing of I-80 that can be used to walk or bike to South Natomas and Downtown Sacramento.
- Class I and/or Class II bike lanes (on-street with appropriate signs and pavement markings) would be provided throughout the plan area.

Figure 5 shows the conceptual locations of bus stops and bus routes within the proposed UWSP.

SACRAMENTO COUNTY BIKEWAY MASTER PLAN



UPPER WESTSIDE PROPOSED BIKEWAY MASTER PLAN AMENDMENT



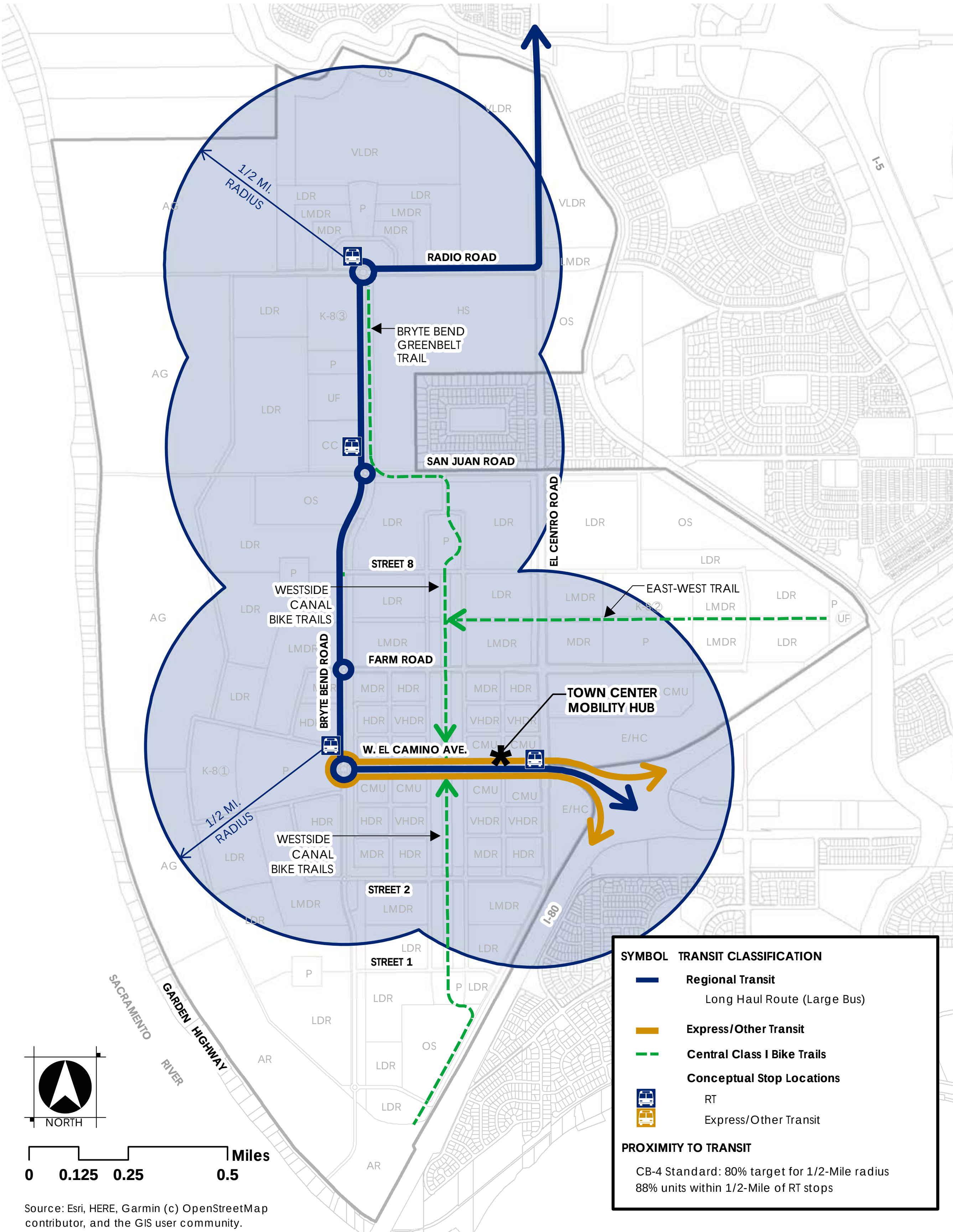
LEGEND

EXISTING (Sac. County)	PROPOSED (Sac. County)	PROPOSED (Upper Westside)
CLASS I	CLASS I	CLASS I
CLASS II	CLASS II	CLASS II
CLASS III	CLASS II (G.H. ALTERNATIVE)	
	CLASS III	

This side-by-side comparison depcits how the Upper Westside Specific Plan would modify the Sacramento County Bikeway Master Plan.

Figure 4

Project Bicycle Network



Source: Esri, HERE, Garmin (c) OpenStreetMap contributor, and the GIS user community.

Figure 5

Project Transit System

2. PROJECT TRAVEL CHARACTERISTICS

This chapter presents the proposed project's anticipated travel characteristics. This information helps inform the project's VMT analyses (presented in Chapter 3) and is used directly in the separate LTA report.

Detailed Project Land Use Assumptions

Table 1 displayed the amount of proposed non-residential development, expressed in terms of total square feet of office or commercial, and school acreage. This section refines those land use totals (based on information provided by the project applicant) to reflect the expected mix and quantity of specific non-residential uses.

The retail component of the Commercial Mixed-Use (CMU) parcels would be developed with 50 percent business professional and 50 percent general retail, entertainment, grocery stores, restaurants, institutional/religious, and specialized uses (e.g., vocational schools, medical-office, etc.). These parcels would be integrated mixed-use properties developed at high densities (i.e., 60 percent floor-to-area ratio and 40 dwelling units per acres).

The two Employment/Highway Commercial (E/HC) parcels would be developed with 60 percent business professional and 40 percent general retail, entertainment, grocery stores, restaurants, institutional/religious, and specialized uses (e.g., vocational schools, medical-office, etc.). These two parcels would develop at a 40 percent floor-to-area ratio.

The project applicant has indicated that the CMU and E/HC parcels will typically provide sufficient on-site parking to meet projected demands. This implies, given the proposed densities, that structured parking will be required, though surface parking may also be provided in some areas. It also means that all parcels are assumed "to park themselves"; meaning trips generated by the parcel are assigned to that parcel (versus a nearby public garage).

Project Trip Generation

The proposed project's trip generation was estimated using the Mixed-Use Trip Generation Model (MXD+), which was originally developed for the US Environmental Protection Agency (EPA) to estimate internal trip-making and external trips made by non-auto travel modes. This model, which was originally developed by consultants and academic researchers based on empirical evidence at 240 mixed-use projects located across the U.S, has been used in numerous EIRs throughout California. The model considers various built environment variables such as land use density, regional location, proximity to transit, and various design variables when calculating the project's internal trips and external trips made by non-auto modes. In Fall 2019, the model underwent a revalidation that confirmed it is still applicable to current (non-COVID) conditions. Moreover, the model was found to validate well against large mixed-use projects such as Upper Westside. Refer to separately bound appendix for that revalidation report.

Trip Generation Rates

MXD+ begins by estimating gross trips generated by project land uses based on data included in *Trip Generation Manual, 10th Edition* (Institute of Transportation Engineers, 2017), which is the most recent version of the manual. It then estimates internal trips and external trips made by non-auto modes of travel. **Table 2** presents the unadjusted vehicular trip generation rates for each project land use category. In most instances, weighted average trip rates were applied due to the absence of fitted curve equations that estimate trips based on land use quantity. At the time the analysis was performed, the 11th Edition of the *Trip Generation Manual* (September 2021) had not yet been released.

Rates chosen for several specific land uses in Table 2 warrant further explanation as described below:

- Trip generation for single-family and multi-family residential units was estimated based on weighted average trip rates. Use of fitted curve equation rates would have led to differing (and unreasonable) trip rates for adjacent residential areas based solely on their differing unit counts.
- Trip generation for professional office and shopping center land use categories[1] was estimated using fitted curve equations based on guidance from the *Trip Generation Handbook* (Institute of Transportation Engineers, 2017). Retail and office land use quantities within the Town Center and

[1] A variety of retail-type uses were assumed on retail parcels including supermarkets, sit-down restaurants, fast-food restaurants, and health/fitness clubs, in addition to general shopping center uses. This approach, which emphasizes the variety of likely retail uses, results in greater total trips, but also more internalization of traffic and an overall more accurate trip estimate (versus using exclusively the shopping center category).

employment/Highway Commercial zone (east of El Centro Road) were estimated separately based on the square footages proposed.

Table 2:
Unadjusted Trip Generation Rates by Land Use Type

Land Use	ITE Code	Unit Type	Daily Trip Rate [1]	AM Peak Hour [1]		PM Peak Hour [1]	
				Trip Rate	%in/ %out	Trip Rate	%in/ %out
Single-Family Detached Housing [2]	210	du's	9.44	0.74	25%/75%	0.99	63%/37%
Multi-Family Housing Mid-Rise [3,4]	221	du's	5.44	0.36	26%/74%	0.99	61%/39%
Professional Office [3,5]	710	ksf	9.74 – 10.25	0.99 – 1.16	86%/14%	1.05 – 1.15	16%/84%
Medical Office [2]	720	ksf	36.32	2.45	78%/22%	3.44	28%/72%
Hotel [2]	310	rooms	8.36	0.47	59%/41%	0.60	51%/49%
Business Hotel [2]	312	rooms	4.02	0.39	42%/58%	0.32	55%/45%
Government Office [2]	730	ksf	22.59	3.33	75%/25%	1.72	26%/74%
Shopping Center [3]	820	ksf	50.64 – 66.26	1.39 – 2.56	62%/38%	4.73 – 5.88	48%/52%
Health/Fitness Club [2]	492	ksf	26.67	1.33	50%/50%	3.47	58%/42%
Supermarket [3]	850	ksf	95.14 – 106.8	3.80 – 3.82	60%/40%	9.27 – 9.32	51%/49%
High-Turnover (Sit-Down) Restaurant [2]	932	ksf	112.18	9.94	55%/45%	9.77	62%/38%
Fast-Food Restaurant with Drive-Through Window [2]	934	ksf	471.00	40.22	51%/49%	32.67	52%/48%
Recreational Community Center [2,3]	495	ksf	28.80 – 28.83	1.77 – 3.85	66%/34%	2.31 – 3.60	47%/53%
Middle School/Junior High School [2]	522	students	2.13	0.58	54%/46%	0.17	49%/51%
High School [2]	530	students	2.03	0.52	67%/33%	0.14	48%/52%
Vocational School	540	ksf	20.25	2.07	77%/23%	1.86	50%/50%
Junior/Community College	540	students	1.15	0.11	81%/19%	0.11	56%/44%

Note:
1. All rates derived from the *Trip Generation Manual, 10th Edition* (Institute of Transportation Engineers, 2017).
2. Weighted average trip rate applied.
3. Fitted curve equation applied.
4. Multi-Family Mid-Rise category chosen given densities proposed (i.e., buildings will range between 3 and 10 floors, which meets the definition of this use type).
5. Range of trip rates shown because varying sized facilities are proposed in different areas of the plan and fitted curve equations yield different trip rates by size.

ksf = thousand square feet. du's = dwelling units.

Source: Fehr & Peers, 2021.

Project Trip Generation

Table 3 presents the project's expected trip generation (prior to any consideration of existing land uses whose trips would be eliminated with the project). The following trip summaries are shown:

1. Gross Project Trips – represents total amount of project travel assuming all trips would be made by vehicle and that no internalization of trips would occur.
2. Net External Vehicular Project Trips – accounts for internal trips between complementary on-site land uses (e.g., residential and retail), and external trips made by walking, biking and transit to estimate external vehicle trips.
3. Net New External Vehicular Trips – further refines external vehicle trip estimate by removing vehicle trips that are "pass-by"[2] from the adjacent street and "diverted-link"[3] from I-80 or I-5.
4. Net New External and Diverted Link Vehicular Trips – adds diverted link trips to the above estimate.

Item #3 above represents the number of new project vehicle trips that would be assigned to study intersections/roadways throughout the study area (based on the expected spatial distribution of those trips). Item #4 above represents the approximate total number of vehicle trips the project would add to its gateway streets (i.e., West El Camino Avenue north of I-80, Arena Boulevard west of I-5, Del Paso Road west of I-5, Garden Highway north of Radio Road and under I-5, and San Juan Road under I-5) including those trips that would be diverted off I-5 and I-80.

As shown in Table 3, the proportion of project trips that would remain internal to the site would vary between 23 and 35 percent depending on the time period. Internalization is greatest during the AM peak hour due to the effect of matched trips between the residences and schools.

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2 A "pass-by" trip to a retail use is made by a motorist already on the adjacent street while en route to a different primary destination. Pass-by trips do not add traffic to the adjacent street, but contribute trips to the driveway(s) serving the retail center. Checks were performed to ensure that primary adjacent roadways (i.e., El Centro Road and West El Camino Avenue) would have sufficient volumes of traffic under "plus project" conditions, from which pass-by trips could be taken.

3 A "diverted-link" trip (in this context) is made by a motorist traveling on a nearby freeway who chooses to exit the freeway to access a retail use. Diverted-link trips are added both to the freeway on/off ramps, surface streets, and driveway(s) serving the retail center.

**Table 3:
Proposed Project Trip Generation**

Land Use	Quantity [1]	Trips		
		Daily	AM Peak Hour	PM Peak Hour
Single-Family Detached Housing	4,367 du's	41,224	3,232	4,323
Multi-Family Housing Mid-Rise	4,989 du's	27,140	1,796	2,195
Professional Office	1,573 ksf	15,669	1,689	1,730
Medical Office	41.6 ksf	1,511	102	143
Hotel	410 rooms	3,428	193	246
Business Hotel	410 rooms	1,648	160	131
Government Office	74 ksf	1,681	248	128
Shopping Center	245 ksf	13,549	426	1,242
Health/Fitness Club	65 ksf	1,730	86	225
Supermarket	65 ksf	6,359	248	605
High-Turnover (Sit-Down) Restaurant	104 ksf	11,644	1,032	1,014
Fast-Food Restaurant with Drive-Through	24 ksf	11,303	965	784
Recreational Community Center	72 ksf	2,075	169	192
Middle School/Junior High School	3,000 students	6,390	1,740	510
High School	1,500 students	3,045	780	210
Vocational School & Junior College	208 ksf & 2,500 students	7,087	706	662
	Gross Project Trips	**155,483**	**13,572**	**14,340**
	Trip Adjustments			
	Internal Trips [2]	-34,890	-4,724	-3,664
	External Transit Trips [3]	-3,576	-271	-315
	Walk/Bike Trips [4]	-622	-81	-72
	Net External Vehicular Project Trips	**116,395**	**8,495**	**10,289**
	Pass-by Trips [5]	-6,614	-366	-1,048
	Diverted Link Trips [6]	-4,372	-221	-726
	Net New External Vehicular Trips	**105,409**	**7,908**	**8,515**
	Net New External and Diverted Link Vehicular Trips	**109,781**	**8,129**	**9,241**

Table 3: Proposed Project Trip Generation				
Land Use	Quantity [1]	Trips		
		Daily	AM Peak Hour	PM Peak Hour

Note:
1. Does not account for eliminated trips due to removal of existing uses. See following tables.
2. Internal trips estimated to be 22.5 percent on a daily basis, 34.9 percent during the AM peak hour, and 25.6 percent during the PM peak hour.
3. Estimated proportion of total external trips made by transit ranges from 2.0 to 2.3 percent depending on time period.
4. Estimated proportion of total external trips made by walking or biking ranges from 0.4 to 0.6 percent depending on time period.
5. Pass-by trips are made to retail uses from the adjacent street. Pass-by percentages are based on the Trip Generation Handbook (Institute of Transportation Engineers, 2017).
6. Diverted link trips come from I-80 or I-5. Percentages are from the Trip Generation Handbook (Institute of Transportation Engineers, 2017).

Source: Fehr & Peers, 2021.

According to this table, use of transit for travel to external destinations is estimated at two percent for the proposed project. It should be noted that a modest amount of transit use is already built into the default ITE trip generation rates that form the starting point of the project trip generation estimate. Thus, this transit estimate represents an increased level of transit use beyond the "base" level that is typically associated with suburban settings, free parking, and modest levels of bus service. A more geographically focused evaluation determined that the Town Center, Employment/Highway Commercial Zone, and adjacent high-density residential would have a combined four percent transit mode split. This is reasonable given that transit use is typically greater for employees versus residents, and in mixed-use urban areas versus suburban settings.

According to this table, selection of walking or biking for travel to external destinations is estimated at 0.5 percent for the proposed project. Again, this represents a modest increase above the default ITE estimate. The project would provide a direct linkage to the multi-use path east of the project site (near Peregrine Park) that connects to the bike/pedestrian bridge over I-80. From that bridge, a number of different destinations in South Natomas can be reached within a 10 to 15 minute bike ride. Downtown Sacramento can be reached by bike in about 25 to 30 minutes depending on travel speed.

Overall, the complementary nature of land uses within the project site, combined with the availability of transit and walking/biking, would result in a combined 25 percent reduction in gross daily vehicle trips. During the AM and PM peak hours, this reduction would increase to 37 percent and 28 percent, respectively.

When retail trips that are pass-by or diverted-link are also considered, the overall reduction percentages climb to 32 percent on a daily basis, 42 percent during the AM peak hour, and 41 percent during the PM peak hour. After these adjustments are made, the project would generate approximately 105,400 new daily vehicle trips, 7,900 new AM peak hour vehicle trips, and 8,500 new PM peak hour vehicle trips.

The above trip totals do not consider potential changes in travel associated with the current COVID-19 pandemic or the next phase "COVID Endemic" condition. In all likelihood, reductions in travel will occur for certain land uses, such as offices, though specific details and estimates of those changes are not known at this time. This analysis is therefore reasonably conservative because it did not consider those changes.

Trip Generation of Existing Land Uses to be Removed

The trip generation estimates in Table 3 do not consider the removal of existing trip generating land uses on the project site. Those trips are shown in **Table 4.** As shown, elimination of these existing land uses would remove 4,568 new daily vehicle trips, 375 new AM peak hour vehicle trips, and 316 new PM peak hour vehicle trips (after considering reductions for pass-by and diverted-link trips to the uses).

Net Increase in Vehicle Trips Generated by the Proposed Project

Table 5 shows the net increase in vehicle trips generated by the proposed project during all three study time periods. This represents the total project trips minus the trips associated with the existing uses that would be removed.

This table indicates that the proposed project would result in a net increase in approximately 100,800 new daily vehicle trips, with 7,530 occurring during the AM peak hour and 8,200 occurring during the PM peak hour. During both peak hours, a fairly equal distribution of inbound versus outbound traffic is expected (i.e., 50 percent inbound/50 percent outbound during the AM peak hour, and 52 percent inbound/48 percent outbound during the PM peak hour).

Table 4: Existing Trip Generating Land Uses to be Removed				
Land Use	**Quantity** [1]	**Trips**		
		Daily	**AM Peak Hour**	**PM Peak Hour**
Single-Family Detached Housing	20 du's	189	15	20
Professional Office	40 ksf	390	46	46
Self-Storage Facility	70 ksf	98	6	7
Business Hotel (2)	145 rooms	583	57	46
High-Turnover (Sit-Down) Restaurant	9 ksf	965	85	84
Fast-Food Restaurant with Drive-Through	3 ksf	1,507	129	105
Gas station with Convenience Market	12 fueling positions	2,464	150	168
Light Industrial	45 ksf	223	31	29
Golf Driving Range	12 tee positions	164	5	15
Truck Stop [1]	Fueling area, conv. market	3,373	172	213
Net External Vehicular Project Trips		**9,956**	**696**	**733**
Pass-by Trips [2]		1,773	118	156
Diverted Link Trips [3]		3,615	203	261
Net New External Vehicular Trips		4,568	375	316
Net New External and Diverted Link Vehicular Trips		**8,183**	**578**	**577**

Note:

1. Trip rates estimated based on data from *Trip Generation Manual* (Institute of Transportation Engineers, 2017), with exception of 49er Truck Stop located at corner of West El Camino Avenue/El Centro Road whose AM and PM peak hour vehicle trips were estimated in early December 2020. Daily trips for that use was estimated by factoring up peak hour trip rates for the Gas Station with Convenience Market land use category from *Trip Generation Manual*.
2. Pass-by trips are made to retail uses from the adjacent street. Pass-by percentages are based on the *Trip Generation Handbook* (Institute of Transportation Engineers, 2017).
3. Diverted link trips come from I-80 or I-5. Percentages are from the *Trip Generation Handbook* (Institute of Transportation Engineers, 2017).

Source: Fehr & Peers, 2021.

Table 5:
Net Increase in Vehicle Trips Generated by Proposed Project

Scenario	Trips						
	Daily	AM Peak Hour			PM Peak Hour		
		Inbound	Outbound	Total	Inbound	Outbound	Total
Net New External Vehicular Trips							
Proposed Project	105,409	3,953	3,955	7,908	4,410	4,107	8,515
Existing Uses To be Removed	4,568	-214	-161	-375	-137	-179	-316
Difference	**100,841**	**3,740**	**3,794**	**7,534**	**4,273**	**3,929**	**8,199**
Net New External and Diverted Link Vehicular Trips							
Proposed Project	109,781	4,076	4,053	8,129	4,796	4,448	9,241
Existing Uses To be Removed	-8,183	-318	-260	-578	-272	-305	-577
Difference	**101,598**	**3,758**	**3,793**	**7,551**	**4,524**	**4,143**	**8,664**

Note:
1. Refer to Table 2 for proposed project trips and Table 3 for existing uses trips.
2. Some volumes may not sum perfectly due to rounding.

Source: Fehr & Peers, 2021.

3. VMT ANALYSIS

This chapter analyzes the proposed project's VMT impacts.

Regulatory Background

Senate Bill 743

SB 743, passed in 2013, required the California Governor's Office of Planning and Research (OPR) to develop new CEQA guidelines that address traffic metrics under CEQA. As stated in the legislation, upon adoption of the new guidelines, "automobile delay, as described solely by level of service or similar measures of vehicular capacity or traffic congestion shall not be considered a significant impact on the environment pursuant to this division, except in locations specifically identified in the guidelines, if any." In December 2018, OPR published *Technical Advisory on Evaluating Transportation Impacts in CEQA ("Technical Advisory")*, which provided guidance for implementing SB 743. On December 28, 2018, the Resources Agency adopted CEQA Guidelines Section 15064.3. Under this guideline, VMT is the primary metric used to identify transportation impacts. On July 1, 2020, the provisions of Section 15064.3 became effective statewide.

Sacramento County TAG

This document provides considerable guidance regarding the County's preferred methods for analyzing the VMT of land use and transportation projects. The TAG incorporates various elements of the *Technical Advisory*, OPR, but refinements and clarifications have been added to reflect local conditions. Technical guidance from the TAG is referenced throughout this chapter.

Analysis Methodology

By definition, one VMT occurs when a vehicle is driven one mile. A given VMT value is representative of the amount of travel during an entire weekday. VMT is calculated in different ways for different purposes as described below.

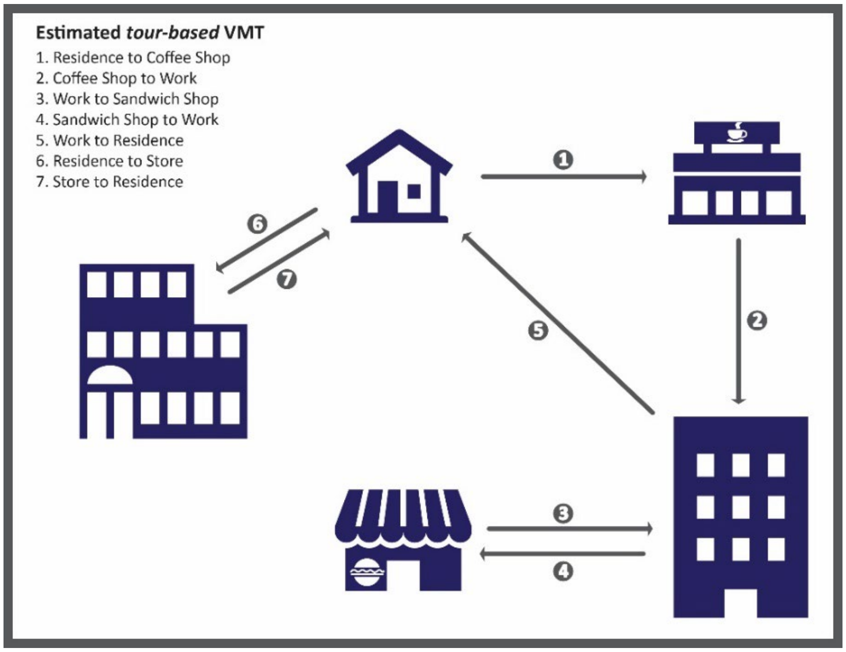
Per the TAG, VMT analysis is performed using the Sacramento Area Council of Government's (SACOG) SACSIM19 tour-based travel demand model. The version of the model that was used is similar to what was used as the basis for SACOG's 2020 MTP/SCS, but has been improved upon by considering the length of trips generated by land uses within the SACOG region that have an origin or destination outside the region.

SACSIM19 simulates people's activities on a typical weekday and tracks travel of individuals throughout the day in trip tours. The model allocates household and employment at a parcel level, which allows the model to capture smaller-scale land use changes and demographic differences. SACSIM19 is sensitive to the local physical environment, including the presence (or absence) of pedestrian and bicycle facilities, the patterns of local street networks (e.g., grid vs. cul-de-sacs), and the density, proximity and mix of surrounding land uses (i.e. employment destinations, schools, retail, parks, etc.). SACSIM19 forecasts automobile, transit, bicycle, and walk trips. SACSIM19 requires a detailed definition of household characteristics, population/demographics and employment by type at a parcel-level of geography.

Key metrics from SACSIM19 used in the VMT analysis include the following (though other types of VMT are analyzed later in this chapter):

- VMT per Capita – includes all vehicle tours (both work/commute vehicle tours and non-work vehicle tours) that start and end at residential units. Tours made by a household resident that do not begin or end at home (e.g., mid-day travel from a worksite for lunch or personal business) are not included in the VMT per Capita estimates. Per the TAG, Household VMT includes trip types #1, 2, 5, 6 & 7 from the figure below. It excludes work-based subtours (Trips #3 and #4).

- VMT per Employee – applies to office/business professional and industrial employment projects and includes all work/commute vehicle tours that start and end at the worksite (including intermediate stops). Per the TAG, Household VMT includes trips #1, 2, and 5 from the figure below.



Significance Thresholds

Table 3-3 of the TAG identifies significance thresholds for various types of land development projects. The following thresholds are utilized in this study:

- Project VMT per capita exceeds 85 percent of the regional average VMT per capita.
- Project VMT per employee exceeds 85 percent of the regional average VMT per employee.
- The project's regional retail land uses causes a net increase in regional VMT.
- The project's proposed widening of "regional roadways" is expected to result in an increase in regional VMT.

When reviewing the project's VMT effects for the above thresholds, it is important to consider the project's overall VMT efficiency. In other words, the broader view of VMT properly considers the net effect, for instance, of a slight exceedance of one threshold versus a "substantially below threshold" outcome for another.

VMT per Capita and per Employee

The TAG describes the specific analytical process to be used to calculate both VMT per capita and VMT per employee both for the project and for the regional average. This process was followed, and the results are shown in **Table 6** for baseline conditions, which is represented by the base (Year 2016) SACSIM19 travel demand model. Refer to separately bound appendix for technical calculations.

As indicated in the table, the project's VMT per capita and VMT per employee would be below (i.e., perform better than) the 85 percent threshold of the regional average.

Table 6: VMT per Capita and per Employee – Baseline Conditions		
Measure	**Work Tour VMT Per Employee [1]**	**Household VMT per Capita [1]**
Regional Average [2]	18.48	17.44
Threshold [3]	15.70	14.83
Project [4, 5, 6]	15.31	14.34

1 Calculated per Sacramento County TAG.

2 Regional Average is from Existing No Project Model run. VMT includes the entire length of trips outside of SACOG Region, whereas Sacramento County TAG threshold didn't include trip length outside SACOG Region; hence, values are slightly different.

3 85% of Regional Average per Sacramento County TAG.

4 Project was added to the base year MTP/SCS model. Average trip distance outside of SACOG region for the project was estimated using the average of nearby TAZs.

5 SACSIM estimated that 15.4% of home-based household trips would be internal to the project site, which is low given the diversity and proximity of on-site land uses. In contrast, the MXD+ mixed-use trip generation model estimated 22.9% of home-based trips being internal. Because SACSIM is a regional travel demand model, while MXD+ was developed to more accurately estimate internal trips associated with mixed-use projects, the household VMT estimate from SACSIM was adjusted to reflect this expected level of internal resident trips.

6 Adjustments were not made to work tour VMT per employee because results appeared reasonable and this VMT represents a relatively small (i.e., about 20%) component of the project's total VMT.

Source: Fehr & Peers, 2021.

Project Regional Retail Effect on VMT

The project's regional retail consists of the retail component of land uses proposed on the east side of El Centro Road both north and south of West El Camino Avenue. These retail uses are considered regional-serving because they are situated nearest to and visible from I-80. In contrast, the retail uses that are part of the CMU parcels within the Town Center would not have the same type of regional retail orientation.

The SACSIM model was run without and with the Regional Retail (but with the remainder of Upper Westside assumed to be developed). The results are shown in **Table 7**. As shown, the proposed project without its regional retail generates more VMT than the project with the regional retail added.

Regional retail is situated at the I-80/Truxel Road interchange in the City of Sacramento and at the I-80/Reed interchange in the City of West Sacramento. These uses are about five miles apart. There is a substantial number of households situated in North and South Natomas, and west of I-5 (north of I-80), many whom visit these regional retail destinations. The project would introduce an additional 9,356 units to this total. Placing regional retail at the I-80/West El Camino Avenue interchange (i.e., between the two existing regional retail destinations) decreases the travel distance for many of residents who are traveling to a regional retail destination. Hence, the conclusion that the project's regional retail would reduce VMT makes sense.

Table 7: Effect of Project's Regional Retail on VMT – Baseline Conditions		
Measure [1]	**Base Year SACSIM Model Plus Project**	**Base Year SACSIM Model Plus Project Without Regional Retail**
Total Regional VMT	42,992,142	43,014,069

1 Calculated using Daysim trip tables, which is a step within the overall SACSIM model.
Source: Fehr & Peers, 2021.

Project Roadway Widening Effect on VMT

The proposed project would construct new roadways and widen existing roadways. These capacity expansions could induce more VMT due to changes in background travel demand, route choice, and other factors. The following specific roadway widenings, which are considered regional in nature, are proposed as part of the project:

- Approximate 2,150-foot widening of West El Camino Avenue from two to six lanes from El Centro Road to just east of I-80.
- 1,375-foot widening of El Centro Road from two to six lanes from West El Camino Avenue to just north of Farm Road.
- 1.5-mile widening of El Centro Road from two to four lanes from just north of Farm Road to just south of Arena Boulevard.

The above widenings represent an addition of 5.7 lane-miles to the County's roadway network. According to the TAG, secondary roadways (e.g., Bryte Bend Road, Farm Road, Radio Road, etc.) are normally not expected to induce more travel due to their local-serving nature and are therefore not considered in the induced travel VMT analysis.

The SACSIM model was run without and with the aforementioned regional roadway widenings (but with all other components of the Upper Westside project included). The net change in VMT is shown in **Table 8**. As shown, the isolated effect of widening these three segments would be a net increase in 1,800 VMT. Review of the model runs indicated that the roadway widenings would eliminate "out of way" travel that would otherwise occur on roadways such as San Juan Road and Garden Highway. But by virtue of providing more roadway capacity to access I-80, the widenings also contribute to longer trip lengths, which more than offsets the eliminated "out of way" travel.

Table 8: VMT Effects of Project Roadway Widening - Baseline Conditions	
Scenario [1]	**VMT [2]**
With Roadway Widenings	57,062,857
Without Roadway Widenings	57,061,058
Difference	+ 1,799

1 See above text for description of regional roadway widening projects.

2 VMT is calculated for the entire model network. TAZ connectors and gateways are excluded.

Source: Fehr & Peers, 2021.

Project Overall Effect on VMT

The prior analyses have utilized both efficiency metrics (i.e., VMT per capita and per employee) and absolute VMT value changes (i.e., due to regional retail and roadway widenings) when evaluating various elements of the project's VMT. To allow for the project's overall effect on VMT to be evaluated, the VMT efficiency metric results were translated into absolute VMT values. The translation process shown in **Table 9** calculates how much VMT is saved by virtue of the project's VMT per capita and employee being less than the applicable thresholds.

Table 9: Project Employee and Resident VMT Savings – Baseline Conditions		
Measure [1]	**Work Tour VMT Budget**	**Household VMT Budget**
Project VMT [1]	87,594	351,276
Number of Employees	5,722	-
Work Tour VMT Savings [2]	2,231	-
Number of Residents	-	24,491
Household VMT Savings [3]	-	12,000

1 Source: SACSIM model.

2 Per Table 6, Work Tour VMT per employee could increase from 15.31 to 15.70 while remaining under the 85% regional average threshold. The VMT savings is calculated as VMT saved per employee multiplied by number of employees (i.e., 0.39 x 5,722= 2,231).

3 Per Table 6, Household VMT per capita could increase from 14.34 to 14.83 while remaining under the 85% of regional average threshold. The VMT savings is calculated as VMT saved per resident multiplied by number of residents. (i.e., 0.49 x 24,491= 12,000).

Source: Fehr & Peers, 2021.

Table 10 provides a reconciliation of the project's VMT budget, noting both savings and exceedances. This table indicates that the project's net increase in VMT due to roadway widenings (1,799 VMT) is more than offset by its beneficial land use efficiency and regional retail VMT saving benefits, which represent a combined savings of 36,158 VMT. The net result is that the project represents 34,359 VMT less than the VMT budgets established by the significance thresholds.

Table 10:
Project VMT Budget Reconciliation – Baseline Conditions

Metric	VMT Saved / Exceeded
VMT Savings by Project Land Use Efficiency [1]	- 14,231
VMT Savings by Placement of Regional Retail 2	- 21,927
VMT Added by Regional Roadway Widenings [3]	+1,799
Net VMT	-34,359

1 Source: Table 9.
2 Source: Table 7.
3 Source: Table 8.
Source: Fehr & Peers, 2021.

4. ROADWAY TRAFFIC FORECASTS

This chapter presents average daily traffic forecasts within the study area under various scenarios. This information is presented for informational purposes only so that reviewers may understand existing levels of traffic and the amount of traffic the project would add to nearby project roadways.

Analysis Scenarios

Average daily traffic (ADT) forecasts are presented for the following scenarios:

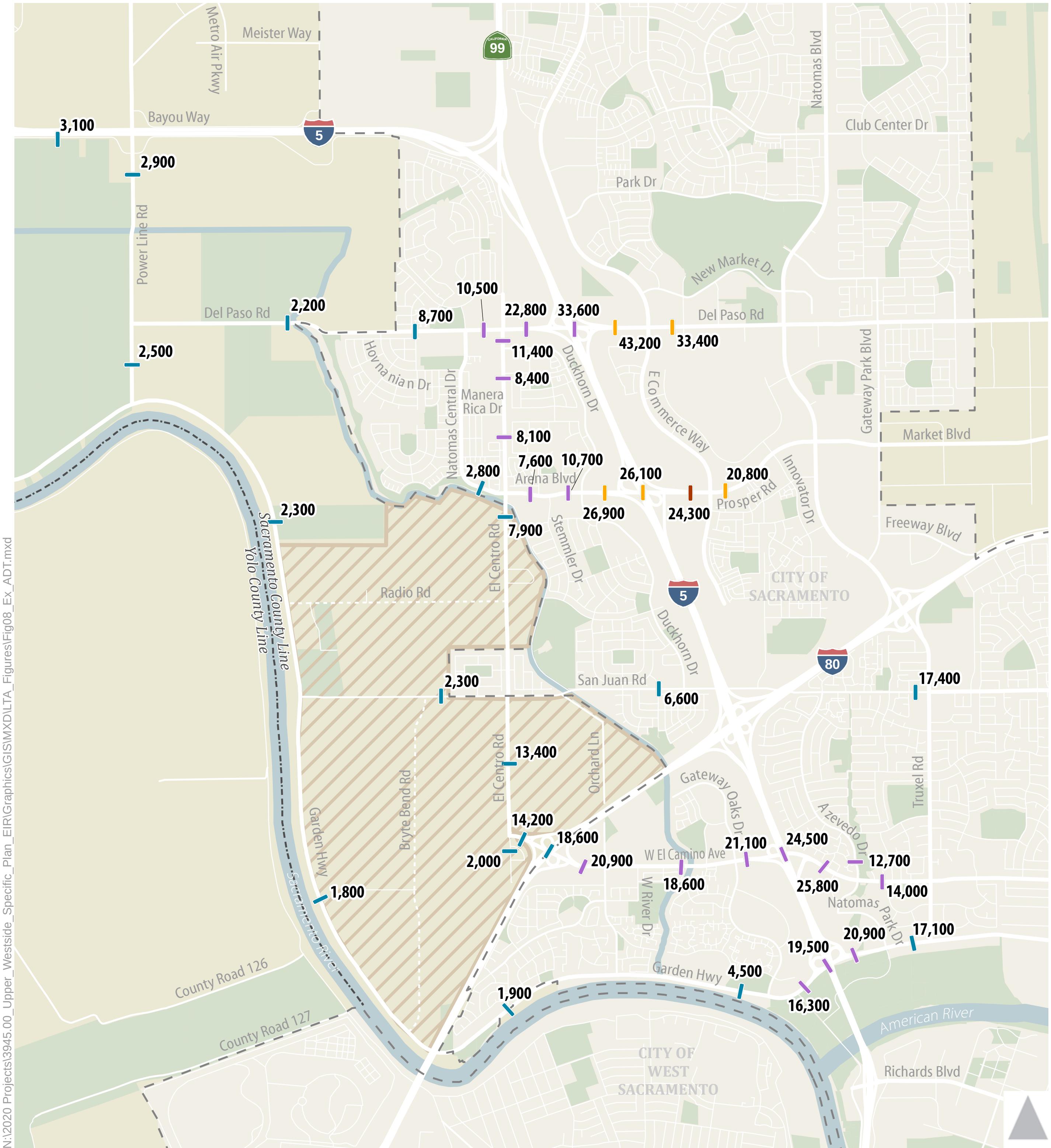
- Existing Conditions – represents conditions in 2018-2019, prior to the beginning of the COVID-19 pandemic in March 2020.
- Existing Plus Proposed Project conditions – presents ADT forecasts for a hypothetical scenario consisting of buildout of the proposed project under existing conditions.
- Cumulative (2040) No Project Conditions – presents ADT forecasts for Year 2040 assuming the project site remains in its current state.
- Cumulative (2040) Plus Proposed Project conditions – presents ADT forecasts assuming buildout of the proposed project under cumulative conditions.

Existing and Existing Plus Project ADT Forecasts

Figure 6 displays the existing ADT on roadways in the project vicinity including facilities under the jurisdiction of Sacramento County, City of Sacramento, and Caltrans.

Figure 7a shows the ADT on the same roadways under existing plus project conditions. **Figure 7b** shows the ADT on the roadways within the Specific Plan area for this scenario. These forecasts were derived from the same SACSIM travel demand model used in the previous chapter. Consistent with standard industry practice, trip matrix adjustments were made for certain traffic analysis zones (TAZs) to ensure that the external vehicle trips estimated by the model for the proposed project matched the values in Table 5.

The values shown in **Table 11** represent the project's effect on travel at each of the project gateways. It comprises both new trips generated by the project that use a given roadway, but also trips currently being made through the project area that reroute as a result of the project construction. Each rerouted trip subtracts two trip ends (i.e., the trip entering the project site area and the trip exiting the project site area).



x,xxx Average Daily Traffic Volume

Existing Number of Lanes
- 2
- 4
- 6
- 8

Upper Westside Specific Plan Boundary

City Boundary

County Boundary

Private and/or Gated, Partially Paved/ Unpaved Rural Road

Public Roadway

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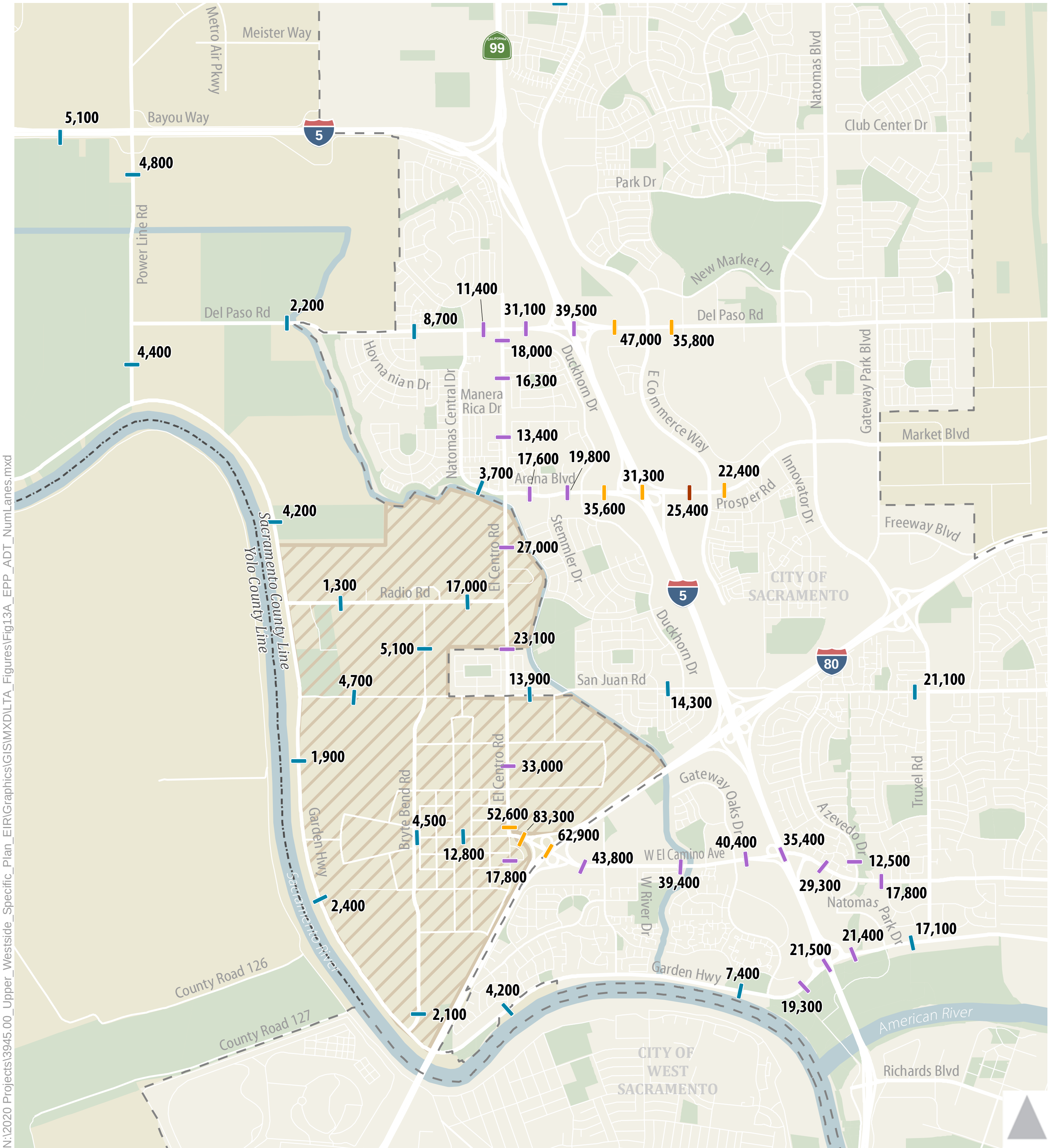
Figure 6

Existing Roadway Network



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x,xxx Average Daily Traffic Volume (Refer to Figure 1B for complete set of daily traffic volumes on internal roadways)

*Existing Plus Project Number of Lanes

- 2
- 4
- 6
- 8

Includes through lanes only.

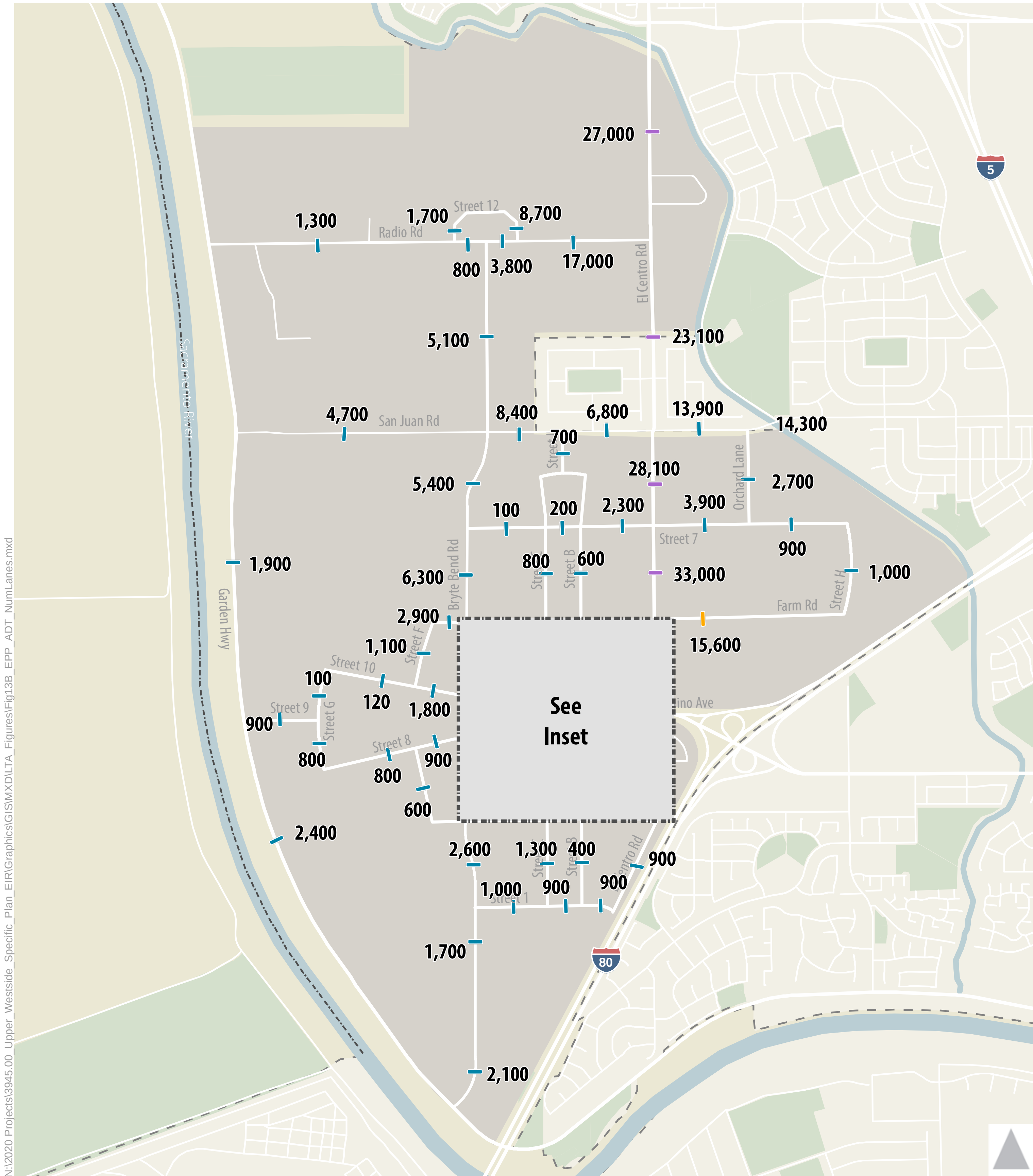
Upper Westside Specific Plan Boundary

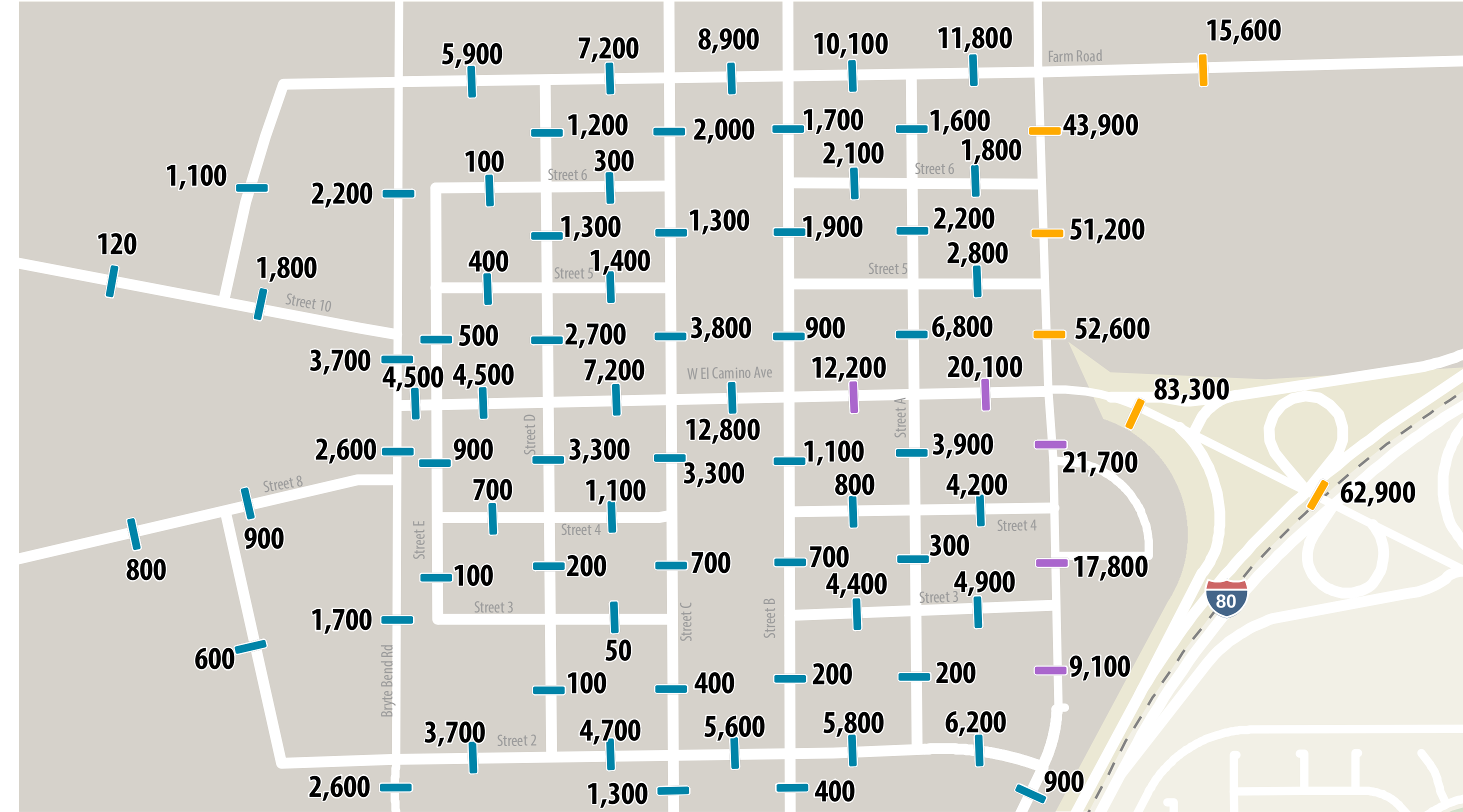
City Boundary

County Boundary

Figure 7a

Average Daily Traffic Volumes and Number of Lanes - Existing Plus Project Conditions





*Existing Plus Project Number of Lanes

x,xxx	Average Daily Traffic Volume	2	Upper Westside Specific Plan Boundary
		4	City Boundary
		6	County Boundary
		8	

*Includes through lanes only.

