FINAL
REPORT

Central Avenue Safety Improvement Traffic Operations Analysis Report (TOAR)

Client: City of Alameda

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CDM Smith

Central Avenue Safety Improvement TOAR
Final Report

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Section 1
Introduction

This document is the Traffic Operations Analysis Report (TOAR) for the Central Avenue Safety Improvement Project (EA 1Q390K – ID 0418000261) in the City of Alameda in Alameda County, California. The Central Avenue Safety Improvement Project is identified as a high-priority project in the City's Transportation Choices Plan. The intersections of Central Avenue and Webster Street, Encinal Avenue/Sherman Street, Sixth Street, and Ninth Street were all identified in the top seven walking concern locations in the pedestrian and bicyclist public input survey conducted for the City of Alameda Pedestrian Plan. This project aims to improve safety, accessibility, and mobility through the corridor.

As part of the Project Initiation Document (PID) phase, a Transportation Engineering Performance Assessment (TEPA) report and Project Study Report-Project Development Support (PSR-PDS) report were prepared and approved by Caltrans in April 2020. This report documents the traffic operations analysis and safety assessment conducted for the PA&ED phase of the project.

1.1 Project Overview

The project extends for approximately 1.7 miles along Central Avenue from Encinal Avenue/Sherman Street (eastern limit) to Main Street/Pacific Street (western limit) (both directions). Central Avenue is an arterial route and a truck, transit, and bicycle priority route that provides access to multiple schools, Alameda Point, and ferry services. Central Avenue from Encinal Avenue/Sherman Street to Webster Street is within the California Department of Transportation's (Caltrans) right of way and designated as SR-61; the portion of the project from Webster Street to Main Street/Pacific Street is within the City of Alameda's right of way.

This project proposes to implement Complete Street elements to improve safety for pedestrians, bicyclists, and drivers, provide traffic calming, and provide multimodal access and regional bicycle and pedestrian facilities. A road diet would be implemented as part of the project to improve safety and create multimodal opportunities along Central Avenue. The project would include three new roundabouts, bicycle lanes and a two-way cycle track, shorter and higher visibility pedestrian crossings, accessible on-street parking, bike racks, signage, and bus stop improvements including bus stop boarding islands where needed.

Figure 1-1 shows the project location.

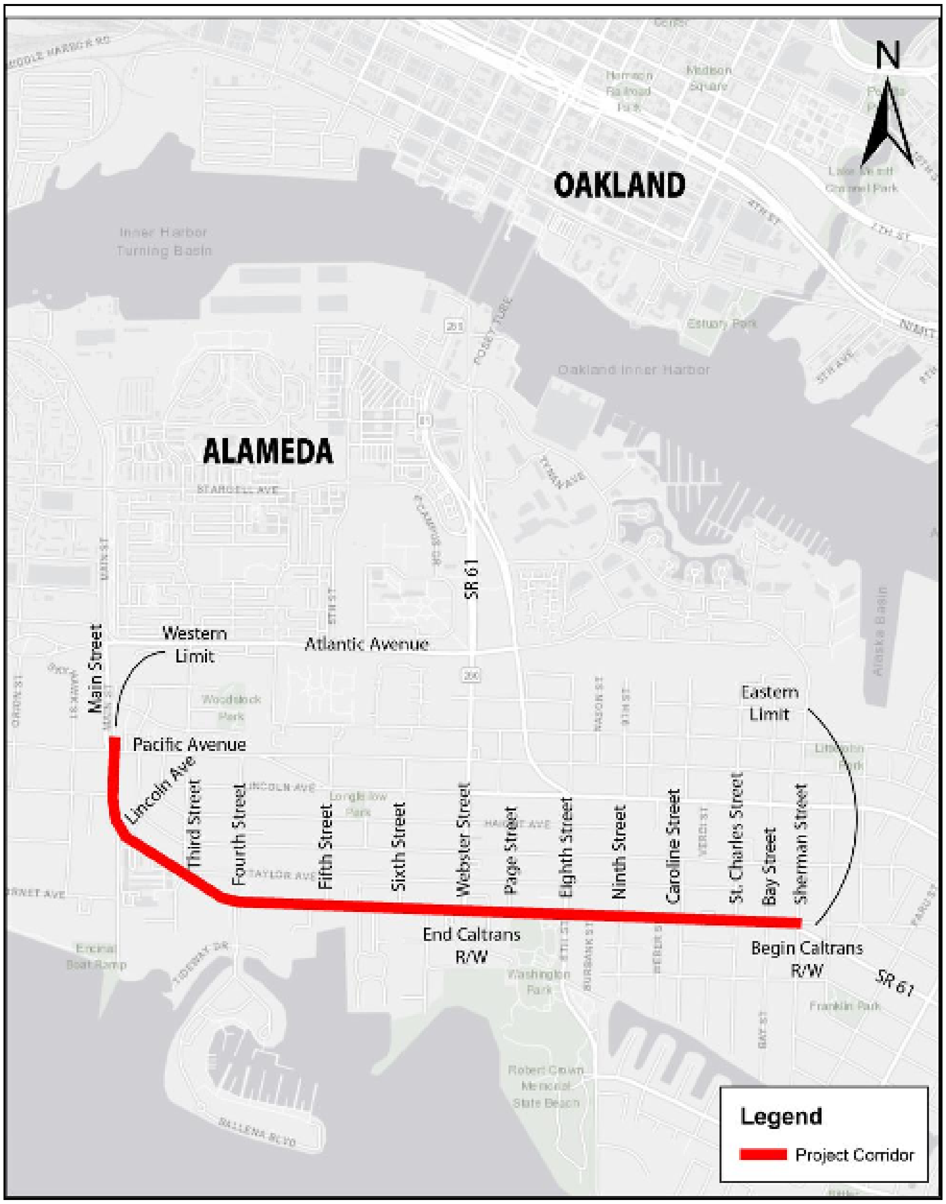

Figure 1-1
Project Location

1.2 Purpose of the Report

The purpose of this report is to document and present data collection, traffic volume development, traffic volume forecasting, traffic diversion analysis, existing and future year traffic analyses, and safety assessment for the Central Avenue Safety Improvement project. The following items are presented in this traffic and safety analysis report:

- Traffic counts collected as part of this project or from other sources
- Traffic analysis methodology

- Traffic volume development and forecasting
- Travel demand model outputs
- Traffic analyses for the existing year (2020) and future year (2045) conditions
- Crash history analysis and safety evaluation of proposed improvements

The report is organized as follows:

- Section 1 – Introduction
- Section 2 – Project Description
- Section 3 – Methodology
- Section 4 - Existing Year (2020) Traffic Operations
- Section 5 - Future Year (2045) Traffic Operations
- Section 6 – Parking Analysis
- Section 7 – Safety Assessment
- Section 8 - Conclusions

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Section 2

Project Description

This section presents the study area and describes the project to be evaluated in the traffic operations and safety analysis.

2.1 Study Area

For this PA&ED phase, the study intersections include seven intersections along Central Avenue already analyzed in the PID phase[1], and six additional intersections along Santa Clara Avenue and Lincoln Avenue (parallel streets for diversion analysis).