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Figure 7b

Average Daily Traffic Volumes and Number of Lanes - Existing Plus Project Conditions

Table 11:
Change in Daily Traffic at Project Gateways – Existing Plus Project Conditions

Segment	Existing ADT [1]	Existing Plus Project ADT [1]	Increase (% of Total)
West El Camino Avenue west of I-80	14,200	83,300	69,100 (69%)
San Juan Road west of Duckhorn Drive	6,600	14,300	7,700 (8%)
El Centro Road south of Arena Boulevard	7,900	27,000	19,100 (19%)
Garden Highway north of Radio Road	2,300	4,200	1,900 (2%)
Garden Highway under I-80	1,900	4,200	2,300 (2%)
Total	32,900	133,000	100,100 (100%)

Notes:
1. Based on Figures 6 and 7A.
ADT = Average Daily Traffic volume; ADT values are rounded to the nearest 100 vehicles.
Source: Fehr & Peers, 2021

The model's estimate of a net increase in 100,100 daily trips is only slightly lower than the predicted 100,840 net increase in daily trips generated by the project (see Table 11). This implies that the analysis was somewhat conservative because there is likely that more than just 370 daily vehicle trips (i.e., half of 100,840 minus 100,100 daily trips) that rerouted due to increased travel time caused by the project.

Cumulative and Cumulative Plus Project ADT Forecasts

Land Use Assumptions

The cumulative version of SACSIM travel demand model already includes partial or full buildout of a number of planned and pending projects within the study area. At the direction of Sacramento County DOT and PER staff, full buildout of each of the projects listed below was assumed:

- Downtown Specific Plan (City of Sacramento)
- Metro Air Park (Sacramento County)
- Grandpark Specific Plan (Sacramento County)
- Northlake (formerly Greenbriar) (City of Sacramento)
- Panhandle (City of Sacramento)
- West Broadway Specific Plan (City of Sacramento)
- Railyards Specific Plan (City of Sacramento)

- River District Specific Plan (City of Sacramento)

In addition to these large projects, buildout of a number of other individual projects located within the City of Sacramento and Sacramento County was assumed. These include currently vacant properties along portions of Arena Boulevard, El Centro Road, Duckhorn Drive, Del Paso Road, and East Commerce Way. Per City of Sacramento staff, no assumptions were made for the reuse of the Sleep Train Arena because at the time the analysis was performed, development plans had not progressed to the point where a reasonable land use assumption could be made.

Figure 8 displays the roadway network assumed in place under cumulative conditions. This list is based primarily on the City of Sacramento General Plan Mobility Element. As shown, several roadways in the study area are assumed to be widened or extended. This includes two new overcrossings of I-5, one new overcrossing of State Route 99, and a new interchange on I-5. Note that the extension of Natomas Crossing Drive was not assumed (either across I-5 or connecting between Duckhorn Drive and El Centro Road, per City of Sacramento direction).

Figure 9 displays the cumulative no project average daily traffic (ADT) on roadways in the project vicinity. **Figure 10a** shows the ADT on the same roadways under cumulative plus project conditions. **Figure 10b** shows the ADT on the roadways within the Specific Plan area for this scenario.

A comparison of the existing and cumulative no project volumes indicates substantial traffic growth on a number of roadways including the following:

- El Centro Road – volume north of West El Camino Avenue increases from 13,400 ADT under existing conditions to 23,700 ADT under cumulative no project conditions.

- El Centro Road – volume north of Arena Boulevard increases from 8,100 ADT under existing conditions to 20,400 ADT under cumulative no project conditions.

- Arena Boulevard – volume east of I-5 increases from 24,300 ADT under existing conditions to 48,900 ADT under cumulative no project conditions.

This growth is caused by several factors including new land use growth north of I-80 on both sides of I-5 and new roadway connections, particularly the four-lane North Park Drive overcrossing of I-5 between El Centro Road and East Commerce Way, which carries 19,200 ADT. The addition of project trips both adds traffic to numerous roadway segments, but also causes a redistribution of background trips (due to increased congestion along roadways within the project site as well as providing new shopping and employment attractions).

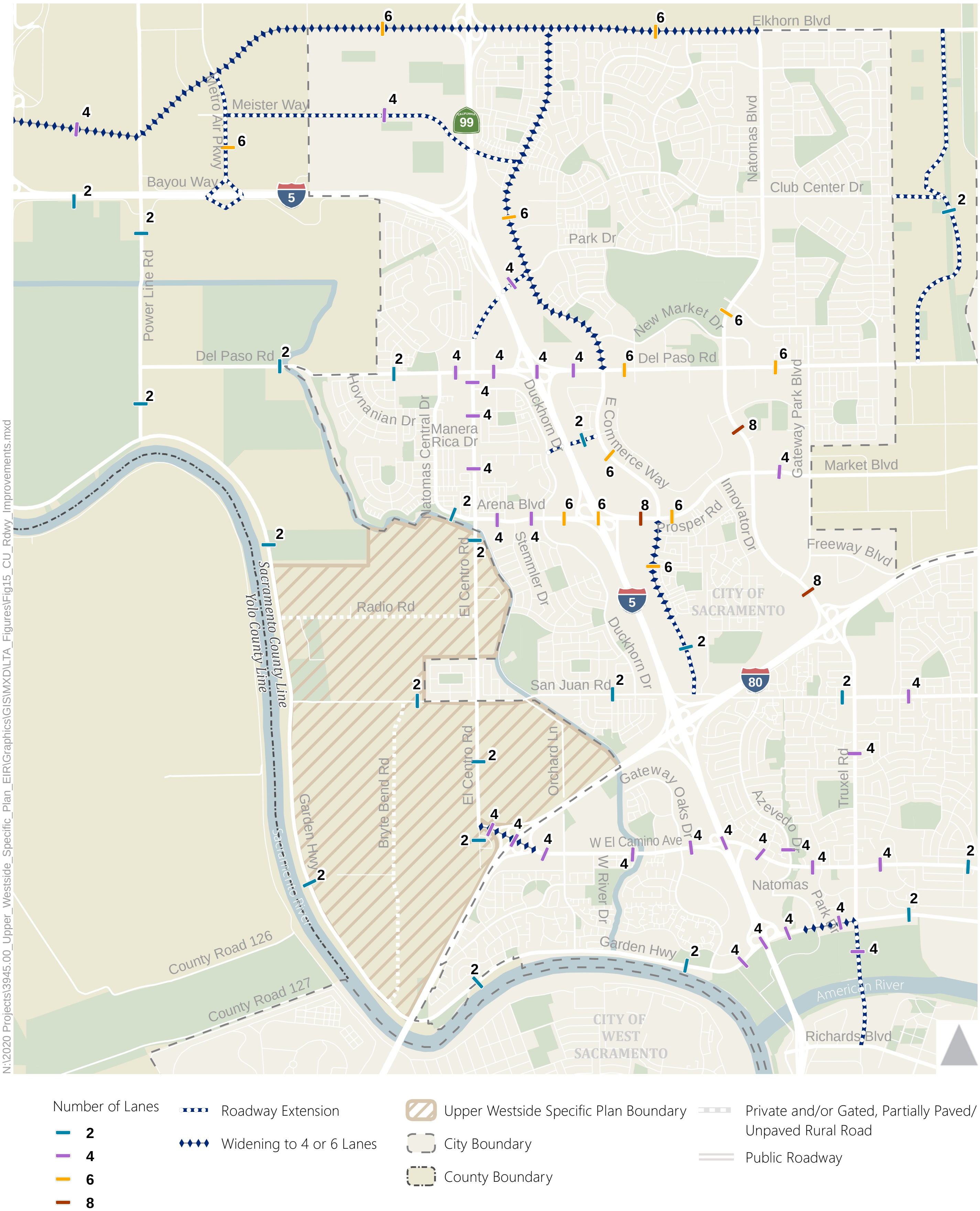
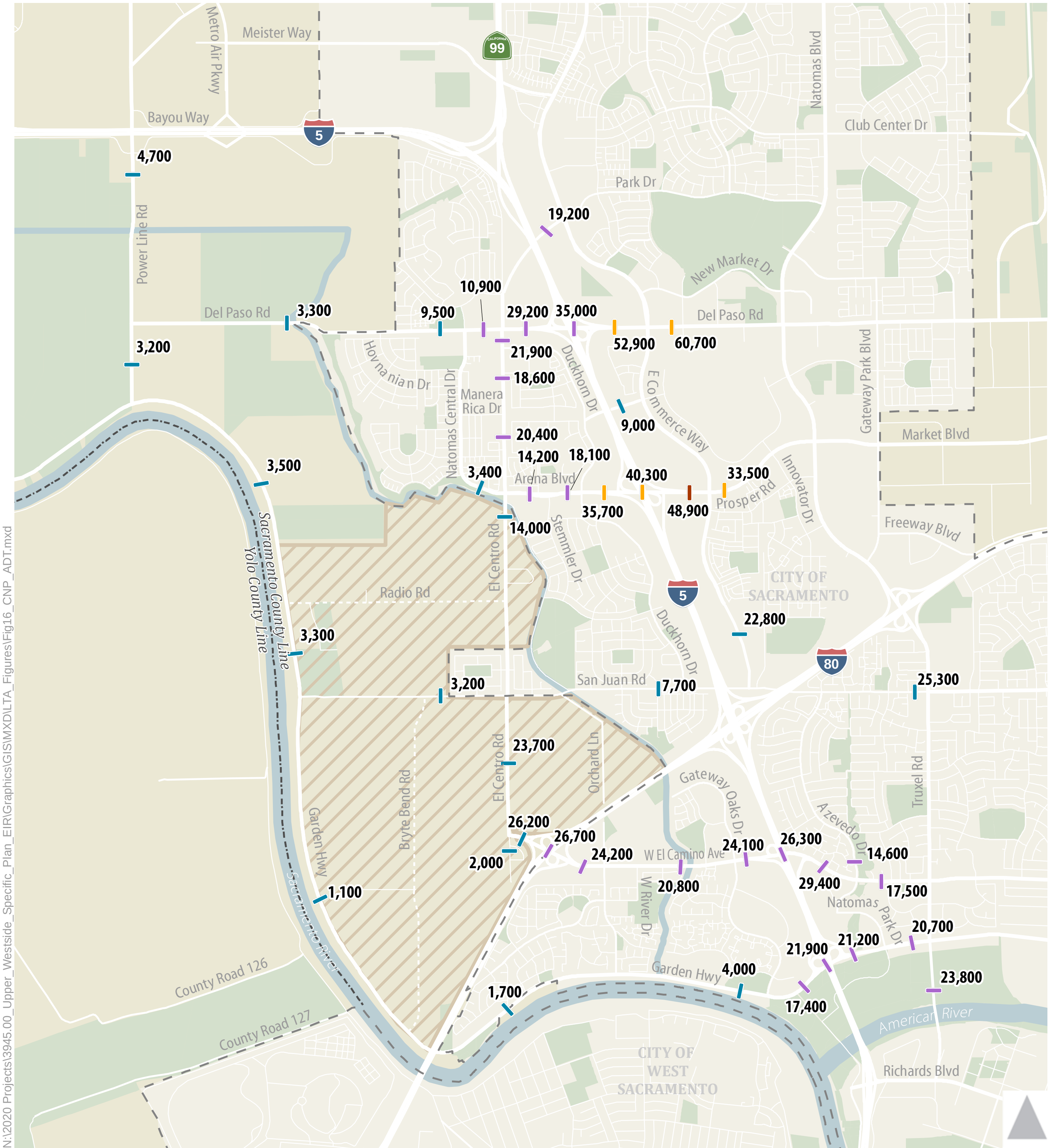


Figure 8

Cumulative Roadway Improvements



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x,xxx Average Daily Traffic Volume

Number of Lanes
- 2
- 4
- 6
- 8

Upper Westside Specific Plan Boundary

City Boundary

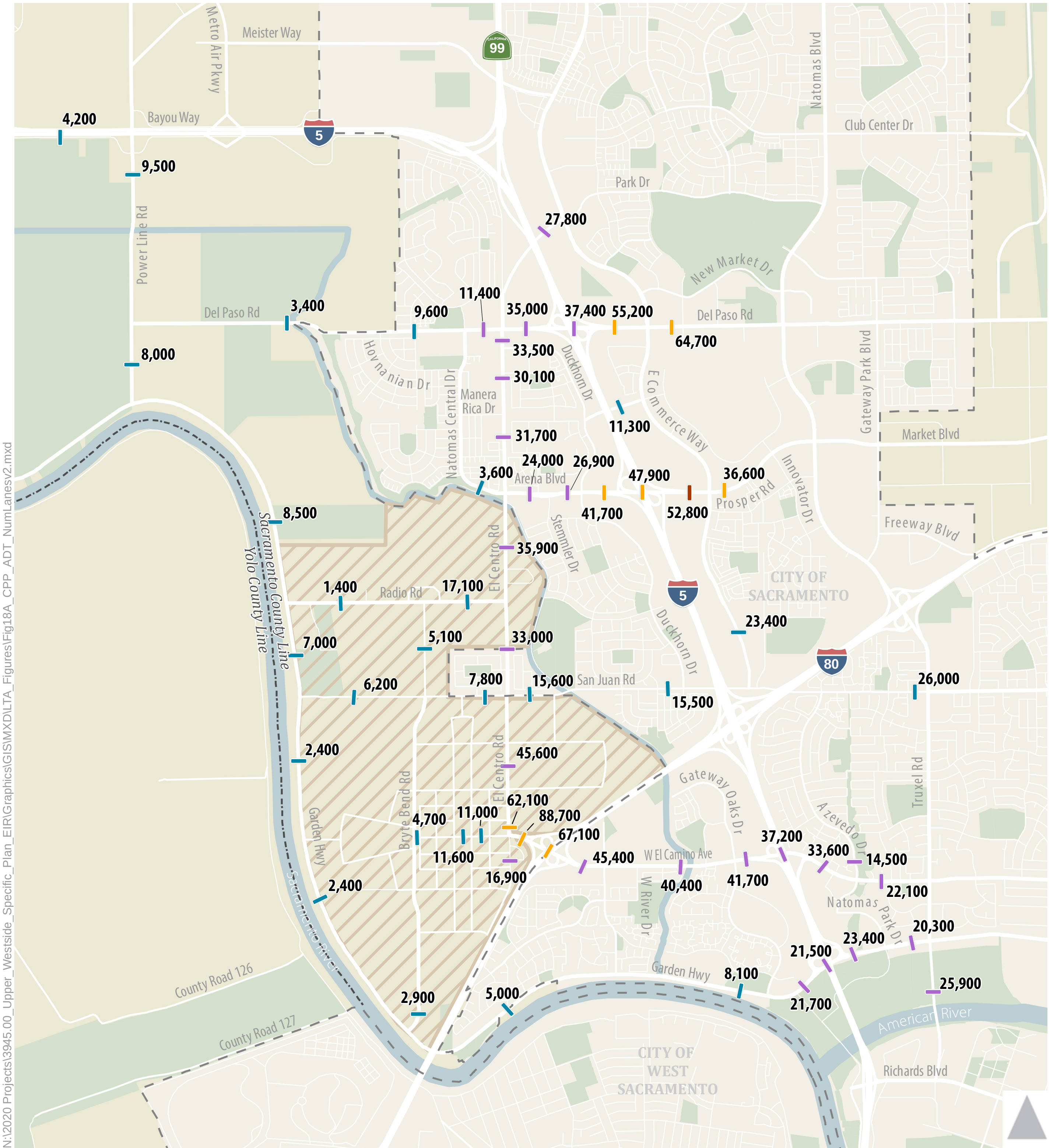
County Boundary

Private and/or Gated, Partially Paved/ Unpaved Rural Road

Public Roadway

Figure 9

Average Daily Traffic - Cumulative No Project



x,xxx Average Daily Traffic Volume (Refer to Figure 18b for complete set of daily traffic volumes on internal roadways)

*Cumulative Plus Project Number of Lanes
- 2
- 4
- 6
- 8

Includes through lanes only.

Upper Westside Specific Plan Boundary

City Boundary

County Boundary

Figure 10a

Average Daily Traffic Volumes and Number of Lanes - Cumulative Plus Project Conditions

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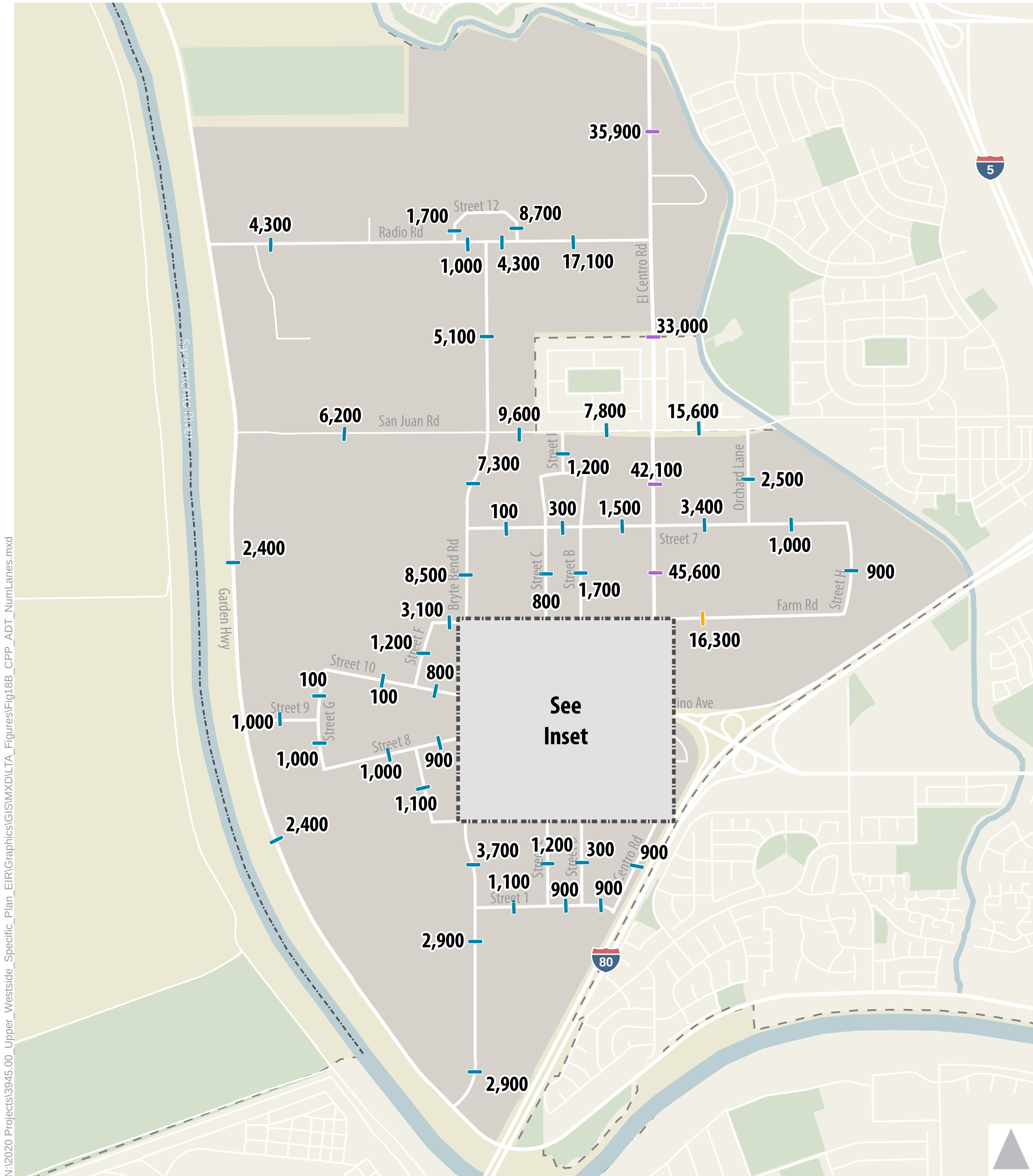

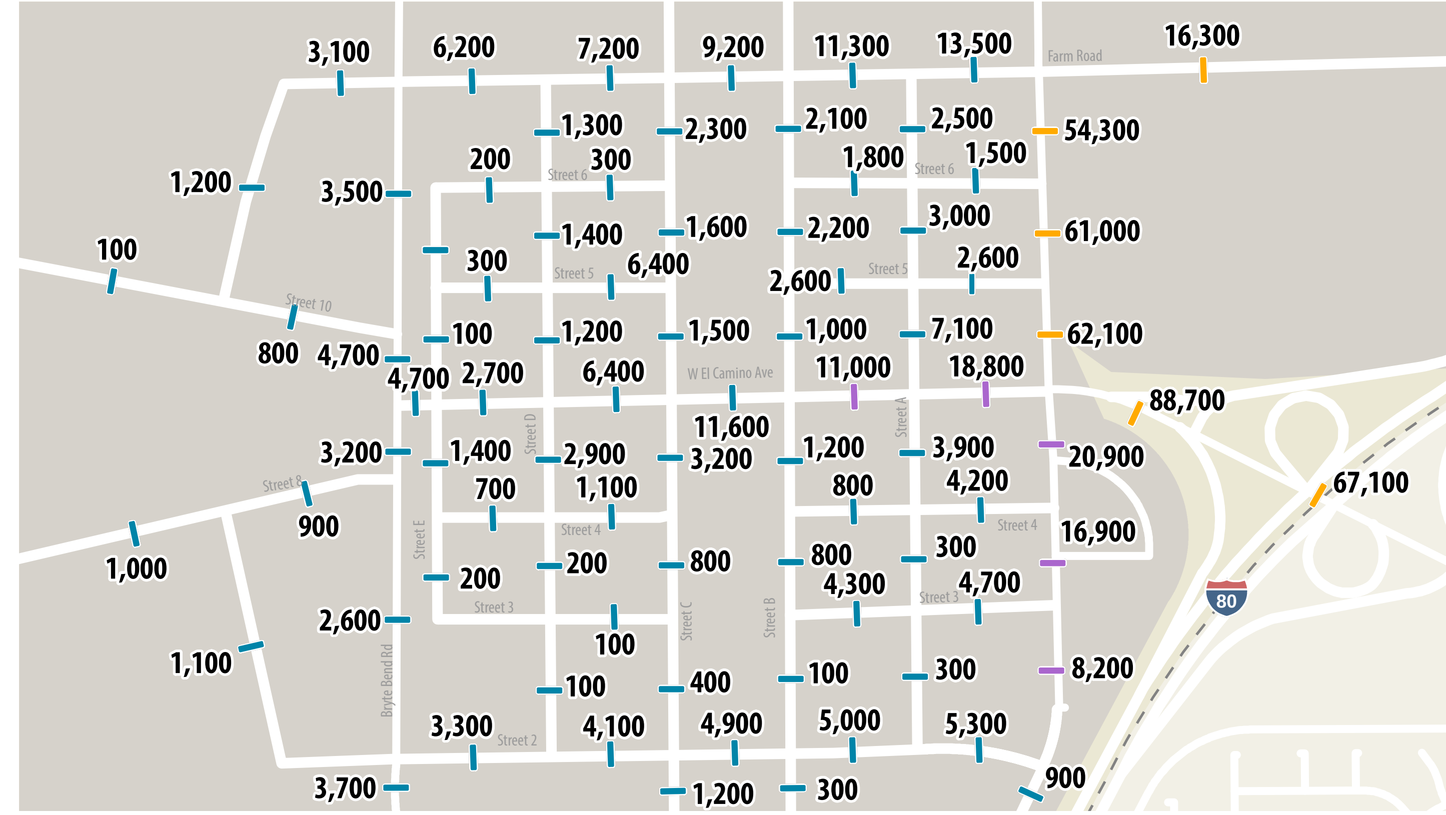

x,xxx Average Daily Traffic Volume

*Cumulative Plus Project Number of Lanes
- 2
- 4
- 6
- 8

*Includes through lanes only.

Upper Westside Specific Plan Boundary

City Boundary

County Boundary

Figure 10b

Average Daily Traffic Volumes and Number of Lanes - Cumulative Plus Project Conditions

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5. ROADWAY SAFETY ASSESSMENT

This chapter presents an assessment of roadway safety, focusing primarily on freeway interchanges under the jurisdiction of Caltrans.

Background

Caltrans' October 29, 2020 comment letter on the Notice of Preparation for the Upper Westside Specific Plan EIR did not make any reference to the need for safety analysis. Prior to issuing that letter, Sacramento County had met (virtually) on two separate occasions with Caltrans staff to discuss the scope of work.

In December 2020, Caltrans published the *Interim Local Land Development and Intergovernmental Review (LDIGR) Safety Review Practitioners Guidance*. This document provides guidance for conducting safety reviews of land use projects and plans that may affect the State Highway System. Although it stops short of including specific thresholds of significance or providing specific recommendations for how safety evaluations should be included in CEQA documents, it does clearly indicate the State's expectation that, when appropriate, CEQA studies of land use projects should include safety investigations of the State Highway System. Appendix A of that document provides practitioners with specific guidance on analysis of project effects on freeway off-ramp queuing. That information along with supplemental explanations provided by Caltrans staff in a webinar on January 20, 2021 is used as the basis for the freeway off-ramp queuing analysis presented in this chapter.

Inter-agency coordination continued between Sacramento County and Caltrans in 2021. On August 6, 2021, Caltrans issued a comment letter based on their staff review of an administrative draft of this report and the LTA report. The following key points related to safety were raised or requested in that letter:

1. Potential safety issues related to the I-80 / W. El Camino Avenue interchange from the Sacramento 49er Travel Plaza Truck Stop driveway(s) should be analyzed.
2. Caltrans will provide an analysis of the current collision patterns on the SHS relative to the project for the use in the County's Safety Analysis in the TIA/DEIR. Two to three years prior to the start of construction for Phase 1 of the project, Caltrans will provide an updated collisions patterns analysis to the County to ensure the current operational and safety conditions are represented.
3. Safety analysis should be conducted to demonstrate that safety impacts are being feasibly mitigated by discussing implementation of the "Four Pillars of Traffic Safety".
4. Cumulative safety impacts should be evaluated on the segment of West El Camino Avenue between the I-80 and I-5 interchanges so that the full safety impact can be examined, and improvements can be proposed when local/state projects are proposed in the area.

Each of the above items is addressed directly in this chapter. The August 6, 2021 comment letter also included reference to specific impacts and mitigation measures and responsibilities. Those comments and responses are included in Chapter 6 (Impacts and Mitigation Measures).

Potential Safety Issues at I-80/West El Camino Avenue Interchange Associated with Sacramento 49er Travel Plaza Truck Stop

This truck stop is located in the northeast corner of the West El Camino Avenue/El Centro Road intersection. As shown in Table 4, it was measured to generate about 175 AM peak hour trips and 215 PM peak hour trips, most of which are trucks. The site is accessed by a right-turn only driveway on West El Camino Avenue and three full-service driveways on El Centro Road. At project buildout, this use would be replaced by commercial mixed-use. However, it would likely remain in place for a period of time while the project begins developing.

The short segment of westbound West El Camino Avenue from the I-80 WB Ramps and El Centro Road features a short (about 150-foot) weaving area. The free-flowing off-ramp from westbound I-80 merges into its own lane, which becomes the right-turn lane at El Centro Road. A Class II bike lane and sidewalk are also present on this segment. During the PM peak hour (which is busier than the AM peak hour), 150 vehicles exit this off-ramp, many of which weave with the 910 vehicles (in a single lane) that continue straight from the freeway overcrossing.

The Transportation Injury Mapping System (TIMS) was developed by the University of California Berkeley's Safe Transportation Research & Education Center (SafeTREC) to map and document California crash data from the Statewide Integrated Traffic Records System (SWITRS). TIMS data was pulled for this area for the seven-year period from 2014 through 2020 inclusive. The data revealed only two collisions between the westbound ramps and El Centro Road, both resulting in complaint of pain, but not being severe or fatal. One was a broadside collision and the other involved a collision with a fixed object. Given the volume of traffic on this segment (14,200 daily trips), this is not considered an above average collision rate. There were six reported collisions on El Centro Road along the 49er Travel Plaza frontage. These collisions included broadside, rear-end, and head-on types.

Notwithstanding the above, it is recommended that the following collision monitoring, access management strategies, and phasing of interchange improvements be a project requirement:

1. *Eliminate the 49er Travel Plaza Driveway on West El Camino Avenue*. Removal of this driveway would reduce the number of conflict points involving passenger vehicles, trucks, bicyclists, and pedestrians.
2. *Replace the Free-Flowing Right-Turn Off-Ramp Movement with a Signal-Controlled Movement*. This would eliminate the weaving movement and also slow travel speeds on westbound West El Camino Avenue approaching El Centro Road.

Analysis of Current Collision Patterns on Adjacent Segments of I-80 and I-5

Caltrans provided collision statistics from June 1, 2018 through May 31, 2021 for two segments of I-5 and one segment of I-80 that would be used to the greatest degree by project trips. **Table 12** summarizes the results for the three-year period including the total number of reported collisions, collision rates, primary collision factors, and most common collision type.

Table 12 indicates that collision rates (total, fatal, and fatal/injury) are greater on the two segments of I-5 versus the segment of I-80. This is expected because the segments of I-5 generally feature more recurring congestion, lane changing, and other travel behaviors that may contribute to these collision patterns. On all segments speeding was the most common primary collision factor and rear-end collisions were most commonly reported. The collision rate (0.95 collisions per million vehicle miles of travel) on I-5 is slightly greater than the average rate for similar facilities (0.90 collisions per million vehicle miles of travel).

While the project would add the most trips to the I-80/West El Camino Avenue interchange on-ramps, it would also reconstruct the interchange to include ramp metering. With ramp metering in place, more orderly traffic flow from these on-ramps onto I-80 would be achieved, which may reduce collision rates.

Table 12: I-5 and I-80 Collision Statistics in Study Area

Segment	Postmile Range	Total Number of Reported Collisions	Collision Rates (per MVM)			Most Common Primary Collision Factors	Most Common Type of Collision
			Total	Fatal	Fatal + Injury		
I-80 from 0.85 miles to the west to 0.45 miles to the east of the I-80/West El Camino Avenue Interchange	M0.5 – M1.8	80	0.73	0.006	0.27	Speeding (51%), Improper Turn (20%)	Rear End (51%), Hit Object (20%)
I-5 from 0.5 miles to the north of the I-5/Del Paso Road interchange to 0.55 miles to the south of the I-5/Arena Blvd Interchange	27.5 – 29.5	224	0.95	0.009	0.36	Speeding (51%), Other Violations (32%)	Rear End (50%), Side Swipe (29%)
I-5 from 0.15 miles to the north of the I-5/West El Camino Avenue interchange to 0.25 miles to the south of the I-5/Garden Highway Interchange	25.0 – 26.0	204	0.95	0.009	0.36	Speeding (46%), Other Violations (24%)	Rear End (47%), Side Swipe (26%)

Notes:

MVM = Million Vehicle Miles
Source: Caltrans TASA Table B Data from June 1, 2018 through May 31, 2021.

Implementation of the Four Pillars of Traffic Safety

Caltrans's *2020-2024 Strategic Plan*[4] lists "Safety First" as its top goal through 2024. The screenshot on the following page summarizes the goals of "Safety First" and lists the actions and strategies to achieve that goal. The *2020 Caltrans Annual Accomplishments Report* describes the Four Pillars of Traffic Safety, which will help guide the department toward the ultimate goal of zero deaths or severe injuries on California roads by 2050. The Four Pillars of Traffic Study are:

1. *Double Down on What Works*
2. *Accelerate Advanced Technology*
3. *Lead Safety Culture Change*
4. *Integrate Equity*

Each of these pillars, including their applicability to the proposed project, are described below.

1. *Double Down on What Works*

This pillar focuses on implementing applicable countermeasures from FHWA's Proven Safety Countermeasures program (https://safety.fhwa.dot.gov/provencountermeasures/). This program contains 20 types of countermeasures including several crosscutting strategies that address multiple safety focus areas. Refer to separately bound appendix for a complete list of these countermeasures and overview of their effectiveness.

The proposed project and Sacramento County design standards already include many of these treatments including: roadway design improvements at horizontal curves, reduced left-turn conflicts at intersections, median barriers, traffic signals with retroreflective backplates, corridor access management, dedicated left/right turn lanes at intersections, roundabouts, medians/pedestrian crossing islands, road diets, and walkways. Other treatments from the FHWA program that could be considered for the proposed project include systemic application of low-cost countermeasures at stop-controlled intersections (e.g., advanced warning signs), leading pedestrian intervals (i.e., pedestrians receive WALK indication before motorists to enhance visibility), USLIMITS2 (a free, web-based tool designed to help practitioners assess and establish safe, reasonable, and consistent speed limits for specific segments of roadway), horizontal curve enhanced delineation and pavement friction, and pedestrian hybrid beacons.

2. *Accelerate Advanced Technology*

This pillar refers to increased and proactive usage of advanced technologies known to improve safety. Examples at traffic signals include vehicle queue spillback detection, coupled with a fixed Changeable Message Sign (CMS) sign upstream to alert drivers of either slowed or stopped traffic ahead. Other examples include extinguishable / blankout signs placed on traffic signal poles to advise travelers of

[4] Caltrans 2020-2024 Strategic Plan

regulatory or advisory conditions (e.g., no right-turn on red, look left for vehicles, etc.). Additionally, adaptive traffic signal systems are now being implemented in a number of corridors in urban areas. These systems can update their traffic signal timings in real-time, in responsive to changes in traffic flows, to better serve travelers (source: Adaptive Traffic Management: SCOOT | Traffic Management | Siemens Mobility USA).

Many of the above technologies are particularly well-suited to the West El Camino Avenue and El Centro Road corridors within and adjacent to the proposed project. Appropriate technologies can be evaluated and deployed at the high-profile West El Camino Avenue/El Centro Road intersection.

3. *Lead Safety Culture Change*

The Safe System approach represents a paradigm shift in roadway safety philosophy. Whereas previously the focus of roadway safety was on preventing collisions, now it is on preventing fatal and severe collisions. Before, the emphasis was on improving human behavior to reduce collision frequency, but now it is recognized that humans make mistakes and are vulnerable, and that roadway design must consider these factors. The Safe System approach refocuses transportation system design and operation on anticipating human mistakes and lessening impact forces to reduce crash severity and save lives. In the Safe System approach, the principles related to prevention of collision-related deaths and serious injuries are:

- Reduce System Kinetic Energy/Control Speeding
- Coordinate and Share Responsibility
- Proactively Address Risks

Some of these Safe System principles (e.g., reduce system kinetic energy) can be employed as part of the project design and mitigation. Others are more regional and programmatic in nature, requiring leadership and commitment by regional and state agencies and other stakeholders. Through preparation of a Local Roadway Safety Plan (LRSP), Sacramento County is proactively addressing risks through a systemic approach to safety (versus simply reacting to high collision locations).

4. *Integrate Equity*

The *2020-2024 Strategic Highway Safety Plan* (Caltrans, March 2021) lists "Integrate Equity" as one of its four guiding principles and a way to address institutional and systemic biases. This principle supports a better understanding of the effects of socioeconomic and demographic influences on fatal and serious injury crashes. Understanding these effects includes use of data related to race, income, population density, and other demographic, socioeconomic, and location-based information. Equity in safety may also relate to disparate treatment of different modes of travel.

The proposed project has been designed to accommodate all modes of travel. As described in this report, comprehensive systems are provided for bicyclists and pedestrians. In many cases, facilities supporting these modes of travel are physically separated from the roadway system to provide greater levels of protection to these vulnerable users.

GOAL: SAFETY FIRST

Transportation professionals and policy makers are confronting growing problems: increases in fatalities, serious injuries, and crashes on our transportation network despite a commitment to safety. In California, nearly 3,600 people die each year in traffic crashes and more than 13,000 people are seriously injured. Today, the traditional notion that roads should be designed to maximize vehicle throughput is increasingly challenged as we rethink the function and purpose of streets, the distinct needs of road users such as bicyclists, pedestrians, and scooter users, and the exponential dangers of excessive speed. We strive to make the year 2050 the first year without a single death or serious injury on California's roads.

We must leave yesterday's definitions about safety in the past if we want to achieve this new ideal. We will no longer accept fatalities and serious injuries as a price for mobility or for doing our job. We are striving for more equitable outcomes for the system's diverse users and for those impacted by our system.

To achieve these ambitious goals, we will start by doing more of what is already proven to be highly effective while also pursuing more meaningful collaboration with our partners. We will proactively identify and implement new technologies, innovations, and best practices. These pursuits are both ambitious and urgent, and their accomplishment involves a focused departure from the status quo to the Safe System approach as we continue to institutionalize safety in all our work.

Actions related to this goal aim to achieve the following outcomes:

Eliminate fatalities and serious injuries.

Eliminate employee fatalities and serious injuries "in the line of duty."

Reduce employee illnesses and injuries.

Eliminate race-based disparities in safety outcomes.

STRATEGIES:

- **Leverage proven practices.**
- **Accelerate advanced technology.**
- **Lead safety culture change.**
- **Partner to reduce speeding-related fatalities and serious injuries.**
- **Increase collaboration with external organizations to identify and implement best practices, technology, and lessons learned.**
- **Advance delivery of safety enhancements in, and that are responsive to, the priorities of underserved communities.**

CALTRANS 2020-2024 STRATEGIC PLAN 9 GOAL SAFETY FIRST

Cumulative Safety Impacts on West El Camino Avenue between I-5 and I-80

Since this segment is located entirely within the Sacramento City limits, the City would take the lead on approving and implementing any improvements on it. Sacramento is a Vision Zero City, which means they are committed to working together with partners to create safer streets.[5] The City has completed a Top Five Corridors study that identifies collision trends and recommends countermeasures on segments considered part of a high-injury network. The nearest Top Five corridor facility to the project site is El Camino Avenue between Northgate Boulevard and Del Paso Boulevard. Additionally, the City regularly undertakes corridor transportation planning studies such as recent/ongoing efforts along Northgate Boulevard, Stockton Boulevard, Pocket Greenhaven, and Freeport Boulevard.[6] The City also regularly evaluates and prioritizes corridors for study and improvement. Since West El Camino Avenue between I-5 and I-80 has continuous bicycle lanes, sidewalks, and median treatments to manage turning movements, it may not rate as high as other less improved city facilities. However, should collision rates increase, the City would presumably prioritize this corridor for study and potential improvements.

[5] Vision Zero - City of Sacramento

[6] Transportation Planning & Projects - City of Sacramento

6. IMPACTS AND MITIGATION MEASURES

This chapter identifies project-specific and cumulative impacts of the proposed project. Impact statements are provided for the topics of VMT and roadway safety, which are the criteria used to evaluate roadway system impacts. Impact statements are also provided for the bicycle, pedestrian, and transit systems. Mitigation measures are recommended for significant impacts.

Thresholds of Significance

The following thresholds of significance are used to evaluate the significance of project impacts to the roadway, bicycle, pedestrian, and transit systems. This report does not reach any conclusions regarding whether mitigation measures would lessen the significant impact to a less than significant level. Sacramento County staff will make that determination at the time the DEIR is being prepared.

Roadway Network VMT

The project would cause a significant impact if:

- Project VMT per capita exceeds 85 percent of the regional average VMT per capita.
- Project VMT per employee exceeds 85 percent of the regional average VMT per employee.
- The project's regional retail land uses cause a net increase in regional VMT.
- The project's proposed widening of "regional roadways" is expected to result in an increase in regional VMT.

When reviewing the project's VMT effects for the above thresholds, it is important to consider the project's overall VMT efficiency. In other words, the broader view of VMT properly considers the net effect, for instance, of a slight exceedance of one threshold versus a "substantially below threshold" result for another.

Roadway Safety / Design Standards

The project would cause a significant impact if it would:

- Cause a substandard rural roadway (i.e., less than 24 feet of pavement width and less than six a foot shoulder) to exceed an average daily traffic volume of 6,000 daily vehicles;

- Add 600 or more new daily vehicle trips to a substandard rural roadway that already carries 6,000 or more daily vehicles;
- Cause the maximum queue length at a freeway off-ramp to extend beyond the gore point onto the mainline (or exacerbate a current or future condition by increasing the maximum queue by one or more vehicles); or
- Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment).

Bicycle and Pedestrian Facilities

The project would cause a significant impact if it would:

- Eliminate or adversely affect an existing bikeway or pedestrian facility in a way that would discourage its use;
- Interfere with the implementation of a planned bikeway as shown in the Bicycle Master Plan, or be in conflict with the Pedestrian Master Plan; or
- Fail to provide adequate access for bicyclists and pedestrians, resulting in unsafe conditions, including unsafe bicycle/pedestrian, bicycle/motor vehicle, or pedestrian/motor vehicle conflicts.

Transit Services and Facilities

The project would cause a significant impact if it would:

- Eliminate or adversely affect existing transit access, service, or operations;
- Interfere with the implementation of transit service as planned in the Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS); or
- Substantially increase transit demand and fail to provide adequate transit service.

Project-Specific Impacts

Roadway Network VMT

The project's effect on VMT was analyzed in a comprehensive manner that considered its relative VMT efficiency per capita and per employee, its VMT effect by adding regional retail, and its VMT effect caused by widening regional roadways. Table 10 showed a reconciliation of the project's VMT budget, noting both savings and exceedances. This table indicated that the project's net increase in VMT due to roadway widenings (1,799 VMT) is more than offset by its beneficial land use efficiency and regional retail VMT saving benefits, which represent a combined savings of 36,158 VMT. The net result is that the project generates 34,359 VMT less than the VMT budgets established by the significance thresholds. Therefore, project impacts to roadway network VMT are considered **less than significant,** and no mitigation is required.

Roadway Safety / Design Standards:

The project would not cause a substandard rural roadway to exceed an ADT of 6,000 vehicles and would not add 600 or more vehicle trips to a substandard rural roadway that already carries 6,000 or more daily vehicles: Therefore, project impacts to rural roadway compatibility is considered **less than significant,** and no mitigation is required.

<u>Impact TR-1</u>: Freeway Off-Ramp Queues Exceed Available Storage

Table 13 presents the AM and PM peak hour maximum queues on freeway off-ramps under Existing Plus Project conditions. Refer to separately bound appendix for technical calculations. As shown, all study freeway off-ramps would continue to have sufficient storage to accommodate the maximum queue under existing plus project conditions with the exception of the I-80 eastbound and westbound off-ramps at West El Camino Avenue (during one or both peak hours) despite the interchange's assumed expansion with the project and I-5 southbound off-ramp at J Street (during the AM peak hour).

Appendix A to the *Interim Local Land Development and Intergovernmental Review (LDIGR) Safety Review Practitioners Guidance (Caltrans, December 2020)* specifies that the speed differential between the off-ramp queue and the adjacent travel lane is an important criterion that should be considered when determining significance of freeway off-ramp impacts. The guidance specifically cites 30 miles per hour as a threshold beyond which collision severity increases. Because the I-80 mainline at West El Camino Avenue operates in a free-flow condition during weekday AM and PM peak hours, there would be a greater than a 30 mph speed differential between queued off-ramp traffic and freeway mainline traffic. In contrast, the travel lane on southbound I-5 at the J Street off-ramp is frequently congested during the AM peak hour as a result of queue spillback from the I-80/US 50/SR 99 interchange. Hence, there would not be a 30 mph speed differential at this off-ramp. Thus, project impacts to off-ramp queuing at the I-80 eastbound and westbound off-ramps at West El Camino Avenue would be considered **significant**.

Mitigation TR-1: *The project applicant shall construct the geometric improvements shown on Figure 11 (or an equivalent or more effective set of alternate improvements subject to the determination of the environmental coordinator) at the I-80/West El Camino Avenue interchange and at the West El Camino Avenue/El Centro Road intersection*.

As noted in the project description, project buildout would be supported by a reconstructed I-80/West El Camino Avenue interchange to accommodate the project's travel needs and provide for a more bicycle/pedestrian friendly design (i.e., by removing the free-flow westbound I-80 off-ramp right-turn movement, for instance). Although the initial proposed project improvements include a traffic signal with additional lanes at the West El Camino Avenue/El Centro Road intersection, the resulting network would not have sufficient capacity to accommodate inbound travel to the project during peak hours. As a result, vehicles queues at each off-ramp would spill onto I-80.

The geometric improvements shown on Figure 11 were analyzed to determine how off-ramp queuing would be affected at the I-80/West El Camino Avenue interchange. The results indicated that the maximum queue with the improvements in place at the eastbound off-ramp would be 1,050 feet during the more critical PM peak hour, which can be accommodated in a standard interchange design. At the westbound off-ramp, the maximum queue would be 475 feet during the AM peak hour and 600 feet during the PM peak hour (see separately bound appendix for technical calculations). Since this is less than the existing storage of 1,500 feet, the improvements on Figure 11 would not cause traffic to spill onto the I-80 mainline under existing plus project conditions.

To implement the improvements shown on Figure 11, a subsequent Intersection Control Evaluation (ICE) process will need to be undertaken in conjunction with Caltrans to identify the proper interchange design to address both operational capacity and safety issues.

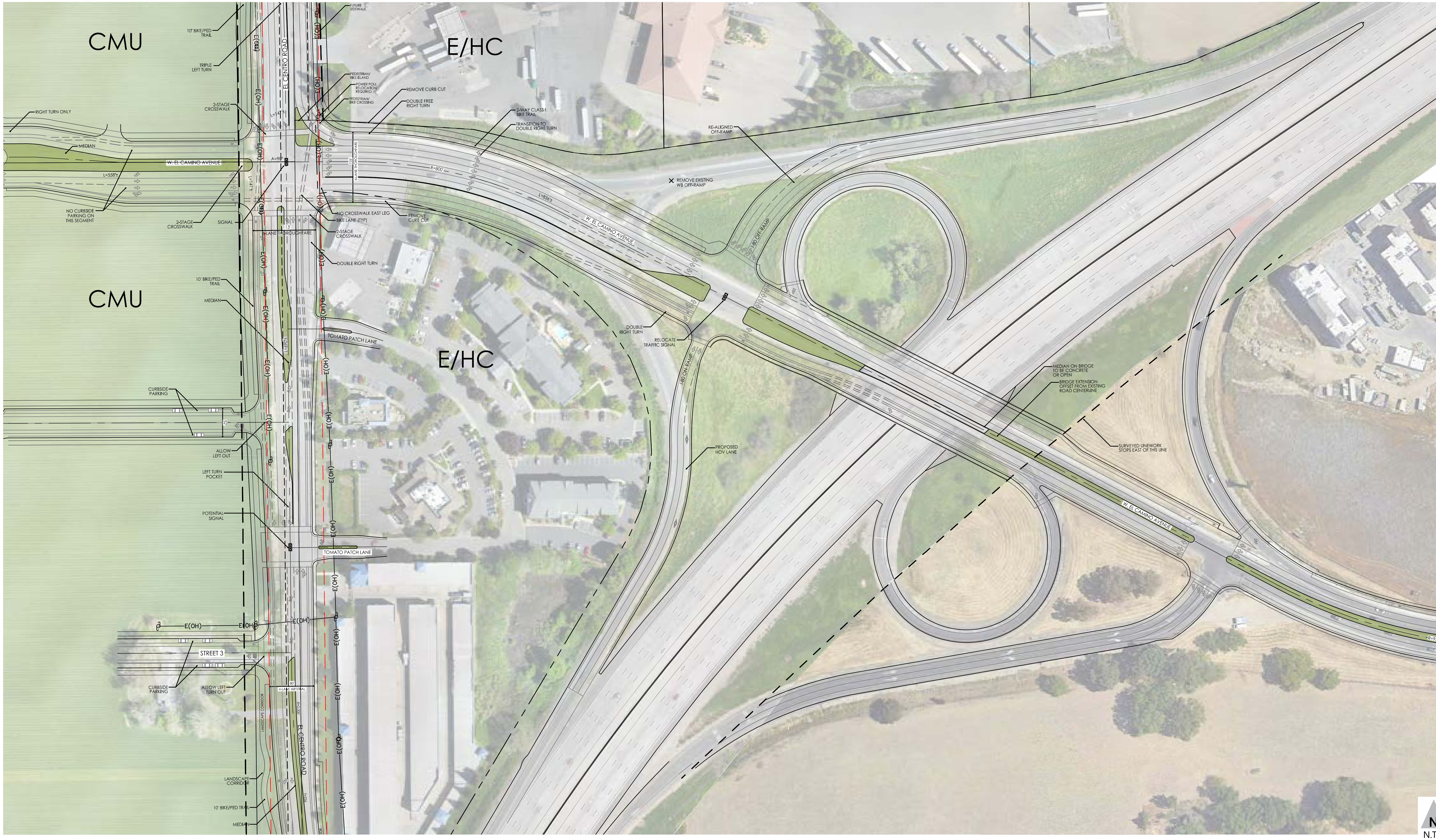
Table 13:
Peak Hour Freeway Off-Ramp Queuing – Existing Plus Project Conditions

Freeway Off-Ramp	Ramp Length[1]	Peak Hour	Average Maximum Queue (feet)[2]	
			Existing	Existing Plus Project
I-80 EB Off-Ramp at West El Camino Avenue	1,500 feet [3]	AM	250	700
		PM	500	**>1 mile**
I-80 WB Off-Ramp at West El Camino Avenue	1,500 feet [3]	AM	700	**>3,900**
		PM	250	**>1 mile**
I-5 NB Off-Ramp at Arena Blvd.	1,475 feet	AM	100	450
		PM	200	950
I-5 SB Off-Ramp at Arena Blvd.	1,425 feet	AM	100	125
		PM	100	300
I-5 NB Off-Ramp at Del Paso Rd.	1,300 feet	AM	375	425
		PM	500	525
I-5 SB Off-Ramp at Del Paso Rd.	1,150 feet	AM	175	1,025
		PM	175	200
I-5 NB Off-Ramp at West El Camino Ave.	1,000 feet	AM	325	425
		PM	225	450
I-5 NB Off-Ramp at Garden Highway	1,275 feet	AM	275	275
		PM	325	875
I-5 SB Off-Ramp at Garden Highway	1,425 feet	AM	175	175
		PM	200	375
I-5 SB Off-Ramp at Richards Boulevard	1,050 feet	AM	625	625
		PM	400	400
I-5 SB Off-Ramp at J Street	1,525 feet	AM	1,400	**1,830**
		PM	325	400

Notes:
1. The ramp length is estimated by measuring the distance from the gore point where the off-ramp departs from the mainline to the limit line at the ramp terminal intersection with the local street, as measured from aerial imagery.
2. Maximum queue, as calculated using the average of 10 SimTraffic microsimulation runs. Queue is expressed on a "per lane" basis.
3. Presumed storage to be provided with reconstructed interchange.

Bolded cells indicated that maximum queue exceeds available storage.

Source: Fehr & Peers, 2021.



Source: Wood Rodgers, Feb 2025

CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Figure 11

Geometric Improvements at West El Camino Avenue and El Centro Road

Impact TR-2: Freeway On-Ramp Ramp Meter Queues Exceed Available Storage

Table 14 presents the AM and PM peak hour queues at freeway on-ramp ramp meter locations that would be used by the project. Refer to separately bound appendix for technical calculations. As shown, most freeway ramp meter on-ramp locations would continue to have sufficient storage for queues except for the I-5 southbound diagonal on-ramp at West El Camino Avenue and I-5 southbound loop on-ramp and I-5 northbound diagonal on-ramp at Garden Highway. Project impacts to freeway on-ramp ramp metering queuing would be considered **significant**.