The thirteen study intersections are as follows:

1. Central Avenue at Main Street/Pacific Avenue
2. Central Avenue at Third Street/Taylor Avenue
3. Central Avenue at Fourth Street
4. Central Avenue at Fifth Street
5. Central Avenue at Webster Street
6. Central Avenue at Eighth Street
7. Central Avenue at Encinal Avenue/Sherman Street
8. Santa Clara Avenue at Webster Street
9. Santa Clara Avenue at Eighth Street
10. Santa Clara Avenue at Sherman Street
11. Lincoln Avenue at Webster Street
12. Lincoln Avenue at Eighth Street
13. Lincoln Avenue at Sherman Street

2.2 Existing / No Build / Build Conditions

The analysis covers the following conditions:

- **Existing Year (2020)** - Existing traffic volumes, existing geometry layouts and lane configurations.
- **Future Year (2045) No Build** - Future year traffic volumes (without diversion), existing geometry layouts and lane configurations. A refined version of the Alameda Countywide travel demand model for this project is utilized to estimate future traffic volume growth.
- **Future Year (2045) Build** - Future year traffic volumes (with diversion), proposed geometry layouts and lane configurations. The Build scenario reflects the proposed improvements along the study corridor

2.3 Project Description

The key design elements included in the project are as follows:

- **Road Diet**: Converting Central Avenue from four lanes to two lanes with a center two-way left-turn lane (TWLTL) between Third Street/Taylor Avenue and Encinal Avenue/Sherman Street (the proposed TWLTL extends to Lincoln Avenue, yet the segment between Lincoln Avenue and Third Street is a two-lane section currently).
- **Bicycle Facilities**: A Protected two-way cycle track, bike lane, or shared pedestrian/bicycle path along the study corridor between Pacific Avenue/Main Street and Encinal Avenue/Sherman Street (see **Table 2-1**).
- **Pedestrian Facilities**: Rectangular rapid flash beacon (RRFB), shorter crosswalk, pedestrian bulb-out curve, and high visibility crosswalk.
- **Roundabout**: Converting the Central Avenue intersections at Pacific Avenue/Main Street, Third Street/Taylor Avenue, and Encinal Avenue/Sherman Street to roundabouts.
- **Turn Storage Bay Improvement**: Turn storage bays are provided or extended at the signalized study intersections to accommodate turning movement queues.

Three bicycle treatment alternatives were initially considered, with different bicycle treatments through Webster Street and Eighth Street. A Preferred Alternative was selected for this analysis. The bicycle treatment at the study intersections under the Build scenario are shown in Table 2-1.

Table 2-1 Bicycle Treatment at Central Avenue Intersections under Build Scenario

Int ID	Intersection Name	Treatment
1	Main St/Pacific Ave	Two-way cycle track
2	Third St/Taylor Ave	Two-way cycle track
3	Fourth St	Two-way cycle track
4	Fifth St	Two-way cycle track
5	Webster St	Two-way cycle track
6	Eighth St	Two-way cycle track
7	Encinal Ave/Sherman St	Shared pedestrian/bicycle path

Source: Study team analysis

RRFBs are proposed to be installed at the following intersections along Central Avenue for pedestrians to cross Central Avenue:

- Central Ave & Lincoln Ave
- Central Ave & Sixth St (already existing)
- Central Ave & Page St
- Central Ave & Caroline St

All the crosswalks in the proposed design would be high-visibility crosswalks, while shorter crosswalks and pedestrian bulb-out curves are proposed to be installed at various locations along Central Avenue.

It is expected that with the road diet on Central Avenue in the Build scenario, some drivers will choose to travel on parallel streets such as Santa Clara Avenue and Lincoln Avenue. The refined Alameda Countywide travel demand model is used to estimate traffic diversion, as described in Section 5.

Section 3

Methodology

This section documents the methodology used to assemble the relevant traffic data, perform the traffic analysis (including volume development, volume forecasts, and development of traffic models), conduct the parking analysis, and perform the safety assessment.

3.1 Traffic Data Collection

3.1.1 Data Availability

Table 3-1 shows the study area turning movement counts that were available prior to the data collection effort undertaken for this PA&ED phase. Those counts had been collected for the City of Alameda for other projects.

Table 3-1 Intersection Turning Movement Counts Available Prior to the PA&ED Phase

Int ID	Intersection Name	2012	2014	2015	2016	2018	2019
1	Central Ave & Main St/Pacific Ave	•					
2	Central Ave & Third St/Taylor Ave			•			
3	Central Ave & Fourth St			•			
4	Central Ave & Fifth St			•			
5	Central Ave & Webster St			•		•	
6	Central Ave & Eighth St			•		•	
7	Central Ave & Encinal Ave/Sherman St	•			•	•	
8	Santa Clara Ave & Webster St			•			•
9	Santa Clara Ave & Eighth St		•				
10	Santa Clara Ave & Sherman St						
11	Lincoln Avenue & Webster St						•
12	Lincoln Ave & Eighth St						
13	Lincoln Ave & Sherman St						

Source: City of Alameda; Study team analysis

It was determined that counts from 2015 or older should not be used and therefore new counts were required as part of the PA&ED phase at Intersections 1 through 4, 9, 10, 12 and 13.

3.1.2 Traffic Counts

New traffic counts conducted for this PA&ED phase include AM and PM peak hour turning movement counts and approach average daily traffic (ADT) counts. Even though the traffic analysis focuses on the AM and PM peak hours, daily volumes were assembled to study the daily level of traffic at the intersections along Central Avenue and parallel streets.

The turning movement counts were conducted from 7:00 to 9:00 AM and from 4:00 to 6:00 PM, at 15-minute intervals at the following intersections (with intersection ID numbers).

1. Central Avenue at Main Street/Pacific Avenue
2. Central Avenue at Third Street/Taylor Avenue
3. Central Avenue at Fourth Street
4. Central Avenue at Fifth Street
9. Santa Clara Avenue at Eighth Street
10. Santa Clara Avenue at Sherman Street
12. Lincoln Avenue at Eighth Street
13. Lincoln Avenue at Sherman Street

The collected counts include vehicle classification by cars, heavy vehicles (buses, single-unit trucks, articulated trucks), bicycles, and pedestrians.

In addition, daily counts without classification were conducted at 15-minute intervals at the following intersections.

1. Central Avenue at Main Street/Pacific Avenue
5. Central Avenue at Webster Street
7. Central Avenue at Encinal Avenue/Sherman Street
8. Santa Clara Avenue at Webster Street (Santa Clara Avenue only)
11. Lincoln Avenue at Webster Street (Lincoln Avenue only)

3.2 Traffic Analysis

3.2.1 Traffic Volume Development

Existing (2020) Volumes

Historical counts and 2020 counts were used to develop the balanced turning movement volumes in the AM and PM peak hours for the study intersections. The highest one-hour volumes were identified for each intersection. The predominant one-hour intervals during the AM and PM periods are 7:30 AM to 8:30 AM and 5 PM to 6 PM, respectively. For intersections without 2020 counts, two years of historical counts were compared to derive the growth rates and estimate existing year volumes.

Future (2045) No Build Volumes

Traffic volume forecasts for the AM and PM peak hours in 2045 were derived from the updated Alameda Countywide travel demand model developed by Caltrans for the Encinal Avenue project. The model files from the Encinal Avenue project were provided to the study team by Caltrans.

Prior to its application for developing future No Build and Build volumes, the Alameda Countywide travel demand model was modified by the project team to add Fifth Street and Taylor Avenue, and split up the land uses (transportation analysis zones) served by these two added streets.

The Alameda Countywide travel demand model years are 2020 and 2040. The difference between 2020 and 2040 model volume outputs was applied to the existing volumes to develop future turning movement volumes at the study intersections. The 2040 volumes were then further extrapolated to derive the 2045 volumes.