Table 14:
Peak Hour Freeway On-Ramp Ramp Meter Queuing – Existing Plus Project Conditions

Freeway Off-Ramp	Ramp Type	Ramp Length[1]	Peak Hour	Average Maximum Queue[2]	
				Existing	Existing Plus Project
I-80 WB Diagonal On-Ramp at West El Camino Avenue	2 GP Lane + 1 HOV Lane	1,000 feet	AM	350	200
			PM	250	150
I-80 EB Loop On-Ramp at West El Camino Avenue	1 GP Lane + 1 HOV Lane	700 feet	AM	250	375
			PM	125	375
I-5 NB Loop On-Ramp at Arena Blvd.	1 GP Lane + 1 HOV Lane	625 feet	AM	200	200
			PM	100	125
I-5 SB Diagonal On-Ramp at Arena Blvd.	1 GP Lane + 1 HOV Lane	1,200 feet	AM	325	475
			PM	325	575
I-5 SB Diagonal On-Ramp at Del Paso Rd.	1 GP Lane	1,100 feet	AM	375	475
			PM	300	300
I-5 SB Diagonal On-Ramp at West El Camino Ave.	1 GP Lane	750 feet	AM	325	525
			PM	300	**3,325**
I-5 SB Loop On-Ramp at Garden Highway	1 GP Lane	625 feet	AM	**775**	**1,075**
			PM	**1,450**	**1,525**
I-5 NB Diagonal On-Ramp at Garden Highway	1 GP Lane	725 feet	AM	Not Operational	
			PM	**900**	**900**

Notes:
1. The ramp meter storage is measured from the ramp meter stop line to the upstream intersection or roadway ramp departure gore point., as measured from aerial imagery. Storage rounded to the nearest 25 feet.
2. Maximum queue, as calculated using the average of 10 SimTraffic microsimulation runs. Queue is expressed on a "per lane" basis.
3. Presumed storage to be provided with reconstructed interchange.

GP = General Purpose. HOV = High Occupancy Vehicle (Carpool).
Bolded cells indicated that maximum queue exceeds available storage.

Source: Fehr & Peers, 2021.

Mitigation TR-2: *The project applicant shall pay its proportionate fair share percentage toward improvements at the I-5 SB on-ramp at West El Camino Avenue and I-5 SB and NB on-ramps at Garden Highway.*

All three on-ramps feature a single general purpose metered lane with storage (625 to 750 feet) that is less than is typically provided at new interchanges. Queuing could be reduced at each on-ramp by widening it to include a second lane (either general purpose or carpool). Caltrans indicated in their August 6, 2021 comment letter that there is a planned project at the I-5 southbound on-ramp at West El Camino Avenue, but nothing planned at the I-5 on-ramps at Garden Highway. It is further noted that the Garden Highway on-ramp queuing is an existing operational issue, caused in part by Caltrans' decision to apply metering rates of about 800 vehicles per hour (due to congestion along I-5). Since adding increased on-ramp capacity could contribute to increased traffic flows on I-5 during peak hours, one option would be to reduce metering rates in conjunction with the on-ramp capacity increase so as to avoid adding more peak hour traffic onto I-5.

Impact TR-3: Increased Hazards at Project Access Intersections on Garden Highway

The project would construct new or expanded intersections on Garden Highway, which along the project frontage is a two-lane undivided roadway featuring horizontal curvature, a 45-mph posted speed limit, and limited to no shoulders. New/improved intersections would be at Radio Road, San Juan Road, Street 9, and Bryte Bend Road. The addition of project trips to these new/improved intersections could increase design hazards due to their geometric features. This impact would be considered **significant**.

The Bryte Bend Road intersection with Garden Highway would be relocated approximately 600 feet north of its current location to a tangential section of Garden Highway. The appendix contains an exhibit showing that motorists exiting Bryte Bend Road (looking to the left, which is the more critical direction) would have adequate sight distance based on the new location and Sacramento County design standards.

Mitigation TR-3: *The project applicant shall construct the following improvements at project access intersections along Garden Highway:*

- Garden Highway/San Juan Road (#4) – Construct exclusive southbound left-turn lane.
- Garden Highway/Bryte Bend Road (#5) – Construct exclusive northbound right-turn lane.
- Garden Highway/Radio Road (#42) – Construct exclusive southbound left-turn lane.
- Garden Highway/Street 9 (#108) – Side-street stop-control with a single lane on all approaches is recommended based on the projected traffic volumes.

The above recommendations are based on the forecast traffic volume and geometric conditions at each intersection.

Bicycle and Pedestrian Facilities

Impact TR-4: Inadequate Bicycle/Pedestrian Access on West El Camino Avenue

The project would not eliminate or adversely affect an existing bikeway or pedestrian facility in a way that would discourage its use. It would also not interfere with the implementation of any planned bikeways in the project vicinity. According to the *Sacramento County Bicycle Master Plan* (2011), Class II bike lanes are planned along portions of El Centro Road, San Juan Road, and Radio Road, both within and adjacent to the project site. According to Figure 4, the project would construct bicycle facilities on each of these streets that would match or exceed (in terms of quality or quantity of facilities) what is planned in the Bikeway Master Plan.

As shown on Figure 4, the project would construct a Class II facility southerly along Bryte Bend Road to Garden Highway, where a Class I facility is planned. The project would also construct a Class I facility along existing El Centro Road south of West El Camino Avenue parallel to I-80 to allow for a future connection under I-80 to a planned Class I facility near West River Drive. A bicycle facility connection from the project site to the existing Class II bike lane to the east on Garden Highway (within the City of Sacramento) would be a multi-agency effort because the facility would traverse both Sacramento County, City of Sacramento, and also need to be coordinated with improvements to the levee being made by the Sacramento Area Flood Control Authority (SAFCA). The *Sacramento County Pedestrian Master Plan* (2007) does not show any priority pedestrian projects within the project's immediate vicinity. The proposed project would fail to provide adequate access for bicyclists/pedestrians along West El Camino Avenue and El Centro Road and along West El Camino Avenue easterly to its I-80 interchange. This impact would be considered **significant**.

Mitigation TR-4a: *Implement Mitigation Measure TR-1 (Geometric Modifications at El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange).*

Mitigation TR-4b: *The project applicant shall implement the bicycle/pedestrian improvements shown on Figure 12 at the El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange.*

Specific amenities shown on **Figure 12** to support biking include:

- Class I multi-use path allowing two-way bicycle travel on the north side of West El Camino Avenue that would extend from El Centro Road to the signalized Orchard Lane intersection (within the City of Sacramento) east of I-80. Additional studies during the interchange design phase will be necessary to determine its exact alignment and how/whether it intersects the three on/off ramps at-grade or not.

- Class I multi-use path on the west side of El Centro Road both north and south of West El Camino Avenue.
- Class II bike lanes in both directions of El Centro Road both north and south of West El Camino Avenue.
- Class II bike lanes in both directions of West El Camino Avenue west of El Centro Road (including an eastbound bike lane that would be located between the left and through lanes at the signal). This bike lane would operate with the eastbound left-turn phase, providing bicyclists with the ability to reach the triangular island to access the Class I multi-use path on the north side of West El Camino Avenue.
- A Class II bike lane is currently shown in the eastbound direction of West El Camino Avenue from El Centro Road extending across the interchange. Bicyclists in this lane need to navigate the merging area with vehicles desiring to travel onto the westbound I-80 diagonal on-ramp. Additional discussion with Caltrans will be necessary during the design phase of the interchange to determine whether this bike lane is desirable or not.

Pedestrian amenities include sidewalks along El Centro Road and West El Camino Avenue west of El Centro Road. It is not known whether a sidewalk would also be provided on the south side of West El Camino Avenue east of El Centro Road across the interchange, as pedestrians using it would encounter three on/off ramps carrying considerable levels of traffic. An alternate route for pedestrians would be the Class I path on the north side. Crosswalks would be provided on three of the four legs at the West El Camino Avenue/El Centro Road intersection. The east leg does not have a crosswalk because it would have adversely affected overall traffic operations in the area.

Transit Services and Facilities

Impact TR-5: Inadequate Transit Service to Meet Demand

Consistent with Sacramento County's General Plan Policy LU-120, the Town Center component of the proposed project would consist of a mix of complementary land uses built at high densities to support transit use. However, existing fixed-route transit service is not provided to the project site. To determine compliance with Policy LU-120, a transit network and frequency analysis needs assessment was performed. This evaluation determined that the area should be served by fixed-route bus service operating on 15-minute headways from approximately 6 AM to 8 PM. Figure 5 displays the recommended route en which buses use portions of Bryte Bend Road and West El Camino Avenue through the Town Center to travel between El Centro Road on the north and I-80 on the east. Since the project would be phased over time, it is anticipated that transit service levels will also increase over time as ridership increases.

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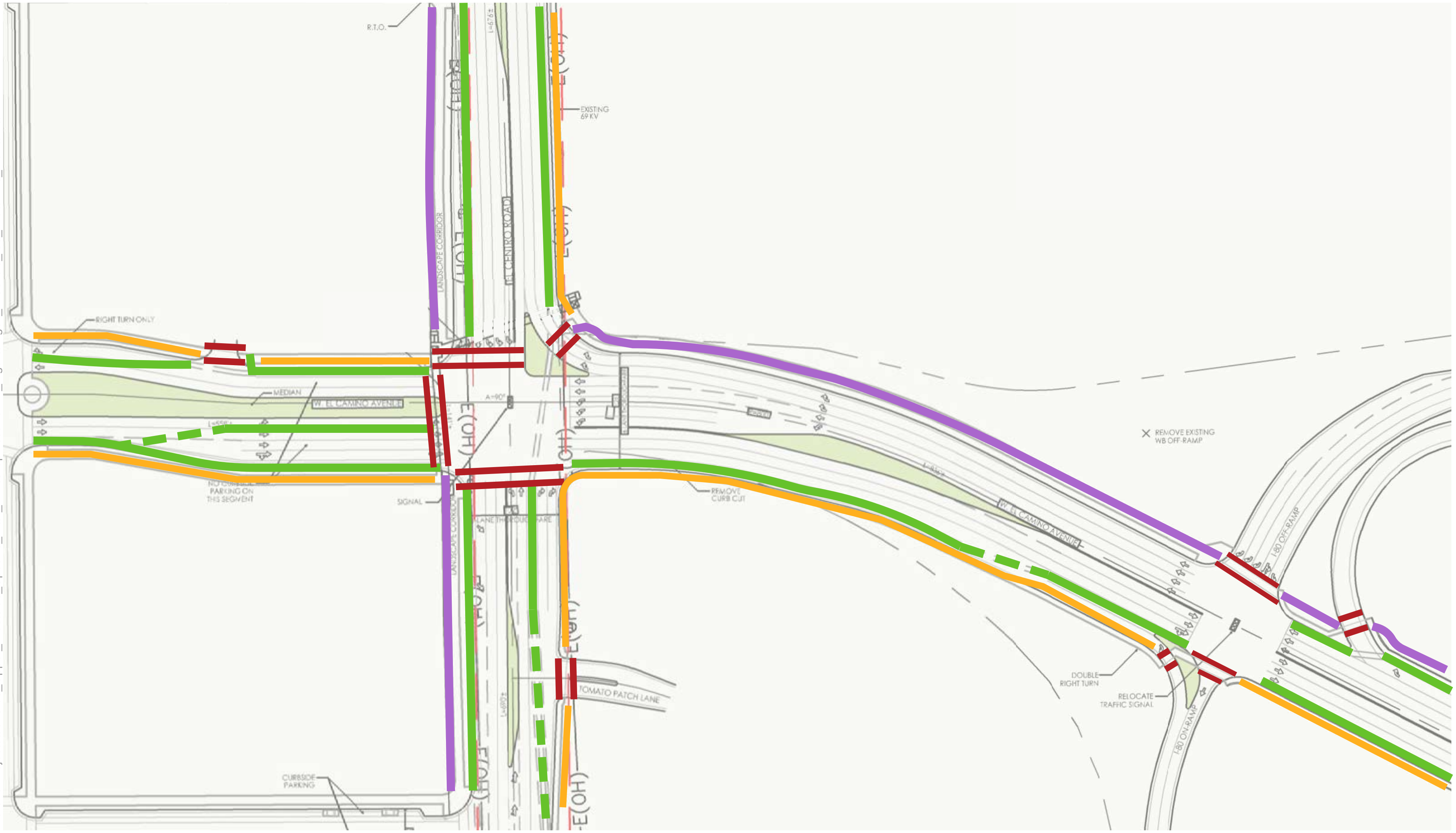

Class I Multi-use Path

Class II Bike Lane

Sidewalk

New Crosswalk

Figure 12

Bicycle and Pedestrian Facilities
El Centro Rd/I-80 WB Ramps/West El Camino Ave Improvements

The project would not eliminate or adversely affect existing transit access, service, or operations, because no service is provided in the immediate project vicinity. The project would not interfere with implementation of transit services as planned in SACOG's MTP/SCS. However, the project would substantially increase transit ridership demand and fail to provide adequate transit service, despite the transit plan that has been prepared for the Specific Plan. Specifically, severe congestion along El Centro Road between West El Camino Avenue and Farm Road would cause substantial delays to planned bus service to operate along this route. Additionally, the lack of planned fixed-route bus service may lead to an unmet demand for transit service. This impact would be considered **significant**.

Mitigation TR-5a: *Implement Mitigation Measure TR-1 (Geometric Modifications at El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange).*

Mitigation TR-5b: *Consistent with General Plan Policy LU-120, the project applicant shall coordinate with Sacramento County and Sacramento Regional Transit District (or other transit operators) to provide the additional transit facilities and services assumed in the transportation analysis, or a cost-effective equivalent level of transit facilities and services. Equivalent transit services may include, but is not limited to buses, vanpools, shuttles, or dial-a-ride service. Ultimate transit service shall include 15-minute headways or equivalent during peak hours (Monday through Friday from 7-9 a.m. and 4-6 p.m.) and 30-minute headways during non-peak hours (Monday through Friday). The implementation of the transit routes and service frequency must be phased with development buildout of the Project. This shall be accomplished through the annexation to County Service Area 10, formation of a transportation services district, or other secured funding mechanism. Such annexation or formation shall occur prior to recordation of any final small lot subdivision map for the project.*

The specified physical improvements would substantially reduce queuing, delays, and congestion on West El Camino Avenue and El Centro Road near the Town Center. They would also decrease average delays at the El Centro Road/West El Camino Avenue, El Centro Road/Farm Road, and two I-80 ramp intersections during peak hours. Operations would generally improve to a level similar to other key corridors in Sacramento County (e.g., Watt Avenue, Arden Way, etc.) that feature high-quality bus service.

Cumulative Project Impacts

Roadway Network VMT

According to the TAG, projects that do not demonstrate a significant VMT impact under baseline conditions can be presumed to also be less than significant in the cumulative year. This guidance is aligned with the *Technical Advisory* (at page 6), which states:

> "*A project that falls below an efficiency-based threshold that is aligned with long-term environmental goals and relevant plans would have no cumulative impact distinct from the project impact. Accordingly, a finding of a less-than-significant project impact would imply a less than significant cumulative impact*."

Page 55 of the SACOG MTP/SCS states that average VMT per capita in the region is expected to decrease by 10 percent relative to current conditions by the Year 2040. This result is due to improved multi-modal transportation choices and planned land use growth in "low VMT areas". Thus, the SACOG region planning principles and projections are aligned with the *Technical Advisory* in terms of long-term environmental goals to reduce VMT and greenhouse gas emissions. Therefore, based on the above, cumulative project impacts to roadway network VMT are considered **less than significant,** and no mitigation is required.

Roadway Safety / Design Standards

<u>Impact TR-6</u>: Degraded Conditions on Substandard Sacramento County Rural Roadways Under Cumulative Conditions

The proposed project would cause the following substandard Sacramento County rural roadways (i.e., less than 24 feet of pavement width and less than a six foot shoulder) to carry over 6,000 daily vehicles:

- Powerline Road: Bayou Way to Del Paso Road
- Powerline Road: Del Paso Road to Garden Highway
- Garden Highway: Powerline Road to Radio Road
- Garden Highway: Radio Road to San Juan Road

Under cumulative no project conditions, they would carry between 3,300 and 4,700 ADT. Under cumulative plus project conditions, they would carry between 7,000 and 9,500 ADT. The project adds considerably more trips to these segments under cumulative conditions versus existing conditions. This is likely due to new employment uses contained within Metro Air Park, which attract home-based work trips from the project.

It is also possible that some of these trips are using the new I-5/Metro Air Park interchange to travel to/from the north on I-5. This impact would be considered **significant** under cumulative conditions.

Mitigation TR-6: The project applicant shall pay their fair share cost of improving the following roadways to conform with current County design standards:

- Powerline Road from Bayou Way to Garden Highway
- Garden Highway from Powerline Road to San Juan Road

The County's TAG indicates that when deficient operations (i.e., volume exceeding 6,000 ADT) are identified on substandard roadways, they should be upgraded to the current rural roadway standard, which consists of two 12-foot travel lanes and 6-foot paved shoulders. The fair share recommendation reflects the fact that the impact is cumulative in nature, and partially driven by other land development and roadway improvements within the County.

Impact TR-7: Freeway Off-Ramp Queues Exceed Available Storage Under Cumulative Conditions

Table 15 presents the AM and PM peak hour maximum queues on freeway off-ramps under cumulative no project and plus project conditions. Refer to separately bound appendix for technical calculations. Under cumulative no project conditions, both off-ramps at the I-5/Del Paso Road and I-5/Garden Highway interchanges and the northbound off-ramp at the I-5/Arena Boulevard interchange would have maximum queues during one or both peak hours that would exceed available storage. This is most often being caused by downstream surface street congestion (primarily at intersections within the City of Sacramento such as Garden Highway/Truxel Road, Del Paso Road/El Centro Road, and Arena Boulevard/East Commerce Way) that causes traffic to spill back to the interchange, thereby hindering the flow of off-ramp traffic. Under cumulative plus project conditions, all study freeway off-ramps would have maximum queues that exceed the available storage. Improvements at the surface street intersection bottlenecks were aimed at reducing vehicle queues that spill back to each interchange. Improvements such as lane restripings, adding lanes, or modifying signal phasing were either found to not be effective or could also cause the need for additional right-of-way. Further, these improvements are outside the control of Sacramento County or Caltrans since they are located within the City of Sacramento. Project impacts to freeway off-ramp queuing would be considered **significant** under cumulative conditions.

This study did not evaluate freeway operations. Therefore, it was not possible to determine whether freeway mainline conditions would be degraded under cumulative conditions to the point that the speed differential between the off-ramp and mainline would be 30 mph or less.

Table 15:
Peak Hour Freeway Off-Ramp Queuing – Cumulative Plus Project Conditions

Freeway Off-Ramp	Ramp Length[1]	Peak Hour	Average Maximum Queue[2] Cumulative No Project	Average Maximum Queue[2] Cumulative Plus Project
I-80 EB Off-Ramp at West El Camino Avenue	1,500 feet [3]	AM	375	**4,850**
		PM	325	**> 1 mile**
I-80 WB Off-Ramp at West El Camino Avenue	1,500 feet [3]	AM	250	**> 1 mile**
		PM	175	**> 1 mile**
I-5 NB Off-Ramp at Arena Blvd.	1,475 feet	AM	475	**> 1 mile**
		PM	**2,525**	**> 1 mile**
I-5 SB Off-Ramp at Arena Blvd.	1,425 feet	AM	200	**2,525**
		PM	125	**1,475**
I-5 NB Off-Ramp at Del Paso Rd.	1,300 feet	AM	250	275
		PM	**4,200**	**5,025**
I-5 SB Off-Ramp at Del Paso Rd.	1,150 feet	AM	275	**1,600**
		PM	**4,500**	**4,525**
I-5 NB Off-Ramp at West El Camino Ave.	1,000 feet	AM	350	525
		PM	250	**1,200**
I-5 NB Off-Ramp at Garden Highway	1,275 feet	AM	**1,775**	**3,950**
		PM	**4,450**	**4,950**
I-5 SB Off-Ramp at Garden Highway	1,425 feet	AM	**3,525**	**1,575** [4]
		PM	**3,525**	**3,625**

Notes:
1. The ramp length is estimated by measuring the distance from the gore point where the off-ramp departs from the mainline to the limit line at the ramp terminal intersection with the local street, as measured from aerial imagery.
2. Maximum queue, as calculated using the average of 10 SimTraffic microsimulation runs. Queue is expressed on a "per lane" basis.
3. Presumed storage to be provided with reconstructed interchange.
4. This queue is shorter than cumulative no project conditions because vehicles attempting to access the southbound on-ramp block the northbound off-ramp. This in turn, results in more green time for eastbound through, thereby reducing the southbound off-ramp queue.

Bolded cells indicated that maximum queue exceeds available storage.

Source: Fehr & Peers, 2021.

Mitigation TR-7a: *Implement Mitigation Measure TR-1 (Geometric Modifications at El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange).*

Mitigation TR-7b: *The project applicant shall construct or pay their fair share cost for the following improvements*:

- *At the Arena Boulevard/El Centro Road intersection, construct second westbound left-turn lane, second southbound through lane, restripe eastbound right-turn lane to a shared through/right, and lengthen northbound right-turn lane to 400 feet with right-turn overlap arrow.*
- *Pay fair share cost of installing an eastbound right-turn overlap phase at Arena Boulevard/East Commerce Way intersection.*

Table 16 illustrates the effectiveness of the above improvements on freeway off-ramp queuing under cumulative plus project conditions. Refer to separately bound appendix for technical calculations as well as an exhibit showing improvements at the Arena Boulevard/El Centro Road intersection. As shown, the recommended mitigation measures would result in maximum queues at freeway off-ramps remaining within the available storage at the I-80/West El Camino Avenue, I-5/West El Camino Avenue, and I-5/Arena Boulevard interchanges. Queues would exceed the available storage at the I-5/Del Paso Road and I-5/Garden Highway interchanges. As noted previously, no known improvements are planned at either interchange. Further, some of the queue spillbacks are due to surface street congestion, which could likely not be fully resolved by interchange reconstruction.

In early 2022, Sacramento County, Fehr & Peers, and Caltrans met to discuss whether the identified geometric improvements at the I-80/West El Camino Avenue interchange would result in vehicle queues on the westbound off-ramp that would spill back onto I-80. As noted previously, the reported maximum queues in this report are the average of the maximum queues from 10 SimTraffic microsimulation runs. To better illustrate the effectiveness of these improvements during the more critical PM peak hour, the separately bound appendix include screen captures of 20 SimTraffic model runs at the end of each run's peak hour. As shown, 18 of the 20 runs had queues that were within the off-ramp storage (only Runs 7 and 18 show queues that slightly exceed the ramp storage). Since the reported maximum queue is the average of the ten SimTraffic runs, it follows that the reported queue would not exceed the available storage. Detailed review of the simulation indicates that the westbound left-turn movement at the West El Camino Avenue/El Centro Road intersection contributes to westbound off-ramp queuing. Additional model runs were conducted to test the effects of increasing this left-turn's maximum green time from 19 to 23 seconds. The separately bound appendix includes screen captures of 20 SimTraffic model runs at the end of each run's peak hour with this timing modification in place. As shown, all 20 runs had queues within the off-ramp storage. In conclusion, this analysis has demonstrated that the identified geometric improvements would not cause vehicle queues to spill back onto I-80 under cumulative plus project conditions.

Table 16:
Peak Hour Freeway Off-Ramp Queuing – Cumulative Plus Project Conditions with Improvements

Freeway Off-Ramp	Ramp Length[1]	Peak Hour	Average Maximum Queue (feet)[2]		
				Cumulative Plus Project	
			Cumulative No Project	Without Improvements	With Improvements
I-80 EB Off-Ramp at West El Camino Avenue	1,500 feet [3]	AM	375	**4,850**	950
		PM	325	**> 1 mile**	975
I-80 WB Off-Ramp at West El Camino Avenue	1,500 feet [3]	AM	250	**> 1 mile**	525
		PM	175	**> 1 mile**	1,025
I-5 NB Off-Ramp at Arena Blvd.	1,475 feet	AM	475	**> 1 mile**	150
		PM	**2,525**	**> 1 mile**	275
I-5 SB Off-Ramp at Arena Blvd. [4]	1,425 feet	AM	200	**2,525**	200
		PM	125	**1,475**	150
I-5 NB Off-Ramp at Del Paso Rd. [4]	1,300 feet	AM	250	**275**	-
		PM	**4,200**	**5,025**	-
I-5 SB Off-Ramp at Del Paso Rd.	1,150 feet	AM	275	**1,600**	-
		PM	**4,500**	**4,525**	-
I-5 NB Off-Ramp at West El Camino Ave.	1,000 feet	AM	350	525	775
		PM	250	**1,200**	425
I-5 NB Off-Ramp at Garden Highway [5]	1,275 feet	AM	**1,775**	**3,950**	-
		PM	**4,450**	**4,950**	-
I-5 SB Off-Ramp at Garden Highway [5]	1,425 feet	AM	**3,525**	**1,575**	-
		PM	**3,525**	**3,625**	-

Notes:
1. The ramp length is estimated by measuring the distance from the gore point where the off-ramp departs from the mainline to the limit line at the ramp terminal intersection with the local street, as measured from aerial imagery.
2. Maximum queue, as calculated using the average of 10 SimTraffic microsimulation runs. Queue is expressed on a "per lane" basis.
3. Presumed storage to be provided with reconstructed interchange.
4. Bottlenecks exist at both Del Paso Road/El Centro Road and Del Paso Road/East Commerce Way that contribute to lengthy off-ramp queues. Feasibility of improvements at those locations is unknown at this time.
5. Off-ramp queuing caused both by ramp storage limitations and also the Truxel Road/Garden Highway/New American River bridge intersection. Feasibility of improvements at those locations is unknown at this time.

Bolded cells indicated that maximum queue exceeds available storage.

Source: Fehr & Peers, 2021.

Impact TR-8: Freeway On-Ramp Ramp Meter Queues Exceed Available Storage Under Cumulative Conditions

Table 17 presents the AM and PM peak hour maximum queues under cumulative conditions at freeway on-ramp ramp meter locations that would be used by the project. Refer to separately bound appendix for technical calculations. As shown, most freeway ramp meter on-ramp locations would continue to have sufficient storage for queues. However, the project would cause the maximum queue at the metered on-ramps at the I-5 southbound diagonal on-ramp (PM peak hour) at West El Camino Avenue and I-5 southbound loop on-ramp at Garden Highway (AM peak hour) to exceed their available storage. It should be noted that the "plus project" scenario assumed a second metered lane at the I-5 southbound on-ramp at Del Paso Road in order to avoid severely over-capacity conditions along Del Paso Road and El Centro Road. This, along with worsening bottlenecks elsewhere in the system, explains why maximum queues at this on-ramp are reduced under plus project conditions. Project impacts to freeway on-ramp ramp metering queuing would be considered **significant**.

Mitigation TR-8: *The project applicant shall pay its proportionate fair share percentage toward improvements at the I-5 SB diagonal on-ramp at West El Camino Avenue, I-5 SB loop on-ramp at Garden Highway, and I-5 SB diagonal on-ramp at Del Paso Road.* Queuing could be reduced at each on-ramp by widening it to include a second metered lane (either general purpose or carpool).

A variety of constraints are present at the I-5/Garden Highway interchange, which could preclude any additional improvements. However, improvements to the I-5 southbound on-ramp at West El Camino Avenue would indirectly benefit the Garden Highway southbound loop on-ramp by redirecting some trips away from it.

Table 17:
Peak Hour Freeway On-Ramp Ramp Meter Queuing – Cumulative Plus Project Conditions

Freeway Off-Ramp	Ramp Type	Ramp Length[1]	Peak Hour	Average Maximum Queue (feet)[2] Cumulative No Project	Average Maximum Queue (feet)[2] Cumulative Plus Project
I-80 WB Diagonal On-Ramp at West El Camino Avenue	2 GP Lane + 1 HOV Lane	1,000 feet	AM	450	125
			PM	350	125
I-80 EB Loop On-Ramp at West El Camino Avenue	1 GP Lane + 1 HOV Lane	700 feet	AM	325	325
			PM	200	275
I-5 NB Loop On-Ramp at Arena Blvd.	1 GP Lane + 1 HOV Lane	625 feet	AM	150	175
			PM	125	125
I-5 SB Diagonal On-Ramp at Arena Blvd.	1 GP Lane + 1 HOV Lane	1,200 feet	AM	950	425
			PM	500	275
I-5 SB Diagonal On-Ramp at Del Paso Rd.	1 GP Lane / 2 GP Lanes [4]	1,100 feet	AM	**1,950**	200
			PM	475	225
I-5 SB Diagonal On-Ramp at West El Camino Ave.	1 GP Lane	750 feet	AM	425	450
			PM	675	**1,350**
I-5 SB Loop On-Ramp at Garden Highway	1 GP Lane	625 feet	AM	**900**	**1,575**
			PM	400	450
I-5 NB Diagonal On-Ramp at Garden Highway	1 GP Lane	725 feet	AM	175	175
			PM	**950**	**950**

Notes:
1. The ramp meter storage is measured from the ramp meter stop line to the upstream intersection or roadway ramp departure gore point., as measured from aerial imagery. Storage rounded to the nearest 25 feet.
2. Maximum queue, as calculated using the average of 10 SimTraffic microsimulation runs. Queue is expressed on a "per lane" basis.
3. Presumed storage to be provided with reconstructed interchange.
4. Assumed to be widened to two lanes under plus project conditions. See discussion on previous page for rationale.

GP = General Purpose. HOV = High Occupancy Vehicle (Carpool).
Shaded cells represent maximum queues that exceed available storage.
Source: Fehr & Peers, 2021.

Impact TR-10: Increased Hazards at Project Access Intersections on Garden Highway Under Cumulative Conditions

The project would construct new or expanded intersections on Garden Highway, which along the project frontage is a two-lane undivided roadway featuring horizontal curvature, a 45-mph posted speed limit, and limited to no shoulders. New/improved intersections would be at Radio Road, San Juan Road, Street 9, and Bryte Bend Road. The addition of project trips to these new/improved intersections could increase design hazards due to their geometric features. Under cumulative conditions, additional background travel is expected at these intersections, which should be considered in their design. This impact would be considered **significant** under cumulative conditions.

Mitigation TR-10: *Implement Mitigation Measure TR-3 (Physical Improvements at Intersections Along Garden Highway):*

The recommended mitigation measures in Mitigation Measure TR-3 are also suitable for cumulative conditions based on the cumulative traffic forecasts and geometric conditions at each intersection.

Bicycle and Pedestrian Facilities

Impact TR-11: Inadequate Bicycle/Pedestrian Access on West El Camino Avenue

The project would not eliminate or adversely affect a planned bikeway or pedestrian facility in a way that would discourage its use. According to the *Sacramento County Bicycle Master Plan* (2011), Class II bike lanes are planned along portions of El Centro Road, San Juan Road, and Radio Road. Both within and adjacent to the project site. According to Figure 4, the project would construct bicycle facilities on each of these streets that would match or exceed (in terms of quality or quantity of facilities) what is planned in the Bikeway Master Plan. The *Sacramento County Pedestrian Master Plan* (2007) does not show any priority pedestrian projects within the project's immediate vicinity.

The proposed project would fail to provide adequate access for bicyclists/pedestrians along West El Camino Avenue and El Centro Road and along West El Camino Avenue easterly to its I-80 interchange. This impact would be considered **significant**.

Mitigation TR-11a: *Implement Mitigation Measure TR-1 (Geometric Modifications at El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange).*

Mitigation TR-11b: *Implement Mitigation Measure TR-4b (Bicycle/pedestrian improvements at El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange).*

Transit Services and Facilities

Impact TR-12: Inadequate Transit Service to Meet Demand

Consistent with Sacramento County's General Plan Policy LU-120, the Town Center component of the proposed project would consist of a mix of complementary land uses built at high densities to support transit use. However, existing fixed-route transit service is not provided to the project site. To determine compliance with Policy LU-120, a transit network and frequency analysis needs assessment was performed. This evaluation determined that the area should be served by fixed-route bus service operating on 15-minute headways from approximately 6 AM to 8 PM. Figure 5 displays the recommended route en which buses use portions of Bryte Bend Road and West El Camino Avenue through the Town Center to travel between El Centro Road on the north and I-80 on the east. Since the project would be phased over time, it is anticipated that transit service levels will also increase over time as ridership increases.

Mitigation TR-12a: *Implement Mitigation Measure TR-1 (Geometric Modifications at El Centro Road/West El Camino Avenue intersection and I-80/West El Camino Avenue interchange).*

Mitigation TR-12b: *Implement Mitigation Measure TR-5B*

The specified physical improvements would substantially reduce cumulative queuing, delays, and congestion on West El Camino Avenue and El Centro Road near the Town Center.

Technical Appendix to

Final Report

CEQA Transportation Impact Analysis for

Upper Westside Specific Plan

Prepared for:
Sacramento County

March 2022

RS20-3945

FEHR PEERS

List of Materials

Note: Freeway On-Ramp Ramp Meter Queuing is part of the SimTraffic intersection analysis outputs contained in the LTA Tech Appendix.

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Mixed-Use Trip Generation (MXD+) Model Recalibration and Validation to 2019 Conditions

July 13, 2020

FEHR & PEERS

Mixed-Use Trip Generation (MXD+) Model
Recalibration and Validation to 2019 Conditions
July 13, 2020

This paper documents the recalibration and validation effort undertaken by Fehr & Peers in 2019-2020 of the MXD+ Tool. This revalidation was necessary given the myriad changes in mobility, technology, and societal behavior that have occurred since MXD+ was originally formulated in the late-2000's. This paper provides a straightforward "nuts and bolts" type description of this process.

MXD+ Model Origin

In the late-2000's, two separate research studies improved the state of practice regarding prediction of trips from mixed-use projects. Studies sponsored by the US EPA (MXD) and the Transportation Research Board (NCHRP 684) developed separate tools for improving trip generation estimates for mixed-use developments. The MXD model was originally derived from 239 mixed-use sites across the country, and validated in 2009 against 22 sites. NC*HRP 684: Enhancing Internal Trip Capture Estimation for Mixed-Use Developments* (2011) was based on six well-known MXD sites.

The principal authors of these original two methods (Reid Ewing at the University of Utah, Brian Bochner at Texas A&M, and Jerry Walters at Fehr & Peers) decided to collaborate on an integrated method that captured the best of both sets of research findings. And thus, MXD+ was created. They published a paper entitled Get*ting Trip Generation Right: Eliminating the Bias Against Mixed-Use Development* (American Planning Association, 2013). According to that paper, MXD+ achieved average errors of 2%, 12%, and 4%, for daily, AM peak hour, and PM peak hour conditions, respectively. These values suggest a good fit between the model's estimation and the counts.

Purpose/Need of Revalidation and Calibration

Excluding the unprecedented changes in travel and economic distress that have occurred in 2020 due to the COVID-19 Pandemic, there have been sweeping changes in travel behavior in the 10-plus years since MXD+ was originally validated. Some of the many examples include increased e-commerce activity, the introduction of ridehailing (i.e., Transportation Network Companies (TNCs), such as Uber and Lyft), increased telecommuting, micromobility (e.g., bikeshare, e-scooters, and microtransit), increased auto ownership, and decreased transit ridership.

Additionally, in 2017, the Institute of Transportation Engineers (ITE) released the 10th Edition of the *Trip Generation Manual*. When compared to the 9th Edition (2012), the 10th Edition demonstrates sizeable decreases in vehicle trip rates for nearly all types of employment uses (due to the replacement of very old data with new data collected after 2010). It also includes several new land use categories (i.e., fast casual restaurant), more overall data, and better definitions for land uses often found in mixed-use sites

Model Recalibration

Model recalibration involved site selection, data collection, and then calibration.

Site Selection

Fehr & Peers selected sites that were geographically diverse, both in terms of locations across the US, and as well as in their place type. They had varying levels of mode choice options, and their site trips were able to be accurately counted. The sites were well understood in terms of occupied land uses, available modes of travel, and other built environment characteristics. This diversity of use type, geographic placement, size allows for the model to be calibrated against a wider set of conditions versus an alternate approach where a more homogeneous set of sites were selected.

Consistent with standard practice in statistical analysis, the selected sites were divided into separate "calibration" and "validation" datasets. Early analysis findings indicated that model accuracy could be improved for weekday AM and PM peak hour conditions through a set of minor adjustments, which are discussed in detail later. The calibration dataset (12 sites) was used to determine the best fit provided by the adjusted set of factors. The validation dataset (4 sites), which was not included in the calibration dataset, were specifically selected to provide a diverse range of geographic settings, modal opportunities, and project sizes, which could be used to test the accuracy of the model. Those results are presented in case study format at the end of this paper.

Figure 1 shows the 12 calibration sites that were selected, as well as the four validation sites. Aside from the four case studies, individual site locations are not disclosed in this article because such information is not necessary to understand the data collection and analysis results. Case in point, transportation planners/engineers routinely use data from the *Trip Generation Manual*, which only discloses the states from which the data was collected. The traffic data collection did not require encroachment onto any private property to place cameras or hose tubes.

Data Collection

Table 1 provides an overview of the size, diversity of uses, and transit proximity of the sites that comprise the calibration database.

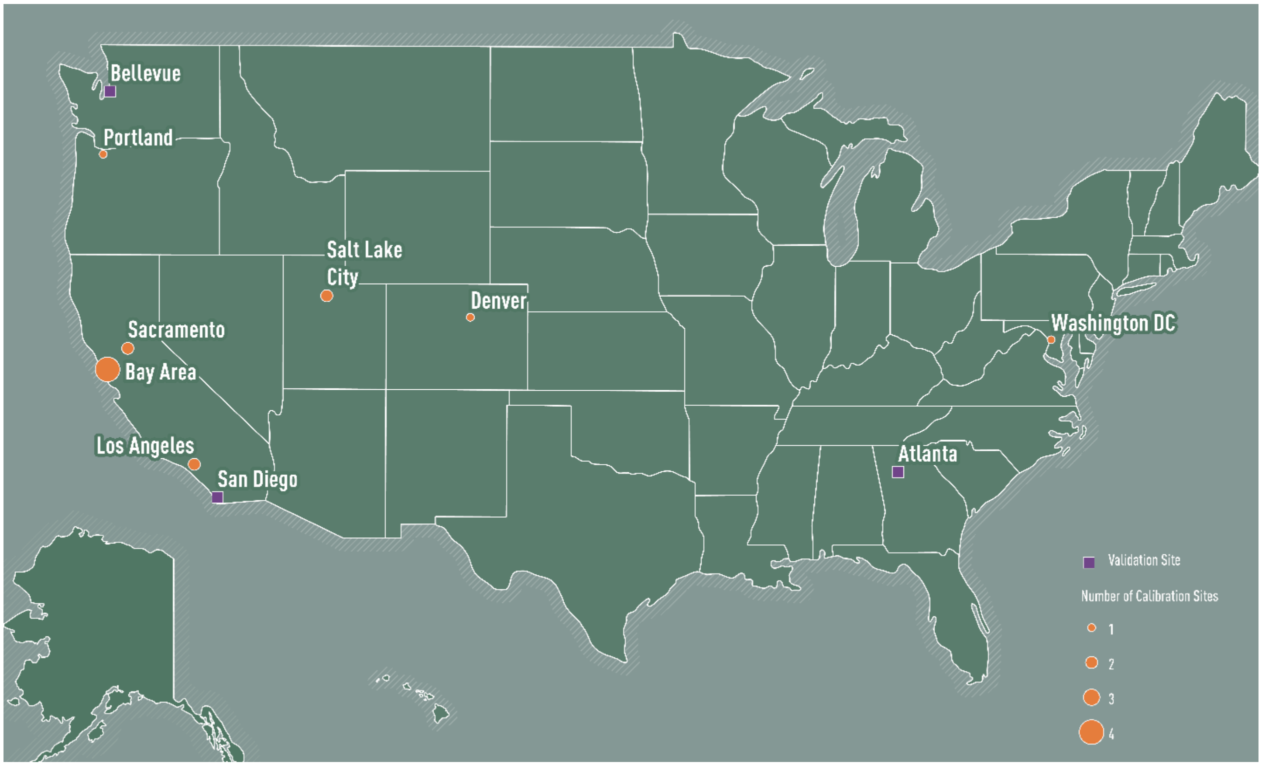


Figure 1: MXD+ Calibration and Validation Sites

Table 1 – Overview of MXD+ Calibration Sites

Metric	Range	Average	Median	Total
Acres	4 – 221 acres	50 acres	19 acres	603 acres
Number of Dwelling Units [1]	8 – 1,841 units	563 units	414 units	6,756 units
Retail	0 – 753,000 sq. ft.	168,000 sq. ft.	38,000 sq. ft.	2,013,000 sq. ft.
Office	0 – 1,084,000 sq. ft.	212,000 sq. ft.	41,000 sq. ft.	2,544,000 sq. ft.
Range of Transit Services	None, adjacent street bus stops, on-site transit centers, and nearby/on-site light rail			
Range of Land Uses	➢ Grocery Store ➢ Student Housing ➢ Medical-Office Building ➢ Restaurants	➢ Health Club ➢ Pharmacy ➢ Hotel ➢ Coffee Shop ➢ Library	➢ Schools ➢ Museum ➢ Movie Theater ➢ Bowling Alley ➢ Hospital	
Notes: [1] Over 95% of dwelling units are multi-family. Site with only 8 dwelling units also includes 315 student housing units.				

The average site was 50 acres and consisted of about 563 dwelling units (the vast majority being multi-family) and 380,000 square feet of non-residential space.

The MXD+ tool includes queries from various sources (e.g., US Census, American Community Survey, local travel demand models, etc.) to enable easy importing of built environment and surrounding area travel characteristics and demographic variables. Some of the more important variables are: Employment within a one-mile walk, Percentage of regional employment within a 30 minute transit ride, and site/adjacent area intersection density (a proxy for site walkability and internal trip-making potential), and Average vehicle ownership per household.

Measurement of vehicle trips generated by each site was a critical component of the data collection effort. It was important that the data collection was comprehensive in terms of collecting all types of vehicle trips generated by each site (including project-related vehicles parking on-site or on-street, persons being dropped-off or picked-up by a taxi, TNC, or friend/spouse/coworker, and truck/service deliveries.

To overcome the considerable cost associated with data collection via video cameras, an innovative approach was undertaken whereby collection of a site's travel during its busiest 14 hours can be used to accurately estimate its 24-hour traffic generation. Typically, these 14 hours represent about 90 percent of the land use's total daily trip generation. A factoring process was then performed using the ITE hourly trip generation data (from the *Trip Generation Manual)* to convert the 14 hour counts into 24-hour observations.

In several instances, site characteristics allowed for a multi-day hose tube count (i.e., a pneumatic tube placed across a road that would register a vehicle as it passes over) to be performed. But this was the exception and not the norm since the majority of sites were located in dense, urban environments where tube counts would have likely yielded inaccurate results.

In several cases, site reconnaissance was necessary to better understand site-specific travel behavior. This led to conclusions that on-street parking on one side of the street is project-related, while the other side is not. Other situations involved motorists parking in nearby garages/lots and walking into the MXD. In those instances, pedestrian activity (both at intersections and mid-block) were observed and classified into groups to translate pedestrian groups into vehicle trips.

Seven (7) of the 12 calibration data sites were counted in October 2019. The remaining five were counted as part of prior research efforts, in either 2015 or 2017. **Table 2** shows the number of vehicle trips these sites were observed to generate on a weekday daily basis, and during the AM and PM peak hours.

Table 2 – Trips Generated by MXD+ Calibration Sites

Time Period	External Vehicle Trips [1]		
	Range	Average	Median
Weekday (Daily)	2,383 – 35,825	12,461	9,495
Weekday AM Peak Hour [2]	100 – 2,017	752	518
Weekday PM Peak Hour [3]	181 – 3,381	1,161	712

Notes:
[1] Includes trips to/from the site for all purposes including deliveries, TNC trips, pass-by trips (i.e., already on the adjacent street) in addition to the typical trip types.
[2] AM peak hour represents the site's busiest consecutive 60-minute period of travel between 7 and 9 AM.
[3] PM peak hour represents the site's busiest consecutive 60-minute period of travel between 4 and 6 PM.

Recalibration of MXD+

The land use and built environment variables described above were input into MXD+ for each of the 12 calibration sites. MXD+ then processes that data in the following generalized steps:

- Step 1 – Gross number of vehicle trips are estimated for land uses based on published rates contained in the *Trip Generation Manual, 10th Edition*.[1]
- Step 2 – Built environment and site characteristics variables are used to estimate the likelihood for internal trip-making, and external trips being made by transit and walking/biking.
- Step 3 – The model estimates the number of internal trips made between complementary land uses within the site.
- Step 4 – The model estimates the number of external trips made by transit and walking/biking.

Nearly all data presented in the current *Trip Generation Manual* for the suburban/urban place type were collected at low-density, single-use, homogeneous developments with little or no public transit service, free parking, and little to no convenient pedestrian access. Hence, direct use of those rates for projects not aligned with those built environment factors are likely to result in an

[1] MXD+ is programmed to include trip generation rates (both weighted averages and as derived from fitted curve equations) from the 10th Edition of the *Trip Generation Manual*. Data is input only for the "suburban/urban" land use category, and not for the "rural", "multi-use urban", or "center city core" categories because their corresponding datasets generally have insufficient numbers of sites from which reliable trip generation rates could be derived.

overestimation of vehicle trips. This statement, while obvious, is intended to set the stage for why gross ITE trip generation estimates (without any adjustments) substantially overestimate trips observed at the MXD sites.

The following guidance from Page 14 of the *Trip Generation Handbook* (Institute of Transportation Engineers, 2017) was used in the calibration process:

> *"The trip generation estimate should reflect, to the extent possible, the specific uses within the known or assumed generalized (using zoning) classification."*

Thus, individual uses such as grocery stores, banks, pharmacies, restaurants, health clubs, day-care centers, etc. present at each site were entered separately into MXD+ versus being aggregated into a single 'retail shopping center' category.

In reviewing the preliminary MXD+ results, it was concluded that the daily results were sufficiently accurate so as to not require any adjustments. But for AM and PM peak hour conditions, it was observed that MXD+ tended to underestimate the observed count more often than desired. This was certainly an undesirable outcome because MXD+ applications should be reasonably conservative. If anything, they should err on the side of overestimating actual trips. The means by which internal trips and external non-auto trips were estimated for AM and PM peak hour conditions was quickly identified as a leading culprit.

The following describes the steps for how internal trips and external walk/bike trips for AM and PM peak hour conditions are estimated:

- Step 1 – Apply the MXD+ peak hour factors by trip purpose to the daily predicted probabilities of these trip reductions to obtain AM and PM peak hour percentages.
- Step 2 – Apply the following weighting of the two methods that independently estimate these trip reductions:
  - AM Peak Hour: 10% NCHRP 684 and 90% MXD+
  - PM Peak Hour: 37% NCHRP 684 and 63% MXD+

An iterative statistical analysis was performed to determine which set of peak hour factors for the MXD+ component of this calculation best fit the data from the calibration dataset. The best fit values are shown in **Table 3**.

The *NCHRP 684* procedure has been incorporated by ITE into its Trip Generation Handbook, and is hence known as the "ITE with Internalization". Note that this procedure estimates internal trips only for AM and PM peak hours (and not daily conditions).

Table 3 – Updated MXD+ Peak Hour Factors by Trip Purpose [1]

Predicted Probability [2]	AM Peak Hour			PM Peak Hour		
	HBW [3]	HBO [4]	NHB [5]	HBW [3]	HBO [4]	NHB [5]
Internal Capture	1.10	1.80	1.00	1.00	1.00	1.00
Walking/Biking External	1.20	1.30	1.00	1.00	1.00	1.00
Transit External	1.40	1.10	1.00	1.40	1.00	1.00

Notes:
[1] Source was analysis of data from the 2017 National Household Travel Survey, specifically analyzing the national dataset to understand the relative likelihood of each type of travel choice during weekday AM and PM peak hours, versus on a daily basis.
[2] These factors are multiplicatively applied (by trip purpose) to the daily predicted possibilities for each type of vehicle trip reduction
[3] HBW = Home-based work trip.
[4] HBO = Home-based other trip (e.g., shopping, school, recreation, etc.).
[5] NHB = Non-home-based trip (e.g., from office to deli).

Transparency in calculations is one of the many objectives of MXD+. By virtue of displaying these values here, it is possible for others to replicate MXD+ results, albeit through a substantial amount of data collection and analysis. The original MXD model (from 2011) is available for download from EPA's website (https://www.epa.gov/smartgrowth/mixed-use-trip-generation-model), though it is noted that model does not include the latest land use categories, trip generation rates, and equations from the 10th Edition of the *Trip Generation Manual*. However, that model does form the basis for the daily module of MXD+, but with these aforementioned adjustments added.

The calibration tests focus on the following five specific areas (from least to most statistically complex):

- Aggregate total trips
- Proportion of cases where MXD+ underestimates the actual number of trips
- Average absolute error
- Correlation coefficient[2]
- Percent RMSE[3]

2 This statistic measures the relationship between variables. A measure close to 1 means that variables are highly positively correlated; a value of zero suggests no or weak correlation, and a value close to -1 represents strong negative correlation.

3 This statistic is a measure of the model's accuracy. It is the square root of the mean squared error between the predicted and observed count divided by the mean of the observed count.

Table 4 displays the five calibration statistics for daily, and AM and PM peak hour conditions, as well as the applicable statistical goal/objective for the given calibration statistic.

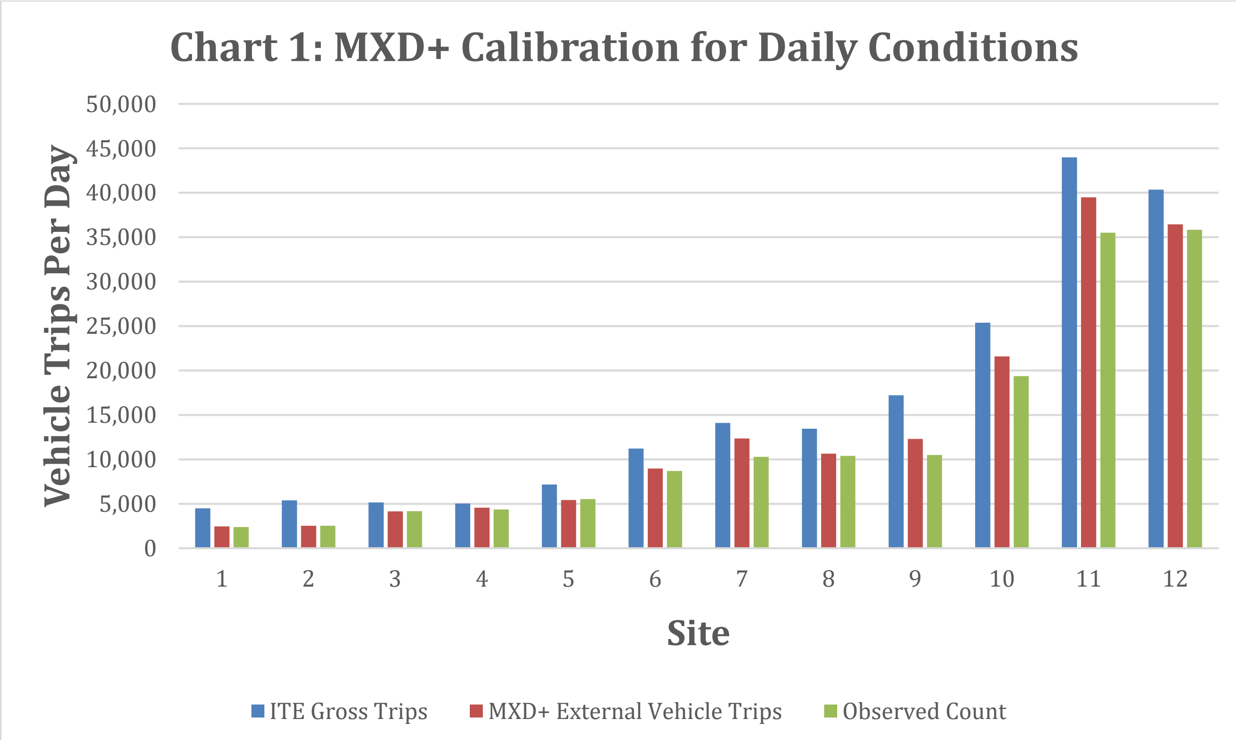
Table 4 – MXD+ Calibration Results

Calibration Statistic	**Goal/Objective**	**Daily**	**AM Peak Hour**	**PM Peak Hour**
Aggregate Total of MXD+ Vehicle Trip Generation Estimates Versus Actual Counts	As close to zero as possible	+ 7%	- 0.9%	+1.6%
Proportion of Calibration Sites That Were Underestimated by MXD+ [1]	Ideally none	0 of 12	4 of 12	3 of 12
Average Absolute Error	As close to zero as possible	6%	11%	6%
Correlation Coefficient	> 0.88 [2]	1.00	0.99	1.00
Percent RMSE	< 40% [2]	12%	13%	7%

Notes:
[1] Estimates that were within five percent of the actual counts were not considered underestimations since traffic volumes themselves may fluctuate by five percent or more from one day to the next.
[2] Based on statistical measures typically applied in travel demand model development.

Table 4 indicates that MXD+ does an excellent job of fitting the data for all three time periods. Challenges did however arise more frequently during peak hours versus daily conditions. Unique site specific conditions, such as their specific temporal commute patterns, degree of retail tenant success, and presence of TNCs contributed to some of these challenges.

Chart 1 orders the 12 calibration sites from least to greatest number of observed daily trips. Data is then presented for the MXD+ external vehicle trip estimate and the ITE gross trip estimate. At sites 1 – 6, MXD+ predictions are nearly identical to the observed counts. Slightly greater variation occurs at the larger sites (i.e., 7 – 12) for reasons discussed below.



For the 12 sites, MXD+ estimated 160,696 daily external vehicle trips. This represents 7% more trips than the 149,527 daily trips that were counted. This implies that MXD+ is being reasonably conservative.

If these sites had simply been analyzed using ITE gross daily trip estimates (i.e., without any reductions of internal trips or external non-auto trips), the resulting estimate would have been 192,905 daily trips, which is a 29% overestimation versus the counts. This reiterates prior research findings that the use of ITE rates for the suburban/urban place type without any adjustments for internal trips and external non-auto trips would result in a substantial overestimation of a mixed-use site's vehicle trip generation. This is acknowledged on page 8 of the *Trip Generation Handbook* by the following statement: "The application of suburban data in dense or multimodal urban settings can in some cases overestimate motor vehicle demand."

For the 12 calibration sites, the reduction in daily trips caused by internal trip-making and external non-auto travel ranged from 10 to 50 percent, with average/median values near 20 percent. This large range is caused by a number of factors including: mix of land use, presence of transit, and site design, size, and geographic location.

Validation of MXD+

Four case studies from across the US were selected for validation purposes. As noted previously, these sites were excluded from the calibration dataset in order to achieve the statistically desirable independent validation dataset. These sites were specifically chosen, as they are geographically diverse, are of widely varying sizes, and provide widely differing levels of modal travel options.

- **Safeway / Avalon, Bellevue, WA** – This four-acre site is situated in downtown Bellevue, across Lake Washington from downtown Seattle. Despite being only 10 miles from downtown Seattle, a commute to downtown by auto can exceed over an hour. Sound Transit operates fixed-route bus service with stops immediately adjacent to the building. The site is located in a suburban downtown setting with good sidewalk connectivity and heavy pedestrian volumes, but also wide arterial streets, large blocks, and heavy traffic. There no bike routes/lanes nearby. Adjacent land uses include a variety of residential, retail, and employment centers as well as a large regional mall and the Downtown Park. Apartment residents pay $85 to $110 per month for a parking space.
- **Hazard Center, San Diego, CA** – is situated on 16-acres and located five miles north of Downtown San Diego near the intersection of Interstate 8 and State Route 163. All land uses are situated within a ¼-mile walk to the Hazard Center Light Rail Station, which serves the San Diego Trolley Green Line light rail service. This station transports riders to downtown San Diego in about 20 minutes. A bus stop is also situated within ¼ mile of the site. A variety of uses are within a ½-mile walk of the site including Westfield Mission Valley Mall, grocers, employers, and restaurants. The San Diego River multi-use pathway is situated adjacent to this site.
- **Avalon, Alpharetta, GA** – is a quintessential suburban mixed-use project now found in many communities across the country. At a considerable size of 79 acres, it features a vast array of land uses – all of the typical ones found in mixed-use sites plus some other atypical uses such as single-family residential. It is a food & beverage destination with numerous bars and restaurants ranging from fast-food, fast casual, high-turnover sit-down, to quality establishments. Avalon is located directly west of US Highway 19, about 25 miles north of downtown Atlanta. Adjacent transit is limited to a single local bus route that operates on 30 minute headways. Parking is not priced anywhere within Avalon with the exception of the hotel. The site is anchored by Avalon Boulevard, a 1,200-foot long, walkable "Main Street" flanked by ground-floor retail and stacked residential on both sides. Lower density residential, office, and parking extends outwardly from the site's hub, with vehicular access provided by 10 distinct driveways on two public streets. Adjacent land uses are suburban or rural in nature.

- **Southport, West Sacramento, CA** – is a very large (3,000 developed acres), established community situated directly west of downtown Sacramento. It features a wide array of land use types (i.e., residential, jobs, shopping, schools, etc.) often found in self-contained communities. Fixed route bus service is provided on main arterials within the community, and downtown Sacramento can be reached via a five-mile trip. It is geographically isolated from adjacent communities by the Sacramento River and shipping channels, allowing for its trips to be accurately counted via four gateways.

Table 5 displays the land uses present at each validation data site.

Table 5 – Validation Sites Land Uses

Site	Single-Family	Multi-Family	Office	General Retail [1]	Sit-Down Restaurants	Grocery Store	Hotel	Other/Note
Safeway / Avalon Bellevue, WA	-	368 du's	-	15 ksf	8 ksf	55 ksf	-	-
Hazard Center, San Diego, CA	-	120 du's	256 ksf	111 ksf	23 ksf	-	305 rooms	7-screen movie theater
Avalon Alpharetta, GA	100 du's	525 du's	582 ksf	250 ksf	54 ksf	45 ksf	330 rooms	12-screen movie theater
Southport, West Sacramento, CA	6,811 du's	893 du's	80 ksf	387 ksf	15 ksf	54 ksf	-	Elementary & High School, 600 ksf manufacturing

Notes:
[1] Includes wide array of uses such as: cleaners, dance studios, bookstore, financial office, salon, learning center, jewelers, salons, auto detailing, optometry, etc. Banks, gas stations, fast-food restaurants, coffee shops, and fitness studios were estimated separately (based on their specific uses) but included in this land use total for reporting purposes.
du's = dwelling units. ksf = thousand square feet.

Table 6 presents the number of external vehicle trips measured at each validation site in October 2019 versus the estimated number it would generate using MXD+. Footnote 2 in the table highlights an interesting phenomenon associated with the Southport validation case study. Because it is being validation at the gateways to entire community (versus essentially driveways for the other sites), it is necessary to subtract pass-by trips that would visit the retail uses, as those trips would not add traffic to the community gateways. Those values are shown in brackets.

Table 6 – Validation Sites Trip Generation Comparison

Site	Size	External Vehicle Trip Generation					
		Daily		AM Peak Hour		PM Peak Hour	
		October 2019 Count	MXD+ [1]	October 2019 Count	MXD+ [1]	October 2019 Count	MXD+ [1]
Safeway / Avalon Bellevue, WA	4 acres	5,505	5,968 (+8%)	239	254 (+6%)	512	497 (- 3%)
Hazard Center San Diego, CA	16 acres	11,189	12,395 (+11%)	680	696 (+2%)	930	977 (+5%)
Avalon Alpharetta, GA	79 acres	33,301	33,332 (0%)	1,685	1,894 (+12%)	2,543	2,674 (+5%)
Southport West Sacramento, CA	3,000 acres	75,191	78,961 [74,138] [2] (-1.4%)	6,484	5,919 [5,672] [2] (-12.5%)	6,192	8,156 [7,480] [2] (+21%)

Notes:
[1] Values in parentheses represent the percent increase in trips estimated by MXD+ versus the 2019 field measurements.
[2] Values in brackets represent the MXD+ external vehicle trips minus pass-by trips (see text below for explanation). The corresponding percentage (shown in parentheses) represents the percent change in trips estimated by MXD+ (after subtracting pass-by trips) versus the 2019 field measurements.
du's = dwelling units. ksf = thousand square feet.

The following findings are derived from Table 6:

- For the three smaller sites, MXD+ produces a desirable result in which each validation site's external vehicle trips tend to be slightly overestimated. This is preferable to the converse in which MXD+ consistently underestimates actual trips. Accordingly, the results from MXD+ can be considered reasonably, but not overly, conservative.
- The goodness of fit at the Avalon validation site was a particularly important outcome, as the calibration sites were not in that part of the US and also not "manufactured mixed-use" in an otherwise suburban setting.
- Despite the calibration dataset consisting of a maximum site size of 221 acres and 1,840 units, the model's estimate was within 1.4% of the actual count for daily conditions. But AM and PM peak hour validation results did not fare as well. We suspect the AM peak hour underestimation could be associated with the various schools (i.e., three K-8 public schools and a public high school) in the community and their district boundaries (i.e., more

students being transported from outside the community to these schools). The PM peak hour overestimation likely stems from reliance on ITE trip rates for single-family and multi-family uses, which turned out to be substantially higher than was observed in one particular neighborhood[4]. The Southport validation site highlights how use of MXD+ may be considered for very large projects, but it would be prudent to perform spot checks of trip rates, understand school district boundaries, etc.

Table 7 displays the internal trip percentage reductions, and external trips made by transit and walk/bike for each validation site.

Table 7 – Percent Internal Trips and External Non-Auto Trips at Each Validation Site

Site	Percent Reduction in Daily Trips Due to			Percent Reduction in AM Peak Hour Trips Due to			Percent Reduction in PM Peak Hour Trips Due to		
	Internal Trips	External Trips		Internal Trips	External Trips		Internal Trips	External Trips	
		Transit	Bike/ Walk		Transit	Bike/ Walk		Transit	Bike/ Walk
Safeway / Avalon Bellevue, WA	4.1%	6.4%	29.1%	9.2%	6.7%	35.0%	14.2%	6.5%	28.4%
Hazard Center, San Diego, CA	4.7%	4.9%	11.6%	10.1%	5.6%	14.3%	14.1%	5.3%	11.6%
Avalon Alpharetta, GA	5.4%	3.8%	2.3%	9.9%	4.1%	2.9%	12.0%	3.9%	2.3%
Southport, West Sacramento, CA	26.8%	1.8%	0.3%	39.0%	2.0%	0.3%	23.7%	2.2%	0.2%

Notes:
[1] Output from MXD+.

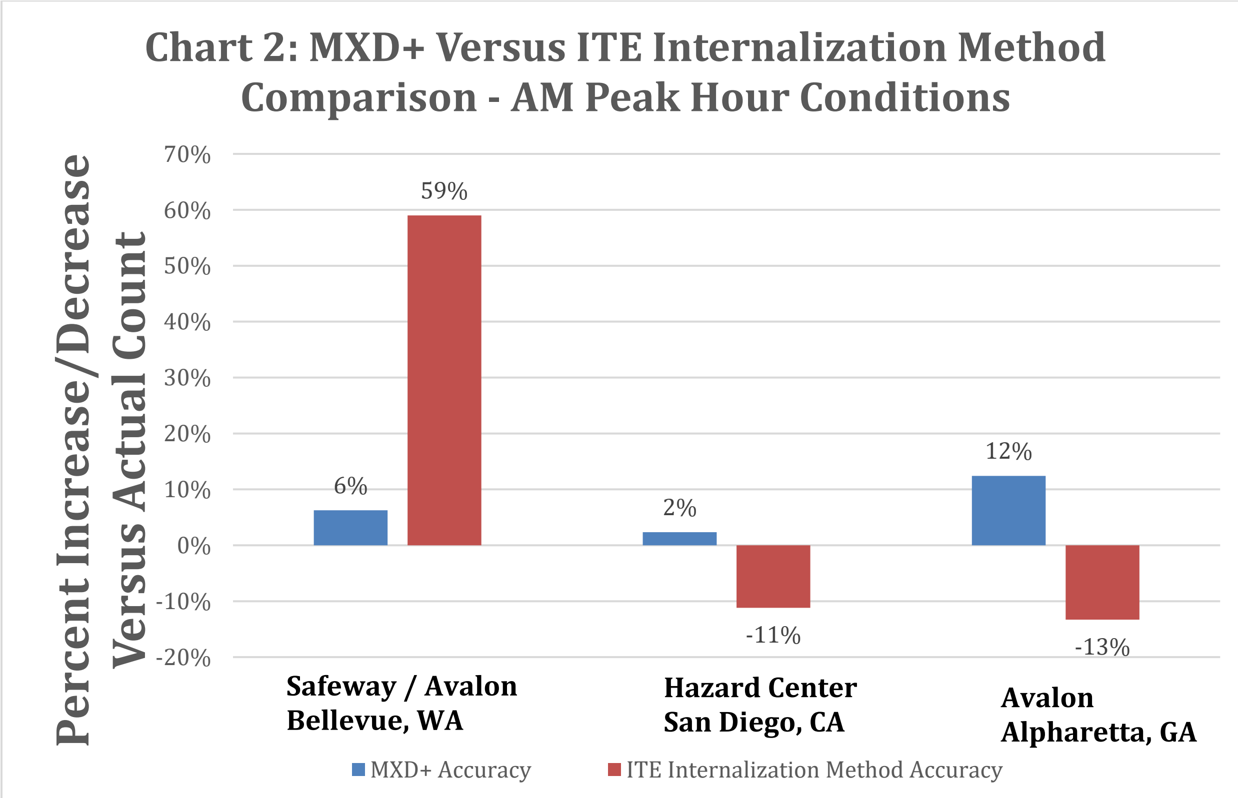
[4] In one neighborhood consisting a combined 325 single-family and multi-family units, the measured vehicle trips entering/exiting the neighborhood during the PM peak hour trip was 51% below the unadjusted ITE trip rates for those uses. When translated to the 7,700 total units in Southport, this resulted in ITE gross trips beginning at a level much higher than was being generated.

The following conclusions are drawn from the results in Table 7:

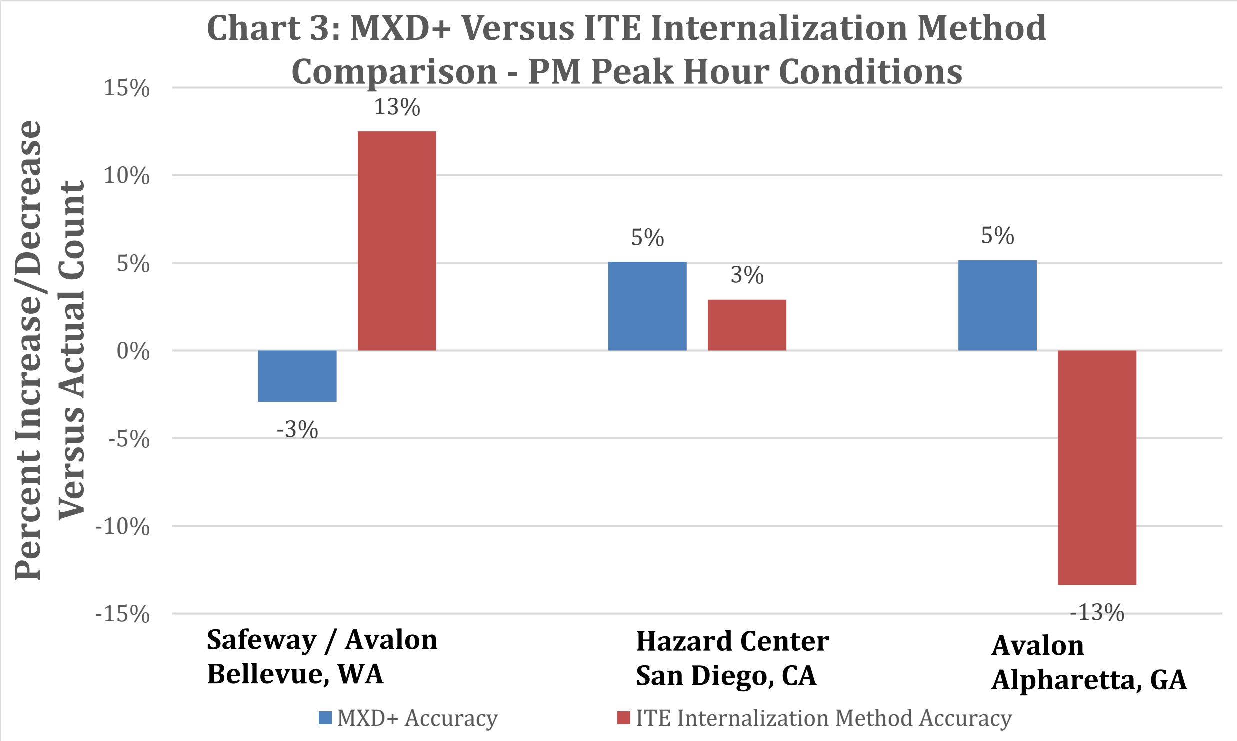
- It is not surprising that the Bellevue, WA site had a large bike/walk percentage given that is situated in Downtown Bellevue, where numerous jobs, retail, and recreation are situated close to the site.
- At the San Diego, CA site, internalization was greatest during the PM peak hour given the full activation of the various retail offerings and conclusion of the office workday.
- Despite the variety of complementary land uses at the Avalon Alpharetta, GA site, only modest levels of internalization were estimated. This is due to the amount of office space (over half a million square feet), which is disproportionately higher than the other uses. The site's jobs-housing balance skews heavily toward non-residential. It should also be noted that about 4% of external trips were assumed to be transit. This would equate to about 140 riders during the PM peak hour, which seems a bit excessive for the fixed-route bus service present.[5]
- At the Southport, CA site, internalization was greatest during the AM peak hour, which is expected given the effects of travel between home and school (to drop off students or work). External travel by transit and walk/bike was modest (less than 2.5%) as expected given that most households are not within walking distance of a bus stop and nearby destinations cannot easily be accessed on foot or by bike.

Charts 2 and 3 show results for AM and PM peak hours, respectively, of how MXD+ performed versus the ITE Internalization Method for the Bellevue, WA, San Diego, CA, and Alpharetta, GA validation sites. The Southport West Sacramento, CA site was excluded for the aforementioned reasons regarding the effects of pass-by traffic, which equally influence results from MXD+ and the ITE Internalization Method.

[5] In situations like this, local knowledge of expected transit ridership could dictate that the analyst modify MXD+ to assume no transit service, with an "off model" approach followed to determine whether any transit reductions are warranted. The presence of transit is a binary choice in MXD+. The type of transit, headways, service duration, and geographic service area are not explicitly considered.



As shown, the MXD+ estimate was closer to the actual count value at all three locations during the AM peak hour, and at two of the three locations during the PM peak hour. During the AM peak hour, the average absolute error was 7% for MXD+ and 28% for the ITE Internalization method. During the PM peak hour, the average absolute error was 4% for MXD+ and 10% for the ITE Internalization method. This clearly indicates that MXD estimates were more accurate than the ITE Internalization Method at the validation data sites.



Conclusions

This study has demonstrated that a minor recalibration of MXD+ has resulted in an analytical tool that accurately estimates the trip generation of mixed-use developments for weekday daily, AM peak hour, and PM peak hour conditions. By focusing the recalibration on 2019 conditions, the model was proven to develop accurate travel estimates despite the myriad changes in travel behavior that have occurred since the model was originally developed. The validation of the model against four mixed-use sites indicates that it may be applied across a wide range of geographies, project sizes, transportation mode availability, and land use mixes.

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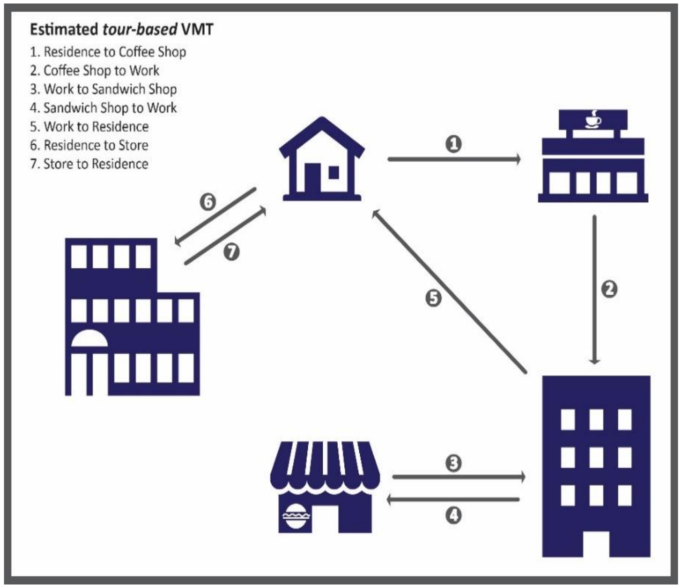
Institute of Transportation Engineers, 2017 *Trip Generation Handbook*.

VMT per Capita and per Employee – Baseline Conditions		
Measure	Work Tour VMT Per Employee	Household VMT per Capita
Regional Average	18.48	17.44
Threshold	15.70	14.83
Project	15.31	14.34

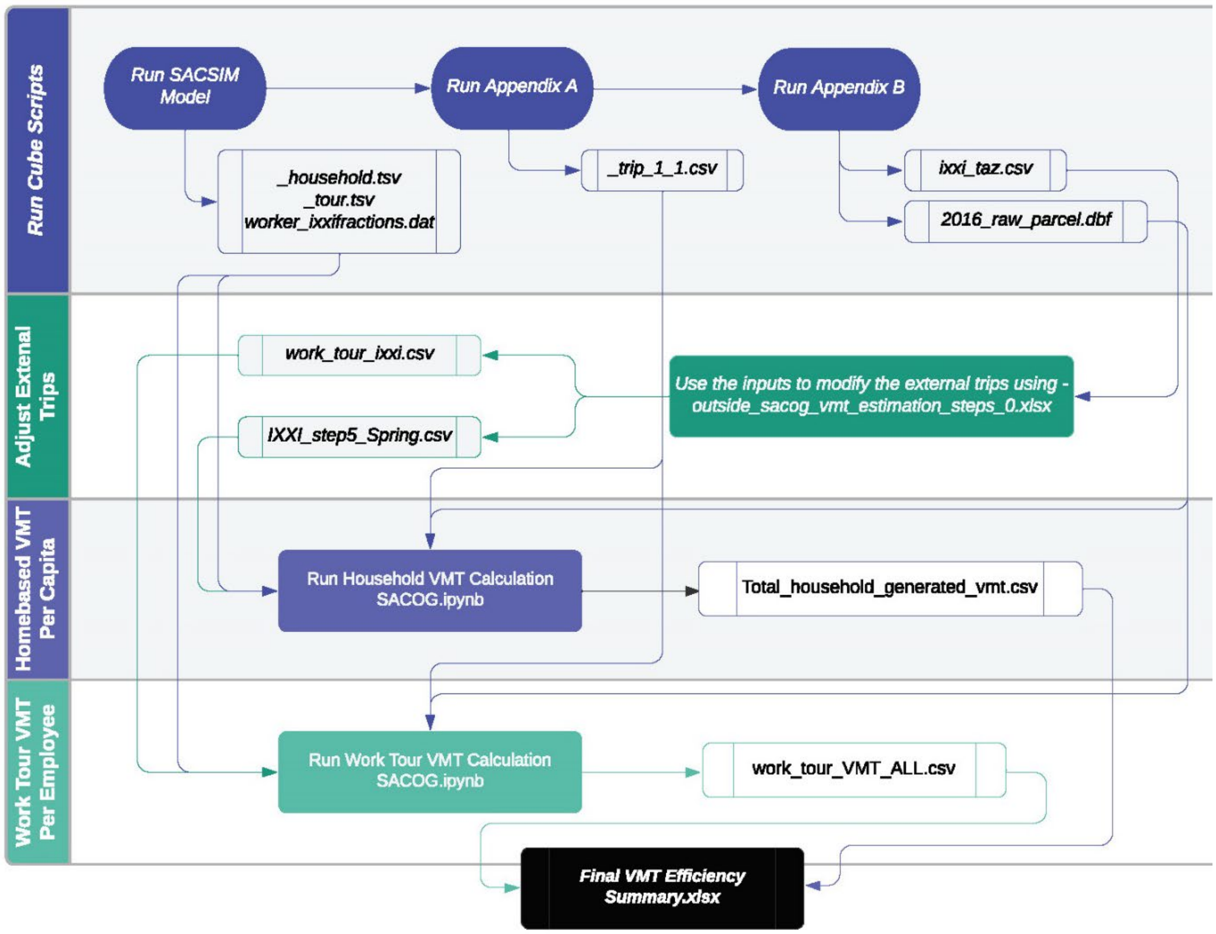
Threshold is ***85%*** *of Base year's Regional average*

VMT per Capita – includes all vehicle tours (both work/commute vehicle tours and non-work vehicle tours) that start and end at residential units. Tours made by a household resident that do not begin or end at home (e.g., mid-day travel from a worksite for lunch or personal business) are not included in the VMT per Capita estimates. From Sac County TAG, Household VMT includes trips #1, 2, 5, 6 & 7 from the figure below. It excludes work-based subtours (Trips #3 &4).

VMT per Employee – applies to office/business professional and industrial employment projects and includes all work/commute vehicle tours that start and end at the worksite (including intermediate stops). From Sac County TAG, Household VMT includes trips #1, 2, 3,4 & 5 from the figure below.



SACSIM VMT Efficiency Matrices Calculation Process



TAZ	pop	VMT_ii	VMT_ixxi	VMT_total	VMT_ii_per_cap	VMT_ixxi_per_cap	VMT_total_per_cap	Jurisdiction
31	351	16008.037	615.6324712	16623.66947	45.60694302	1.753938664	47.36088168	SUTTER COUNTY
32	624	28118.585	915.5331066	29034.11811	45.06183494	1.467200491	46.52903543	SUTTER COUNTY
ROWS 33 Thru 1574 are hidden for page limit purposes. Calculations in these zones match those shown.								
1575	305	4081.077	743.0458929	4824.122893	13.38058033	2.436216042	15.81679637	YOLO COUNTY
1576	770	13272.321	1762.330961	15034.65196	17.23678052	2.288741508	19.52552203	SACRAMENTO
	2376310			41449049.06				
			VMT/per Capita	17.44				

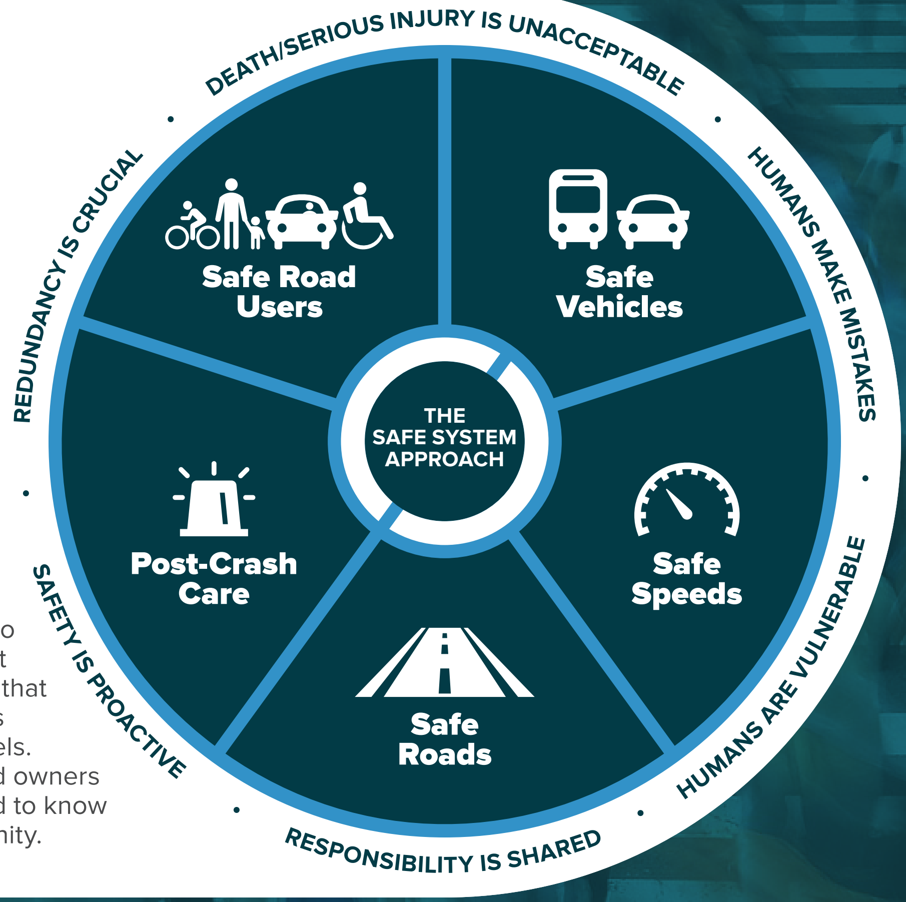
TAZ	pop	VMT_ii	VMT_ixxi	VMT_total	VMT_ii_per_cap	VMT_ixxi_per_cap	VMT_total_per_cap	Jurisdiction	Project	Project Adjusted VMT
1577	184	3093.231	350.713125	3443.944125	16.81103804	1.906049592	18.71708764	SACRAMENTO COUNTY	1	3035.637633
1578	221	2828.058	407.3058667	3235.363867	12.79664253	1.843012971	14.63965551	SACRAMENTO COUNTY	1	2862.060211
1579	368	5968.091	683.034403	6651.125403	16.21763859	1.856071747	18.07371033	SACRAMENTO COUNTY	1	5863.337391
1580	323	4654.073	589.6972174	5243.770217	14.40889474	1.82568798	16.23458272	SACRAMENTO COUNTY	1	4629.432581
1581	316	4667.864	585.1015126	5252.965513	14.77172152	1.851587065	16.62330858	SACRAMENTO COUNTY	1	4636.807465
1582	752	10869.136	7023.282456	17892.41846	14.4536383	9.339471351	23.79310965	SACRAMENTO COUNTY	1	16457.6925
1585	883	14933.349	1760.891429	16694.24043	16.91206002	1.994214528	18.90627455	SACRAMENTO COUNTY	1	14723.03836
1586	182	3429.28	378.6408451	3807.920845	18.8421978	2.080444204	20.92264201	SACRAMENTO COUNTY	1	3355.255885
1587	435	7263.069	1015.408889	8278.477889	16.69671034	2.334273308	19.03098365	SACRAMENTO COUNTY	1	7319.752781
1588	713	10749.288	1490.768635	12240.05663	15.07614025	2.0908396	17.16697985	SACRAMENTO COUNTY	1	10821.15062
1589	629	9232.377	1340.610288	10572.98729	14.67786486	2.131335911	16.80920078	SACRAMENTO COUNTY	1	9354.313524
1590	185	2709.707	388.2140845	3097.921085	14.64706486	2.098454511	16.74551938	SACRAMENTO COUNTY	1	2740.239761
1591	136	1919.415	272.0098039	2191.424804	14.11334559	2.000072088	16.11341768	SACRAMENTO COUNTY	1	1938.062024
1592	153	2709.115	356.8836923	3065.998692	17.70663399	2.332573152	20.03920714	SACRAMENTO COUNTY	1	2708.395512
1593	233	3142.137	450.9823171	3593.119317	13.48556652	1.935546425	15.42111295	SACRAMENTO COUNTY	1	3178.357233
1594	216	3156.064	420.9021333	3576.966133	14.61140741	1.948620988	16.5600284	SACRAMENTO COUNTY	1	3160.365685
1596	356	5626.673	796.8079167	6423.480917	15.80526124	2.238224485	18.04348572	SACRAMENTO COUNTY	1	5680.760081
1597	604	9706.219	1281.126272	10987.34527	16.06989901	2.121069987	18.19096899	SACRAMENTO COUNTY	1	9706.124364
1598	125	1472.562	257.8481633	1730.410163	11.780496	2.062785306	13.84328131	SACRAMENTO COUNTY	1	1536.031979
1599	241	3224.472	530.6124731	3755.084473	13.37955187	2.201711507	15.58126337	SACRAMENTO COUNTY	1	3329.454169
1600	262	3715.536	570.1304854	4285.666485	14.18143511	2.176070555	16.35750567	SACRAMENTO COUNTY	1	3795.215733
1601	279	3767.511	621.6271304	4389.13813	13.50362366	2.228054231	15.73167789	SACRAMENTO COUNTY	1	3891.826678
1602	169	2460.894	395.5295775	2856.423577	14.56150296	2.340411701	16.90191466	SACRAMENTO COUNTY	1	2531.585569
1603	469	7010.098	972.9433526	7983.041353	14.94690405	2.074506082	17.02141013	SACRAMENTO COUNTY	1	7057.708417
1604	147	1943.094	296.6329825	2239.726982	13.21832653	2.017911445	15.23623798	SACRAMENTO COUNTY	1	1983.238574
1605	121	1401.666	250.9028571	1652.568857	11.58401653	2.073577332	13.65759386	SACRAMENTO COUNTY	1	1467.548945
1606	218	3299.864	521.2548	3821.1188	15.13699083	2.391077064	17.52806789	SACRAMENTO COUNTY	1	3385.536752
1607	112	1830.723	251.3129167	2082.035917	16.34574107	2.243865327	18.5896064	SACRAMENTO COUNTY	1	1840.380481
1608	231	2547.48	505.0669474	3052.546947	11.02805195	2.186437002	13.21448895	SACRAMENTO COUNTY	1	2716.279587
1609	2782	33549.012	5603.569696	39152.5817	12.05931416	2.014223471	14.07353763	SACRAMENTO COUNTY	1	34724.11211
1610	215	2750.605	428.892619	3179.497619	12.79351163	1.994849391	14.78836102	SACRAMENTO COUNTY	1	2816.417759
1611	332	3764.176	675.1362879	4439.312288	11.33787952	2.033543036	13.37142255	SACRAMENTO COUNTY	1	3942.441056
1612	347	4364.449	692.6625	5057.1115	12.57766282	1.996145533	14.57380836	SACRAMENTO COUNTY	1	4481.004232
1613	331	3485.731	686.221374	4171.952374	10.53090937	2.073176357	12.60408572	SACRAMENTO COUNTY	1	3711.835882
1614	419	5125.768	866.2239053	5991.991905	12.23333652	2.067360156	14.30069667	SACRAMENTO COUNTY	1	5315.390529
1615	814	9739.865	1875.193139	11615.05814	11.96543612	2.303677075	14.26911319	SACRAMENTO COUNTY	1	10329.39596
1617	400	4194.514	894.3736896	5088.88769	10.486285	2.235934224	12.72221922	SACRAMENTO COUNTY	1	4535.211842
1618	451	5471.272	945.234966	6416.506966	12.1314235	2.09586467	14.22728817	SACRAMENTO COUNTY	1	5694.299062
1619	395	4745.628	1001.403189	5747.031189	12.0142481	2.535197946	14.54944605	SACRAMENTO COUNTY	1	5120.608293
1620	481	5533.223	1034.104575	6567.327575	11.50358212	2.149905561	13.65348768	SACRAMENTO COUNTY	1	5836.942139
1622	370	4241.543	603.1626391	4844.705639	11.46362973	1.630169295	13.09379902	SACRAMENTO COUNTY	1	4284.821963
1623	446	5338.452	1450.816077	6789.268077	11.96962332	3.252950844	15.22257416	SACRAMENTO COUNTY	1	6084.592413
1624	464	5294.95	2311.968456	7606.918456	11.41153017	4.982690638	16.39422081	SACRAMENTO COUNTY	1	6907.985056
1625	487	5551.99	2247.860049	7799.850049	11.40039014	4.615729054	16.0161192	SACRAMENTO COUNTY	1	7066.987369
1627	461	6204.956	899.7687861	7104.724786	13.4597744	1.951776109	15.41155051	SACRAMENTO COUNTY	1	6285.670594
1628	194	2328.937	437.997093	2766.934093	12.0048299	2.257716974	14.26254687	SACRAMENTO COUNTY	1	2459.514409
1629	327	3866.365	666.0357576	4532.400758	11.82374618	2.036806598	13.86055278	SACRAMENTO COUNTY	1	4022.040578
1630	331	3469.84	703.182197	4173.022197	10.4829003	2.124417514	12.60731782	SACRAMENTO COUNTY	1	3715.003317
1631	352	3995.629	735.8587681	4731.487768	11.35121875	2.090507864	13.44172661	SACRAMENTO COUNTY	1	4204.06474
1632	970	12437.487	4527.47999	16964.96699	12.82215155	4.667505144	17.48965669	SACRAMENTO COUNTY	1	15323.21871
1633	190	2428.795	397.38	2826.175	12.78313158	2.091473684	14.87460526	SACRAMENTO COUNTY	1	2505.57406
1634	130	1716.299	268.9705882	1985.269588	13.2023	2.069004525	15.27130452	SACRAMENTO COUNTY	1	1758.71812
1635	232	3478.058	530.2712621	4008.329262	14.99162931	2.285651992	17.2772813	SACRAMENTO COUNTY	1	3549.225606
1636	108	1476.146	256.662	1732.808	13.66801852	2.3765	16.04451852	SACRAMENTO COUNTY	1	1537.956728
1637	284	3228.728	588.1433333	3816.871333	11.36876056	2.07092723	13.43968779	SACRAMENTO COUNTY	1	3390.679237
1638	451	7108.32	994.6321788	8102.952179	15.76124169	2.205392858	17.96663454	SACRAMENTO COUNTY	1	7164.653939
1639	230	3442.813	481.2286364	3924.041636	14.96875217	2.092298419	17.06105059	SACRAMENTO COUNTY	1	3469.59032
1640	665	10278.181	1459.347126	11737.52813	15.45591128	2.194506957	17.65041824	SACRAMENTO COUNTY	1	10380.80823
1641	241	3407.618	509.2085556	3916.826556	14.13949378	2.112898571	16.25239235	SACRAMENTO COUNTY	1	3467.02098
1642	251	3654.209	520.5278351	4174.736835	14.55860159	2.073816076	16.63241767	SACRAMENTO COUNTY	1	3692.381247
1643	137	2154.629	332.9213115	2487.550311	15.72721898	2.430082566	18.15730154	SACRAMENTO COUNTY	1	2203.139283
1644	127	1616.718	231.035	1847.753	12.73006299	1.819173228	14.54923622	SACRAMENTO COUNTY	1	1634.346224
1645	586	9937.648	1249.695982	11187.34398	16.95844369	2.132587	19.09103069	SACRAMENTO COUNTY	1	9875.574446
1646	227	3949.497	558.1083495	4507.60535	17.3986652	2.45862709	19.85729229	SACRAMENTO COUNTY	1	3986.271746
	24491									351183.0887
										14.33927111

taz	VMT_II	I	F_exW_VMT(XI)	F_exW_VMT(IX)	VMT_IXXI	VMT_Total	taz_p	emptot_p	VMT_Per_Job	Jurisdiction
31	1831.545	31	17.79529346	19.54823654	37.34353	1868.88853	31	76	24.59063855	SUTTER COUNTY
32	6360.04	32	31.88501157	29.52888488	61.41389645	6421.453896	32	162	39.6386043	SUTTER COUNTY
ROWS 33 Thru 1643 are hidden for page limit purposes. Calculations in these zones match those shown.										
1645	0	1645	0	0	0	0	1645	0	0	SACRAMENTO COUNTY
1646	0	1646	0	0	0	0	1646	0	0	SACRAMENTO COUNTY
						17543596.23		949533.7		
						VMT per emp		18.47601		

taz	VMT_II	I	F_exW_VMT(XI)	F_exW_VMT(IX)	VMT_IXXI	VMT_Total	taz_p	emptot_p	VMT_Per_Job	Jurisdiction	Project	Project_Nonret_TAZ
1577	0	1577	6.797425851	6.837833934	13.63525978	13.63525978	1577	0	0	SACRAMENTO COUNTY	1	0
1578	0	1578	7.864028867	7.904690556	15.76871942	15.76871942	1578	0	0	SACRAMENTO COUNTY	1	0
1579	0	1579	13.12870395	13.21469655	26.3434005	26.3434005	1579	0	0	SACRAMENTO COUNTY	1	0
1580	0	1580	11.35685167	11.42031418	22.77716585	22.77716585	1580	0	0	SACRAMENTO COUNTY	1	0
1581	0	1581	11.24022417	11.29204375	22.53226792	22.53226792	1581	0	0	SACRAMENTO COUNTY	1	0
1582	13296.15	1582	234.1721781	226.1656143	460.3377924	13756.48779	1582	901.78	15.2548158	SACRAMENTO COUNTY	1	0
1583	5270.349	1583	63.25762344	61.00839459	124.266018	5394.615018	1583	400	13.48653755	SACRAMENTO COUNTY	1	0
1584	14291.479	1584	195.8388634	188.3994255	384.2382889	14675.71729	1584	800	18.34464661	SACRAMENTO COUNTY	1	0
1585	0	1585	33.92270676	34.120199	68.04290576	68.04290576	1585	0	0	SACRAMENTO COUNTY	1	0
1586	0	1586	7.317840609	7.348461691	14.6663023	14.6663023	1586	0	0	SACRAMENTO COUNTY	1	0
1587	0	1587	19.71799805	19.82759582	39.54559387	39.54559387	1587	0	0	SACRAMENTO COUNTY	1	0
1588	0	1588	29.03765694	29.16650187	58.20415881	58.20415881	1588	0	0	SACRAMENTO COUNTY	1	0
1589	0	1589	26.10117064	26.22732066	52.3284913	52.3284913	1589	0	0	SACRAMENTO COUNTY	1	0
1590	0	1590	7.646406616	7.674096561	15.32050318	15.32050318	1590	0	0	SACRAMENTO COUNTY	1	0
1591	0	1591	5.393919582	5.410226435	10.80414602	10.80414602	1591	0	0	SACRAMENTO COUNTY	1	0
1592	0	1592	7.062034857	7.105295918	14.16733078	14.16733078	1592	0	0	SACRAMENTO COUNTY	1	0
1593	0	1593	8.873704134	8.919754729	17.79345886	17.79345886	1593	0	0	SACRAMENTO COUNTY	1	0
1594	0	1594	8.270255375	8.315034756	16.58529013	16.58529013	1594	0	0	SACRAMENTO COUNTY	1	0
1595	4215.552	1595	41.63367256	40.17049026	81.80416282	4297.356163	1595	250	17.18942465	SACRAMENTO COUNTY	1	0
1596	0	1596	15.54801298	15.648764	31.19677698	31.19677698	1596	0	0	SACRAMENTO COUNTY	1	0
1597	0	1597	24.94332188	25.07131826	50.01464014	50.01464014	1597	0	0	SACRAMENTO COUNTY	1	0
1598	0	1598	5.126886328	5.155936668	10.282823	10.282823	1598	0	0	SACRAMENTO COUNTY	1	0
1599	0	1599	10.48187591	10.55564777	21.03752368	21.03752368	1599	0	0	SACRAMENTO COUNTY	1	0
1600	0	1600	11.21194517	11.27073063	22.4826758	22.4826758	1600	0	0	SACRAMENTO COUNTY	1	0
1601	0	1601	12.21928469	12.27790081	24.4971855	24.4971855	1601	0	0	SACRAMENTO COUNTY	1	0
1602	0	1602	7.785814118	7.831785221	15.61759934	15.61759934	1602	0	0	SACRAMENTO COUNTY	1	0
1603	0	1603	19.04301629	19.11696585	38.15998214	38.15998214	1603	0	0	SACRAMENTO COUNTY	1	0
1604	0	1604	5.841263838	5.868299528	11.70956337	11.70956337	1604	0	0	SACRAMENTO COUNTY	1	0
1605	0	1605	4.959221825	4.985651565	9.94487339	9.94487339	1605	0	0	SACRAMENTO COUNTY	1	0
1606	0	1606	10.2320274	10.27273223	20.50475963	20.50475963	1606	0	0	SACRAMENTO COUNTY	1	0
1607	0	1607	5.000790576	5.030742673	10.03153325	10.03153325	1607	0	0	SACRAMENTO COUNTY	1	0
1608	0	1608	9.948674151	9.995484238	19.94415839	19.94415839	1608	0	0	SACRAMENTO COUNTY	1	0
1609	27142.986	1609	362.2991692	347.7407734	710.0399426	27853.02594	1609	1787.32	15.58368168	SACRAMENTO COUNTY	1	1
1610	0	1610	8.413742877	8.469493416	16.88323629	16.88323629	1610	0	0	SACRAMENTO COUNTY	1	0
1611	0	1611	13.21949895	13.30054099	26.52003994	26.52003994	1611	0	0	SACRAMENTO COUNTY	1	0
1612	0	1612	13.58219796	13.66507297	27.24727093	27.24727093	1612	0	0	SACRAMENTO COUNTY	1	0
1613	0	1613	13.46907395	13.53647898	27.00555293	27.00555293	1613	0	0	SACRAMENTO COUNTY	1	0
1614	0	1614	16.91612976	16.95954861	33.87567837	33.87567837	1614	0	0	SACRAMENTO COUNTY	1	0
1615	11837.397	1615	152.880654	146.940842	299.821496	12137.2185	1615	862.84	14.0665923	SACRAMENTO COUNTY	1	1
1616	27284.277	1616	318.3659877	307.5457324	625.9117201	27910.18872	1616	1824.77	15.29518171	SACRAMENTO COUNTY	1	1
1617	10837.343	1617	155.2860927	149.8932618	305.1793545	11142.52235	1617	835.88	13.33028946	SACRAMENTO COUNTY	1	0
1618	5101.887	1618	78.70651663	75.63061531	154.3371319	5256.224132	1618	431.42	12.18354303	SACRAMENTO COUNTY	1	1
1619	12774.062	1619	158.4608968	152.9402271	311.4011239	13085.46312	1619	835.88	15.65471494	SACRAMENTO COUNTY	1	0
1620	12732.498	1620	163.2415711	157.5874937	320.8290648	13053.32706	1620	835.88	15.61626916	SACRAMENTO COUNTY	1	0
1621	3811.779	1621	41.02598734	39.56525615	80.59124349	3892.370243	1621	250	15.56948097	SACRAMENTO COUNTY	1	0
1622	3592.014	1622	32.10232359	30.71190588	62.81422947	3654.828229	1622	164.77	22.18139364	SACRAMENTO COUNTY	1	1
1623	5142.688	1623	81.4025672	78.32422713	159.7267943	5302.414794	1623	350.34	15.13505393	SACRAMENTO COUNTY	1	1
1624	2648.188	1624	61.94826961	59.5458287	121.4940983	2769.682098	1624	150.3	18.42769194	SACRAMENTO COUNTY	1	0
1625	2275.376	1625	60.53512362	58.20408333	118.739207	2394.115207	1625	150.3	15.92891023	SACRAMENTO COUNTY	1	0
1626	10087.082	1626	121.1936303	117.042564	238.2361943	10325.31819	1626	725.3	14.23592747	SACRAMENTO COUNTY	1	0
1627	0	1627	17.58234552	17.61801325	35.20035877	35.20035877	1627	0	0	SACRAMENTO COUNTY	1	0
1628	0	1628	8.59891738	8.648440297	17.24735768	17.24735768	1628	0	0	SACRAMENTO COUNTY	1	0
1629	0	1629	13.04904795	13.11308588	26.16213383	26.16213383	1629	0	0	SACRAMENTO COUNTY	1	0
1630	0	1630	13.81812121	13.89659096	27.71471217	27.71471217	1630	0	0	SACRAMENTO COUNTY	1	0
1631	0	1631	14.47702697	14.53855738	29.01558435	29.01558435	1631	0	0	SACRAMENTO COUNTY	1	0
1632	5244.05	1632	120.6053596	115.9252545	236.5306141	5480.580614	1632	300.6	18.23213777	SACRAMENTO COUNTY	1	1
1633	0	1633	7.816687618	7.858661664	15.67534928	15.67534928	1633	0	0	SACRAMENTO COUNTY	1	0
1634	0	1634	5.336932581	5.352393549	10.68932613	10.68932613	1634	0	0	SACRAMENTO COUNTY	1	0
1635	0	1635	10.39307666	10.43466267	20.82773933	20.82773933	1635	0	0	SACRAMENTO COUNTY	1	0
1636	0	1636	5.092561077	5.121232003	10.21379308	10.21379308	1636	0	0	SACRAMENTO COUNTY	1	0
1637	0	1637	11.57187243	11.65040906	23.22228149	23.22228149	1637	0	0	SACRAMENTO COUNTY	1	0
1638	0	1638	19.43422354	19.52043605	38.95465959	38.95465959	1638	0	0	SACRAMENTO COUNTY	1	0
1639	0	1639	9.469111143	9.521236481	18.99034762	18.99034762	1639	0	0	SACRAMENTO COUNTY	1	0
1640	0	1640	28.40503468	28.55226189	56.95729657	56.95729657	1640	0	0	SACRAMENTO COUNTY	1	0
1641	0	1641	10.0679034	10.11558645	20.18348985	20.18348985	1641	0	0	SACRAMENTO COUNTY	1	0
1642	0	1642	10.21871565	10.27648045	20.4951961	20.4951961	1642	0	0	SACRAMENTO COUNTY	1	0
1643	0	1643	6.559706599	6.601953496	13.1616601	13.1616601	1643	0	0	SACRAMENTO COUNTY	1	0
1644	0	1644	4.62318332	4.641382468	9.264565788	9.264565788	1644	0	0	SACRAMENTO COUNTY	1	0
1645	0	1645	24.39422887	24.51851406	48.91274293	48.91274293	1645	0	0	SACRAMENTO COUNTY	1	0
1646	0	1646	10.93642667	11.00603797	21.94246464	21.94246464	1646	0	0	SACRAMENTO COUNTY	1	0
						87594.48093		5722.06				
								15.30821				

THE SAFE SYSTEM

APPROACH



Zero is our goal. A Safe System is how we will get there.

Imagine a world where nobody has to die from vehicle crashes. The Safe System approach aims to eliminate fatal & serious injuries for all road users. It does so through a holistic view of the road system that first anticipates human mistakes and second keeps impact energy on the human body at tolerable levels. Safety is an ethical imperative of the designers and owners of the transportation system. Here's what you need to know to bring the Safe System approach to your community.

SAFE SYSTEM PRINCIPLES

Death/Serious Injury is Unacceptable

While no crashes are desirable, the Safe System approach prioritizes crashes that result in death and serious injuries, since no one should experience either when using the transportation system.