Future (2045) Build Volumes

For the future Build scenario, the Alameda Countywide travel demand model was refined and rerun to reflect the Build scenario roadway characteristics. A traffic diversion analysis was performed by reviewing traffic diversion predicted by the Alameda Countywide travel demand model as well as reasonableness check on the congestion levels at the study intersections on parallel routes including Santa Clara Avenue and Lincoln Avenue.

Even though there is no study intersection on Taylor Avenue (just north of and parallel to Central Avenue), the impact of potential diverted traffic on Taylor Avenue was assessed qualitatively.

3.2.2 Traffic Analysis Methodology and Models

Intersection delay and level of service (LOS) based on the Highway Capacity Manual (HCM) methodology were used as the metrics for traffic operations analysis. Delay is the average delay experienced by a vehicle. LOS is a qualitative measure representing the operating conditions of a transportation facility. LOS ratings range from A to F, with LOS A representing free flow conditions with minimal or no delay, while LOS F representing forced flow with heavy congestion and queues failing to clear. The LOS criteria for signalized and unsignalized intersections from the HCM, Sixth Edition are shown in **Table 3-2**.

Table 3-2 LOS Criteria for Signalized and Unsignalized Intersections

LOS	Average Control Delay (sec/veh)	
	Signalized	Unsignalized
A	0 - 10	0 - 10
B	> 10 - 20	> 10 – 15
C	> 20 - 35	> 15 – 25
D	> 35 - 55	> 25 – 35
E	> 55 - 80	> 35 – 50
F	> 80	> 50

Source: Highway Capacity Manual, Sixth Edition

The Synchro traffic analysis software (version 10) was used to analyze traffic operations at the study intersections. Traffic volumes developed as described in the previous section were imported into the Synchro models. Signal phasing and timings were based on the signal timing sheets provided by the City of Alameda to reflect actual operations under Existing conditions. In the future No Build and Build scenarios, splits were optimized using the Synchro optimization function. In the Build scenario, the signalization control type of the study intersection along the Central Avenue corridor was set to "actuated-coordinated", and offsets were further optimized to ensure coordination between intersections. The control type of the study intersections in the Existing/2045 No Build and 2045 Build scenarios is shown in **Table 3-3**.

Table 3-3 Intersection Control Type Comparison

ID	Location	Existing/ 2045 No Build	2045 Build
1	Central Ave at Main St/Pacific Ave	Signalized	Roundabout
2	Central Ave at Third St/Taylor Ave	Side-Street Stop	Roundabout
3	Central Ave at Fourth St	Signalized	Signalized
4	Central Ave at Fifth St	All-Way Stop	All-Way Stop
5	Central Ave at Webster St	Signalized	Signalized
6	Central Ave at Eighth St	Signalized	Signalized
7	Central Ave at Encinal Ave/Sherman St	Signalized	Roundabout
8	Santa Clara Ave at Webster Street	Signalized	Signalized
9	Santa Clara Ave at Eighth St	Signalized	Signalized
10	Santa Clara Ave at Sherman St	All-Way Stop	All-Way Stop
11	Lincoln Ave at Webster St	Signalized	Signalized
12	Lincoln Ave at Eighth St	Signalized	Signalized
13	Lincoln Ave at Sherman St	Signalized	Signalized

Source: Study team analysis

In general, the reported delay is based on the HCM Sixth Edition methodology. When the HCM Sixth Edition methodology is not applicable due to its limitations for certain geometry, lane configuration, or signal phasing, the reported delay is instead based on the HCM 2000 methodology. The proposed roundabouts in the Build scenario were also coded and analyzed in Synchro. The reported delay is based on the HCM Sixth Edition methodology for roundabouts.

In general, the average delay is reported for the entire intersection, except at one side-street stop-controlled intersection: Third Street under existing conditions. In this case, the delay of the worst stop-controlled side street approach is reported. In addition to average intersection delays, the 95th-percentile queue lengths for lane groups at the signalized intersections are also reported from Synchro to analyze the congestion level for each intersection approaches and evaluate the required turn storage length.

The Synchro models developed in the previous PID phase were updated with the new volumes and revised design layouts to analyze traffic conditions for the study intersections along Central Avenue. In addition, intersections along Santa Clara Avenue and Lincoln Avenue were added to the Synchro models for the diversion analysis.

For corridor travel time analysis, SimTraffic models were developed based on Synchro models for the PM peak hour. The SimTraffic existing PM model was calibrated by checking vehicle throughput and comparing the reported corridor travel time against typical weekday travel time as reported by Google Maps. Travel times along Central Avenue between Pacific Avenue/Main

Street and Webster Street and between Webster Street and Sherman Street/Encinal Avenue were evaluated with SimTraffic.

3.3 Parking Analysis

The availability of on-street parking was analyzed by comparing the approximate number of parking spaces on major blocks available between the No Build conditions and the Build alternative.

3.4 Safety Assessment

The safety assessment includes an evaluation of the crash history along the study corridor, and an analysis of the anticipated impact of the proposed improvements.

3.4.1 Crash History

Historical crash data was assembled from two sources – Caltrans TASAS accidents reports and City of Alameda's police reports.

Caltrans TASAS Data

The crash and roadway records from California State's Traffic Accident Surveillance and Analysis System (TASAS) were collected and compiled for the 5-year period from 01/01/2014 to 12/31/2018 for the SR-61 portion of the study corridor (Central Avenue from Sherman Street/Encinal Avenue to Webster Street).

Crash rates, crash severity, and crash type were analyzed.

City of Alameda's Police Reports

An additional crash dataset from the police reports was provided by the City of Alameda. It includes crashes along the entire corridor (including those within Caltrans ROW) from 01/01/2009 to 12/31/2018. Crash severity, crash type, and contributing factor for the crashes during a 5-year period from 01/01/2014 to 12/31/2018 were analyzed.

3.4.2 Safety Evaluation of Proposed Improvements

The anticipated safety impact of the proposed improvements (road diet, pedestrian crossing features, bicycle facilities, and roundabouts) was evaluated based on the Highway Safety Manual[2] (HSM)'s method for estimating the safety effectiveness of a proposed project. The method is described as Method 4 under Section C.7 of the manual.

The method starts with observed crash frequency under existing condition, and then applies an appropriate crash modification factor (CMF) from Part D of the HSM to derive the estimated expected average crash frequency for the proposed improvement.

Section 4

Existing Year (2020) Traffic Operations

This section documents the development of existing year traffic volume, the calibration of Synchro/SimTraffic models, and the results of the traffic operations analysis under existing conditions for the AM and PM peak hours.

4.1 Traffic Volumes

4.1.1 AM and PM Peak Hour Volumes

As mentioned in Section 3.1.1, 2020 counts were not available at all study intersections. In absence of 2020 counts, two years of historical counts were used to derive 2020 volumes from older counts by estimating annual average growth rates. This happened at three intersections: Central Avenue & Webster Street, Central Avenue & Eighth Street, and Central Avenue & Encinal Avenue/Sherman Street. At these locations, compound annual growth rates (CAGRs) for two approaches on one roadway were averaged to derive the total CAGR for that roadway, unless the CAGR for one of the approaches was significantly different. If historical counts showed declining volumes, no growth was applied.

For the Central Avenue & Webster Street intersection, 2015 and 2018 counts along Central Avenue and Webster Street were compared to derive the CAGRs. The Central Avenue CAGR was also used for the Santa Clara Avenue approaches at Webster Street and Lincoln Avenue at Webster Street.

For the Central Avenue & Eighth Street intersection, the 2016 and 2018 counts along Central Avenue were compared to derive the CAGR in the AM peak hour; and, 2012 and 2018 counts were used to derive the CAGR for Eighth Street intersection because the 2016 count on the northbound approach of Eighth Street appeared to be an anomaly. In the PM peak hour, 2012 and 2018 counts along Central Avenue and Eighth Street were compared to derive the CAGRs.

For the Central Avenue & Encinal Avenue/Sherman Street intersection, 2015 and 2018 counts along Central Avenue/Encinal Avenue and Sherman Street were compared to derive the CAGRs

Table 4-1 shows the growth rates used to grow historical volumes to 2020 volumes for the intersection approaches.

Table 4-1 Growth Rates from Historical to Existing Year

Location	From Historical Year	To Existing Year	AM CAGR	PM CAGR
Central Ave at Webster St	2018	2020	3%	0%
Central Ave at Eighth St	2018	2020	3%	1%
Central/Encinal Ave at Sherman	2018	2020	4%	1%
Webster St at Central Ave	2018	2020	5%	3%
Eighth St at Central Ave	2018	2020	0%	0%
Sherman St at Central Ave	2018	2020	3%	0%
Santa Clara Ave at Webster St	2019	2020	3%	0%
Webster St at Santa Clara Ave	2019	2020	5%	3%
Lincoln Ave at Webster St	2019	2020	3%	0%
Webster St at Lincoln Ave	2019	2020	5%	3%

Source: Study team analysis

A reasonableness check was performed to review the volume differences between two adjacent intersections. Due to the presence of driveways, streets, and school entrances/exits, upstream and downstream volumes do not necessarily have to match between two intersections.

Conflicting bicycle and pedestrian volumes, peak hour factors, and heavy vehicle percentages were also identified from the turning movement counts for the study intersections and coded into the Synchro models. The only exception is heavy vehicle percentages at the study intersection for which no turning movement count was conducted in 2020. For the intersections of Central Avenue & Webster Street, Central Avenue & Eighth Street, and Central Avenue & Encinal Avenue/Sherman Street, two percent was used based on reviewing the heavy vehicle percentages at the SR 61 locations on 2016 Caltrans Truck Traffic Book. For the Santa Clara Avenue & Webster Street and Lincoln Avenue & Webster Street intersection approaches, truck percentages from adjacent intersections were used. The resulting 2020 AM and PM peak hour volumes are shown in **Figure 4-1**.

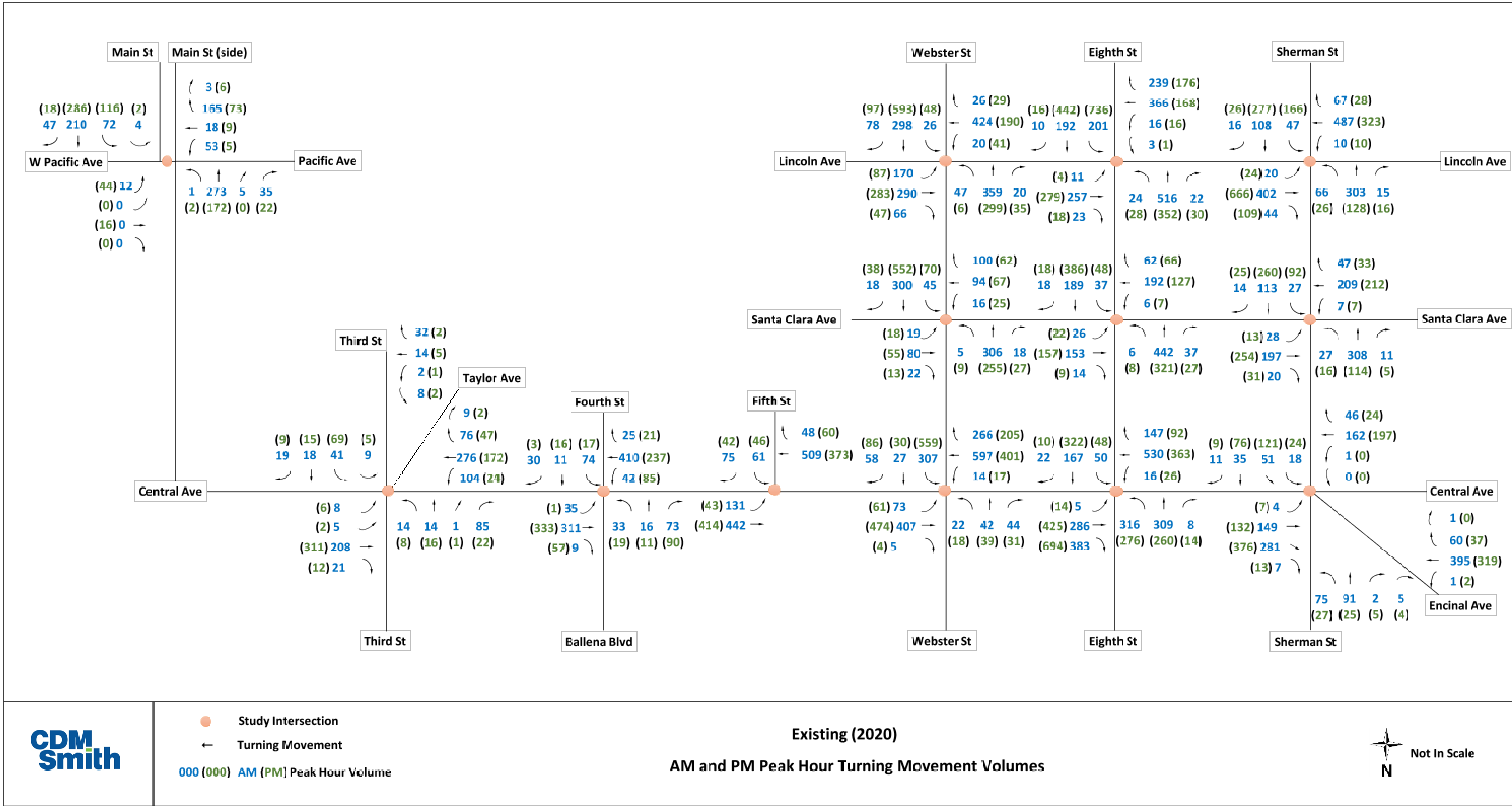

Figure 4-1
Existing Year AM and PM Peak Hour Volumes

4.1.2 Daily Volumes

In order to analyze daily congestion levels at key intersections along Central Avenue, Santa Clara Avenue and Lincoln Avenue, daily approach volumes were collected as part of this project at the following intersections (with intersection ID):

1. Central Avenue & Pacific Avenue/Main Street
5. Central Avenue& Webster Street
7. Central Avenue & Encinal Avenue/Sherman Street
8. Webster Street & Santa Clara Ave (eastbound and westbound only)
11. Webster Street & Lincoln Avenue (eastbound and westbound only)

In addition, northbound and southbound segment counts on Webster Street north of Lincoln Avenue and north of Central Avenue were available from the Webster Street Signal Coordination project.

The daily volumes at these locations are shown in **Figure 4-2**.