Humans Make Mistakes

People will inevitably make mistakes that can lead to crashes, but the transportation system can be designed and operated to accommodate human mistakes and injury tolerances and avoid death and serious injuries.

Humans Are Vulnerable

People have limits for tolerating crash forces before death and serious injury occurs; therefore, it is critical to design and operate a transportation system that is human-centric and accommodates human vulnerabilities.

Responsibility is Shared

All stakeholders (transportation system users and managers, vehicle manufacturers, etc.) must ensure that crashes don't lead to fatal or serious injuries.

Safety is Proactive

Proactive tools should be used to identify and mitigate latent risks in the transportation system, rather than waiting for crashes to occur and reacting afterwards.

Redundancy is Crucial

Reducing risks requires that all parts of the transportation system are strengthened, so that if one part fails, the other parts still protect people.

U.S.Department of Transportation
Federal Highway Administration
FHWA-SA-20-015

Safe Roads for a Safer Future
Investment in roadway safety saves lives

SAFE SYSTEM ELEMENTS

Making a commitment to zero deaths means addressing every aspect of crash risks through the five elements of a Safe System, shown below. These layers of protection and shared responsibility promote a holistic approach to safety across the entire transportation system. The key focus of the Safe System approach is to reduce death and serious injuries through design that accommodates human mistakes and injury tolerances.

Safe Road Users

The Safe System approach addresses the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes.

Safe Vehicles

Vehicles are designed and regulated to minimize the occurrence and severity of collisions using safety measures that incorporate the latest technology.

Safe Speeds

Humans are unlikely to survive high-speed crashes. Reducing speeds can accommodate human injury tolerances in three ways: reducing impact forces, providing additional time for drivers to stop, and improving visibility.

Safe Roads

Designing to accommodate human mistakes and injury tolerances can greatly reduce the severity of crashes that do occur. Examples include physically separating people traveling at different speeds, providing dedicated times for different users to move through a space, and alerting users to hazards and other road users.

Post-Crash Care

When a person is injured in a collision, they rely on emergency first responders to quickly locate them, stabilize their injury, and transport them to medical facilities. Post-crash care also includes forensic analysis at the crash site, traffic incident management, and other activities.

THE SAFE SYSTEM APPROACH VS. TRADITIONAL ROAD SAFETY PRACTICES

Traditional	Safe System
Prevent crashes →	Prevent deaths and serious injuries
Improve human behavior →	Design for human mistakes/limitations
Control speeding →	Reduce system kinetic energy
Individuals are responsible →	Share responsibility
React based on crash history →	Proactively identify and address risks

Whereas traditional road safety strives to modify human behavior and prevent all crashes, the Safe System approach also refocuses transportation system design and operation on anticipating human mistakes and lessening impact forces to reduce crash severity and save lives.

WHERE ARE YOU ON THE SAFE SYSTEM JOURNEY?

Implementing the Safe System approach is our shared responsibility, and we all have a role. It requires shifting how we think about transportation safety and how we prioritize our transportation investments. Consider applying a Safe System lens to upcoming projects and plans in your community: put safety at the forefront and design to accommodate human mistakes and injury tolerances. Visit **safety.fhwa.dot.gov/zerodeaths** to learn more.

U.S. Department of Transportation
Federal Highway Administration

Making Our Roads Safer

ONE COUNTERMEASURE AT A TIME

20 Proven Safety Countermeasures that offer significant and measurable impacts to improving safety

Safe Roads for a Safer Future
Investment in roadway safety saves lives

http://safety.fhwa.dot.gov

Proven Safety Countermeasures

ROADWAY DEPARTURE

1. EnhancedDelineation and Friction for Horizontal Curves
2. Longitudinal Rumble Strips and Stripes
3. SafetyEdge$_{sm}$
4. Roadside Design Improvements at Curves
5. Median Barriers

PEDESTRIANS/BICYCLES

13. Leading Pedestrian Intervals
14. Medians and Pedestrian Crossing Islands in Urban and Suburban Areas
15. Pedestrian Hybrid Beacons
16. Road Diets/Reconfigurations
17. Walkways

INTERSECTIONS

6. Backplates with Retroreflective Borders
7. Corridor Access Management
8. Left-and Right-Turn Lanes at Two-Way Stop-Controlled Intersections
9. Reduced Left-Turn Conflict Intersections
10. Roundabouts
11. Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections
12. Yellow Change Intervals

CROSSCUTTING

18. Local Road Safety Plans
19. Road Safety Audits
20. USLIMITS2

➔For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures.

1. Enhanced Delineation and Friction for Horizontal Curves

This proven safety countermeasure for reducing crashes at curves includes a variety of potential strategies that can be implemented in combination or individually. These strategies fall into two categories: enhanced delineation and increased pavement friction.

Chevron signs installed along a curve.

Enhanced Delineation

Enhanced delineation treatments can alert drivers in advance of the curve and vary by the severity of the curvature and operating speed. Price ranges for these strategies are low to moderate. Treatments include the following:

- Pavement markings.
- Post-mounted delineation.
- Larger signs and signs with enhanced retroreflectivity.
- Dynamic advance curve warning signs and sequential curve signs.

Increased Pavement Friction

High friction surface treatment (HFST) is another highly cost-effective countermeasure. HFST compensates for the high friction demand at curves where the available pavement friction is not adequate to support operating speeds due to one or more of the following situations:

- Sharp curves.
- Inadequate cross-slope design.
- Wet conditions.
- Polished roadway surfaces.
- Driving speeds in excess of the curve advisory speed.

To implement these proven safety countermeasures, agencies can take the following steps:

1. Develop a process for identifying and treating problem curves.
2. Use the appropriate application for the identified problem(s), consider the full range of enhanced delineation and friction treatments.
3. Improve consistency in application of horizontal curve guidance provided in the *Manual on Uniform Traffic Control Devices* for new and existing devices.
4. Review signing practices and policies to ensure they comply with the intent of the new guidance.

SAFETY BENEFITS:

CHEVRON SIGNS

25%

Reduction in nighttime crashes

16%

Reduction in non-intersection fatal and injury crashes

Source: CMF Clearinghouse, CMF IDs 2438 and 2439

HIGH FRICTION SURFACE TREATMENTS

52%

Reduction in wet road crashes

24%

Reduction in curve crashes

Source: CMF Clearinghouse, CMF IDs 7900 and 7901

2. Longitudinal Rumble Strips and Stripes

SAFETY BENEFITS:

CENTER LINE RUMBLE STRIPS

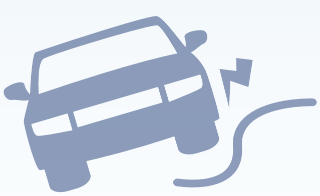
44-64%

Head-on, opposite-direction, and sideswipe fatal and injury crashes

SHOULDER RUMBLE STRIPS

13-51%

Single vehicle, run-off-road fatal and injury crashes



Source: NCHRP Report 641, *Guidance for the Design and Application of Shoulder and Centerline Rumble Strips.*

Shoulder rumble strips and center line rumble stripes are installed on this roadway.

Source: FHWA

Longitudinal rumble strips are milled or raised elements on the pavement intended to alert drivers through vibration and sound that their vehicles have left the travel lane. They can be installed on the shoulder, edge line of the travel lane, or at or near center line of an undivided roadway.

Rumble stripes are edge line or center line rumble strips where the pavement marking is placed over the rumble strip, which can result in an increased visibility of the pavement marking during wet, nighttime conditions.

With roadway departure crashes accounting for more than half of the fatal roadway crashes annually in the United States, rumble strips and stripes are designed to address these crashes caused by distracted, drowsy, or otherwise inattentive drivers who drift from their lane. They are most effective when deployed in a systemic application since driver error may occur on all roads.

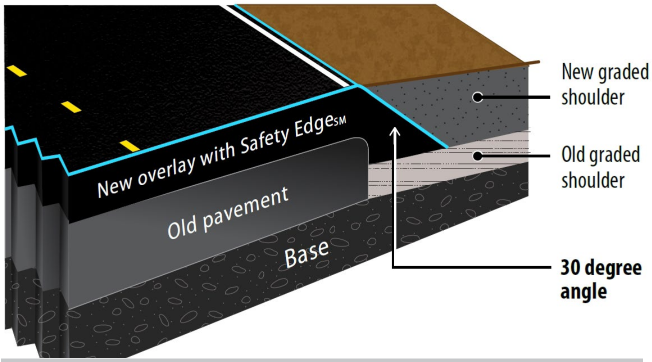
Example of an edge line rumble stripe.

Source: Missouri DOT

Transportation agencies should consider milled center line rumble strips (including in passing zone areas) and milled edge line or shoulder rumble strips with bicycle gaps for systemic safety projects, location-specific corridor safety improvements, as well as reconstruction or resurfacing projects.

3. SafetyEdge$_{SM}$

SafetyEdge$_{SM}$ technology shapes the edge of the pavement at approximately 30 degrees from the pavement cross slope during the paving process. This systemic safety treatment eliminates the vertical drop-off at the pavement edge, allowing drifting vehicles to return to the pavement safely. It has minimal effect on asphalt pavement project cost with the potential to improve pavement life.



Cross-section view of an overlay with SafetyEdge$_{SM}$.

Source: FHWA-SA-17-044

Vehicles may leave the roadway for various reasons, ranging from distracted driver errors to low visibility, or to the presence of an animal on the road. Exposed vertical pavement edges can cause vehicles to be unstable and prevent their safe return to the roadway. SafetyEdge$_{SM}$ gives drivers the opportunity to return to the roadway while maintaining control of their vehicles.

For both SafetyEdge$_{SM}$ and traditional edge, agencies should bring the adjacent shoulder or slope flush with the top of the pavement. Since over time the edge may become exposed due to settling, erosion, and tire wear, the gentle slope provided by SafetyEdge$_{SM}$ is preferred versus the traditional vertical pavement edge.

Transportation agencies should develop standards for implementing SafetyEdge$_{SM}$ on all new asphalt paving and resurfacing projects where curbs are not present, while encouraging standard application for concrete pavements.

Example of SafetyEdge$_{SM}$ after backfill material settles or erodes.

Source: FHWA

SAFETY BENEFIT:

11%

Reduction in fatal and injury crashes

Source: Safety Effects of the SafetyEdge$_{SM}$, FHWA-SA-17-044.

SafetyEdge$_{SM}$ adds nominal cost to repaving a road.

Calculated benefit-cost ratios typically range between

500-1400

Source: Safety Effects of the SafetyEdge$_{SM}$, FHWA-SA-17-044.

Rural road crashes involving edge drop-offs are

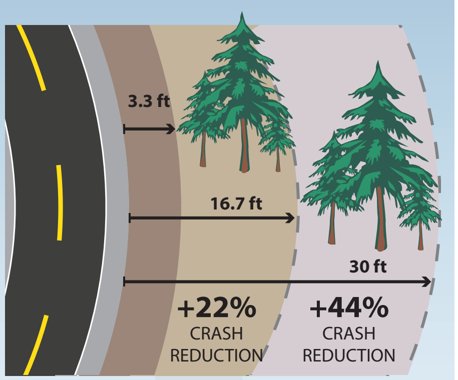
2 to 4 times

more likely to include a fatality than other crashes on similar roads.

Source: S.L. Hallmark, et al., Safety Impacts of Pavement Edge Drop-offs, (Washington, DC: AAA Foundation for Traffic Safety: 2006), p 93.

4. Roadside Design Improvements at Curves

Increasing the Clear Zone prevents crashes

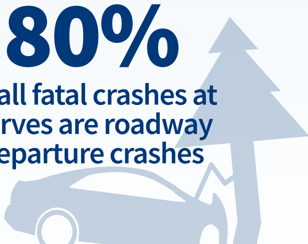


Source: Leidos. Data Source: CMF Clearinghouse (CMF IDs 35 and 36)

SAFETY BENEFIT:

27% of all fatal crashes occur at curves

80% of all fatal crashes at curves are roadway departure crashes



Source: Fatality Analysis Reporting System (FARS)

Roadside design improvement at curves is a strategy encompassing several treatments that target the high-risk roadside environment along the outside of horizontal curves. These treatments prevent roadway departure fatalities by giving vehicles the opportunity to recover safely and by reducing crash severity.

Roadside design improvements can be implemented alone or in combination and are particularly recommended at horizontal curves—where data indicates a higher-risk for roadway departure fatalities—and where cost effectiveness can be maximized.

Roadside Design Improvements to Provide for a Safe Recovery

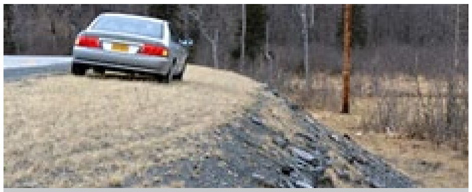
In cases where a vehicle leaves the roadway, strategic roadside design elements, including clear zone addition or widening, slope flattening, and shoulder addition or widening, can provide drivers with an opportunity to regain control and re-enter the roadway.

- A **clear zone** is an unobstructed, traversable area beyond the edge of the through traveled way for the recovery of errant vehicles. Clear zones are free of rigid fixed objects such as trees and utility cabinets or poles. AASHTO's *Roadside Design Guide* details the clear zone width adjustment factors to be applied at horizontal curves.
- **Slope flattening** reduces the steepness of the sideslope to increase drivers' ability to keep the vehicle stable, regain control of the vehicle, and avoid obstacles.
- **Adding or widening shoulders** gives drivers more recovery area to regain control in the event of a roadway departure.

Roadside Design Improvements to Reduce Crash Severity

Since not all roadside hazards can be removed at curves, installing roadside barriers to shield unmovable objects or embankments may be an appropriate treatment. Roadside barriers come in three forms:

- **Cable barrier** is a flexible barrier made from wire rope supported between frangible posts.
- **Guardrail** is a semi-rigid barrier, usually either a steel box beam or W-beam. These deflect less than flexible barriers, so they can be located closer to objects where space is limited.
- **Concrete barrier** is a rigid barrier that does not deflect. These are typically reserved for use on divided roadways.



Shoulder is provided along roadway curve.

Source: Alaska DOT

5. Median Barriers

Median cable barrier prevents a potential head-on crash.

Source: Washington State DOT

Median barriers are longitudinal barriers that separate opposing traffic on a divided highway and are designed to redirect vehicles striking either side of the barrier. Median barriers significantly reduce the severity of cross-median crashes, which are attributed to the relatively high speeds that are typical on divided highways. Approximately 8 percent of all fatalities on divided highways are due to head-on crashes.

In the past, median barriers were typically only used when medians were less than 30 feet wide, but many States realized they were experiencing cross-median fatal crashes in medians that exceeded 30 feet. AASHTO's *Roadside Design Guide* was revised in 2006 to encourage consideration of barriers in medians up to 50 feet wide.

The application of cable median barriers is a very cost-effective means of reducing the severity of median crossover crashes. Median barriers can be **cable, concrete,** or **beam guardrail**.

- **Cable barriers** are softer, resulting in less impact force and redirection, are more adaptable to slopes typically found in medians, and can be installed through less invasive construction methods.
- **Concrete barriers** are rigid, yielding little to no deflection upon impact, and absorbing little crash energy. Although this system is expensive to install, it performs well when hit and only requires repair in the most extreme circumstances.
- **Beam guardrails** are considered semi-rigid barriers. When impacted, they deform and deflect, absorbing some of the crash energy, and usually redirecting the vehicle. Beam guardrails are less expensive to install than rigid barriers, and are more resilient than cable barriers.

To reduce the number and severity of cross-median crashes, transportation agencies should review their median crossover crash history to identify the locations where median barriers are most warranted. Agencies should also consider implementing a systemic median barrier policy based on cross-median crash risk factors.

8%

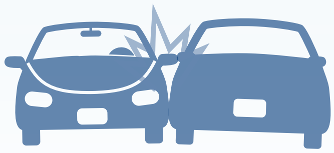
OF ALL FATALITIES ON DIVIDED HIGHWAYS ARE DUE TO HEAD-ON CRASHES[1]

SAFETY BENEFIT:

MEDIAN BARRIERS INSTALLED ON RURAL FOUR-LANE FREEWAYS

97%

Reduction in cross-median crashes [2]



[1] Fatality Analysis Reporting System (FARS).

[2] NCHRP Report 794, *Median Cross-Section Design for Rural Divided Highways*.

6. Backplates with Retroreflective Borders

Source: FHWA

SAFETY BENEFIT:

15%
Reduction in total crashes

Source: CMF Clearinghouse, CMF ID 1410.

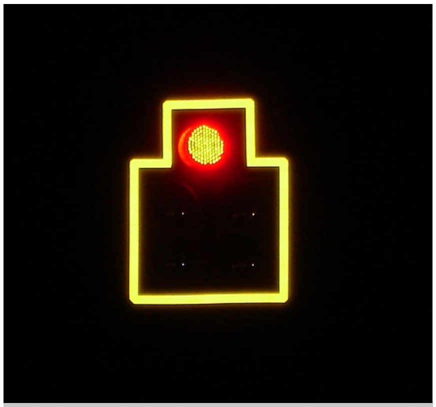
Backplates added to a traffic signal indication improve the visibility of the illuminated face of the signal by introducing a controlled-contrast background. The improved visibility of a signal head with a backplate is made even more conspicuous by framing it with a retroreflective border. Signal heads that have backplates equipped with retroreflective borders are more visible and conspicuous in both daytime and nighttime conditions.

Example of a signal backplate framed with a retroreflective border.

Source: FHWA

This treatment is recognized as a human factors enhancement of traffic signal visibility, conspicuity, and orientation for both older and color vision deficient drivers. This countermeasure is also advantageous during periods of power outages when the signals would otherwise be dark, providing a visible cue for motorists.

Transportation agencies should consider backplates with retroreflective borders as part of their efforts to systemically improve safety performance at signalized intersections. Adding a retroreflective border to an existing signal backplate is a very low-cost safety treatment. The most effective means of implementing this proven safety countermeasure is to adopt it as a standard treatment for signalized intersections across a jurisdiction.



Retroreflective borders are highly visible during the night.

Source: South Carolina DOT

7. Corridor Access Management

Access management refers to the design, application, and control of entry and exit points along a roadway. This includes intersections with other roads and driveways that serve adjacent properties. Thoughtful access management along a corridor can simultaneously enhance safety for all modes, facilitate walking and biking, and reduce trip delay and congestion.

A raised median reduces conflict points along this roadway.

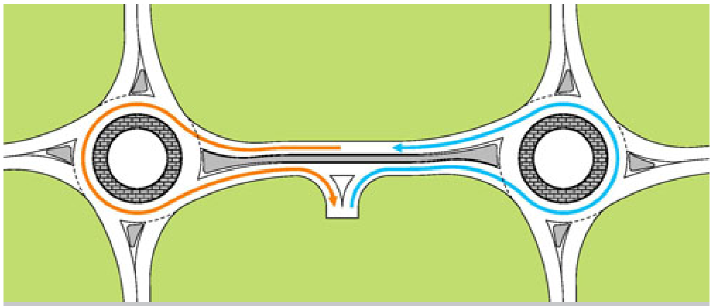
Source: Missouri DOT

Every intersection, from a signalized intersection to an unpaved driveway, has the potential for conflicts between vehicles, pedestrians, and bicycles. The number and types of conflict points—locations where the travel paths of two users intersect—influence the safety performance of the intersection or driveway.

The following access management strategies can be used individually or in combination with one another:

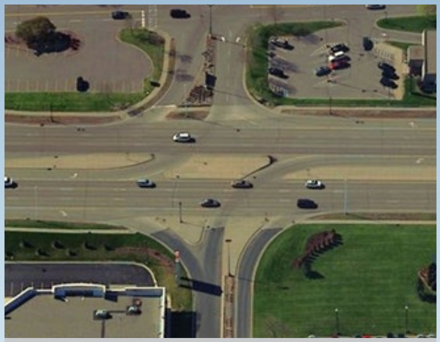
- Driveway closure, consolidation, or relocation.
- Limited-movement designs for driveways (such as right-in/right-out only).
- Raised medians that preclude across-roadway movements.
- Intersection designs such as roundabouts or those with reduced left-turn-conflicts (such as J-turns, median U-turns, etc.).
- Turn lanes (i.e., left-only, right-only, or interior two-way left).
- Lower speed one-way or two-way off-arterial circulation roads.

Successful corridor access management involves balancing overall safety and corridor mobility for all users along with the access needs of adjacent land uses.



Use of roundabouts, raised median, and right-in/right-out driveways can be an effective access management plan.

Source: FHWA-SA-15-005



This intersection design restricts left-turn movements to improve safety.

Source: FHWA

SAFETY BENEFITS:

5-23%

Reduction in total crashes along 2-lane rural roads

25-31%

Reduction in injury and fatal crashes along urban/suburban arterials

Source: *Highway Safety Manual*

8. Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections

SAFETY BENEFITS:

LEFT-TURN LANES

28-48%

Reduction in total crashes

RIGHT-TURN LANES

14-26%

Reduction in total crashes

Source: *Highway Safety Manual*

Example of left-turn lanes.

Source: FHWA

Auxiliary turn lanes—either for left turns or right turns—provide physical separation between turning traffic that is slowing or stopped and adjacent through traffic at approaches to intersections. Turn lanes can be designed to provide for deceleration prior to a turn, as well as for storage of vehicles that are stopped and waiting for the opportunity to complete a turn.

While turn lanes provide measurable safety and operational benefits at many types of intersections, they are particularly helpful at two-way stop-controlled intersections. Crashes occurring at these intersections are often related to turning maneuvers. Since the major route traffic is free flowing and typically travels at higher speeds, crashes that do occur are often severe. The main crash types include collisions of vehicles turning left across opposing through traffic and rear-end collisions of vehicles turning left or right with other vehicles following closely behind. Turn lanes reduce the potential for these types of crashes.

Installing left-turn lanes and/or right-turn lanes should be considered for the major road approaches for improving safety at both three- and four-leg intersections with two-way stop control on the minor road, where significant turning volumes exist, or where there is a history of turn-related crashes. Pedestrian and bicyclist safety and convenience should also be considered when adding turn lanes at an intersection.

Example of a right-turn lane.

Source: FHWA

9. Reduced Left-Turn Conflict Intersections

Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur in order to simplify decisions and minimize the potential for related crashes. Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the restricted crossing U-turn (RCUT) and the median U-turn (MUT).

Example of RCUT intersection.

Source: FHWA

Restricted Crossing U-turn (RCUT)

The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location – either signalized or unsignalized – to continue in the desired direction.

The RCUT is suitable for a variety of circumstances, including along rural, high-speed, four-lane, divided highways or signalized routes. It also can be used as an alternative to signalization or constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections.

Median U-turn (MUT)

The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns.

The MUT is an excellent choice for heavily traveled intersections with moderate left-turn volumes. When implemented at multiple intersections along a corridor, the efficient two-
phase signal operation of the MUT can reduce delay, improve travel times,
and create more crossing opportunities for pedestrians and bicyclists.

Example of MUT intersection.

Source: FHWA

SAFETY BENEFITS:

RCUT

54%

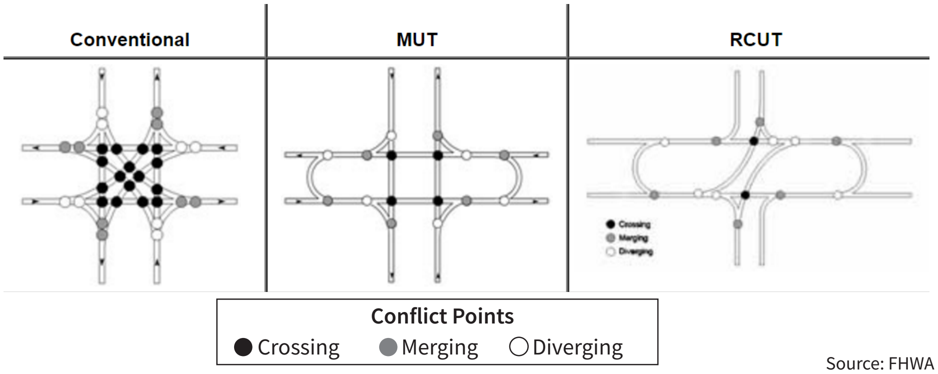
Reduction in injury and fatal crashes[1]

MUT

30%

Reduction in intersection-related injury crash rate[2]

MUT and RCUT Can Reduce Conflict Points by 50%



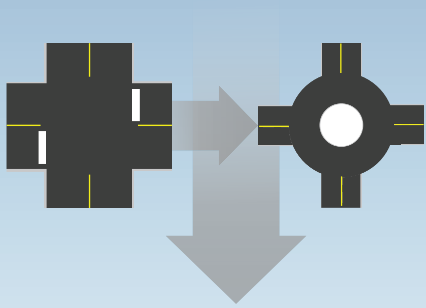
Source: FHWA

1 Edara et al., "Evaluation of J-turn Intersection Design Performance in Missouri," December 2013.

2 FHWA, *Median U-Turn Intersection Informational Guide*, FHWA-SA-14-069 (Washington, DC: 2014), pp. 41-42.

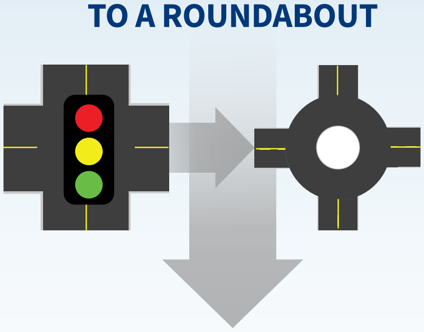
10. Roundabouts

TWO-WAY STOP-CONTROLLED INTERSECTION TO A ROUNDABOUT



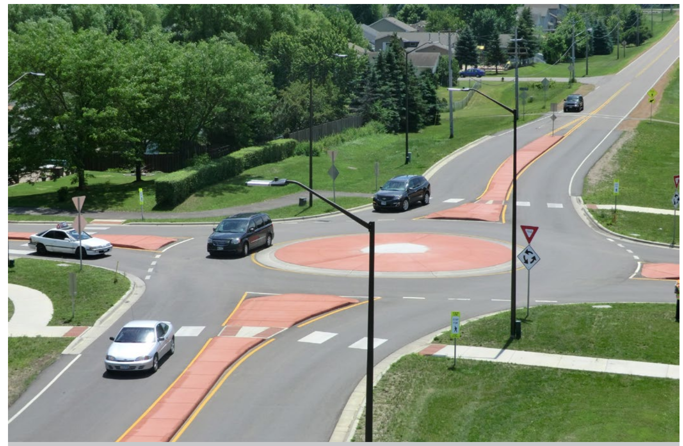
82%
Reduction in severe crashes

SIGNALIZED INTERSECTION TO A ROUNDABOUT



78%
Reduction in severe crashes

Source: *Highway Safety Manual*



Example of a single-lane roundabout.

Source: FHWA

The modern roundabout is a type of circular intersection configuration that safely and efficiently moves traffic through an intersection. Roundabouts feature channelized approaches and a center island that results in lower speeds and fewer conflict points. At roundabouts, entering traffic yields to vehicles already circulating, leading to improved operational performance.

Roundabouts provide substantial safety and operational benefits compared to other intersection types, most notably a reduction in severe crashes.

Roundabouts can be implemented in both urban and rural areas under a wide range of traffic conditions. They can replace signals, two-way stop controls, and all-way stop controls. Roundabouts are an effective option for managing speed and transitioning traffic from high-speed to low-speed environments, such as freeway interchange ramp terminals, and rural intersections along high-speed roads.

Example of a multi-lane roundabout.

Source: FHWA

FHWA encourages agencies to consider roundabouts during new construction and reconstruction projects as well as for existing intersections that have been identified as needing safety or operational improvements.

11. Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections

This systemic approach to intersection safety involves deploying a group of multiple low-cost countermeasures, such as enhanced signing and pavement markings, at a large number of stop-controlled intersections within a jurisdiction. It is designed to increase driver awareness and recognition of the intersections and potential conflicts.


Example of countermeasures on the through approach.

Source: South Carolina DOT

Average Benefit-Cost Ratio

12:1

The systemic approach to safety has three components: (1) analyze systemwide data to identify a problem, (2) look for similar risk factors present in severe crashes, and (3) deploy on a large scale low-cost countermeasures that address the risk factors contributing to crashes.

The low-cost countermeasures for stop-controlled intersections generally consist of the following treatments:

On the Through Approach

- Doubled up (left and right), oversized advance intersection warning signs, with street name sign plaques.
- Enhanced pavement markings that delineate through lane edge lines.

On the Stop Approach

- Doubled up (left and right), oversized advance “Stop Ahead” intersection warning signs.
- Doubled up (left and right), oversized Stop signs.
- Retroreflective sheeting on sign posts.
- Properly placed stop bar.
- Removal of any vegetation, parking, or obstruction that limits sight distance.
- Double arrow warning sign at stem of T-intersections.


Example of countermeasures on the stop approach.

Source: South Carolina DOT

SAFETY BENEFITS:

10%
Reduction in injury and fatal crashes

15%
Reduction in nighttime crashes

Source: T. Le et al, “Safety Effects of Low-Cost Systemic Safety Improvements at Signalized and Stop-Controlled Intersections,” 96th Annual Meeting of the Transportation Research Board, Paper Number 17-05379, January 2017. **id.trb.org/view.aspx?id=1439120**.

12. Yellow Change Intervals

SAFETY BENEFITS:

36-50%

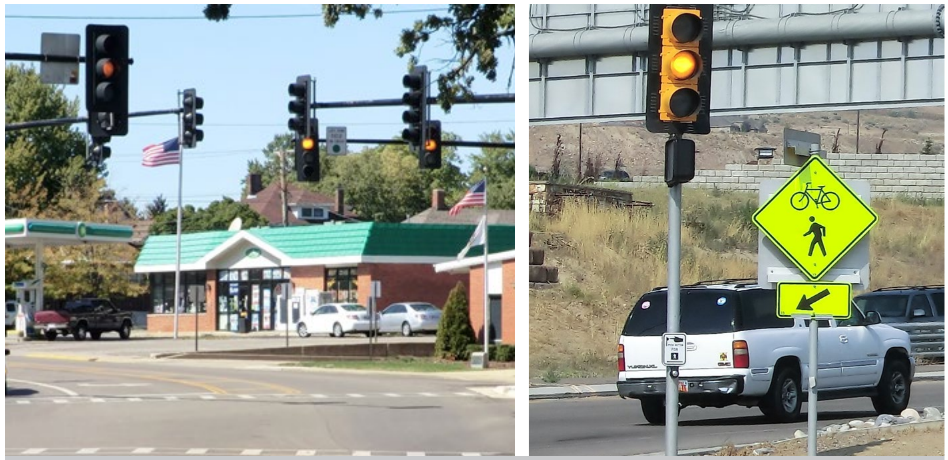
Reduction in red light running

8-14%

Reduction in total crashes

12%

Reduction in injury crashes



Properly-timed yellow change intervals can reduce red-light running and improve overall intersection safety.

Source: FHWA

At a signalized intersection, the yellow change interval is the length of time that the yellow signal indication is displayed following a green signal indication. The yellow signal confirms to motorists that the green has ended and that a red will soon follow.

Since red-light running is a leading cause of severe crashes at signalized intersections, it is imperative that the yellow change interval be appropriately timed. Too brief an interval may result in drivers being unable to stop safely and cause unintentional red-light running, while too long an interval may result in drivers treating the yellow as an extension of the green phase and invite intentional red light running. Factors such as the speed of approaching vehicles, driver perception-reaction time, vehicle deceleration rates, intersection width, and roadway approach grades should all inform the timing calculation.

Transportation agencies can improve signalized intersection safety and reduce red-light running by reviewing and updating their traffic signal timing policies and procedures concerning the yellow change interval. Agencies should institute regular evaluation and adjustment protocols for existing traffic signal timing. Refer to the *Manual on Uniform Traffic Control Devices* for basic requirements and further recommendations about yellow change interval timing.

Source: NCHRP Report 731, *Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections.*

13. Leading Pedestrian Intervals

A leading pedestrian interval (LPI) gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn left.

An LPI allows a pedestrian to establish presence in the crosswalk before vehicles are given a green indication.
Source: FHWA

LPIs provide the following benefits:

- Increased visibility of crossing pedestrians.
- Reduced conflicts between pedestrians and vehicles.
- Increased likelihood of motorists yielding to pedestrians.
- Enhanced safety for pedestrians who may be slower to start into the intersection.

Pedestrians wait for the walk signal.
Source: pedbikeimages.org / Burden

FHWA's *Handbook for Designing Roadways for the Aging Population* recommends the use of the LPI at intersections with high turning-vehicle volumes. Transportation agencies should refer to the *Manual on Uniform Traffic Control Devices* for guidance on LPI timing. Costs for implementing LPIs are very low, since only signal timing alteration is required. This makes it an easy and inexpensive countermeasure that can be incorporated into pedestrian safety action plans or policies and can become routine agency practice.

SAFETY BENEFIT:

60%

Reduction in pedestrian-vehicle crashes at intersections

LPIs are beneficial at intersections with high left-turning volumes.
Source: pedbikeimages.org / Burden

Source: Aaron C. Fayish and Frank Gross, "Safety Effectiveness of Leading Pedestrian Intervals Evaluated by a Before–After Study with Comparison Groups," Transportation Research Record 2198 (2010): 15–22. DOI: 10.3141/2198-03

14. Medians and Pedestrian Crossing Islands in Urban and Suburban Areas

Median and pedestrian crossing islands near a roundabout.

Source: www.pedbikeimages.org / Dan Burden

SAFETY BENEFITS:

RAISED MEDIAN

46%

Reduction in pedestrian crashes

PEDESTRIAN CROSSING ISLAND

56%

Reduction in pedestrian crashes

Source: *Desktop Reference for Crash Reduction Factors*, FHWA-SA-08-011, September 2008, Table 11.

Example of a road with a median and pedestrian crossing islands.

Source: City of Charlotte, North Carolina

Example of a pedestrian crossing island.

Source: pedbikeimages.org / Dan Burden

A ***median*** is the area between opposing lanes of traffic, excluding turn lanes. Medians in urban and suburban areas can be defined by pavement markings, raised medians, or islands to separate motorized and non-motorized road users.

A ***pedestrian crossing island*** (or refuge area) is a raised island, located between opposing traffic lanes at intersection or midblock locations, which separate crossing pedestrians from motor vehicles.

Pedestrian crashes account for approximately 15 percent of all traffic fatalities annually, and over 75 percent of these occur at non-intersection locations.[1] For pedestrians to safely cross a roadway, they must estimate vehicle speeds, adjust their walking speed, determine gaps in traffic, and predict vehicle paths. Installing raised medians or pedestrian crossing islands can help improve safety by simplifying these tasks and allowing pedestrians to cross one direction of traffic at a time.

Transportation agencies should consider medians or pedestrian crossing islands in curbed sections of urban and suburban multi-lane roadways, particularly in areas with a significant mix of pedestrian and vehicle traffic and intermediate or high travel speeds. Some example locations that may benefit from raised medians or pedestrian crossing islands include:

- Mid-block areas.
- Approaches to multi-lane intersections.
- Areas near transit stops or other pedestrian-focused sites.

[1] National Highway Traffic Safety Administration, *Traffic Safety Facts - 2015 Data - Pedestrians.* Report DOT HS 812 375, (Washington, DC: 2017).

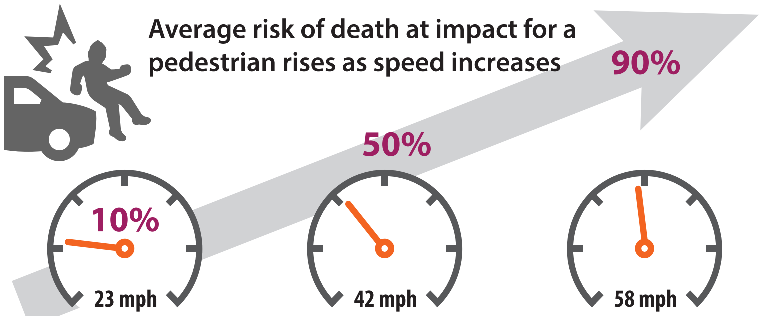
15. Pedestrian Hybrid Beacons

The pedestrian hybrid beacon (PHB) is a traffic control device designed to help pedestrians safely cross busy or higher-speed roadways at midblock crossings and uncontrolled intersections. The beacon head consists of two red lenses above a single yellow lens. The lenses remain "dark" until a pedestrian desiring to cross the street pushes the call button to activate the beacon. The signal then initiates a yellow to red lighting sequence consisting of steady and flashing lights that directs motorists to slow and come to a stop. The pedestrian signal then flashes a WALK display to the pedestrian. Once the pedestrian has safely crossed, the hybrid beacon again goes dark.

Example of PHBs mounted on a mast arm.

Source: FHWA

More than 75 percent of pedestrian fatalities occur at non-intersection locations, and vehicle speeds are often a major contributing factor.[1] As a safety strategy to address this pedestrian crash risk, the PHB is an intermediate option between a flashing beacon and a full pedestrian signal because it assigns right of way and provides positive stop control. It also allows motorists to proceed once the pedestrian has cleared their side of the travel lane, reducing vehicle delay.



Data from the AAA Foundation for Traffic Safety, Impact Speed and a Pedestrian's Risk of Severe Injury or Death, September 2011.

Transportation agencies should refer to the *Manual on Uniform Traffic Control Devices* for information on the application of PHBs. In general, PHBs are typically used when gaps in traffic are not large enough or vehicle speeds are too high for pedestrians to cross safely. PHBs are not widely implemented, so agencies should consider an education and outreach effort when implementing a PHB within a community.

SAFETY BENEFITS:

55%
Reduction in pedestrian crashes

29%
Reduction in total crashes

15%
Reduction in serious injury and fatal crashes

Pedestrians cross the roadway at a PHB location.

Source: City of Tuscon, Arizona

Source: Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Transportation Research Board, Washington, D.C.

[1] National Highway Traffic Safety Administration, *Traffic Safety Facts - 2015 Data - Pedestrians*. Report DOT HS 812 375, (Washington, DC: 2017).

16. Road Diets

(Roadway Reconfiguration)

A "Road Diet," or roadway reconfiguration, can improve safety, calm traffic, provide better mobility and access for all road users, and enhance overall quality of life.

SAFETY BENEFIT:

4-LANE → 3-LANE ROAD DIET CONVERSIONS

19-47%

Reduction in total crashes

Source: *Evaluation of Lane Reduction "Road Diet" Measures on Crashes,* FHWA-HRT-10-053.

Before and after photos of a Road Diet project.

Source: City of Orlando, Florida

A Road Diet typically involves converting an existing four-lane undivided roadway to a three-lane roadway consisting of two through lanes and a center two-way left-turn lane (TWLTL).

Benefits of Road Diet installations may include:

- An overall crash reduction of 19 to 47 percent.
- Reduction of rear-end and left-turn crashes due to the dedicated left-turn lane.
- Reduced right-angle crashes as side street motorists cross three versus four travel lanes.
- Fewer lanes for pedestrians to cross.
- Opportunity to install pedestrian refuge islands, bicycle lanes, on-street parking, or transit stops.
- Traffic calming and more consistent speeds.
- A more community-focused, "Complete Streets" environment that better accommodates the needs of all road users.

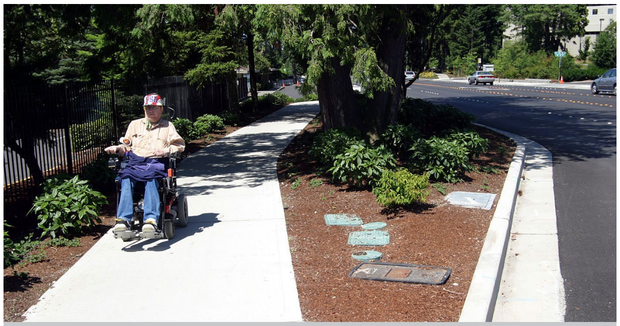
A Road Diet can be a low-cost safety solution when planned in conjunction with a simple pavement overlay, and the reconfiguration can be accomplished at no additional cost.

Road Diet project in Honolulu, Hawaii.

Source: Leidos

17. Walkways

A walkway is any type of defined space or pathway for use by a person traveling by foot or using a wheelchair. These may be pedestrian walkways, shared use paths, sidewalks, or roadway shoulders.[1]



Example of a sidewalk in a residential area.

Source: pedbikeimages.org / Burden

With more than 5,000 pedestrian fatalities and 70,000 pedestrian injuries occurring in roadway crashes annually, it is important for transportation agencies to improve conditions and safety for pedestrians and to integrate walkways more fully into the transportation system.[2]

Paved shoulder used as a walkway.

Source: pedbikeimages.org / Burden

Well-designed pedestrian walkways, shared use paths, and sidewalks improve the safety and mobility of pedestrians. In some rural or suburban areas, where these types of walkways are not feasible, roadway shoulders provide an area for pedestrians to walk next to the roadway.

Transportation agencies should work towards incorporating pedestrian facilities into all roadway projects unless exceptional circumstances exist. It is important to provide and maintain accessible walkways along both sides of the road in urban areas, particularly near school zones and transit locations, and where there is pedestrian activity. Walkable shoulders should also be considered along both sides of rural highways routinely used by pedestrians.

SAFETY BENEFITS:

SIDEWALKS

65-89%

Reduction in crashes involving pedestrians walking along roadways

PAVED SHOULDERS

71%

Reduction in crashes involving pedestrians walking along roadways

Example of a shared use path.

Source: pedbikeimages.org / Burden

Source: *Desktop Reference for Crash Reduction Factors*, FHWA-SA-08-011, Table 11.

1 FHWA defines a pedestrian walkway as a continuous way designated for pedestrians and separated from motor vehicle traffic by a space or barrier. By contrast, sidewalks are walkways that are paved and separated from the street, generally by a curb and gutter.

https://safety.fhwa.dot.gov/legislationay

2 National Highway Traffic Safety Administration, *Traffic Safety Facts - 2015 Data - Pedestrians.* Report DOT HS 812 375, (Washington, DC: 2017).

18. Local Road Safety Plans

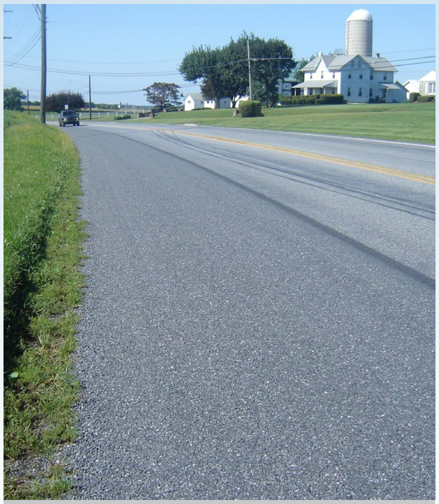
Local roads experience

3x the fatality rate

of the

Interstate Highway System.

Source: FARS and FHWA Highway Statistics Series (2014)



Safety improvements on local roads can be determined through the LRSP process.

Source: Delaware Valley Regional Planning Commission

A local road safety plan (LRSP) provides a framework for identifying, analyzing, and prioritizing roadway safety improvements on local roads. The LRSP development process and content are tailored to local issues and needs. The process results in a prioritized list of issues, risks, actions, and improvements that can be used to reduce fatalities and serious injuries on the local road network.

While local roads are less traveled than State highways, they have a much higher rate of fatal and serious injury crashes. Developing an LRSP is an effective strategy to improve local road safety for all road users and support the goals of a State's overall strategic highway safety plan.

Although the development process and resulting plan can vary depending on the local agency's needs, available resources, and targeted crash types, aspects common to LRSPs include:

- Stakeholder engagement representing the 4E's – engineering, enforcement, education, and emergency medical services, as appropriate.
- Collaboration among municipal, county, Tribal, State and/or Federal entities to leverage expertise and resources.
- Identification of target crash types and crash risk with corresponding recommended proven safety countermeasures.
- Timeline and goals for implementation and evaluation.

Local road agencies should consider developing an LRSP to be used as a tool for reducing roadway fatalities, injuries, and crashes.[1] The plan should be viewed as a living document that can be updated to reflect changing local needs and priorities.

[1] *Developing Safety Plans: A Manual for Local Rural Road Owners*, FHWA-SA-12-017, provides guidance on developing an LRSP.

19. Road Safety Audits

A road safety audit is a proactive, formal safety performance examination of an existing or future road or intersection by an independent and multi-disciplinary team.

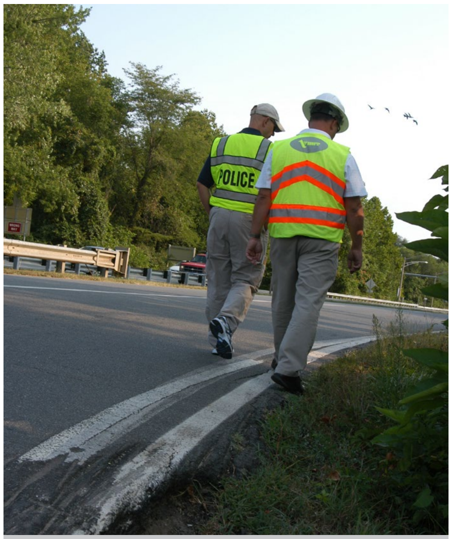
SAFETY BENEFIT:

10-60%

Reduction in total crashes

Source: *Road Safety Audits: An Evaluation of RSA Programs and Projects*, FHWA-SA-12-037; and *FHWA Road Safety Audit Guidelines,* FHWA-SA-06-06.

While most transportation agencies have established traditional safety review procedures, a road safety audit (RSA) is unique. RSAs are performed by a multi-disciplinary team independent of the project. RSAs consider all road users, account for human factors and road user capabilities, are documented in a formal report, and require a formal response from the road owner. (See the eight steps for conducting an RSA below.)



Multi-disciplinary team performs field review during an RSA.

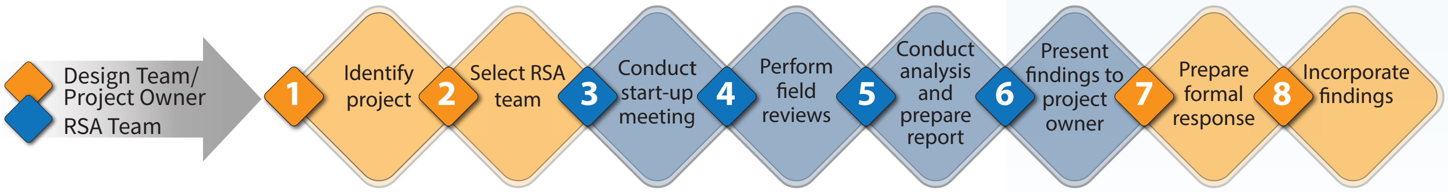
Source: FHWA

RSAs provide the following benefits:

- Reduced number and severity of crashes due to safer designs.
- Reduced costs resulting from early identification and mitigation of safety issues before projects are built.
- Improved awareness of safe design practices.
- Increased opportunities to integrate multimodal safety strategies and proven safety countermeasures.
- Expanded ability to consider human factors in all facets of design.

RSAs can be performed in any phase of project development, from planning through construction. RSAs can also be conducted on any size project, from minor intersection and roadway retrofits to large-scale construction projects. Agencies are encouraged to conduct an RSA at the earliest stage possible, as all roadway design options and alternatives are being explored.

CONDUCTING AN RSA



20. USLIMITS2

USLIMITS2 helps practitioners assess and establish safe, reasonable, and consistent speed limits

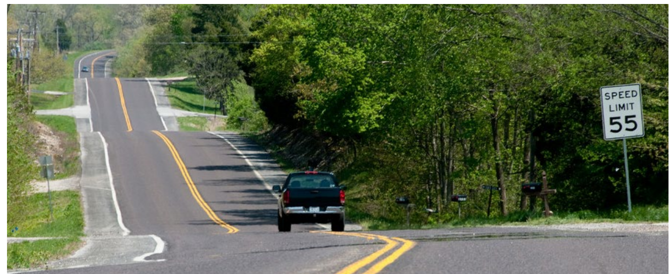
USLIMITS2 helps support speed limit decisions.

Source: Richard Retting

"USLIMITS2 acts as an external, impartial, second set of eyes."

Georgia DOT Traffic Engineer

USLIMITS2[1] is a free, web-based tool designed to help practitioners assess and establish safe, reasonable, and consistent speed limits for specific segments of roadway. It is applicable to all types of facilities, from rural and local roads and residential streets to urban freeways.



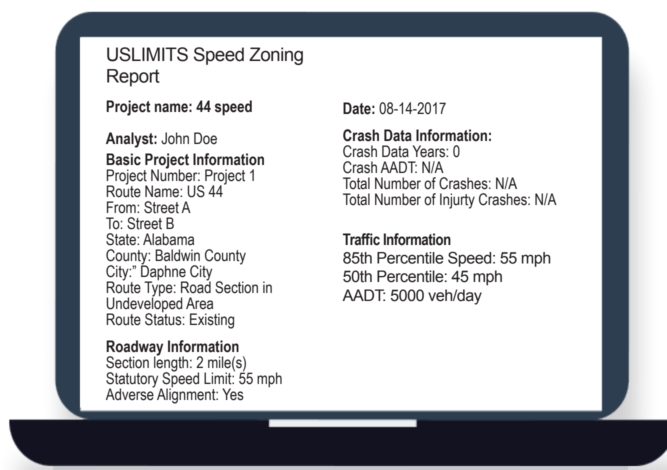
USLIMITS2 is applicable to all types of roadways.

Source: Missouri DOT

USLIMITS2 supports customary engineering studies[2] used to determine appropriate speed limits. These studies typically include evaluating criteria such as 85th percentile speed, traffic volumes, roadway type, roadway setting, number of access points, crash history, pedestrian/bicyclist activity, etc. Similarly, USLIMITS2 produces an unbiased and objective suggested speed limit value based on 50th and 85th percentile speeds, traffic volume, roadway characteristics, and crash data.

Traffic engineers often communicate with the public, community leaders, and government officials to explain the methodology behind setting speed limits. USLIMITS2 provides an objective second opinion and helps support these speed limit decisions. USLIMITS2 augments the credibility of engineering speed studies, helping to address concerns from local government officials and private citizens when speed limits are adjusted.

To begin using USLIMITS2, users create a new project or upload an existing project file for revisions or updates through the online tool. The website contains the user guide, information on the tool's decision logic and related research, and frequently asked questions.



Users can save their USLIMITS2 project files for future analysis or reviews.

1 USLIMITS2 is available free online at **https://safety.fhwa.dot.gov/uslimits/**.

2 For more information on setting speed limits based on engineering studies, refer to the *Manual on Uniform Traffic Control Devices*.

https://safety.fhwa.dot.gov/provencountermeasures.