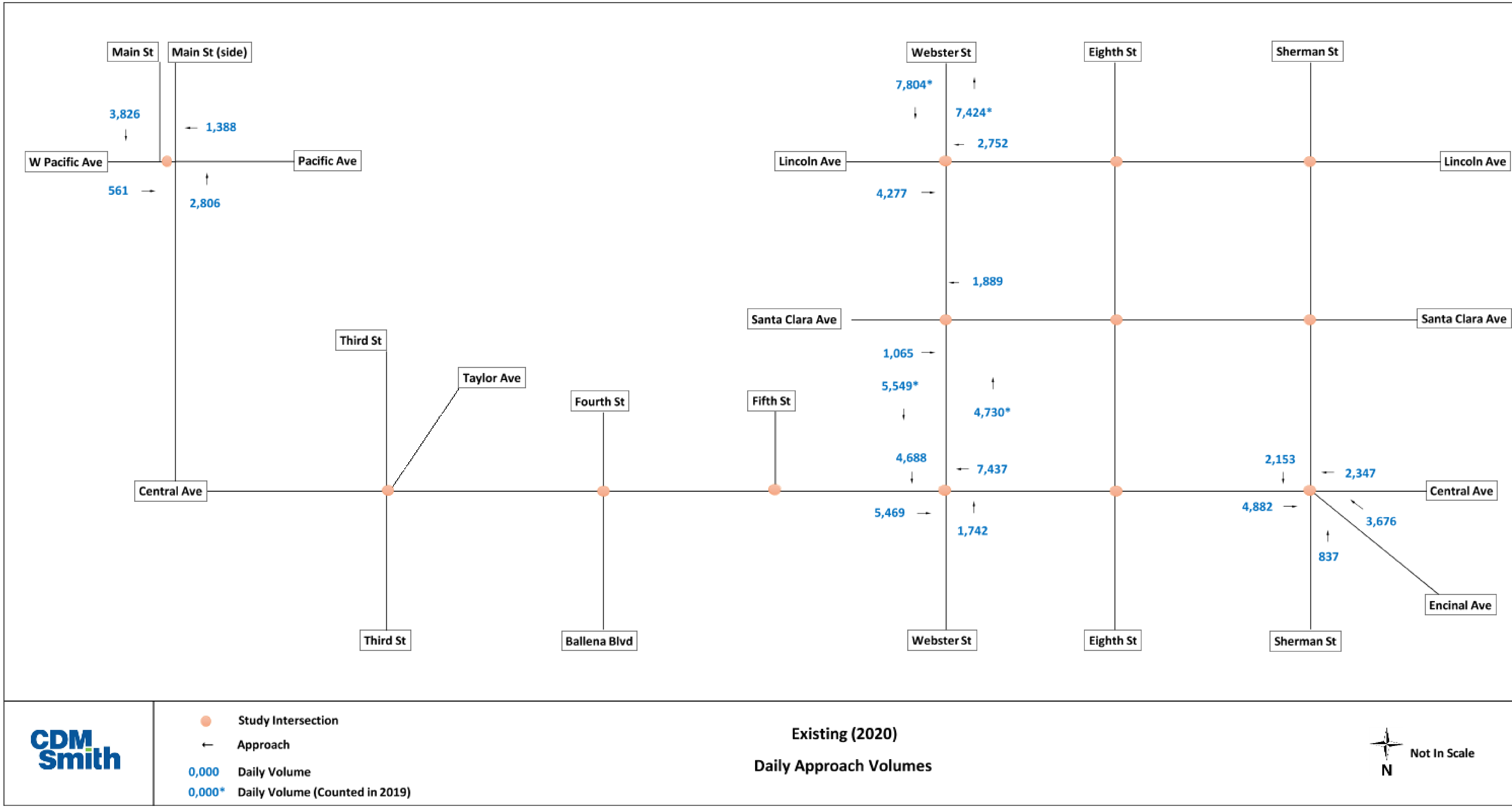

Figure 4-2
Existing Year Daily Volumes

For a four-lane urban street, the LOS thresholds recommended in the Highway Capacity Manual[1] are shown in **Table 4-2**. The daily volumes at key intersections along Central Avenue and Webster Street and the resulting LOS are shown in **Table 4-3**. All these locations operate at LOS C at the daily level.

Table 4-2 LOS Thresholds for Urban Four-Lane Urban Street Facilities

K-Factor	D-Factor	LOS B	LOS C	LOS D	LOS E
Posted Speed = 30 mph*					
0.10*	0.55*	NA	2,000	22,300	32,200

*Only 30 mph and 45 mph are available. 30 mph was used (closest to the posted speed limit of 25 mph on the study corridor)

**K-Factor is the proportion of AADT that occurs during the peak hour; a value of 0.10 was assumed. D-Factor is the proportion of traffic moving in the peak direction of travel on a given roadway during the peak hour; a value of 0.55 was assumed.

Source: Exhibit 16-16 of Highway Capacity Manual, Sixth Edition

Table 4-3 Daily Volumes and LOS for Key Intersections on Central Avenue and Webster Street

Location	Number of Lanes	Existing Daily Volume*	Level of Service*
Central Ave/Main St at Pacific Ave	4	6,632	C
Central Ave at Webster St	4	12,906	C
Central Ave/Encinal Ave at Sherman St	4	8,558	C
Webster St between Santa Clara Ave and Central Ave	4	10,279	C
Webster St north of Lincoln Ave	4	15,228	C

*Approach volumes on both sides added for an intersection location

Source: Study team analysis

4.2 Model Calibration

The level of calibration of the SimTraffic model for existing PM peak hour conditions was checked against criteria provided by FHWA in the Guidelines for Applying Traffic Microsimulation Modeling Software[3]. Those calibration criteria focus on volume throughput and corridor travel times.

4.2.1 Volume Throughput

The intersection turning movement volumes from the SimTraffic reports (output) were compared to the developed volumes (input) for each movement for volume throughput check. The calibration criteria for volume throughput are as follows:

- GEH Statistic < 5 for Individual Link Flows, > 85% of cases
- Sum of All Link Flows, within 5% of sum of all link counts

Individual turning movement volumes are treated as individual links in this check. **Table 4-4** shows the summary of the volume throughput check for the existing PM SimTraffic model. Both criteria were met. The detailed numbers are shown in **Appendix B**.

Table 4-4 Volume Throughput Calibration Summary

Calibration Criterion	Result	Meeting the Criteria?
Percent cases with GEH statistic < 5	99%	Yes
Difference in Sum of all flows	2%	Yes

Source: Study team analysis

4.2.2 Corridor Travel Time

Eastbound and westbound travel times across the Central Avenue corridor were collected from SimTraffic's arterial reports based on five simulation runs. They were compared to typical weekday PM peak hour travel time from Google Maps. The FHWA's calibration criteria for travel time is as follows:

- Travel Times, Model Versus Observed Journey Times, Network: Within 15% (or 1 min, if higher), > 85% of cases

Google Maps provides a range of travel time estimates, rather than one average travel time. Both the eastbound and westbound travel times from SimTraffic output meet the FHWA calibration criterion when compared to the travel time upper limits. **Table 4-5** shows the summary of the travel time check for the existing PM SimTraffic model. The SimTraffic arterial report is shown in **Appendix A**.

Table 4-5 Travel Time Calibration Summary

Corridor Segment	Distance (mi)	Google Maps Travel Time Lower Limit (sec)	Google Maps Travel Time Upper Limit (sec)	SimTraffic Output (sec)	Meeting the Criteria?
Central Ave Eastbound from Main St/Pacific Ave to Sherman St	1.7	300	540	554	Yes
Central Ave Westbound from Sherman St to Main St/Pacific Ave	1.7	240	480	487	Yes

Source: Study team analysis

4.3 Traffic Operations Analysis

This section presents the traffic operations analysis results from the Synchro/SimTraffic study. Intersection delay and LOS for each study intersection and 95th-percentile queue length for each lane group at the study intersections are reported from the Synchro models. The travel times along Central Avenue between Webster Street and Sherman Street/Encinal Avenue during the PM peak hour are reported using SimTraffic.