SimTraffic Off-Ramp Queue Report

Existing Conditions (AM Peak Hour)

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	975	25	6	75	17	100	48	0%	0%
SB	Left Diagonal	1,425	50	3	75	7	100	11	0%	0%
	Left Diagonal	1,425	50	3	75	7	100	11	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
WB	Through	250	25	0	25	0	25	0	0%	0%
SB										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	250	50	7	100	16	150	30	0%	0%
NB	Left Diagonal	1,475	25	3	75	10	100	20	0%	0%
	Left Diagonal	1,475	25	3	75	10	100	20	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
NB										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Existing Conditions
AM Peak Hour

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	225	100	11	175	15	225	29	0%	0%
SB	Left Turn	1,150	100	7	150	12	175	17	0%	0%
	Right Turn	1,150	100	8	150	15	175	24	0%	0%
WB	Through	750	100	8	175	13	200	35	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	950	250	17	275	23	350	21	0%	0%
NB	Left Turn	1,300	125	18	200	50	300	92	6%	0%
	Right Turn	1,300	150	23	275	59	375	135	0%	0%
WB	Through	600	150	13	250	24	300	40	0%	0%
0										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	575	150	12	225	32	275	57	0%	0%
	Right Turn	575	25	4	25	39	50	114	0%	0%
SB	Left Turn	1,500	375	75	600	164	700	198	1%	0%
	Right Turn	1,500	25	11	50	106	100	310	0%	0%
WB	Through	650	125	26	225	88	300	140	0%	1%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	675	350	55	525	96	575	69	0%	1%
NB	Left Turn	1,500	75	6	125	12	175	23	0%	0%
	Right Turn	1,500	125	7	200	16	250	26	0%	0%
WB	Through	775	75	12	175	33	250	103	0%	0%
0										

SimTraffic Post-Processor | **Upper Westside Specific Plan**
Average Results from 10 Runs | **Existing Conditions**
Queue Length | **AM Peak Hour**

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

		Storage	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
Direction	Lane Group	(ft)	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	800	75	6	125	14	150	34	0%	0%
NB	Left Turn	1,000	200	11	300	27	325	45	0%	0%
WB	Through	1,625	550	138	950	251	1,075	269	0%	0%
0										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Existing Conditions
AM Peak Hour

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	175	10	275	13	300	3	3%	0%
	Through	1,625	75	16	175	49	325	77	0%	0%
SB	Left Turn	1,425	75	3	125	10	175	37	0%	0%
	Shared	1,425	75	7	125	14	175	43	0%	0%
WB	Through	800	150	10	250	43	300	137	0%	0%
	Right Turn	800	50	33	200	139	350	235	0%	0%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	75	6	100	13	150	24	0%	0%
	Through	800	75	4	125	10	150	26	0%	0%
SB	Left Turn	1,275	150	8	200	18	275	41	0%	0%
	Shared	1,275	100	8	150	32	225	75	0%	0%
WB	Through	1,150	175	20	275	46	350	75	13%	0%
	Right Turn	125	50	18	175	38	200	0	0%	0%
0										

SimTraffic Off-Ramp Queue Report

Existing Conditions (PM Peak Hour)

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Existing Conditions
PM Peak Hour

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	400	25	5	50	11	75	19	0%	0%
SB	Left Turn	1,425	50	4	75	8	100	19	0%	0%
	Right Turn	1,425	50	4	100	14	125	21	0%	0%
WB	Through	275	100	11	175	18	225	38	0%	0%
0										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	275	100	7	150	16	200	42	0%	0%
NB	Left Diagonal	1,475	100	10	150	15	200	33	0%	0%
	Left Diagonal	1,475	100	10	150	15	200	33	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
NB										

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	225	75	4	100	9	150	20	0%	0%
SB	Left Turn	1,150	100	6	150	10	175	23	0%	0%
	Right Turn	1,150	75	4	100	7	100	17	0%	0%
WB	Through	750	75	8	150	18	200	25	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	200	125	11	200	24	250	50	0%	2%
NB	Left Turn	1,300	125	17	250	72	375	225	7%	0%
	Right Turn	1,300	200	32	350	109	500	217	1%	0%
WB	Through	200	100	14	175	21	200	36	0%	0%
0										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	575	50	5	100	10	125	27	0%	0%
SB	Left Turn	1,500	150	12	225	26	250	48	0%	0%
WB	Through	650	250	17	400	30	475	49	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	425	75	7	150	16	200	42	0%	0%
NB	Left Turn	1,500	275	38	425	82	500	132	0%	0%
	Right Turn	1,500	200	29	325	58	425	89	0%	0%
WB	Through	925	250	47	425	81	525	101	0%	0%
0										

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	800	50	6	100	12	125	28	0%	0%
NB	Left Turn	1,000	125	9	200	15	225	18	0%	0%
WB	Through	1,625	75	11	150	28	200	51	0%	0%
0										

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	150	8	250	17	275	25	2%	0%
	Through	1,625	75	6	175	23	250	71	0%	0%
SB	Left Turn	1,425	100	7	150	14	175	31	0%	0%
	Shared	1,425	100	3	150	9	200	24	0%	0%
WB	Through	800	325	140	775	293	750	305	0%	2%
	Right Turn	800	400	202	825	289	800	164	0%	3%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	175	22	250	32	275	17	9%	0%
	Through	800	75	33	200	110	275	149	0%	0%
SB	U/Left Turns	1,275	125	18	175	36	200	30	1%	0%
	Shared	1,275	125	21	225	48	325	50	4%	2%
WB	Through	1,150	400	110	825	250	975	288	35%	1%
	Right Turn	125	125	29	275	22	200	0	4%	0%
0										

SimTraffic Off-Ramp Queue Report

Existing Plus Project Conditions (AM Peak Hour)

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	975	50	12	125	35	200	57	0%	0%
SB	Left Diagonal	1,425	50	5	100	36	125	100	0%	0%
	Left Diagonal	1,425	50	5	100	36	125	100	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
WB	Through	650	200	47	550	71	575	31	0%	0%
SB										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	650	125	34	250	84	325	92	0%	1%
NB	Left Diagonal	1,475	100	31	275	120	450	223	0%	0%
	Left Diagonal	1,475	100	31	275	120	450	223	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
NB										

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	1,125	275	24	475	52	875	87	0%	0%
SB	Left Turn	1,150	250	56	375	38	350	15	3%	29%
	Right Turn	1,150	675	256	1,050	315	1,025	240	44%	17%
WB	Through	950	325	62	575	160	700	135	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	950	275	21	375	35	475	40	0%	0%
NB	Left Turn	1,300	100	11	175	30	225	89	3%	0%
	Right Turn	1,300	150	27	300	107	425	266	0%	0%
WB	Through	550	175	10	250	22	275	38	0%	0%
0										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

		Storage	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
Direction	Lane Group	(ft)	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	700	300	51	575	168	675	261	10%	0%
	Right Turn	225	150	25	325	35	300	63	0%	0%
SB	Left Turn	1,500	200	20	325	19	300	11	0%	12%
	Right Turn	1,500	3,075	377	3,700	456	4,400	391	0%	35%
WB	Through	825	675	135	900	170	850	138	0%	12%
	Right Turn	325	25	4	25	42	50	122	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

		Storage	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
Direction	Lane Group	(ft)	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
B116	Through									
B6020	Through									
EB	Through	825	325	23	400	57	425	161	0%	0%
NB	Left Turn	1,500	375	107	625	310	700	394	2%	0%
	Right Turn	1,500	75	4	100	6	150	24	0%	0%

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	800	75	9	150	15	175	36	0%	0%
NB	Left Turn	1,000	250	17	375	31	425	77	0%	0%
WB	Through	1,625	900	311	1,275	376	1,350	332	0%	2%
0										

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	200	13	275	19	300	6	7%	0%
	Through	1,625	75	19	225	67	375	83	0%	0%
SB	Left Turn	1,425	75	7	125	21	175	34	0%	0%
	Shared	1,425	75	8	125	22	175	52	0%	0%
WB	Through	800	175	29	325	127	475	243	0%	0%
	Right Turn	800	125	91	350	246	500	290	0%	0%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	75	8	125	16	125	15	0%	0%
	Through	800	75	8	125	18	150	38	0%	0%
SB	Left Turn	1,275	100	7	250	16	275	23	0%	0%
	Shared	1,275	75	5	125	13	150	30	0%	0%
WB	Through	1,150	150	10	250	21	325	37	12%	0%
	Right Turn	125	50	15	175	34	200	0	0%	0%
0										

SimTraffic Off-Ramp Queue Report

Existing Plus Project Conditions (PM Peak Hour)

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	400	50	10	100	28	175	35	0%	0%
SB	Left Turn	1,425	75	19	175	75	300	139	2%	0%
	Right Turn	1,425	100	16	175	36	225	35	5%	0%
WB	Through	675	550	34	975	52	825	52	0%	44%
0										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
B94	Through								#N/A	#N/A
EB	Through	675	175	20	275	44	325	63	0%	0%
NB	Left Diagonal	1,475	400	37	975	67	950	1	21%	0%
	Left Diagonal	1,475	400	37	975	67	950	1	21%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Existing Plus Project Conditions
PM Peak Hour

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	1,125	150	14	250	39	375	67	0%	0%
SB	Left Turn	1,150	100	4	150	7	200	20	0%	0%
	Right Turn	1,150	100	8	150	15	200	20	0%	0%
WB	Through	750	100	9	175	17	225	35	0%	0%
	Right Turn	750	25	1	25	5	25	13	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
B76	Through								#N/A	#N/A
EB	Through	950	250	17	300	31	375	33	0%	0%
NB	Left Turn	1,300	125	15	200	33	275	70	6%	0%
	Right Turn	1,300	200	56	375	189	525	326	1%	0%
WB	Through	200	100	15	200	19	225	35	0%	0%

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	700	175	34	325	106	500	203	4%	0%
	Right Turn	225	75	17	200	59	275	77	0%	0%
SB	Left Turn	1,500	75	11	150	19	175	31	0%	0%
	Right Turn	1,500	3,950	192	4,825	166	5,500	46	0%	13%
WB	Through	825	800	45	975	52	900	21	28%	11%
	Right Turn	325	200	55	525	52	400	0	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
B116	Through									
B6020	Through									
EB	Through	325	300	18	400	53	450	127	0%	4%
NB	Left Turn	1,500	3,475	124	5,000	163	5,625	9	90%	82%
	Right Turn	1,500	100	49	425	265	800	486	0%	0%

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length
Intersection 39 **I-5 NB Ramps/W El Camino Ave**

Upper Westside Specific Plan
Existing Plus Project Conditions
PM Peak Hour
Signal

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	800	125	13	225	23	250	37	0%	0%
NB	Left Turn	1,000	275	17	400	38	450	31	0%	0%
WB	Through	1,625	150	16	275	30	350	52	0%	0%
0										

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	275	18	350	17	300	0	53%	0%
	Through	1,625	875	328	1,775	504	1,600	479	0%	6%
SB	Left Turn	1,425	200	11	300	17	325	17	4%	0%
	Shared	1,425	200	25	350	52	375	57	12%	5%
WB	Through	800	350	125	775	254	750	221	0%	3%
	Right Turn	800	325	176	875	373	825	290	0%	18%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	200	41	300	43	275	14	21%	0%
	Through	800	150	111	375	222	450	223	0%	0%
SB	Left Turn	1,275	100	22	200	51	225	23	0%	0%
	Shared	1,275	275	163	675	283	875	279	12%	7%
WB	Through	1,150	425	199	875	389	950	325	36%	1%
	Right Turn	125	150	35	275	22	200	0	9%	0%
0										

LEGEND:

STOPPING SIGHT DISTANCE TRIANGLE - DESIGN OF VERTICAL ELEMENTS IN THIS AREA TO BE CONSISTENT WITH SACRAMENTO COUNTY STREET DESIGN STANDARDS SECTION 4-15

DESIGN SPEED:

GARDEN HWY = 50 MPH
(5 MPH ABOVE POSTED
45 MPH SPEED LIMIT)

SIGHT DISTANCE:

SIGHT DISTANCE = 550' PER SACRAMENTO COUNTY
STREET DESIGN STANDARDS SECTION 4-15

CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Figure 1

Sight Distance Analysis
Bryte Bend Road at Garden Highway

SimTraffic Off-Ramp Queue Report

Cumulative No Project Conditions (AM Peak Hour)

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative No Project Conditions
AM Peak Hour

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	975	25	11	100	78	225	236	0%	0%
	Right Turn	975	25	10	50	58	75	123	0%	0%
SB	Left Diagonal	1,425	75	7	150	18	200	26	0%	0%
	Left Diagonal	1,425	75	7	150	18	200	26	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
WB	Through	650	50	10	75	25	100	34	0%	0%
SB										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	650	200	69	325	113	350	104	0%	0%
NB	Left Diagonal	1,475	250	4	300	10	475	40	0%	0%
	Left Diagonal	1,475	250	4	300	10	475	40	0%	0%
	Right Turn	1,475	50	1	50	2	50	4	0%	0%
	Right Turn	1,475	50	1	50	2	50	4	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
NB										

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	1,125	950	47	1,275	68	1,150	37	0%	0%
SB	Left Turn	1,150	175	6	250	17	275	45	1%	0%
	Right Turn	1,150	75	9	125	22	175	46	0%	0%
WB	Through	950	150	9	225	15	250	26	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	200	125	15	225	28	250	38	0%	2%
NB	Left Turn	1,300	125	10	175	19	225	38	5%	0%
	Right Turn	1,300	150	9	225	16	250	31	0%	0%
WB	Through	550	125	10	225	24	250	45	0%	0%
0										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative No Project
AM Peak Hour

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	550	100	8	175	22	200	38	0%	0%
	Right Turn	325	25	3	25	22	50	62	0%	0%
SB	Left Turn	1,500	150	8	225	20	250	34	0%	0%
WB	Through	350	200	16	300	46	375	105	0%	1%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	375	100	16	175	29	225	47	0%	0%
NB	Left Turn	1,500	200	16	325	29	375	41	0%	0%
	Right Turn	1,500	150	19	225	36	275	58	0%	0%
WB	Through	775	50	7	125	12	175	39	0%	0%
0										

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	800	75	7	125	13	150	25	0%	0%
NB	Left Turn	1,000	225	10	325	17	350	38	0%	0%
WB	Through	1,625	200	19	325	46	425	65	0%	0%
0										

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	225	18	325	29	300	0	11%	0%
	Through	1,625	350	218	925	582	1,125	532	29%	3%
SB	Left Turn	1,425	1,700	171	3,675	200	3,525	46	44%	14%
	Shared	1,425	300	18	475	11	400	16	47%	48%
WB	Through	800	175	11	300	47	375	146	0%	0%
	Right Turn	800	50	46	175	184	250	283	0%	0%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	200	9	400	7	300	0	1%	0%
	Through	800	650	49	1,100	22	825	16	77%	38%
SB	Left Turn	1,275	625	179	1,550	301	1,775	301	34%	0%
	Shared	1,275	200	14	350	18	300	16	20%	24%
WB	Through	1,150	175	15	325	26	425	61	19%	0%
	Right Turn	125	75	19	200	29	200	0	0%	0%
0										

SimTraffic Off-Ramp Queue Report

Cumulative No Project Conditions (PM Peak Hour)

SimTraffic Post-Processor | **Upper Westside Specific Plan**
Average Results from 10 Runs | **Cumulative No Project**
Queue Length | **PM Peak Hour**

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
B1005	Through									
EB	Through	400	25	5	75	14	100	29	0%	0%
	Right Turn	400	25	1	25	6	25	18	0%	0%
SB	Left Turn	1,425	50	3	100	11	125	34	0%	0%
	Right Turn	1,425	75	6	100	14	125	25	0%	0%
WB	Through	275	125	8	200	14	250	33	0%	0%

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	275	125	13	200	20	250	42	0%	0%
NB	Left Diagonal	1,475	1,425	196	2,025	295	2,525	0	0%	0%
	Left Diagonal	1,475	1,425	196	2,025	295	2,525	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
NB										

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	1,125	300	76	400	144	450	145	0%	0%
SB	Left Turn	1,150	2,175	115	4,400	140	4,500	42	51%	22%
	Right Turn	1,150	175	21	325	20	250	0	0%	1%
WB	Through	750	75	9	150	17	175	24	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	950	775	51	1,275	37	975	29	0%	26%
NB	Left Turn	1,300	950	109	1,850	39	1,400	51	13%	43%
	Right Turn	1,300	2,000	258	3,825	367	4,200	328	50%	1%
WB	Through	575	75	7	150	17	175	31	0%	0%
0										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	550	50	7	100	45	175	151	0%	0%
	Right Turn	325	25	1	25	7	25	16	0%	0%
SB	Left Turn	1,500	125	5	175	12	175	25	0%	0%
	Right Turn	1,500	25	3	25	25	75	66	0%	0%
WB	Through	600	175	8	275	22	325	71	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	375	100	8	150	13	200	36	0%	0%
NB	Left Turn	1,500	150	6	200	13	225	25	0%	0%
	Right Turn	1,500	175	14	275	50	325	110	0%	0%
WB	Through	775	125	9	200	27	250	58	0%	0%
0										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative No Project
PM Peak Hour

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	800	75	8	125	17	150	51	0%	0%
NB	Left Turn	1,000	150	9	200	16	250	35	0%	0%
WB	Through	1,625	75	9	150	14	200	28	0%	0%
0										

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	275	14	375	25	300	0	16%	0%
	Through	1,625	1,475	88	2,100	89	1,650	14	88%	39%
SB	Left Turn	1,425	3,175	52	4,300	66	3,525	16	75%	21%
	Shared	1,425	375	4	400	26	400	8	87%	81%
WB	Through	800	100	21	150	29	175	32	0%	0%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	275	14	350	34	300	0	17%	0%
	Through	800	800	7	850	26	850	20	99%	59%
SB	U/Left Turns	1,275	3,225	5	4,250	8	4,400	0	77%	26%
	Shared	1,275	3,275	3	4,300	10	4,450	13	70%	74%
WB	Through	1,150	825	320	1,225	432	1,100	351	24%	5%
	Right Turn	125	175	33	250	40	200	0	63%	0%
0										

SimTraffic Off-Ramp Queue Report

Cumulative Plus Project Conditions (AM Peak Hour)

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	975	375	158	800	290	850	197	0%	1%
	Right Turn	975	275	202	800	349	875	173	0%	3%
SB	Left Diagonal	1,425	825	315	1,600	529	2,525	338	0%	24%
	Left Diagonal	1,425	825	315	1,600	529	2,525	338	0%	24%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
WB	Through	925	475	104	825	116	800	88	0%	0%
SB										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	925	900	83	1,050	94	1,025	84	0%	42%
NB	Left Diagonal	1,475	650	88	1,275	55	950	0	1%	0%
	Left Diagonal	1,475	650	88	1,275	55	950	0	1%	0%
	Right Turn	1,475	3,200	320	4,625	307	5,425	55	0%	0%
	Right Turn	1,475	3,200	320	4,625	307	5,425	55	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
	Right Turn	575	25	0	25	0	25	0	0%	0%
NB										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project
AM Peak Hour

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	1,125	175	21	375	57	625	94	0%	0%
SB	Left Turn	1,150	525	266	1,250	499	1,600	547	2%	1%
	Right Turn	1,150	150	34	250	55	250	20	15%	5%
WB	Through	950	225	95	400	247	450	254	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	950	225	14	250	23	275	27	0%	0%
NB	Left Turn	1,300	125	12	200	34	250	70	8%	0%
	Right Turn	1,300	175	8	225	15	275	24	0%	0%
WB	Through	200	75	6	150	13	175	40	0%	0%
0										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	700	175	27	350	69	575	172	4%	0%
	Right Turn	225	100	9	200	27	300	71	0%	0%
SB	Left Turn	1,500	200	29	325	24	325	14	0%	12%
	Right Turn	1,500	3,200	792	6,400	1,053	5,950	898	0%	17%
WB	Through	825	750	141	875	177	825	154	21%	29%
	Right Turn	325	100	26	375	56	400	0	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
B6020	Through									
EB	Through	825	400	44	450	108	500	179	0%	0%
NB	Left Turn	1,500	1,775	600	3,950	987	4,850	1,003	51%	1%
	Right Turn	1,500	400	207	1,150	308	1,100	0	0%	0%
WB	Through	425	350	149	425	175	425	163	3%	9%
	Right Turn	275	50	24	175	83	250	85	0%	0%

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project Conditions
AM Peak Hour

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	800	100	8	150	13	200	33	0%	0%
NB	Left Turn	1,000	350	29	475	68	525	91	0%	0%
WB	Through	1,625	275	44	425	96	500	150	0%	0%
0										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project
AM Peak Hour

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	300	1	300	4	300	0	68%	0%
	Through	1,625	1,300	230	1,875	294	1,625	162	1%	9%
SB	Left Turn	1,425	600	306	1,425	547	1,575	559	19%	3%
	Shared	1,425	250	51	400	66	375	14	23%	18%
WB	Through	800	700	132	950	136	825	20	0%	26%
	Right Turn	800	725	95	1,175	47	925	16	0%	54%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	150	45	325	70	300	1	1%	0%
	Through	800	400	183	775	339	700	223	48%	8%
SB	Left Turn	1,275	1,800	406	4,225	622	3,950	521	3%	1%
	Shared	1,275	200	27	375	12	300	17	47%	50%
WB	Through	1,150	475	129	1,150	301	1,125	316	49%	7%
	Right Turn	125	125	22	275	21	200	0	0%	0%
0										

SimTraffic Off-Ramp Queue Report

Cumulative Plus Project Conditions (PM Peak Hour)

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project
PM Peak Hour

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
B1005	Through									
EB	Through	400	50	8	100	20	125	34	0%	0%
SB	Left Turn	1,425	525	207	1,275	370	1,475	265	11%	2%
	Right Turn	1,425	250	24	375	31	325	41	63%	0%
WB	Through	975	950	42	1,125	46	1,075	30	0%	78%

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	675	200	21	325	51	350	79	0%	0%
NB	Left Diagonal	1,475	4,725	65	5,225	32	5,950	0	26%	0%
	Left Diagonal	1,475	4,725	65	5,225	32	5,950	0	26%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
	Right Turn	575	25	0	25	0	25	0	0%	0%
NB										

Intersection 20 **I-5 SB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	1,125	375	92	775	158	1,075	163	0%	3%
SB	Left Turn	1,150	2,775	114	5,450	103	4,525	38	53%	41%
	Right Turn	1,150	225	8	325	6	250	0	3%	3%
WB	Through	750	125	23	250	58	325	107	0%	0%
0										

Intersection 21 **I-5 NB Ramps/Del Paso Rd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	950	800	30	1,275	26	1,000	23	0%	26%
NB	Left Turn	1,300	1,050	55	1,925	22	1,400	41	4%	54%
	Right Turn	1,300	2,675	148	5,000	188	5,025	49	57%	13%
WB	Through	550	75	7	150	16	175	26	0%	0%
0										

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project Conditions
PM Peak Hour

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	700	200	34	400	90	625	170	5%	0%
	Right Turn	225	100	16	225	38	300	49	0%	0%
SB	Left Turn	1,500	75	13	150	25	175	33	0%	0%
	Right Turn	1,500	4,625	341	8,125	299	6,800	61	0%	13%
WB	Through	825	825	47	1,000	40	925	23	30%	25%
	Right Turn	325	275	50	575	19	400	0	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
B6020	Through									
EB	Through	825	325	16	400	50	425	143	0%	0%
NB	Left Turn	1,500	3,450	448	7,275	532	6,875	65	69%	19%
	Right Turn	1,500	525	194	1,325	256	1,100	0	0%	0%
WB	Through	425	400	35	550	39	550	16	20%	20%
	Right Turn	275	150	25	350	32	275	0	1%	1%

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project Conditions
PM Peak Hour

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	800	100	10	175	18	225	46	0%	0%
NB	Left Turn	1,000	525	139	900	293	1,200	328	13%	0%
	Right Turn	1,000	100	114	325	321	375	310	0%	0%
WB	Through	1,625	1,225	168	2,150	95	1,675	15	0%	55%
0										

Intersection 8 **I-5 SB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	225	300	17	350	45	300	0	29%	0%
	Through	1,625	1,575	118	2,150	116	1,650	16	81%	43%
SB	Left Turn	1,425	3,200	58	3,475	75	3,625	23	74%	18%
	Shared	1,425	375	3	400	17	400	8	83%	79%
WB	Through	800	150	26	250	40	325	132	0%	0%
0										

Intersection 9 **I-5 NB Ramps/Garden Hwy** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	U/Left Turns	200	250	15	375	22	300	0	14%	0%
	Through	800	800	12	850	41	850	14	99%	58%
SB	U/Left Turns	1,275	3,225	4	4,250	7	4,900	0	62%	13%
	Shared	1,275	3,275	3	4,300	20	4,950	10	61%	65%
WB	Through	1,150	400	273	825	486	850	432	15%	1%
	Right Turn	125	125	62	225	60	200	0	31%	0%
0										

SimTraffic Off-Ramp Queue Report

Cumulative Plus Project with Improvements Conditions

(AM Peak Hour)

SimTraffic Post-Processor
Average Results from 10 Runs
Queue Length

Upper Westside Specific Plan
Cumulative Plus Project With Improvements
AM Peak Hour

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	975	50	5	100	21	150	66	0%	0%
	Right Turn	975	25	29	75	111	150	208	0%	0%
SB	Left Diagonal	1,425	100	6	175	13	200	23	0%	0%
	Left Diagonal	1,425	100	6	175	13	200	23	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
	Right Turn	1,425	25	0	25	0	25	0	0%	0%
WB	Through	250	25	0	25	0	25	0	0%	0%
SB										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	650	275	26	325	42	375	59	0%	0%
NB	Left Diagonal	1,475	75	8	125	17	150	25	0%	0%
	Left Diagonal	1,475	75	8	125	17	150	25	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
NB										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	700	175	13	325	21	375	40	0%	0%
	Through/Right	700	325	15	450	28	475	52	0%	0%
	Right Turn	700	150	21	275	47	350	51	0%	0%
SB	Left Turn	1,500	275	12	325	10	300	15	0%	51%
	Right Turn	1,500	350	62	475	86	525	97	0%	0%
WB	Through	850	225	16	325	26	375	84	1%	0%
	Right Turn	325	25	6	50	56	100	164	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
B6020	Through									
EB	Through	850	425	27	475	37	525	33	0%	0%
NB	Left Turn	1,500	650	74	875	94	950	127	0%	0%
	Right Turn	1,500	100	17	200	62	275	177	0%	0%
WB	Through	275	175	12	325	26	350	40	1%	1%
	Right Turn	275	50	18	200	44	275	0	0%	0%

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	800	75	7	150	31	200	69	0%	0%
NB	Left Turn	1,000	475	123	750	320	775	287	12%	8%
	Right Turn	1,000	100	101	300	305	375	310	0%	0%
WB	Through	1,625	375	86	700	222	850	337	0%	0%
0										

SimTraffic Off-Ramp Queue Report

Cumulative Plus Project with Improvements Conditions

(PM Peak Hour)

Intersection 26 **I-5 SB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	400	50	6	75	14	100	34	0%	0%
SB	Left Turn	1,425	75	4	100	8	150	26	0%	0%
	Right Turn	1,425	75	3	100	12	125	34	0%	0%
WB	Through	275	125	9	200	17	225	37	0%	0%
0										

Intersection 27 **I-5 NB Ramps/Arena Blvd** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft) Average	Average Queue (ft) Std. Dev.	95th Queue (ft) Average	95th Queue (ft) Std. Dev.	Maximum Queue (ft) Average	Maximum Queue (ft) Std. Dev.	Block Time Pocket	Block Time Upstream
EB	Through	675	250	49	350	87	425	90	0%	1%
NB	Left Diagonal	1,475	100	5	175	9	275	145	0%	0%
	Left Diagonal	1,475	100	5	175	9	275	145	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
	Right Turn	1,475	25	0	25	0	25	0	0%	0%
WB	Through	1,200	25	0	25	0	25	0	0%	0%
	Right Turn	575	25	0	25	0	25	0	0%	0%
NB										

Intersection 33 **I-80 WB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	700	200	19	425	39	475	51	0%	0%
	Through/Right	700	400	23	575	40	650	52	0%	0%
	Right Turn	700	225	45	400	67	500	103	0%	0%
SB	Left Turn	1,500	125	13	200	32	225	29	0%	2%
	Right Turn	1,500	400	201	775	344	1,025	346	0%	2%
WB	Through	850	325	104	600	190	650	164	6%	0%
	Right Turn	325	50	62	100	187	100	164	0%	0%
0										

Intersection 34 **I-80 EB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
B6020	Through									
EB	Through	850	300	20	400	26	425	48	0%	0%
NB	Left Turn	1,500	650	145	925	366	975	331	3%	0%
	Right Turn	1,500	175	111	350	317	375	258	0%	0%
WB	Through	275	250	17	400	18	375	34	9%	8%
	Right Turn	275	125	18	350	19	275	0	1%	1%

Intersection 39 **I-5 NB Ramps/W El Camino Ave** **Signal**

Direction	Lane Group	Storage (ft)	Average Queue (ft)		95th Queue (ft)		Maximum Queue (ft)		Block Time	
			Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Pocket	Upstream
EB	Through	800	100	11	175	16	200	39	0%	0%
NB	Left Turn	1,000	275	15	375	21	425	35	0%	0%
WB	Through	1,625	200	95	350	272	425	420	0%	0%
0										

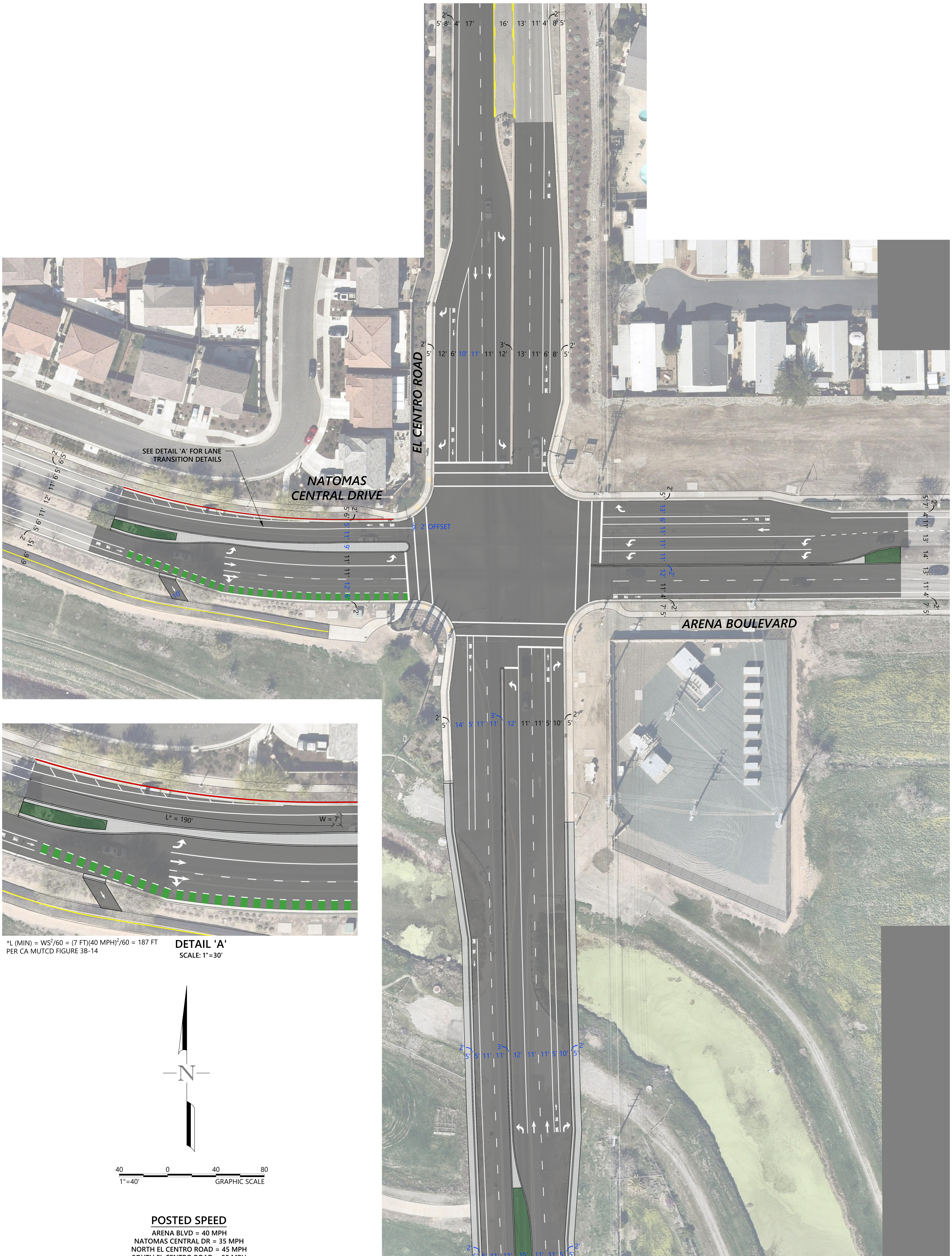


Figure 2

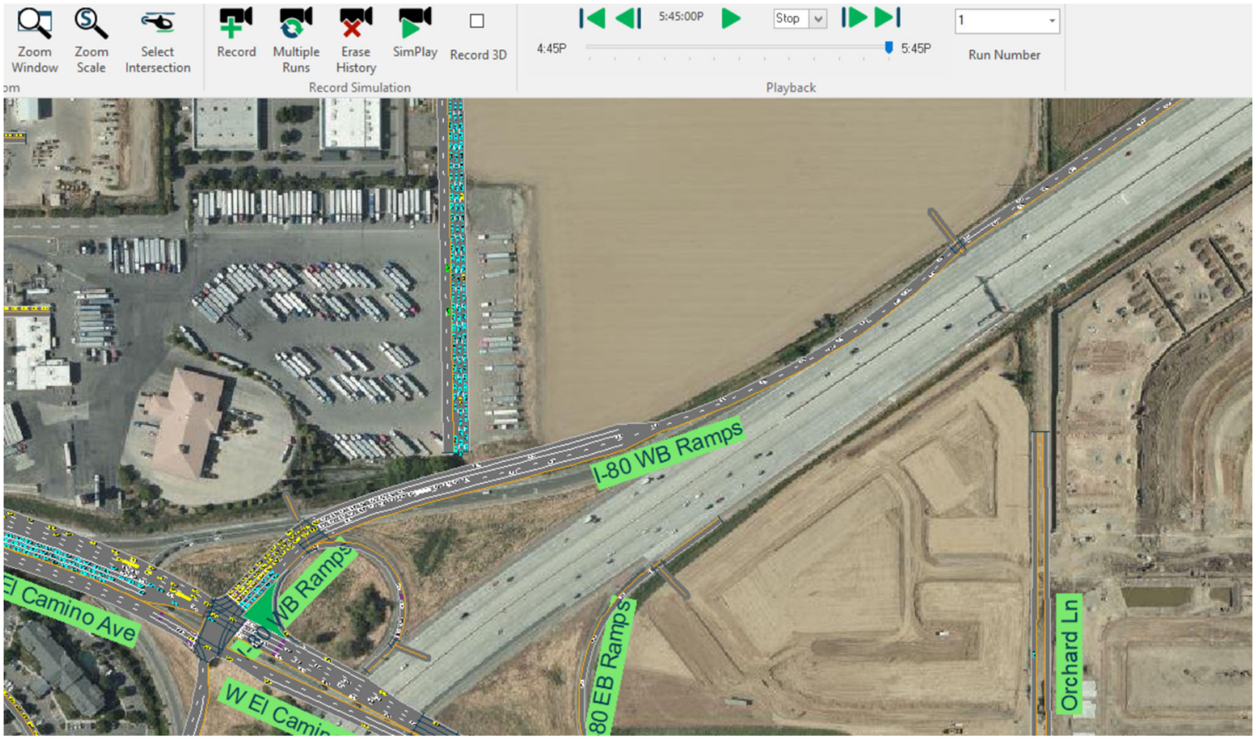
Proposed Geometrics

Natomas Central Dr - Arena Blvd & El Centro Blvd

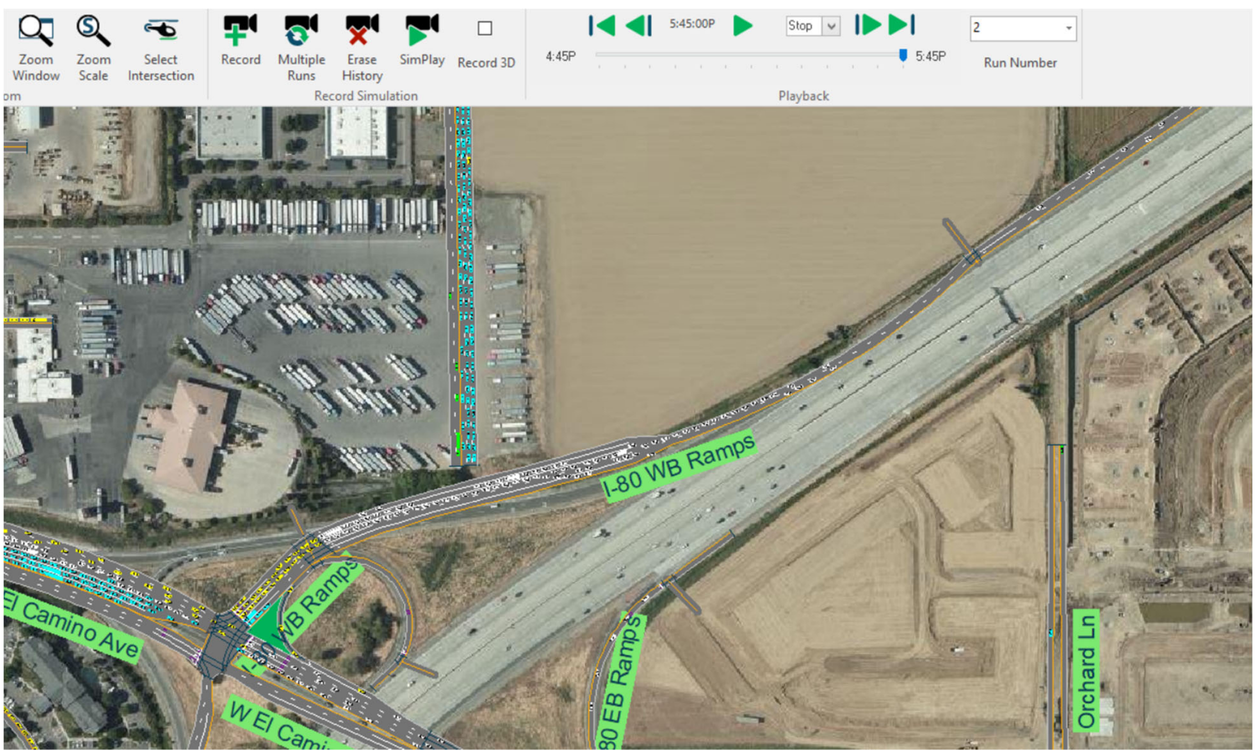
CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Cumulative Plus Project With Improvements – PM Peak Hour Simulation (at end of the Peak Hour)

Run 1



Run 2



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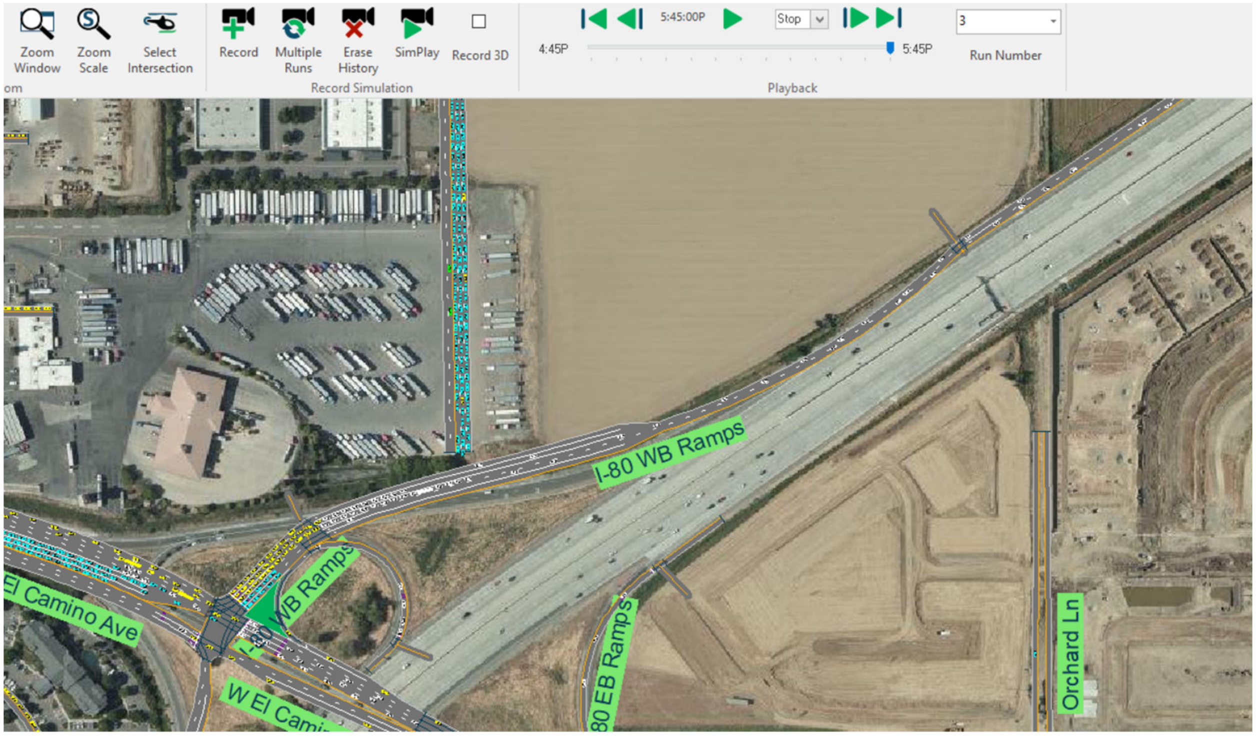
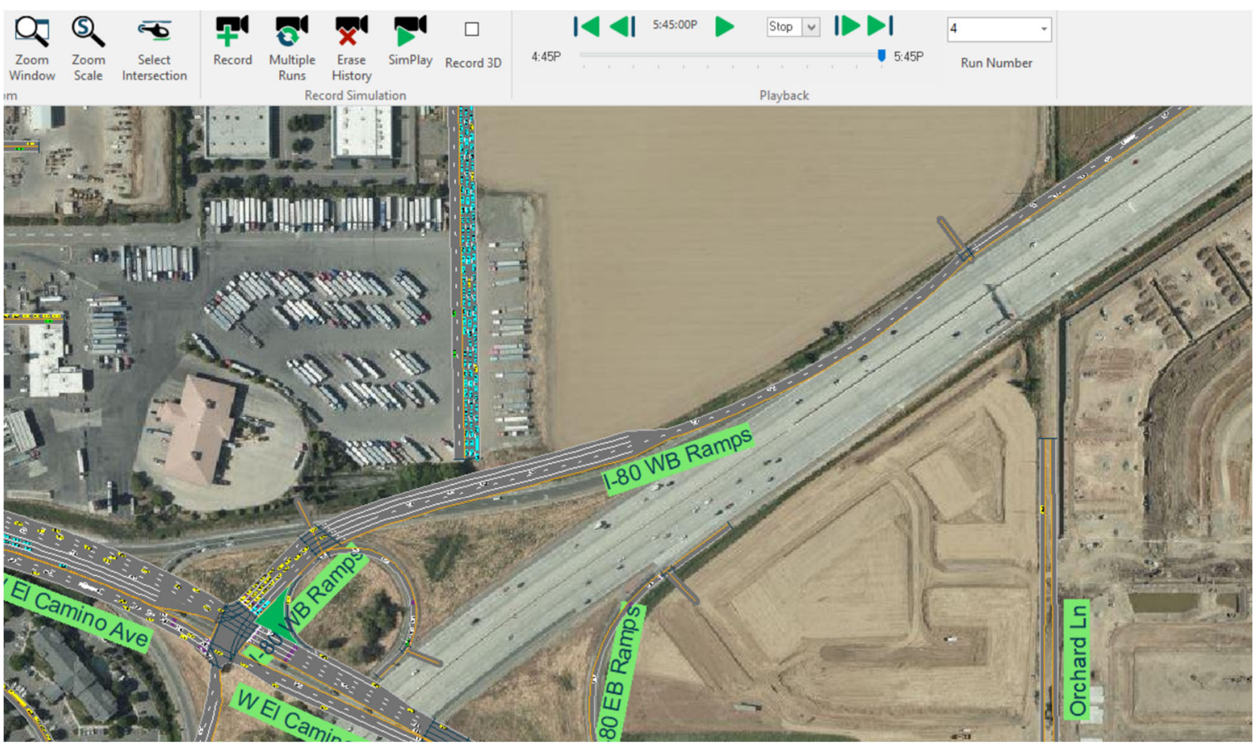

Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
3
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Cami
80 EB Ramps
Orchard Ln

Run 4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Zoom Scale
Select Intersection
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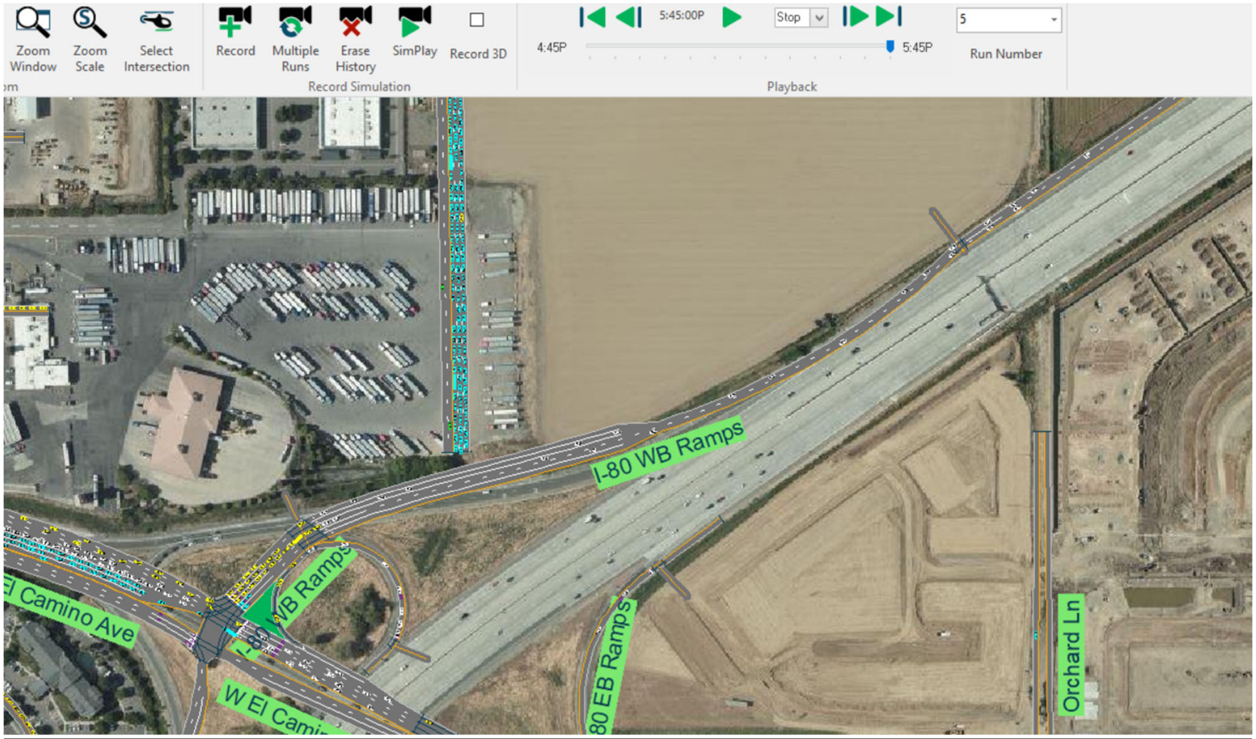
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
4
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

Run 5



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Zoom Scale
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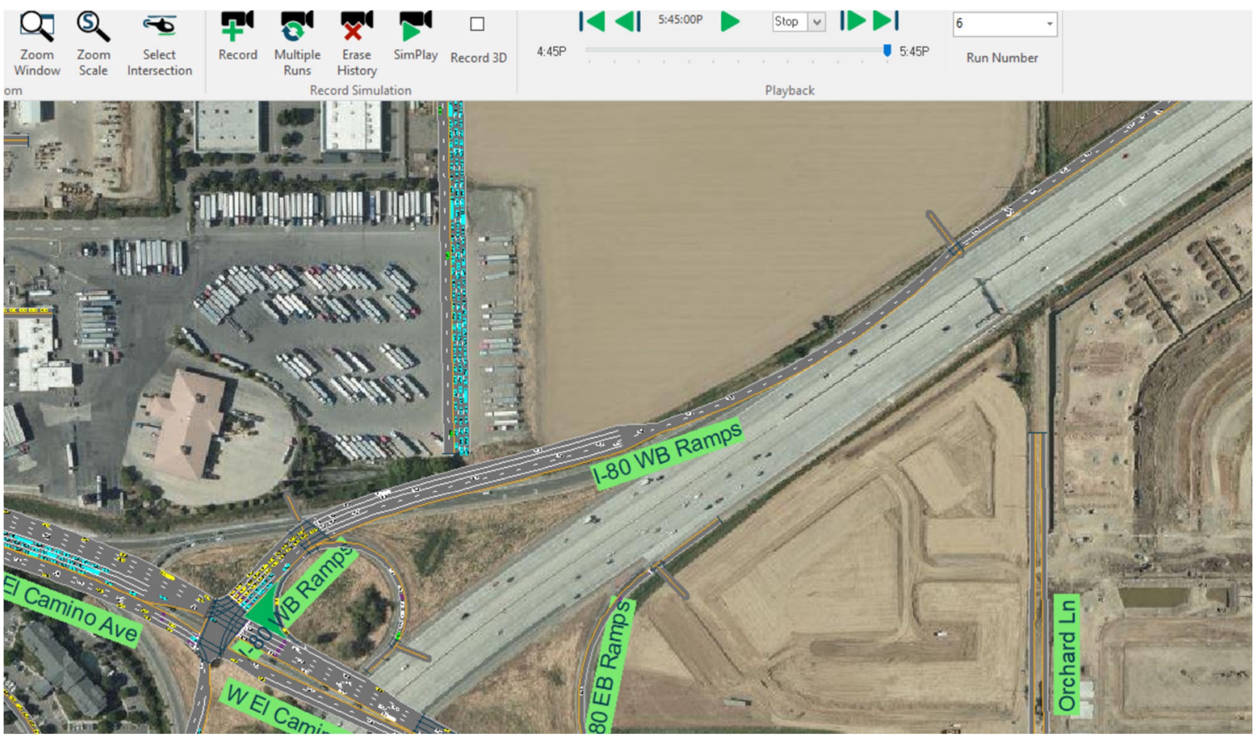
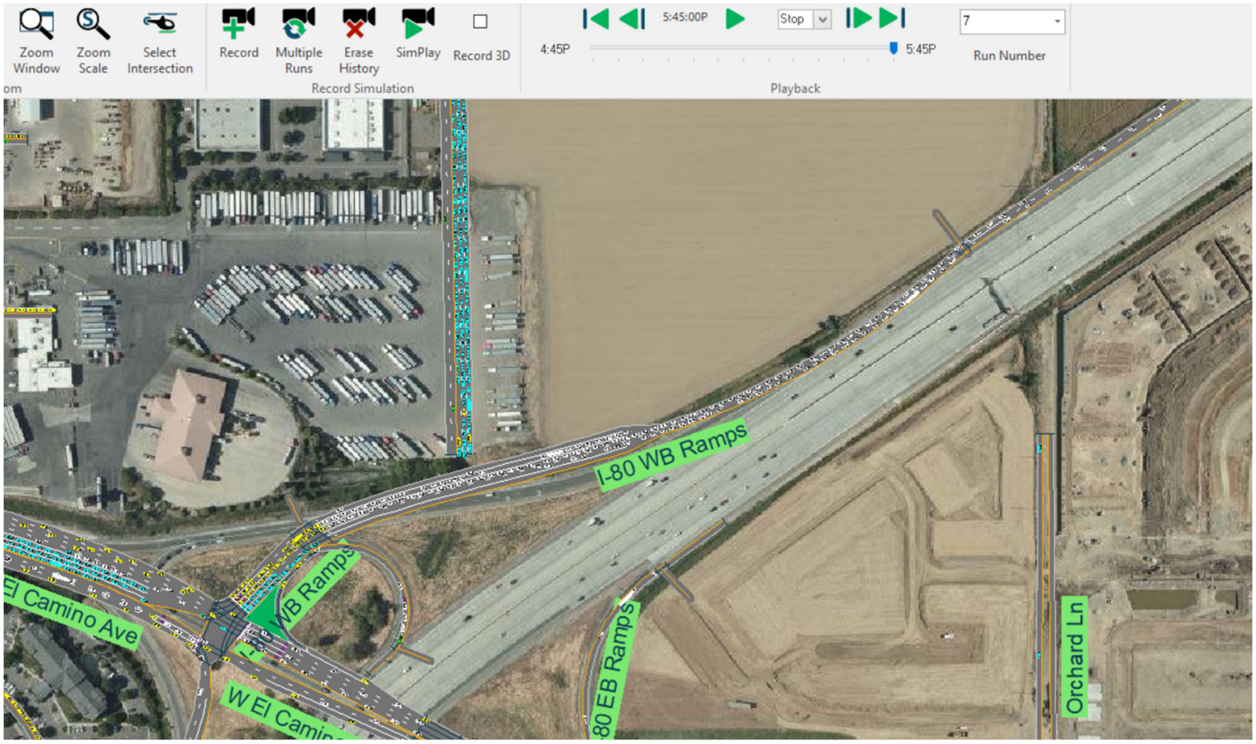
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
5
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Cami
80 EB Ramps
Orchard Ln

Run 6



Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
6
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Cami
80 EB Ramps
Orchard Ln

Run 7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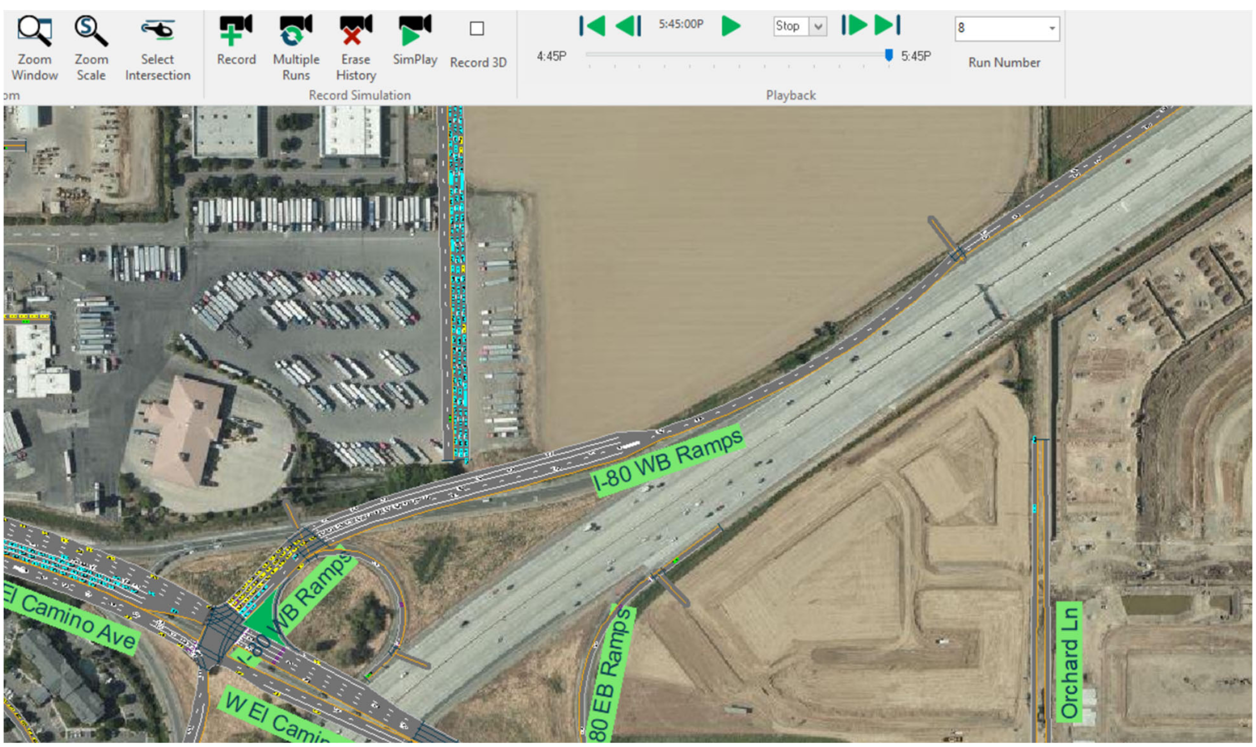
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
7
Run Number
I-80 WB Ramps
WB Ramps
El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

Run 8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Zoom Scale
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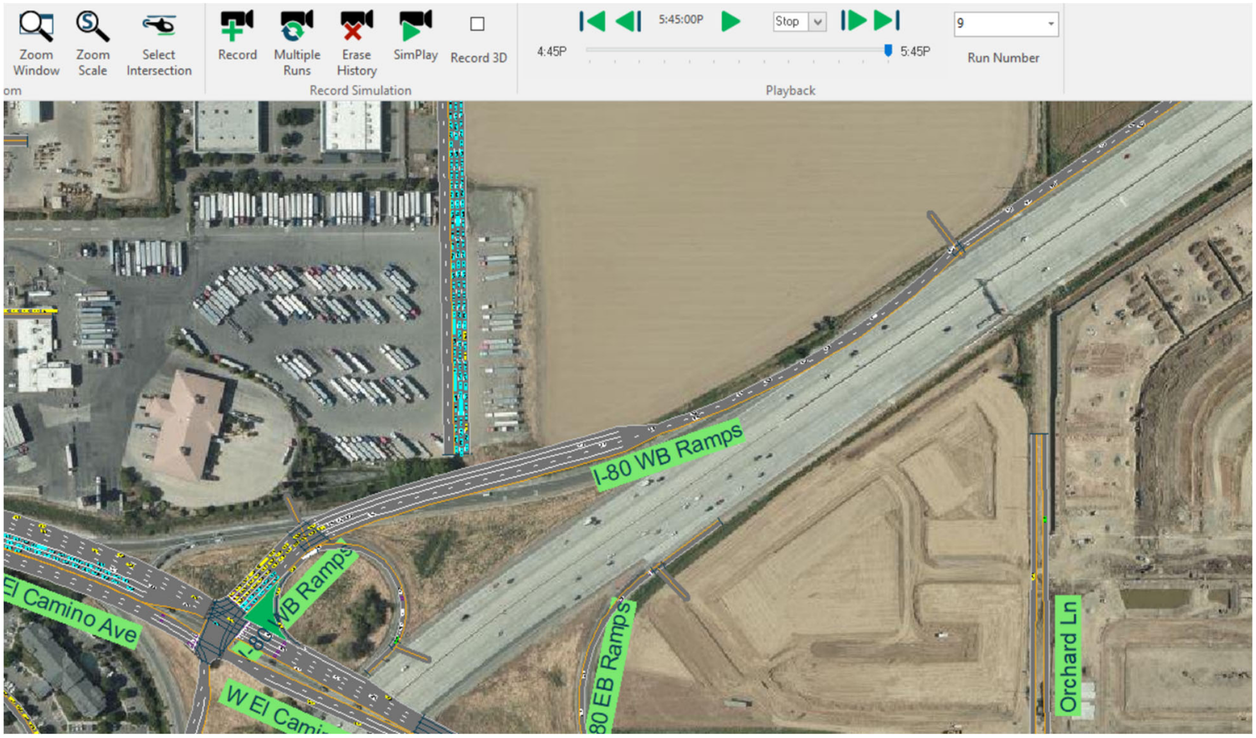
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
8
Run Number
I-80 WB Ramps
WB Ramps
El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

Run 9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Zoom Scale
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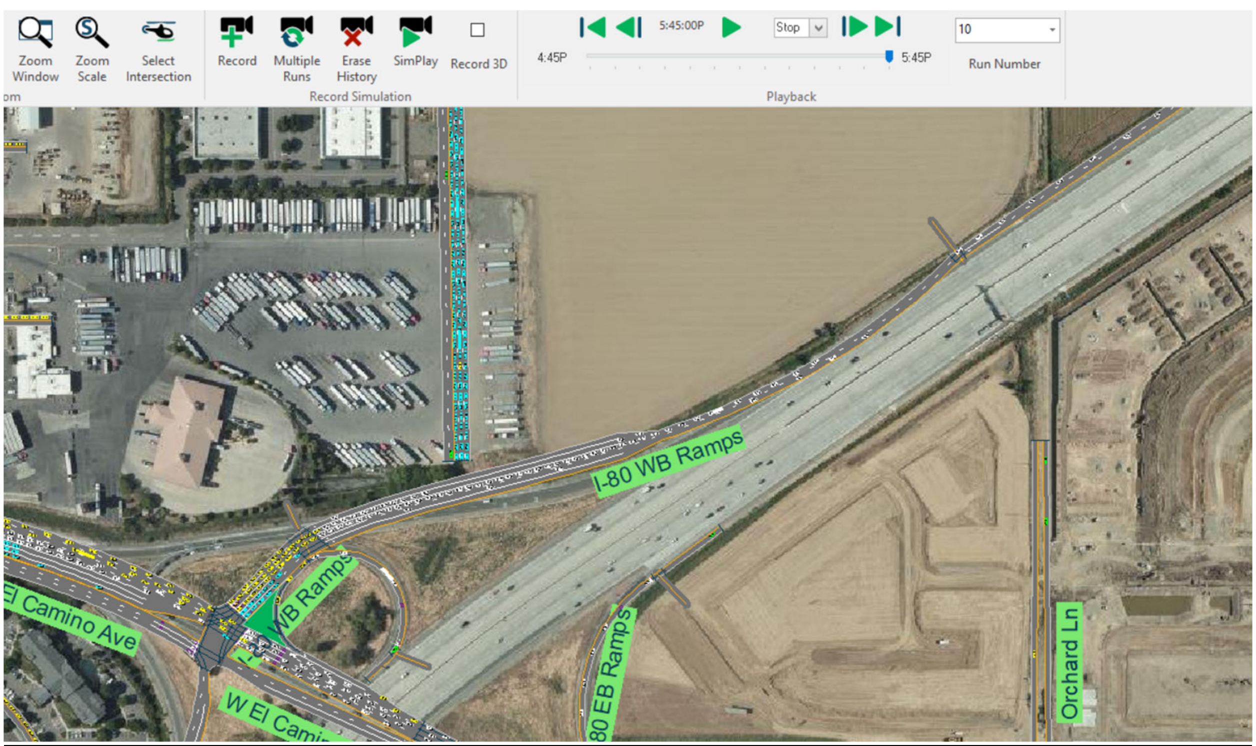
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
9
Run Number
I-80 WB Ramps
El Camino Ave
W El Cami
80 EB Ramps
Orchard Ln

Run 10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Zoom Scale
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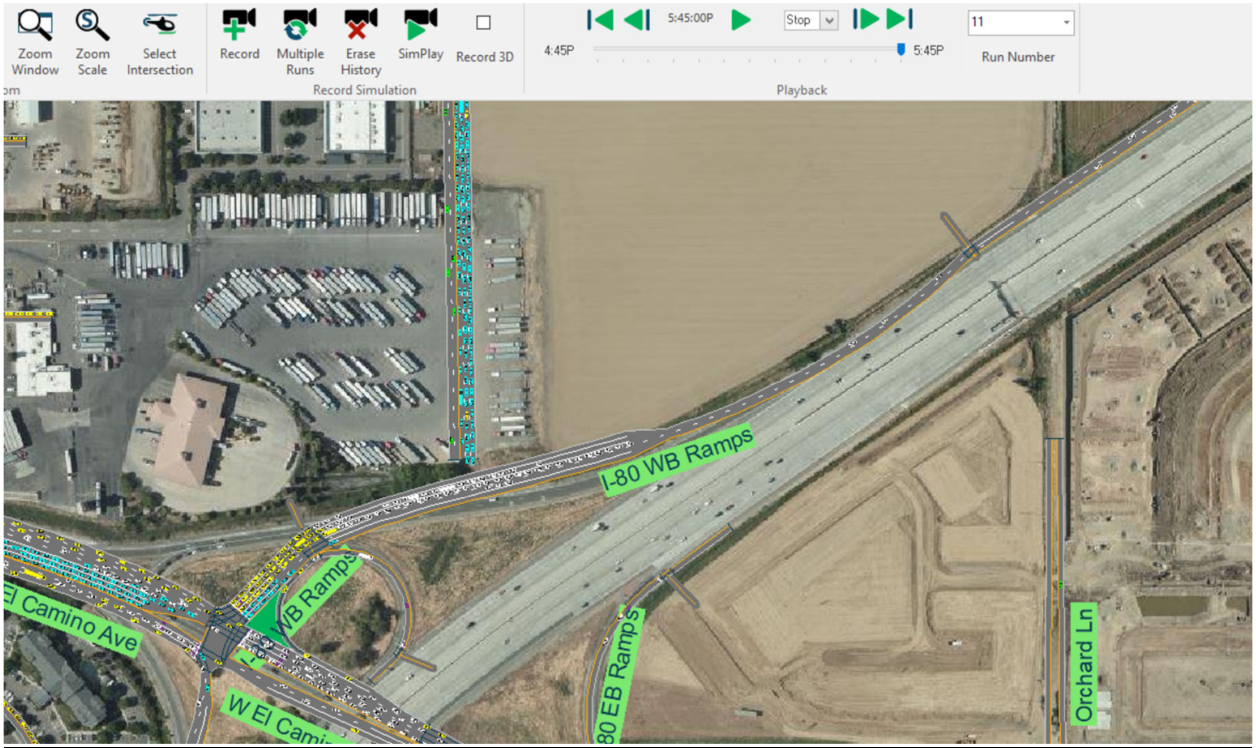
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
10
Run Number
I-80 WB Ramps
El Camino Ave
W El Cami
80 EB Ramps
Orchard Ln

Run 11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Zoom Scale
Select Intersection
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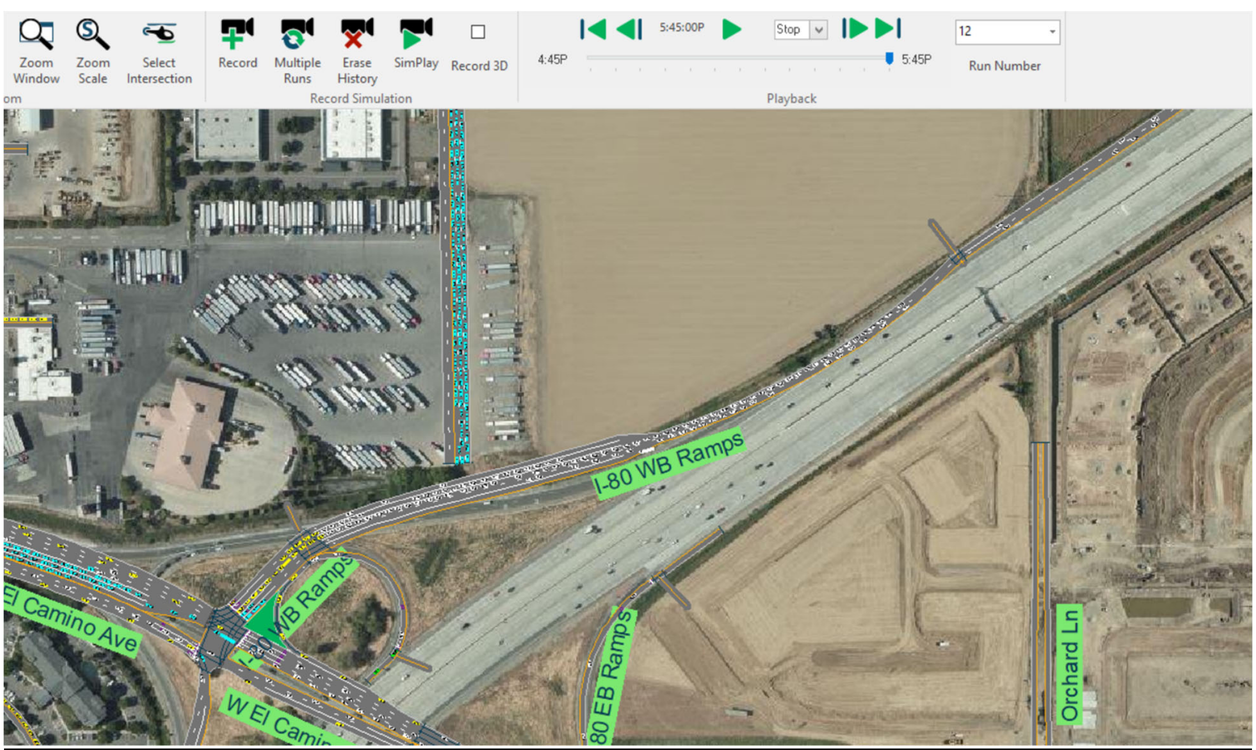
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
11
Run Number
Playback
I-80 WB Ramps
El Camino Ave
WB Ramps
W El Cami
80 EB Ramps
Orchard Ln

Run 12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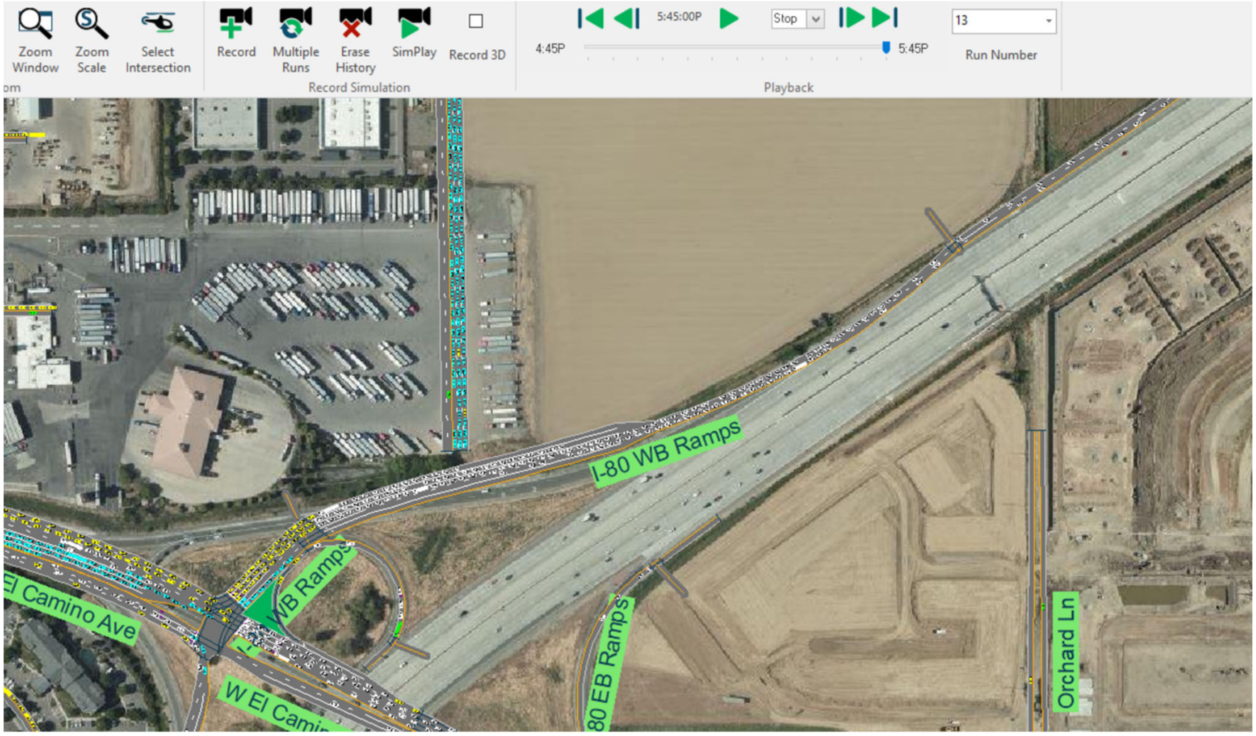
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
12
Run Number
Playback
I-80 WB Ramps
El Camino Ave
WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

Run 13


Zoom Window
Zoom Scale
Select Intersection
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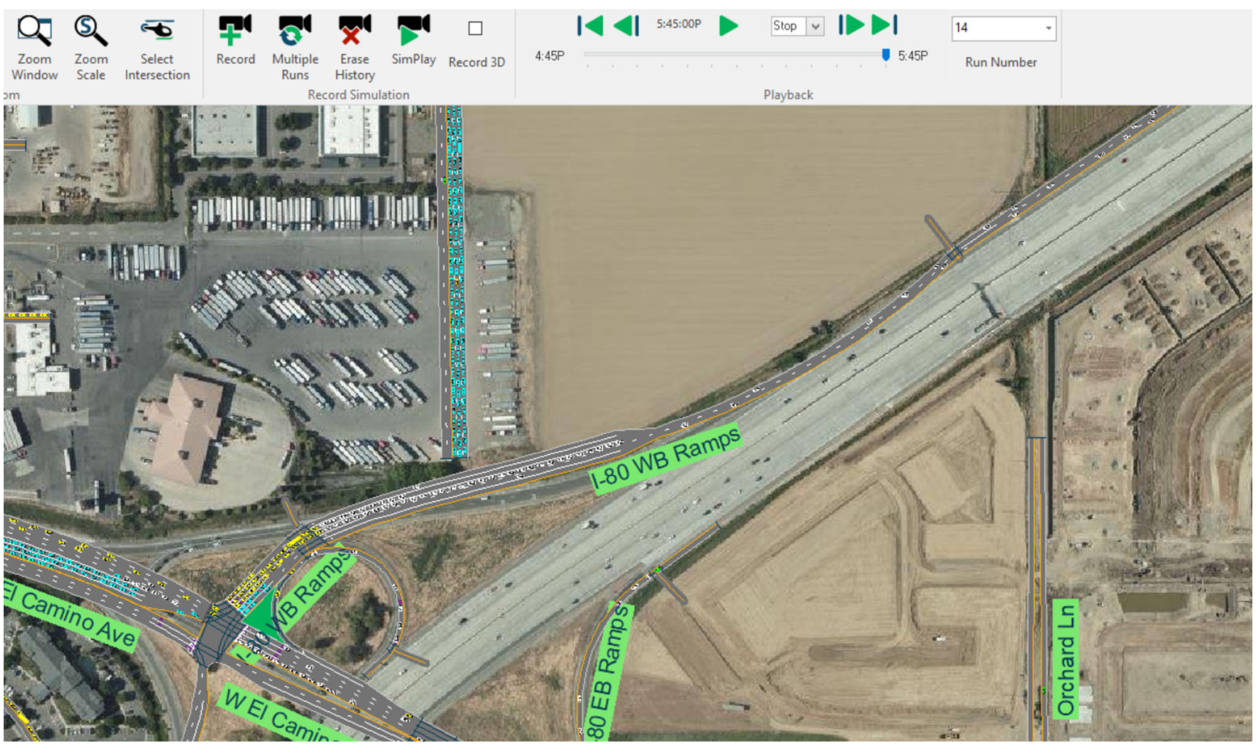
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
13
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

Run 14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Zoom Scale
Select Intersection
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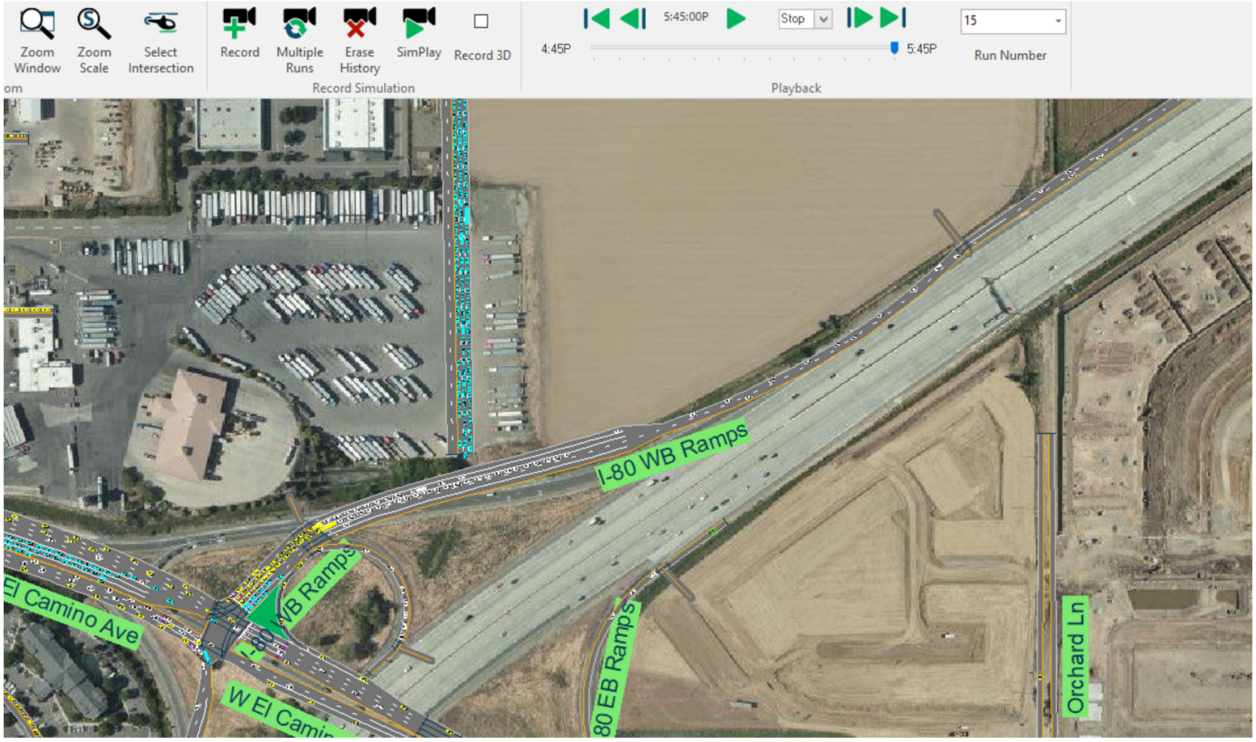
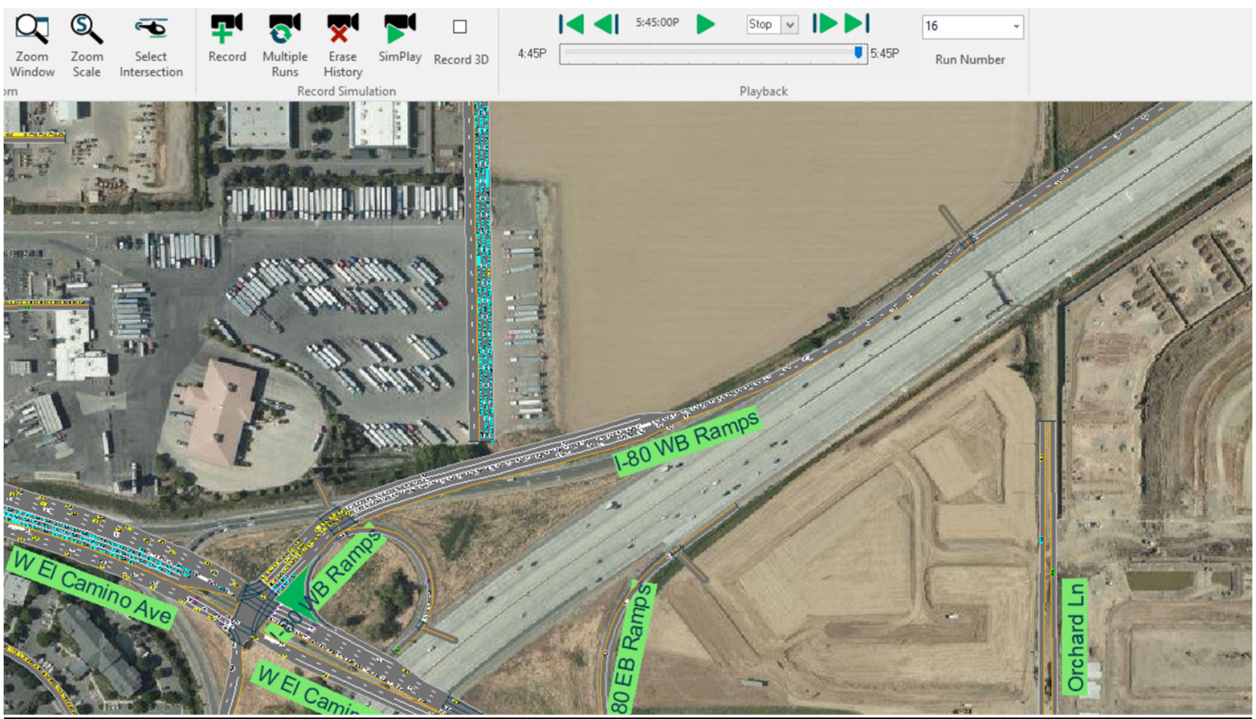
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
14
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

Run 15



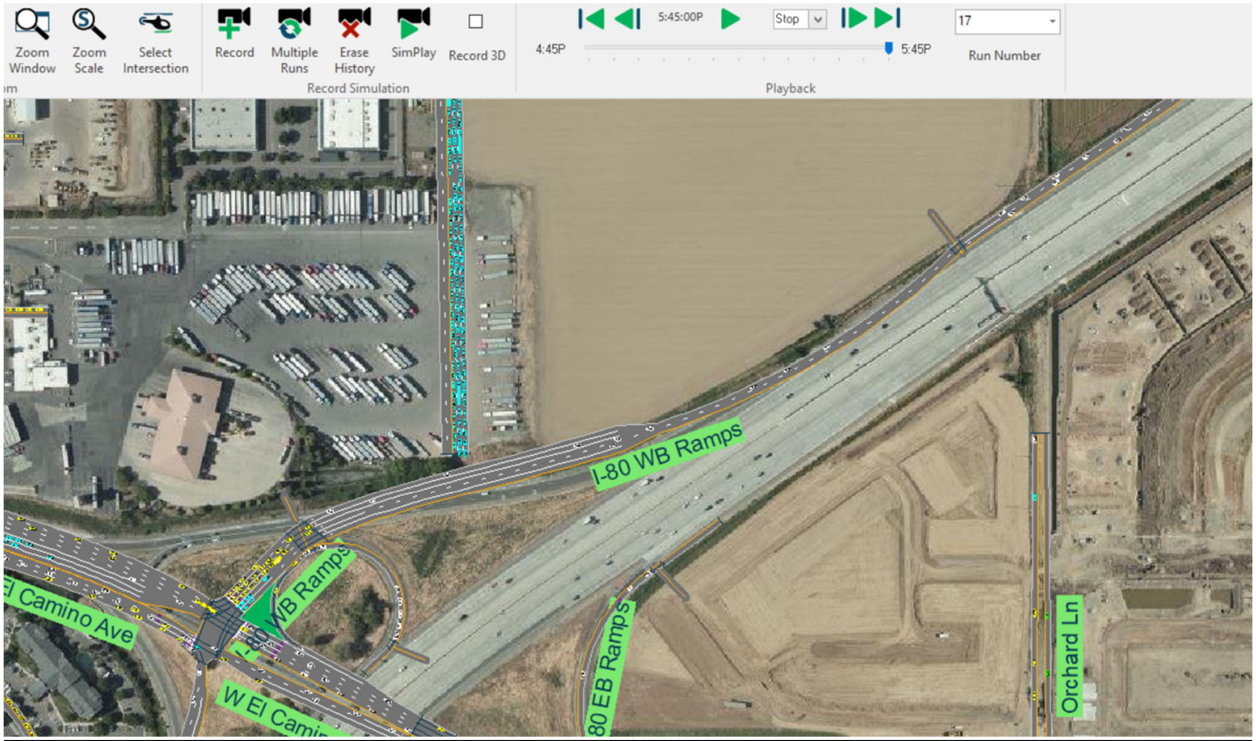
Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
15
Run Number
Playback
I-80 WB Ramps
El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

Run 16

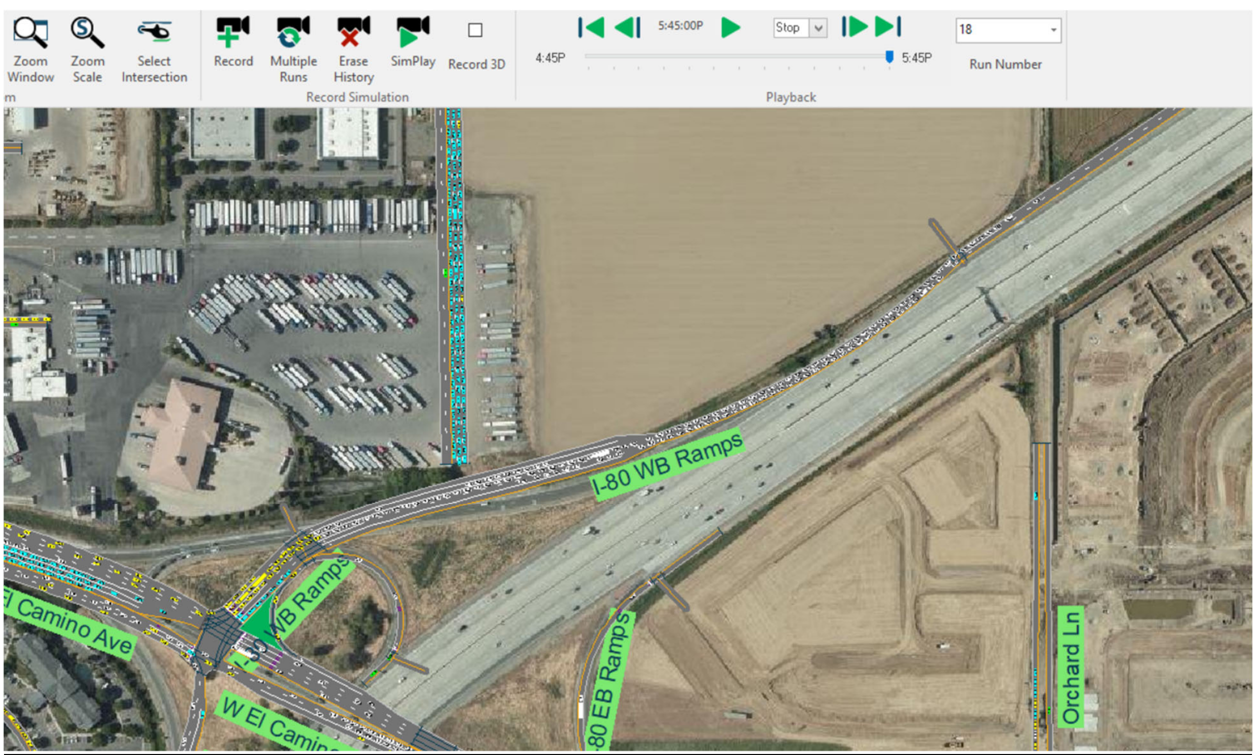


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
16
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
W El Camin
80 EB Ramps
Orchard Ln

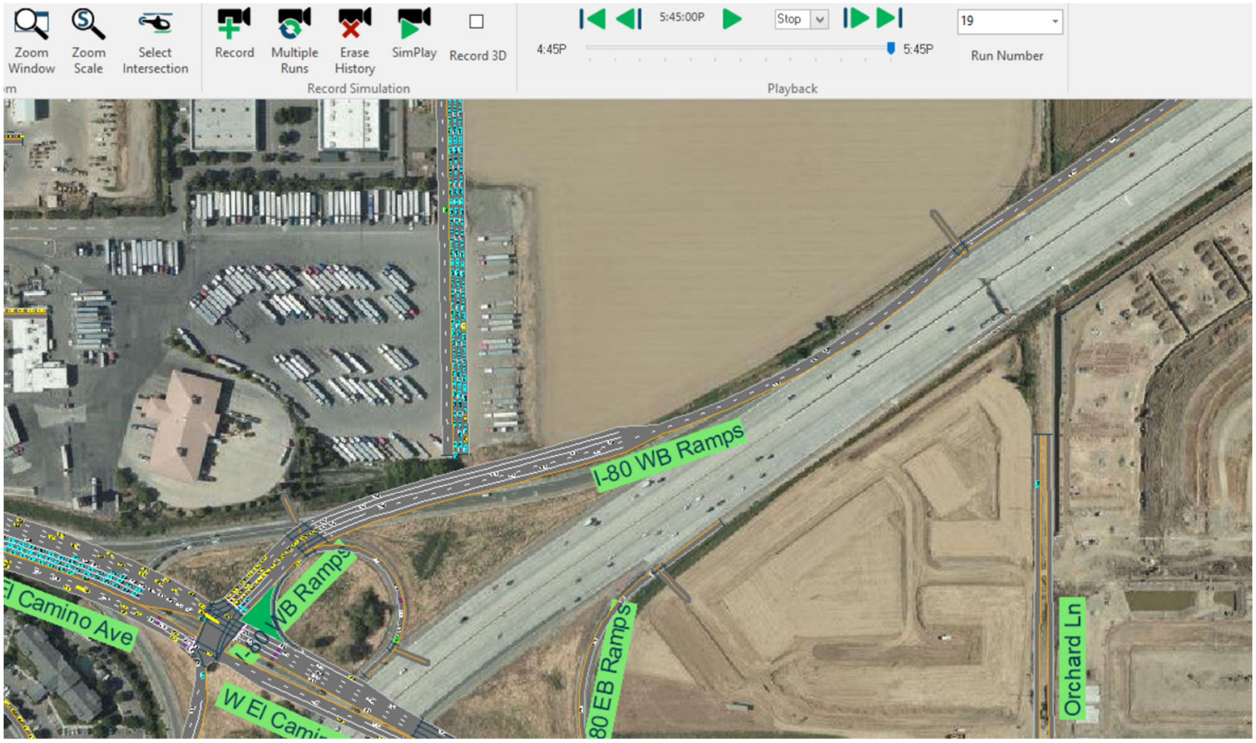
Run 17


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
4:45P
5:45P
Stop
17
Run Number
Playback
I-80 WB Ramps
El Camino Ave
I-80 WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

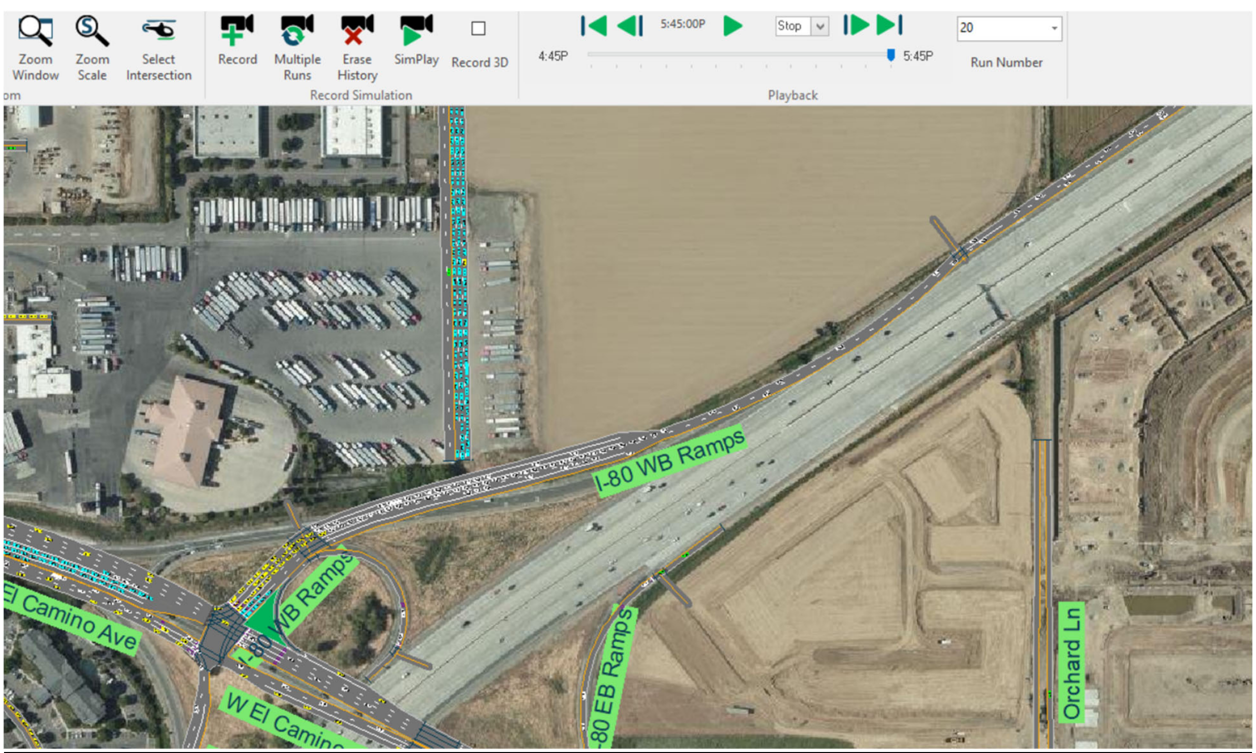
Run 18


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
4:45P
5:45P
Stop
18
Run Number
Playback
I-80 WB Ramps
El Camino Ave
WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

Run 19

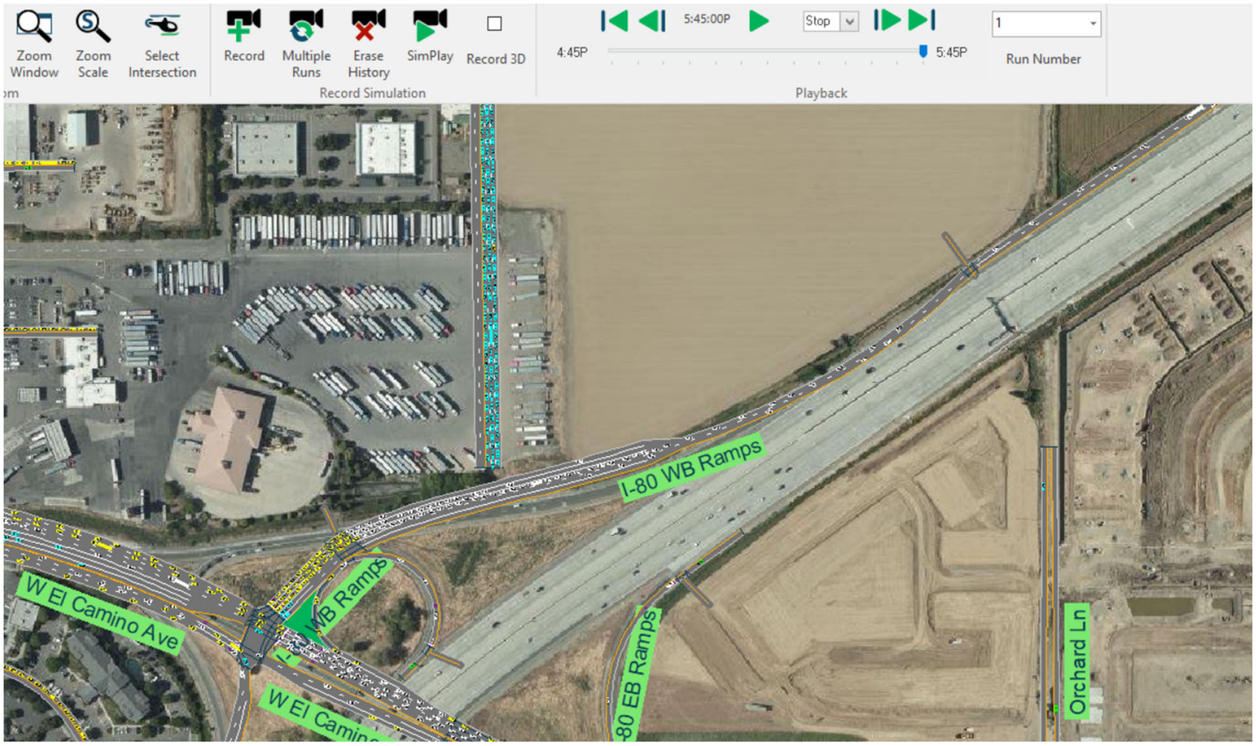

Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
4:45P
5:45:00P
Stop
5:45P
Playback
19
Run Number
I-80 WB Ramps
El Camino Ave
I-80 WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

Run 20

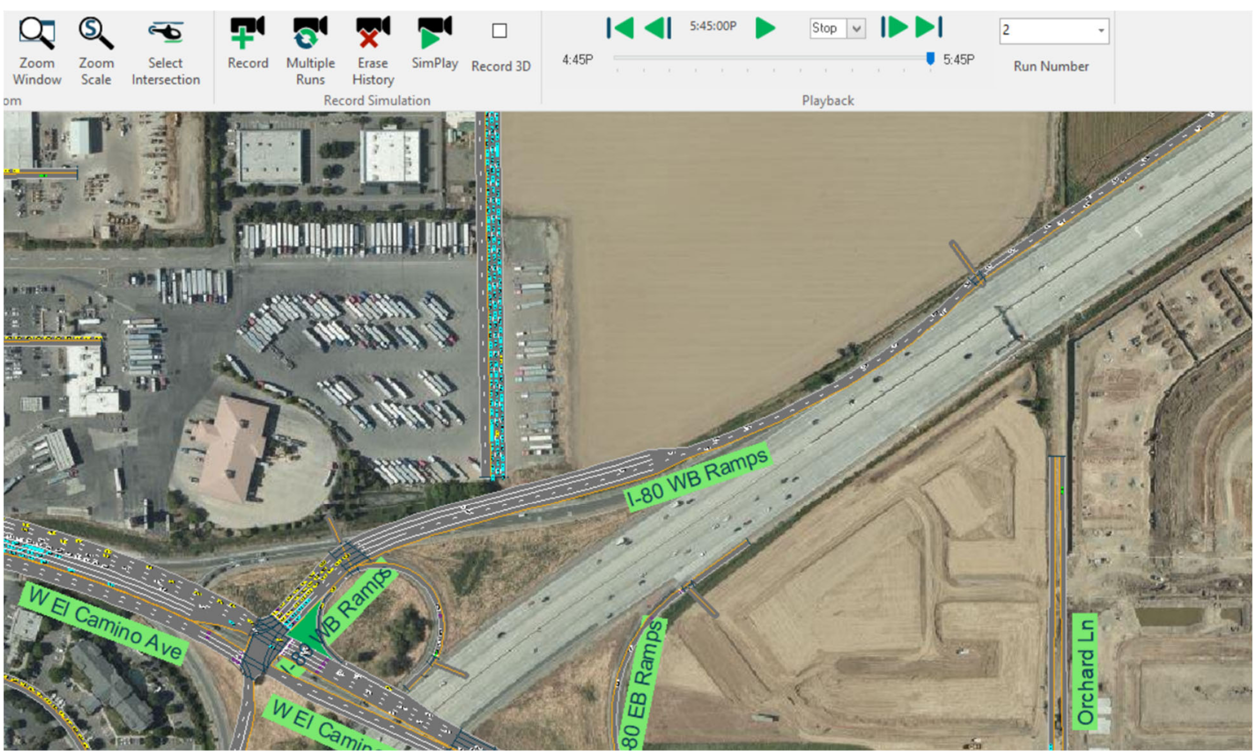

Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
4:45P
5:45:00P
Stop
5:45P
Playback
20
Run Number
I-80 WB Ramps
El Camino Ave
I-80 WB Ramps
W El Camino
80 EB Ramps
Orchard Ln

Cumulative Plus Project With Improvements - Updated Signal Timing at Westbound W. El Camino – PM Peak Hour Simulation (at end of the Peak Hour)