4.3.1 Intersection Operating Conditions

Because this is not a demand-inducing project, the Vehicle Miles Traveled (VMT) at the regional level is not expected to change. Therefore, LOS analysis is used to see how traffic operates at the study intersections and along the study corridor in scenarios with and without the proposed improvements, instead of VMT analysis for this project.

The intersection control types and operating conditions for the existing year (2020) scenario are summarized in **Table 4-6**. The Synchro reports with delay/LOS reports are shown in **Appendix B**.

Table 4-6 Intersection Delay and LOS Summary for Existing Year (2020)

ID	Location	Control Type	AM Peak Hour		PM Peak Hour	
			Delay (sec)	LOS	Delay (sec)	LOS
1	Central Ave at Main St/Pacific Ave	Signalized	77.6	E	115.2	F
2	Central Ave at Third St/Taylor Ave	Side-Street Stop	76.6 (SB)*	F	27.8 (SB)*	D
3	Central Ave at Fourth St	Signalized	10.2	B	9.3	A
4	Central Ave at Fifth St	All-Way Stop	17.6	C	11.1	B
5	Central Ave at Webster St	Signalized	120.4	F	113.9	F
6	Central Ave at Eighth St	Signalized	46.3	D	206.9	F
7	Central Ave at Encinal Ave/Sherman St	Signalized	22.7	C	22.3	C
8	Santa Clara Ave at Webster St	Signalized	10.7	B	7.8	A
9	Santa Clara Ave at Eighth St	Signalized	16.2	B	19.5	B
10	Santa Clara Ave at Sherman St	All-Way Stop	19.2	C	18.3	C
11	Lincoln Ave at Webster St	Signalized	14.2	B	10.3	B
12	Lincoln Ave at Eighth St	Signalized	23.7	C	18.5	B
13	Lincoln Ave at Sherman St	Signalized	13.0	B	16.9	B

Source: Study team analysis

*Side-street stop-controlled intersection. Worst delay of the stop-controlled approaches (southbound in this case) is reported.

In the AM peak hour, the Central Avenue & Third Street/Taylor Avenue intersection operates at LOS F. This is a side-street stop-controlled intersection. The long delay occurring on the southbound approach is primarily a result of heavy pedestrian volumes crossing the north and west crosswalks during the AM peak hour. The Central Avenue & Webster Street intersection also operates at LOS F; delays for the eastbound and westbound approaches are high. The Central Avenue & Main Street/Pacific Avenue intersection operates at LOS E while the Central Avenue &

Eighth Street intersection operates at LOS D. All other intersections operate at LOS C or better during the AM peak hour.

In the PM peak hour, the highest overall delay occurs at the Central Avenue & Eighth Street intersection, with a delay of over 200 seconds (LOS F). At the movement level, the highest delay was found to occur on the eastbound-right turn movement, with a delay of over 600 seconds. Other intersections operating at LOS F are the Central Avenue & Main Street/Pacific Avenue and Central Avenue & Webster Street intersections, both with a delay of over 100 seconds. The southbound approach of the Central Avenue & Third Street/Taylor Avenue stop-controlled intersection operates at LOS D. All other intersections operate at LOS C or better during the PM peak hour.

4.3.2 Queuing Analysis

The 95th-percentile queue lengths are reported from the Synchro models for the signalized intersections. **Table 4-7** summarizes the 95th-percentile queue lengths during the AM and PM peak hours and can be compared with the available turning bay storage length (where available, measured in Google Earth) at the study intersections. The queue lengths that exceed storage lengths are highlighted in red. The Synchro queuing reports are shown in **Appendix A**.

Within the study area, the longest queues are observed at the Central Avenue & Eighth Street intersection. In the AM peak hour, the westbound-through movement queue length is over 300 feet, while the northbound-left and northbound-through queues are over 200 feet long. In the PM peak hour, the southbound-through queue is over 300 feet, while the eastbound-right queue is close to 300 feet. Note that the eastbound-right storage length is significantly shorter than the queue length in the PM peak hour, and the northbound-left storage length is significantly shorter than the queue length in both AM and PM peak hours.

At the Lincoln Avenue & Eighth Street intersection outside the Central Avenue corridor, the southbound-left movement queue length is over 300 feet in the PM peak hour and exceeds the storage length of 200 feet. This is a movement with heavy left-turn traffic; dual left turn lanes are available at this location.

Table 4-7 95th-Percentile Queue Lengths (in feet) at Signalized Intersections (2020)

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NWL
1. Central Ave at Main St/Pacific Ave													
Storage Length													
AM		21			86	94		254	0	141	216		
PM		122			28	18		158	0	232	268		
3. Central Ave at Fourth St													
Storage Length	50			95									
AM	43	84		53	118			42	18		74		
PM	5	101		110	66			31	30		31		
5. Central Ave at Webster St													
Storage Length													
AM		343			567			117		153	138		
PM		428			407			95		351	338		
6. Central Ave at Eighth St													
Storage Length			100				85						
AM		122	71		351		248	244			199		
PM		174	270		191		215	208			346		
7. Central Ave at Encinal Ave/Sherman St													
Storage Length		50											
AM		109	38		144			129			91		104
PM		99	52		154			53			227		96
8. Santa Clara Ave at Webster Street													
Storage Length													
AM		55			83			57			78		
PM		43			62			49			44		
9. Santa Clara Ave at Eighth St													
Storage Length													
AM		93			117			260			126		
PM		115			108			223			314		
11. Lincoln Ave at Webster St													
Storage Length	165			140									
AM	132	61		15	86			104			72		
PM	46	58		26	41			91			150		
12. Lincoln Ave at Eighth St													
Storage Length										200			
AM		108			206			246		90	192		
PM		125			88			193		345	547		
13. Lincoln Ave at Sherman St													
Storage Length	60												
AM	12	60			75			250			86		
PM	12	105			50			85			350		

Source: Study team analysis

Note:
1. Storage length information is provided for all approaches where turn bays are available. When there is no turn bay, the cell is left blank.
Unit: feet

4.3.3 Corridor Travel Times

The corridor travel times in the eastbound and westbound directions along Central Avenue between Pacific Avenue/Main Street and Webster Street (City of Alameda portion) and between Webster Street and Sherman Street/Encinal Avenue (Caltrans portion) were reported from the SimTraffic existing PM model. The results of five runs were averaged and are shown in **Table 4-8**. It takes approximately three to five minutes to travel between Pacific Avenue/Main Street and Webster Street, and between Webster Street and Encinal Avenue/Sherman Street during the PM peak hour. The travel time along the entire Central Avenue is approximately eight to nine minutes. The full SimTraffic arterial report is provided as **Appendix A** to this report.

Table 4-8 Corridor Travel Time

Direction	Corridor Segment	Distance (mi)	SimTraffic Output (min)
Eastbound	From Pacific Ave/Main St to Webster St	1.0	5.2
	From Webster St to Encinal Ave/ Sherman St	0.7	4.1
	Total	**1.7**	**9.2**
Westbound	From Encinal Ave/ Sherman St to Webster St	0.7	5.1
	From Webster St to Pacific Ave/Main St	1.0	3.0
	Total	**1.7**	**8.1**

Source: Study team analysis

Section 5

Future Year (2045) Traffic Operations

This section documents the development of future year (2045) traffic volumes, development of the Synchro/SimTraffic models and the results of the traffic operations analysis under future year No Build and Build conditions for the AM and PM peak hours.

5.1 Traffic Volumes

5.1.1 2045 No Build Volumes

As mentioned in Section 3.2.1, the difference between 2020 and 2040 No Project volumes from the Alameda Countywide travel demand model outputs was applied to the existing volumes to develop future turning movement volumes at the study intersections. The resulting 2040 turning movement volumes were then further extrapolated to derive the 2045 volumes.

The resulting 2045 No Build AM and PM peak hour volumes are shown in **Figure 5-1**.

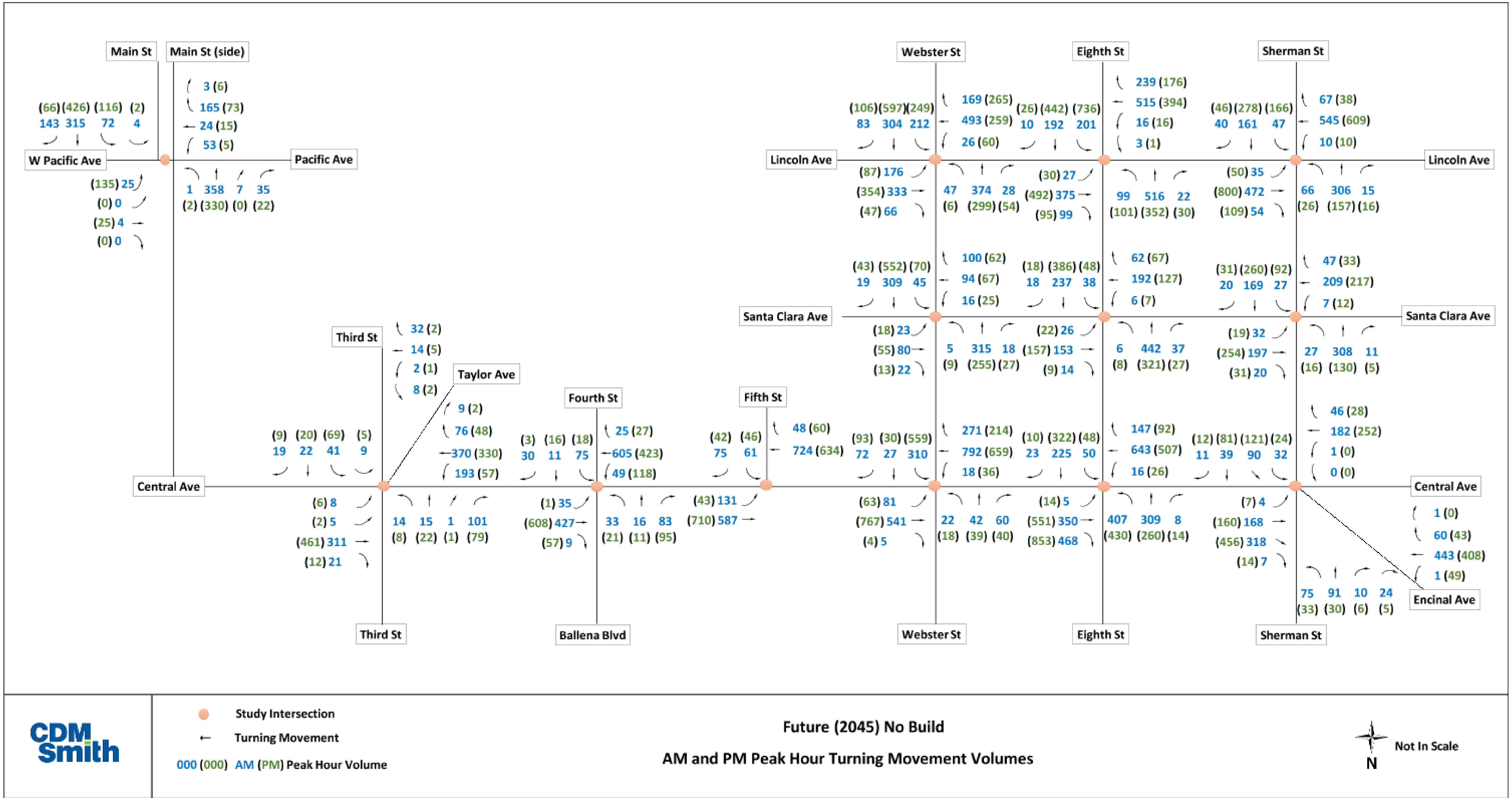

Figure 5-1
Future Year No Build AM and PM Peak Hour Volumes

5.1.2 2045 Build Volumes

As mentioned in Section 3.2.1, the Alameda Countywide travel demand was refined and rerun to reflect the Build scenario roadway characteristics. The study team reviewed the traffic diversion predicted by the model and found the amount and pattern of diversion to be reasonable.

Figure 5-2 shows a screenshot of the 2040 PM peak hour traffic diversion volumes predicted by the model. The width of a line represents the magnitude of volume difference between No Build and Build condition, while red color represents an increase in traffic volume while green represents a decrease in traffic volume. The model shows that the primary diversion route would be Ralph Appezzato Memorial Parkway via portions of Eighth Street and Webster Street. For the streets parallel to Central Avenue in the study area, Lincoln Avenue receives the most traffic diverted away from Central Avenue, especially between Webster Street and Eighth Street. Santa Clara and Taylor Avenue also receive some diverted traffic between Fourth Street and Webster Street, but the magnitude is much lower than on Lincoln Avenue.