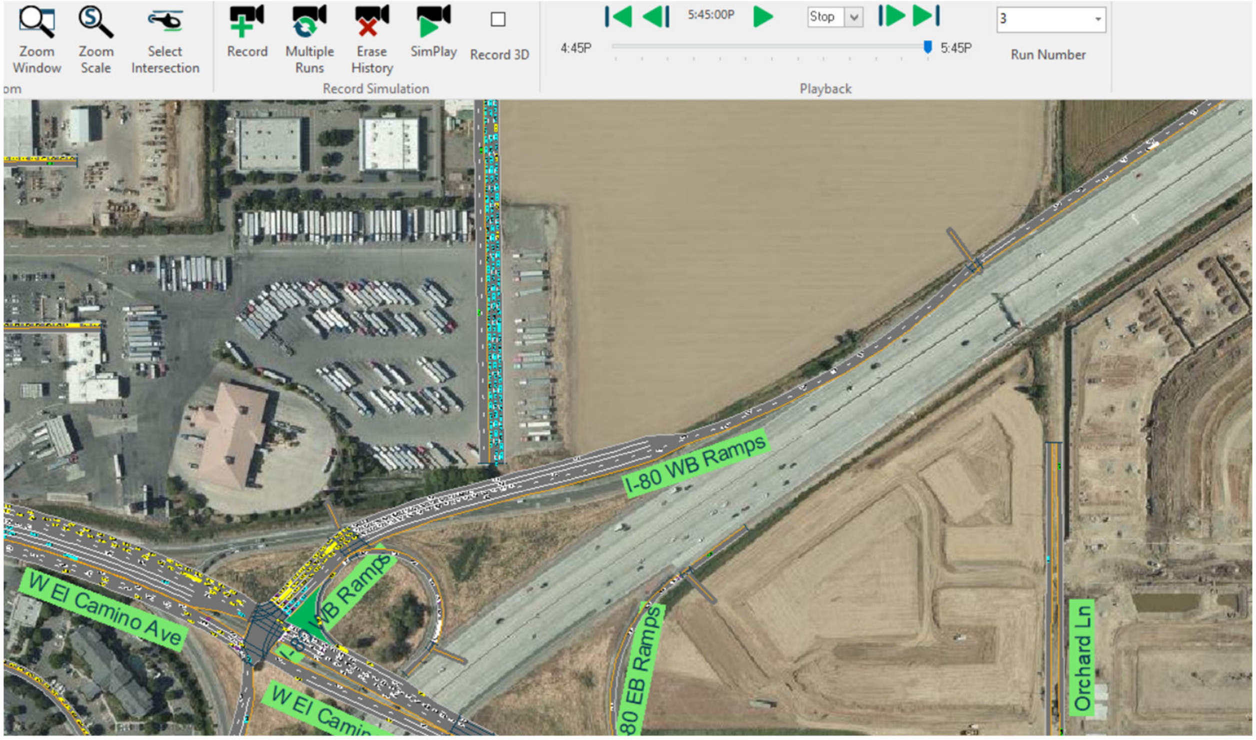
Run 1



Run 2

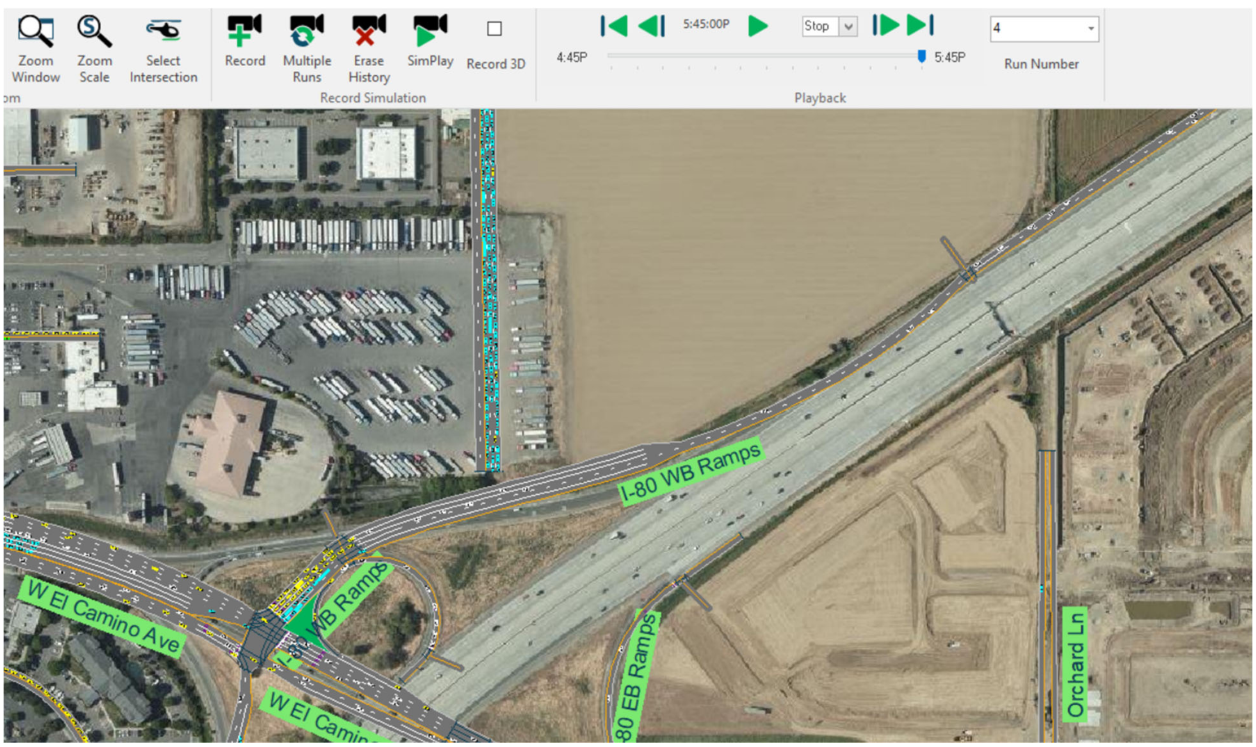


Run 3



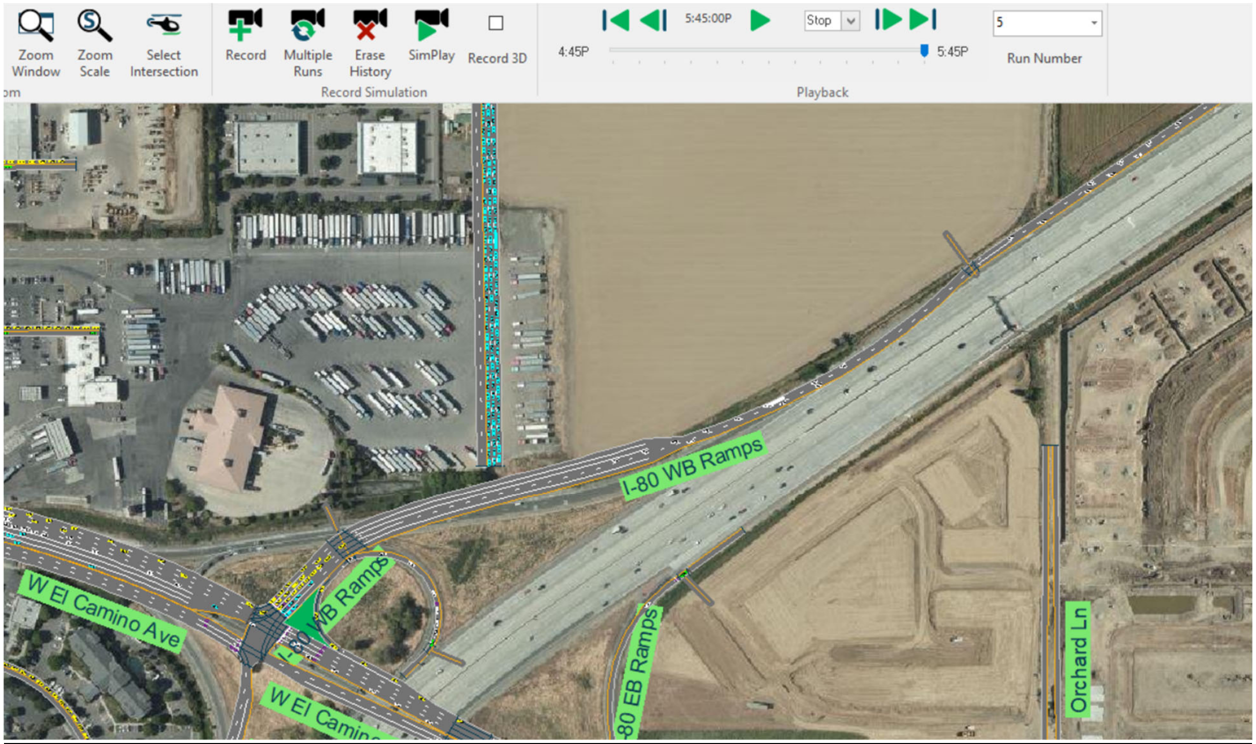
Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
3
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
WB Ramps
80 EB Ramps
Orchard Ln

Run 4

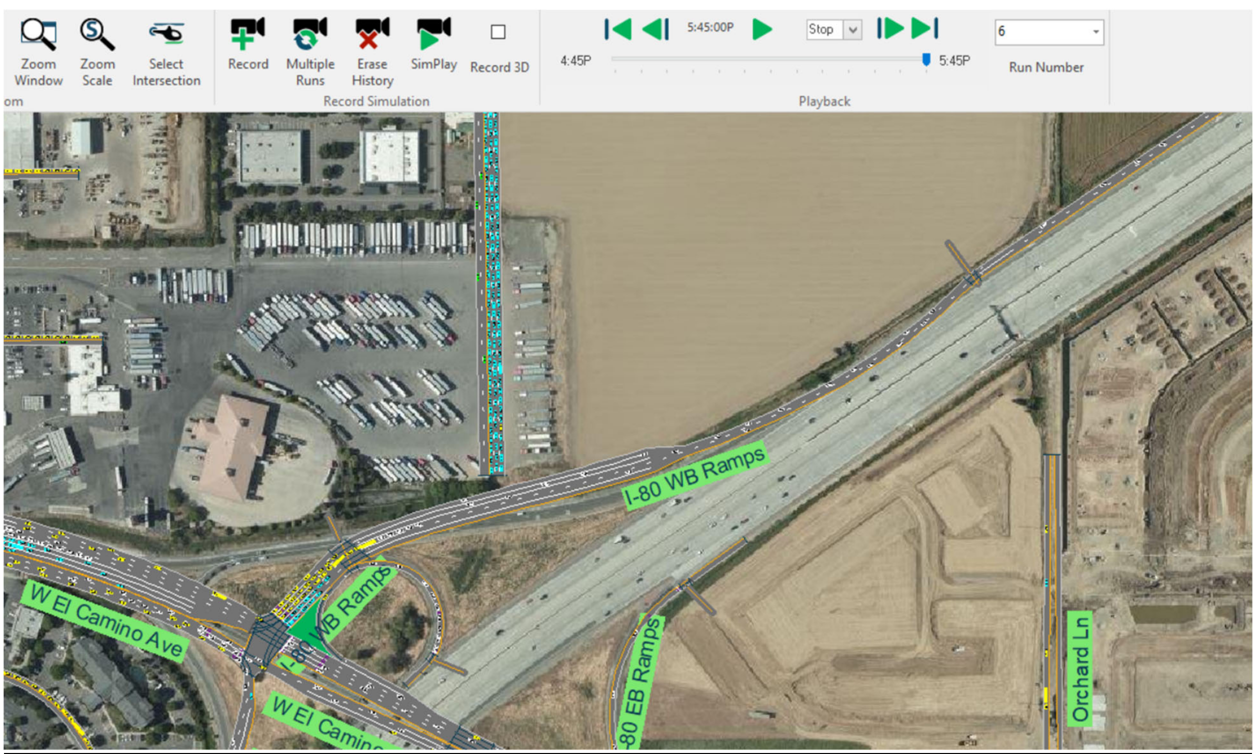


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
4
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
WB Ramps
80 EB Ramps
Orchard Ln

Run 5


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
5
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
80 EB Ramps
Orchard Ln

Run 6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Zoom Scale
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Multiple Runs
Erase History
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Record 3D
Record Simulation
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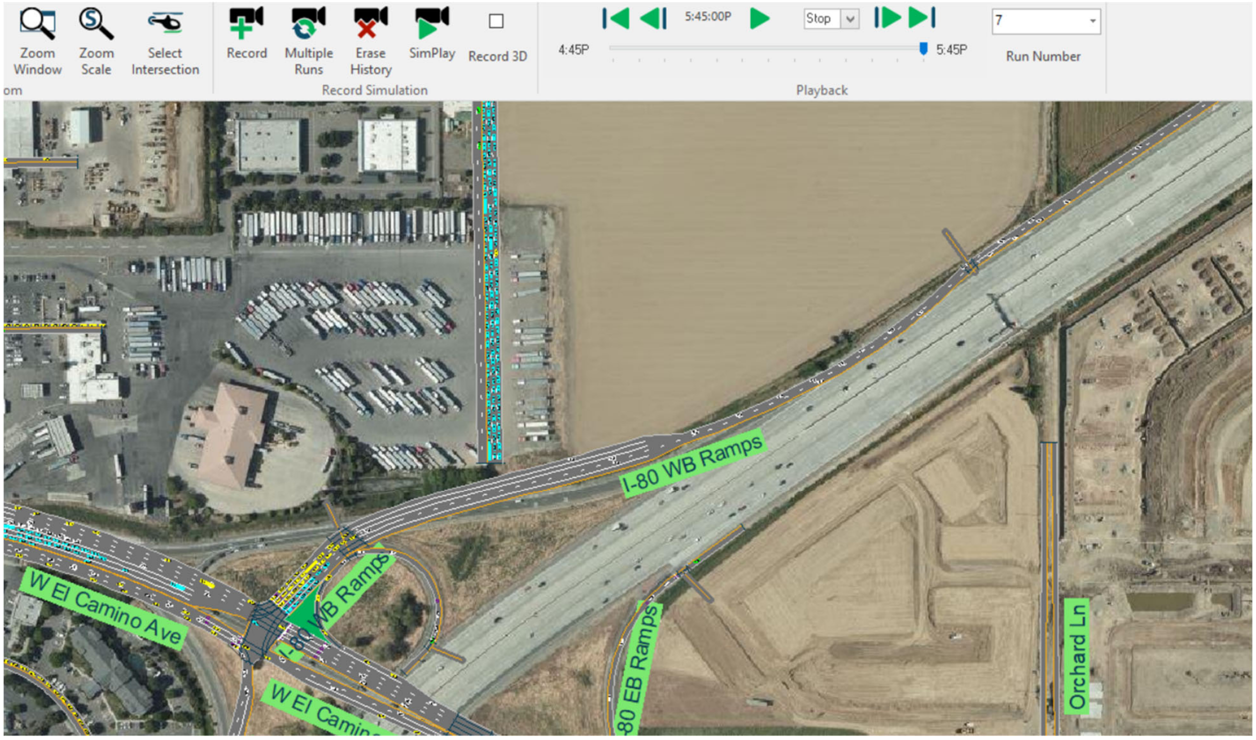
4:45P
5:45P
6
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
80 EB Ramps
Orchard Ln

Run 7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Zoom Scale
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SimPlay
Record 3D
Record Simulation
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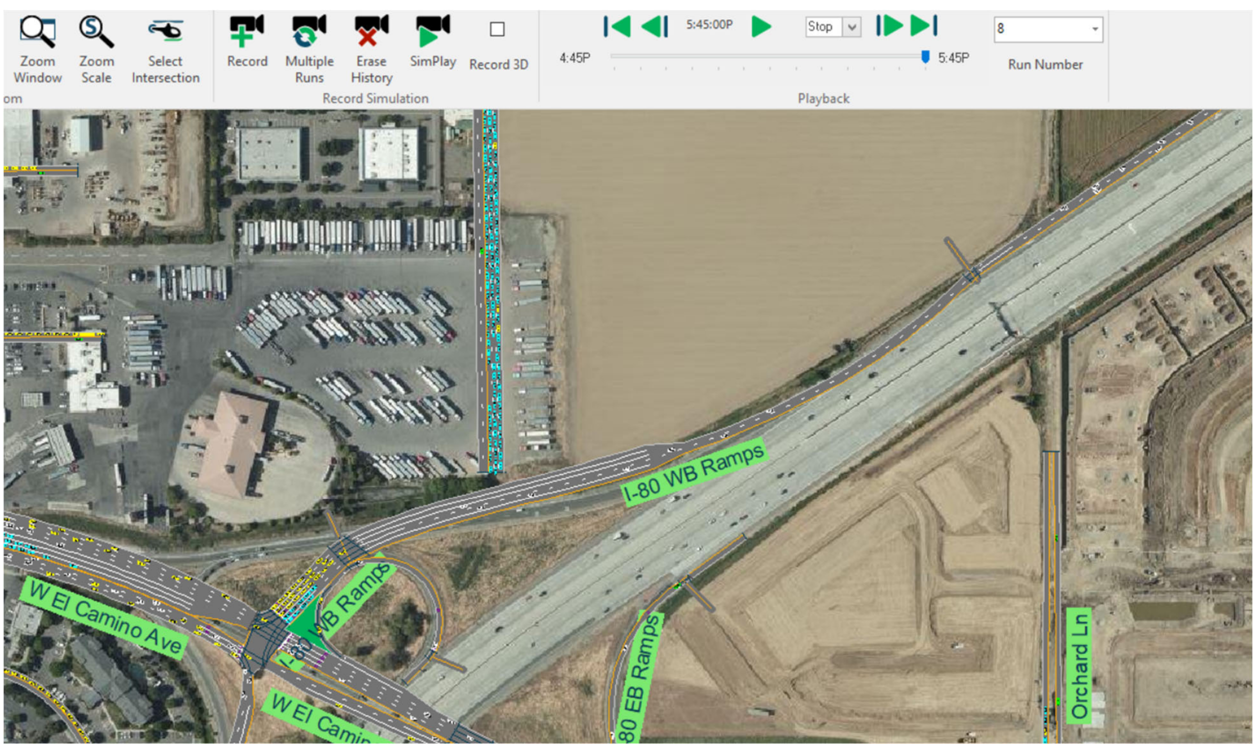
4:45P
5:45P
7
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
Orchard Ln

Run 8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Zoom Scale
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Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
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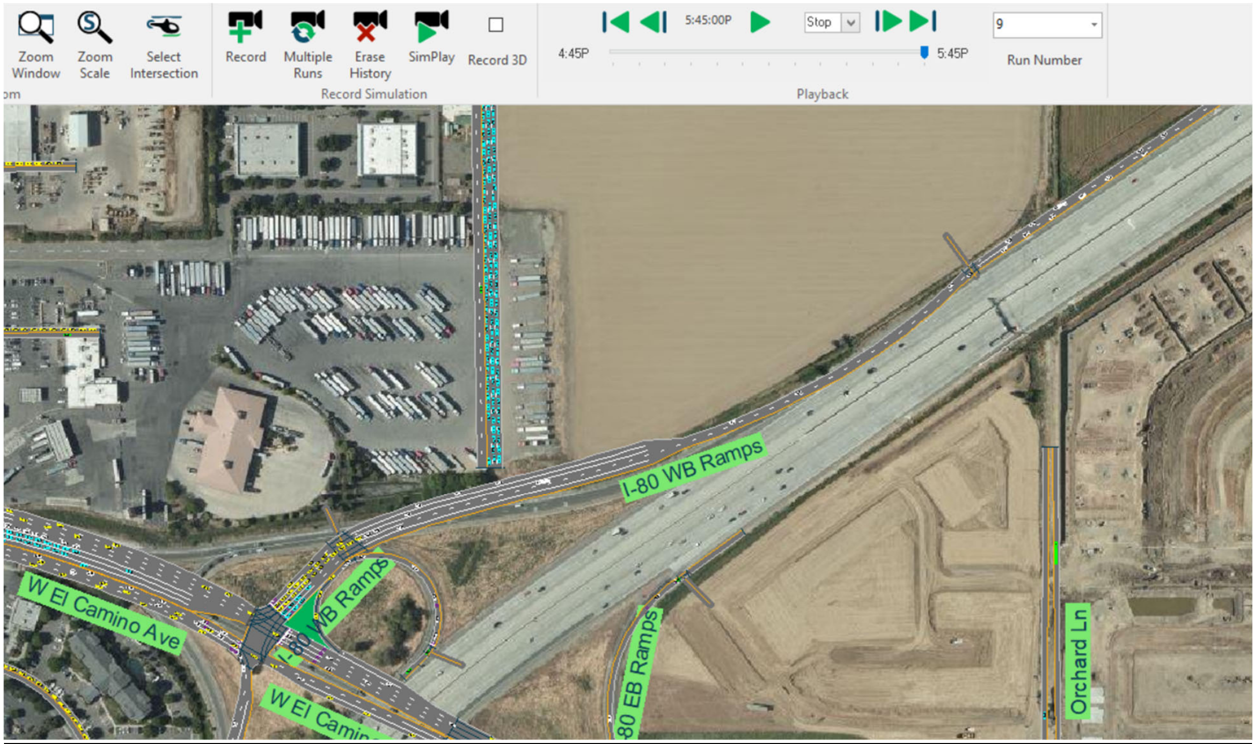
Stop
4:45P
5:45P
8
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
Orchard Ln

Run 9



Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
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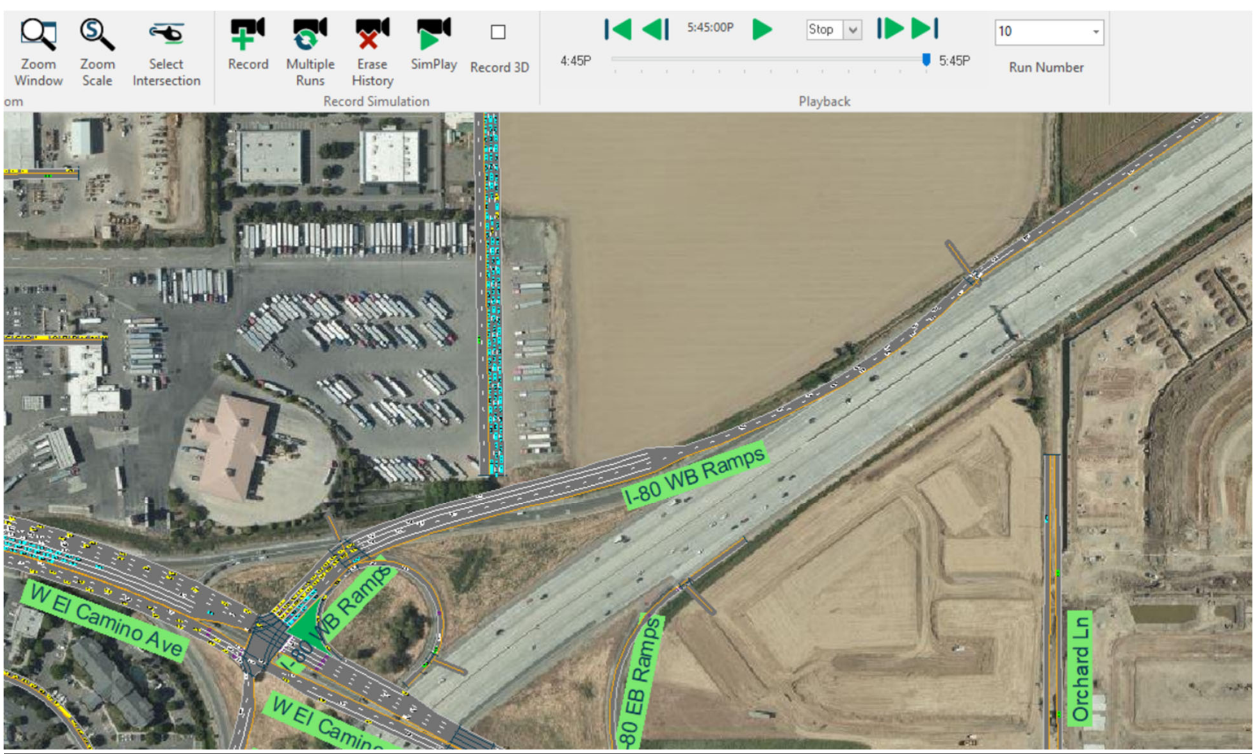
Stop
4:45P
5:45P
9
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
Orchard Ln

Run 10



Zoom Window
Zoom Scale
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Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
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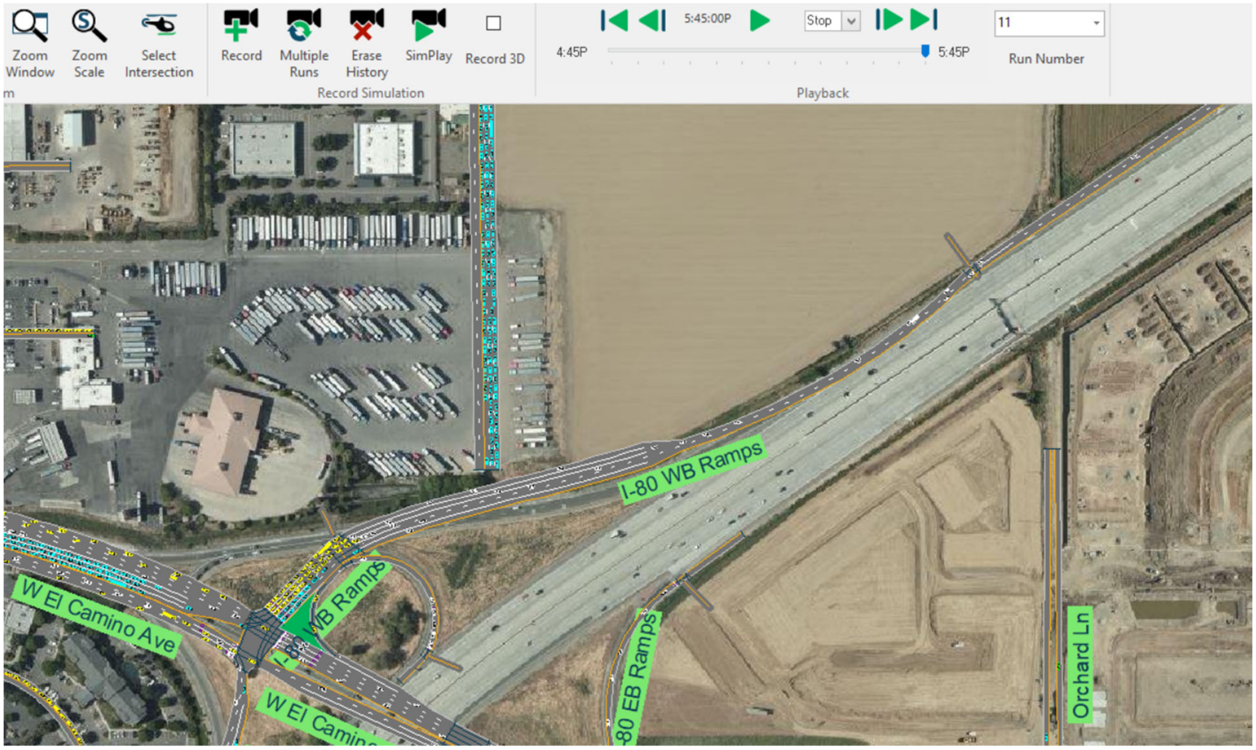
Stop
4:45P
5:45P
10
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
Orchard Ln

Run 11



Zoom Window
Zoom Scale
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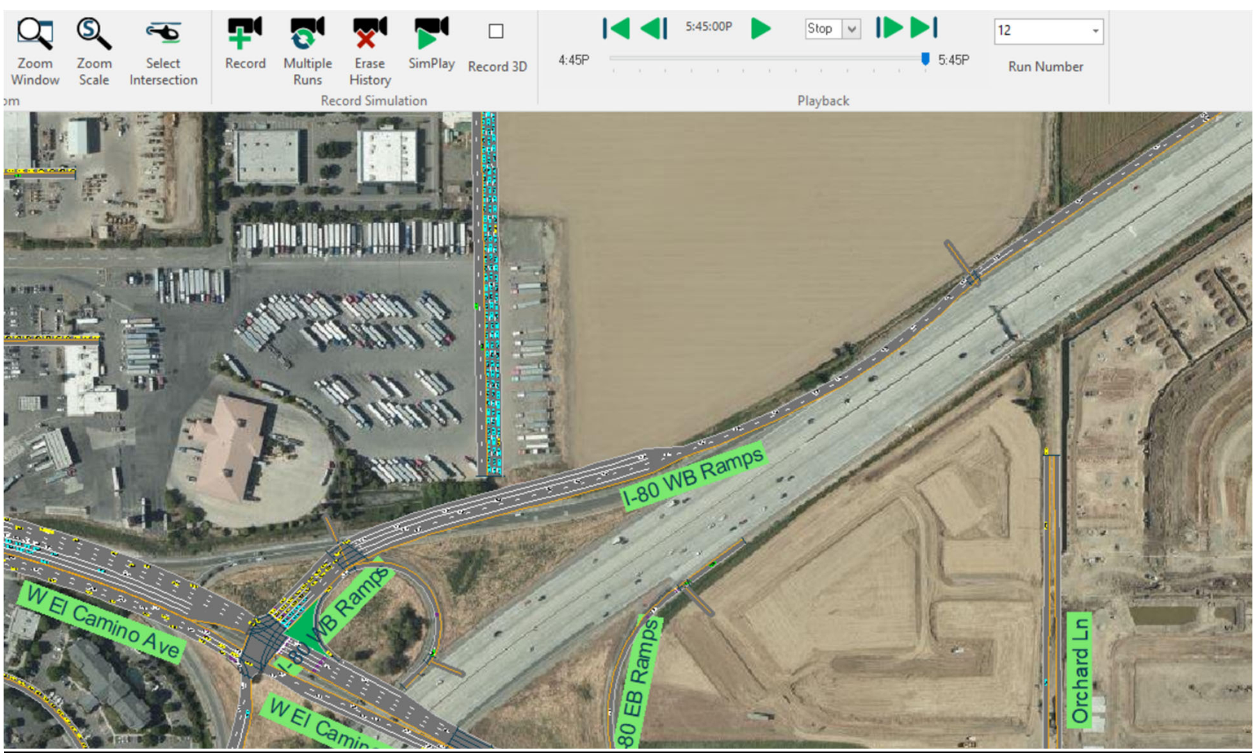
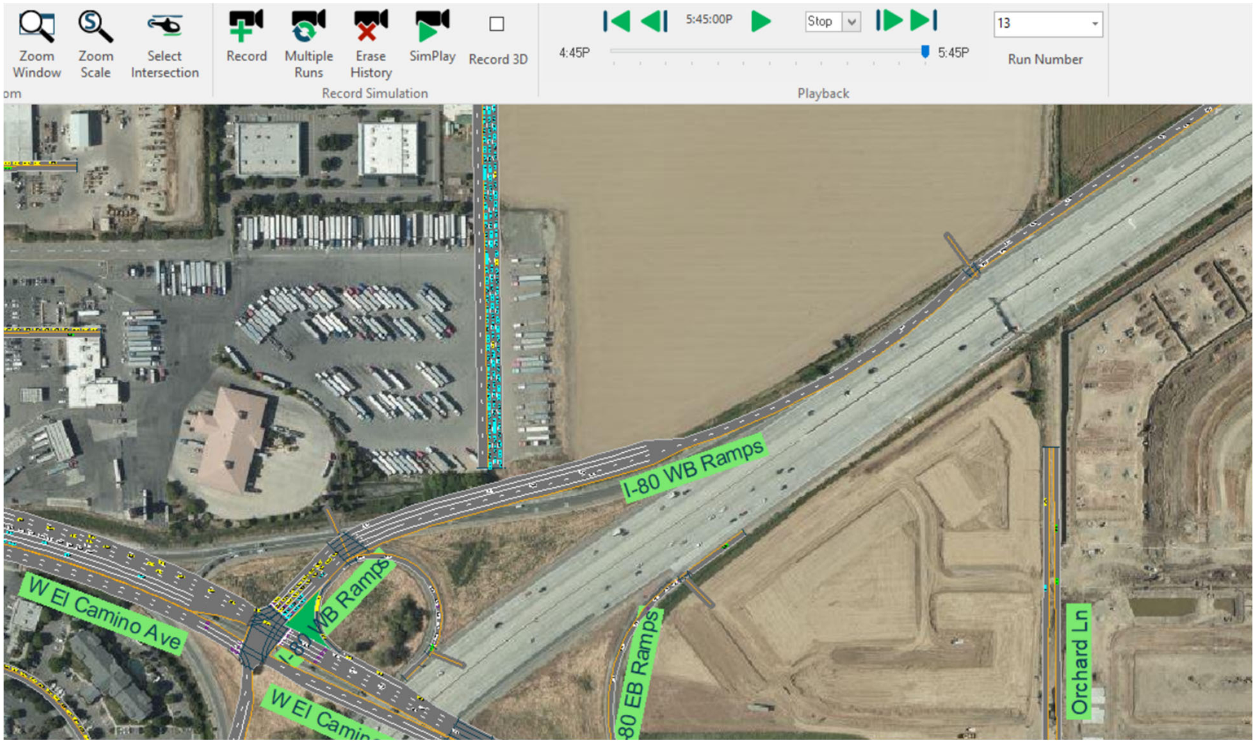
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
11
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
80 EB Ramps
Orchard Ln

Run 12



Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
12
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
80 EB Ramps
Orchard Ln

Run 13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Zoom Scale
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Erase History
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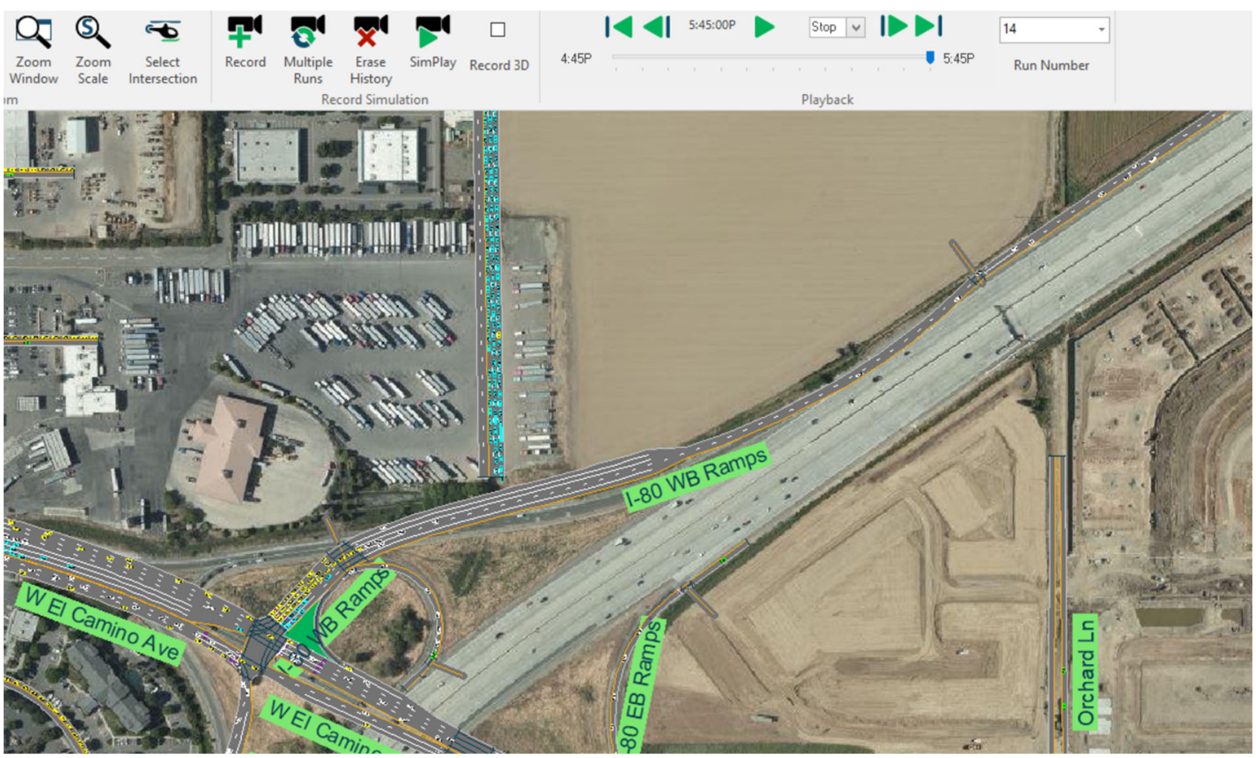
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
13
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
I-80 WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

Run 14


Zoom Window
Zoom Scale
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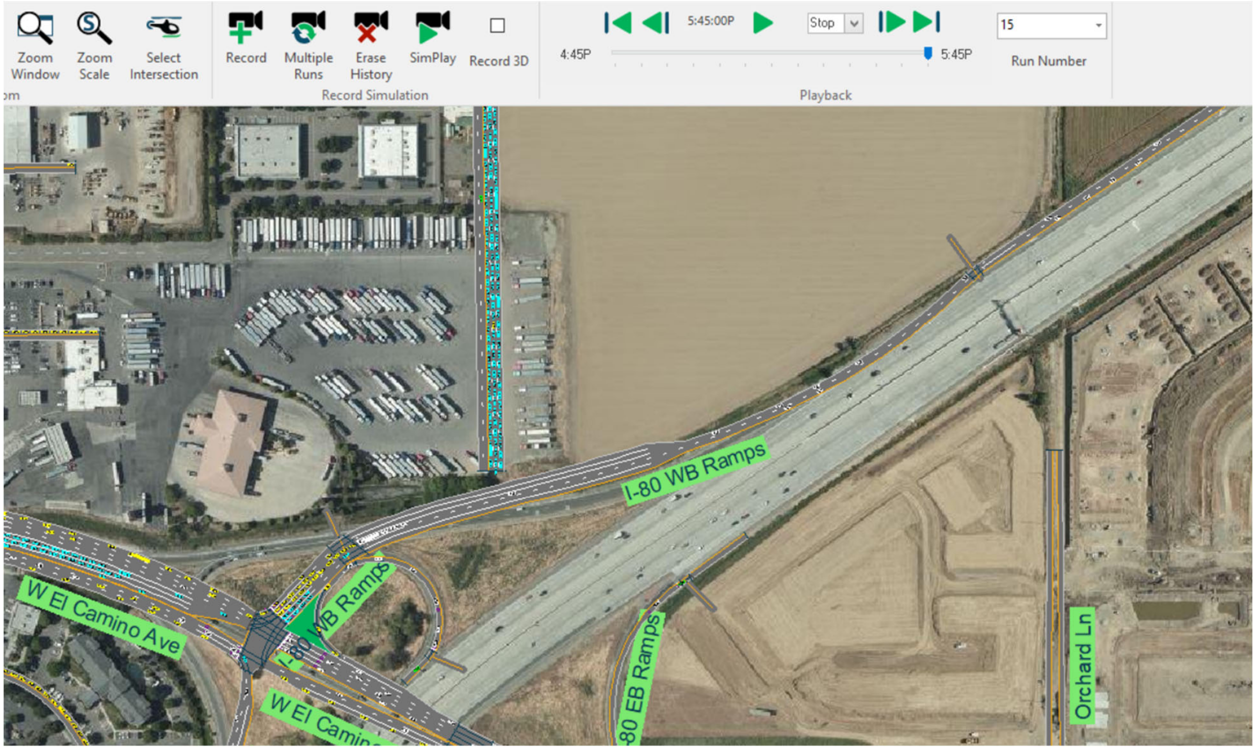
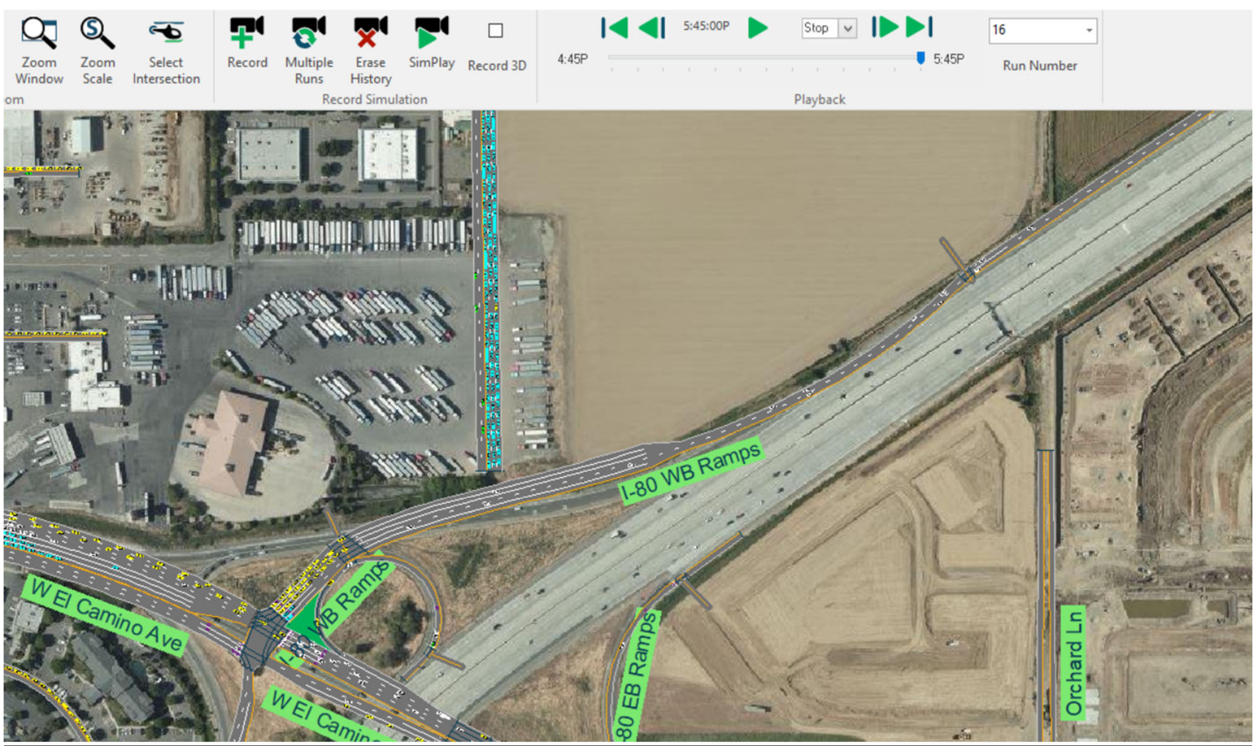
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
14
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
I-80 WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

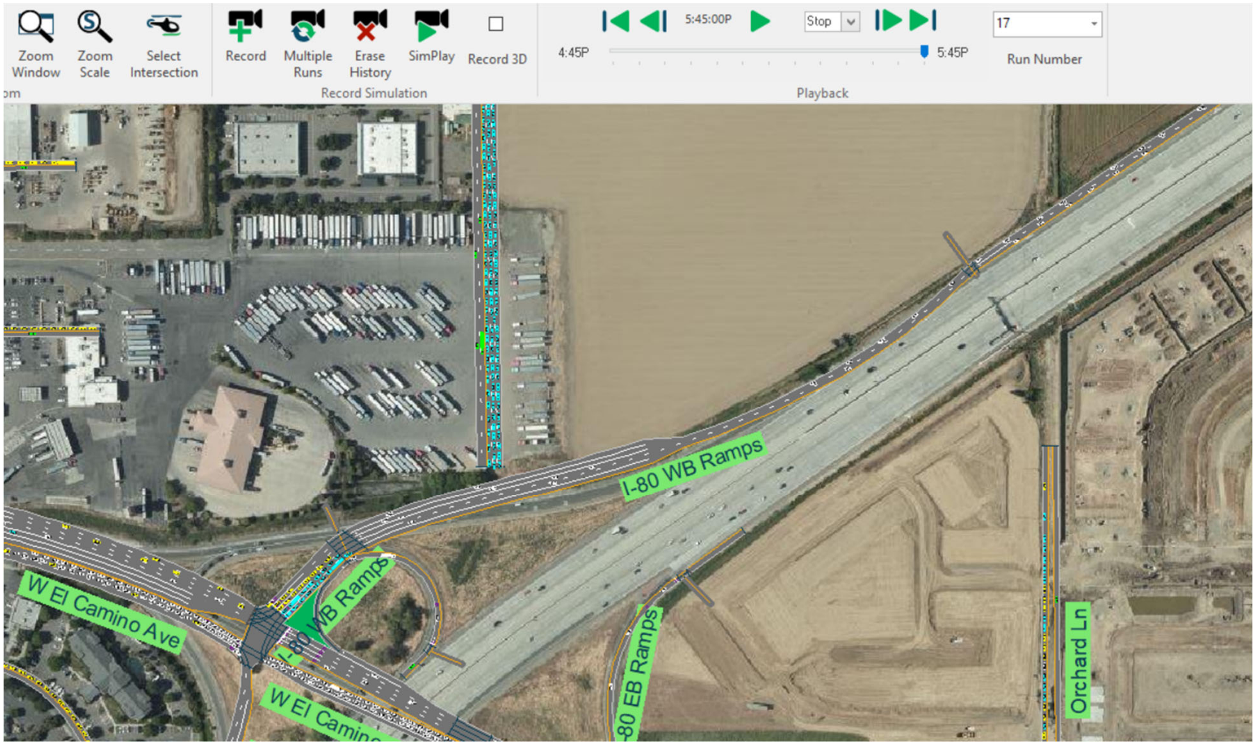
Run 15


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
15
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
WB Ramps
80 EB Ramps
Orchard Ln

Run 16


Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
16
Run Number
Playback
I-80 WB Ramps
W El Camino Ave
WB Ramps
80 EB Ramps
Orchard Ln

Run 17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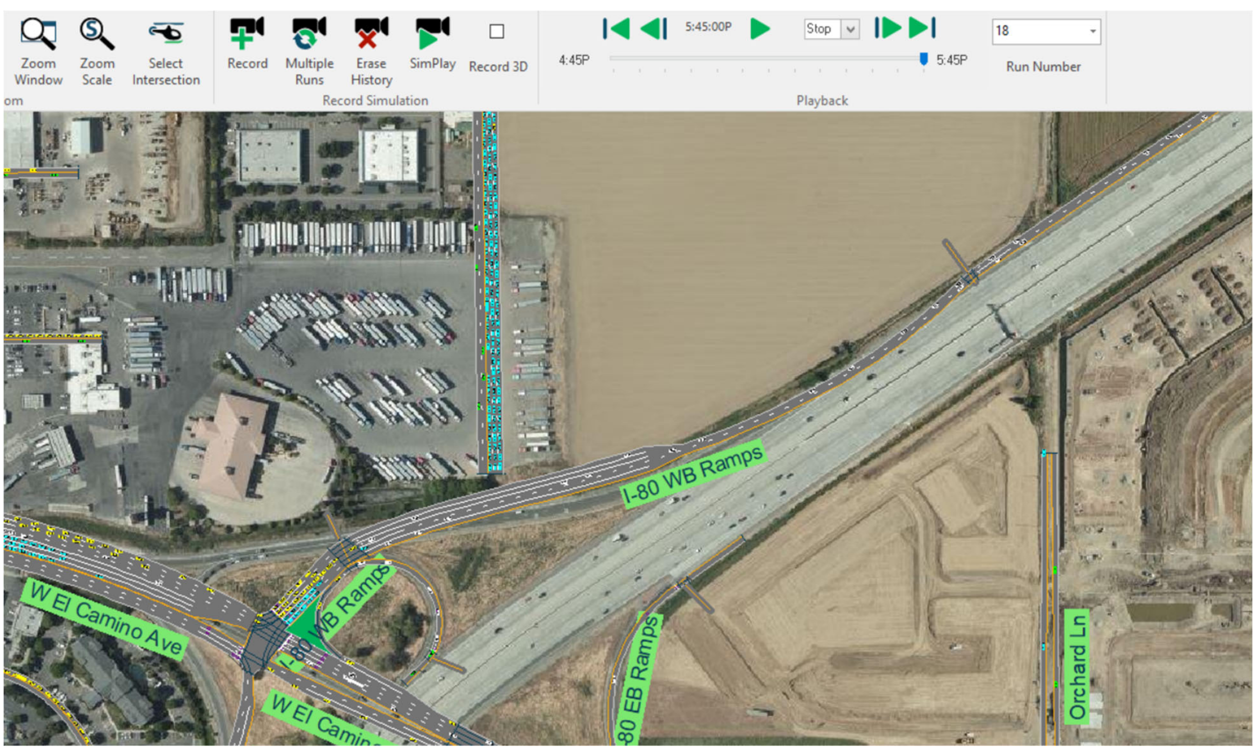
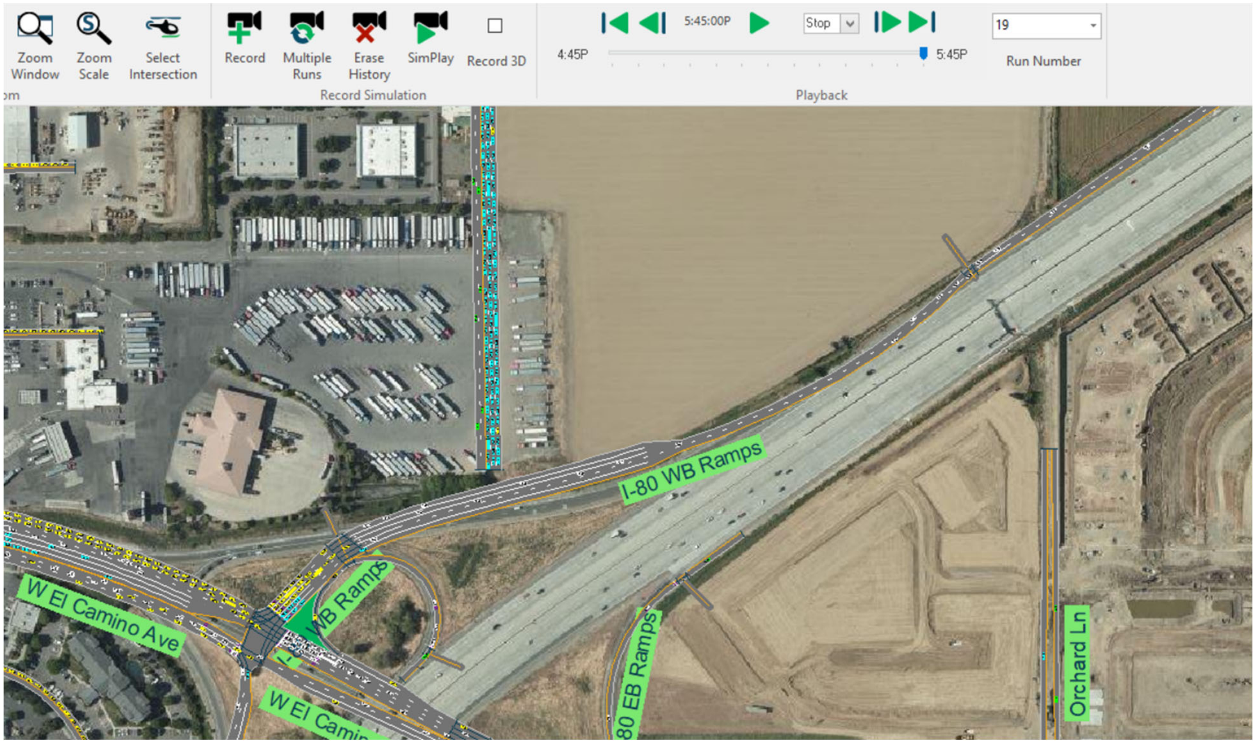
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
17
Run Number
I-80 WB Ramps
W El Camino Ave
I-80 WB Ramps
W El Camino
80 EB Ramps
Orchard Ln

Run 18

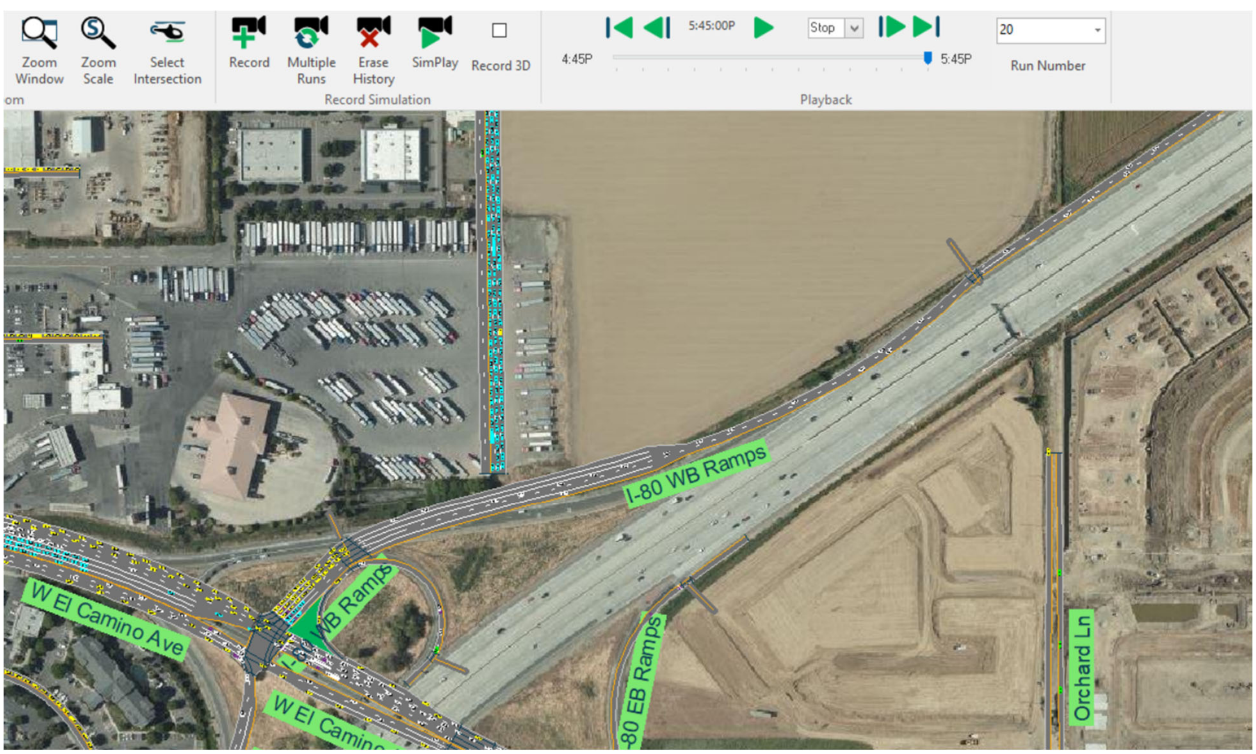

Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
18
Run Number
I-80 WB Ramps
W El Camino Ave
WB Ramps
W El Camino
80 EB Ramps
Orchard Ln

Run 19



Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
19
Run Number
I-80 WB Ramps
W El Camino Ave
WB Ramps
W El Camin
80 EB Ramps
Orchard Ln

Run 20



Zoom Window
Zoom Scale
Select Intersection
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
5:45:00P
Stop
4:45P
5:45P
Playback
20
Run Number
I-80 WB Ramps
W El Camino Ave
WB Ramps
W El Camino
80 EB Ramps
Orchard Ln