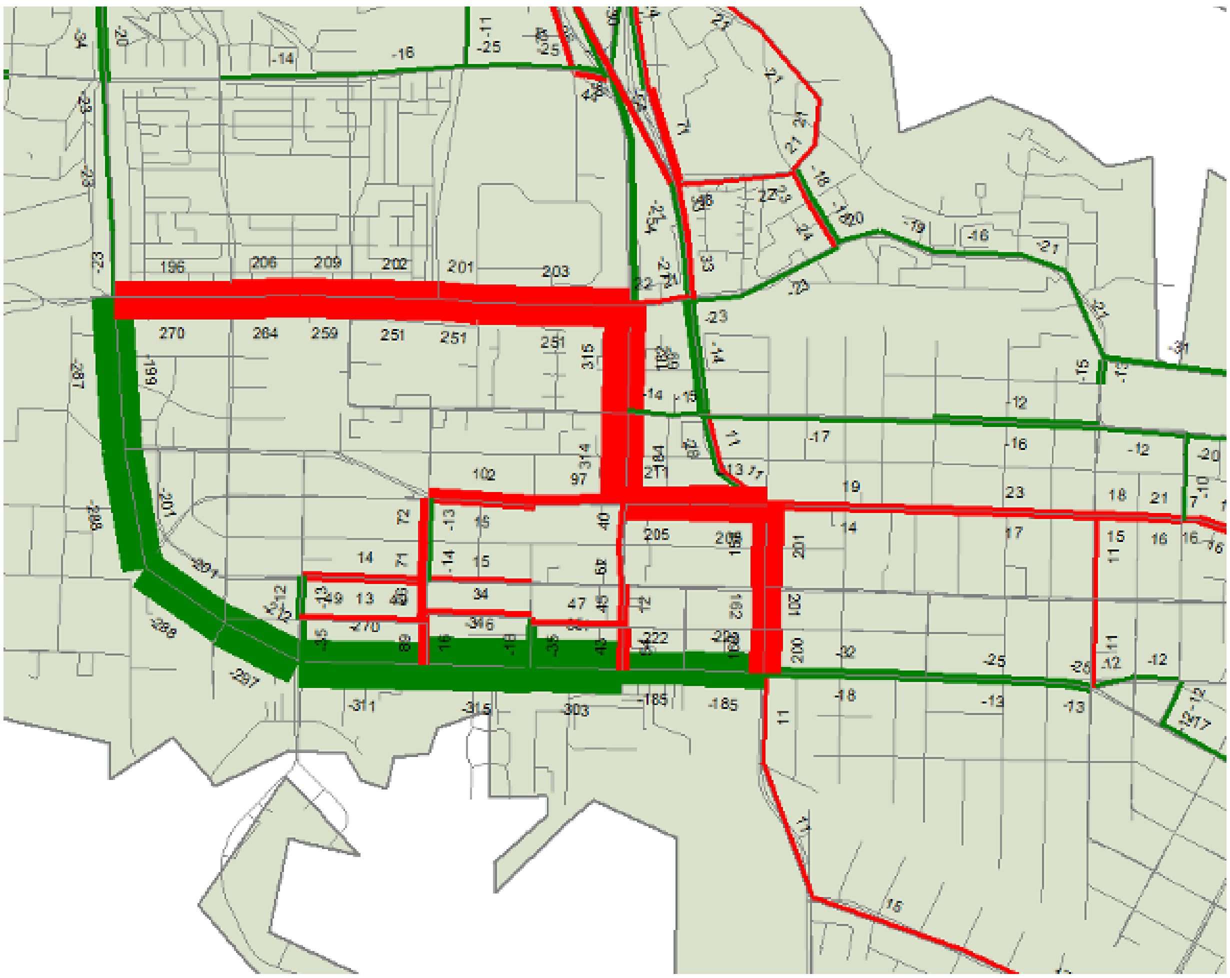

Figure 5-2
Traffic Diversion (PM Peak Hour) Predicted by the Alameda Model

It was found from the 2040 PM model outputs that the diverted traffic on Santa Clara Avenue and Taylor Avenue would not be through traffic but rather neighborhood traffic choosing to use those streets rather than Central Avenue. In addition, the peak hour traffic volumes on these parallel streets would remain well below street capacity according to the model.

As for the 2045 No Build volumes, the difference between the 2020 Existing and 2040 With Project volumes from the model was applied to the existing volumes to develop 2040 Build turning movement volumes at the study intersections. The 2040 Build turning movement volumes were then further extrapolated to derive the 2045 volumes.

The resulting 2045 Build AM and PM peak hour volumes are shown in **Figure 5-3**.

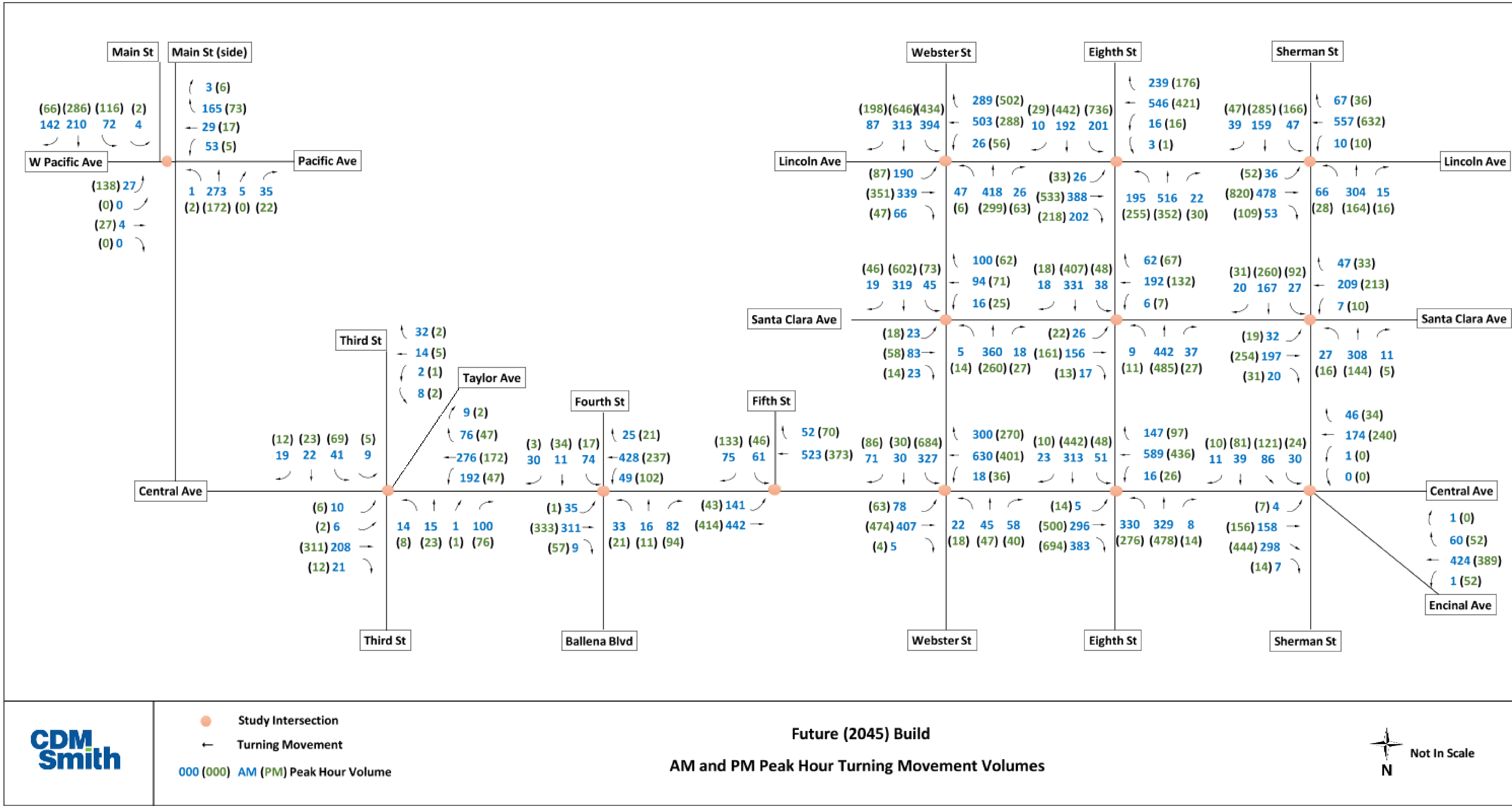

Figure 5-3
Future Year Build AM and PM Peak Hour Volumes

5.2 Synchro/SimTraffic Model Development

The development of the Synchro/SimTraffic models for 2045 No Build and Build is described in this section.

5.2.1 2045 No Build

The AM and PM peak hour volumes developed for 2045 No Build conditions were imported into Synchro. The signal timings, including splits and offsets for the coordinated intersections along Webster Street, were optimized using the Synchro optimization function.

5.2.2 2045 Build

Similarly, the AM and PM peak hour volumes developed for 2045 Build conditions were imported into Synchro.

The network geometry in the Synchro models were modified to reflect the proposed improvements under the Build scenario. One of the main changes is the implementation of road diet (converting from four to two lanes with a center left-turn lane) along the Central Avenue corridor from Third Street/Taylor Avenue to Encinal Avenue/Sherman Street. Turn storage bays are provided or extended to accommodate turning movement volumes for the signalized study intersections.

In conjunction with the proposed improvements along Central Avenue, the signal phasings for the intersections along Central Avenue were redesigned. The main difference is the introduction of a protected bicycle signal phase at all signalized study intersections along Central Avenue with the two-way cycle track: Central Avenue & Fourth Street, Central Avenue & Webster Street, and Central Avenue & Eighth Street. The protected bicycle signal phase must not conflict with any vehicular movement. Therefore, apart from the signal phasing changes, Right Turn on Red was prohibited for the eastbound-right and northbound-right movements at these three intersections. The proposed signal phasings for these intersections are shown in **Figure 5-4**.

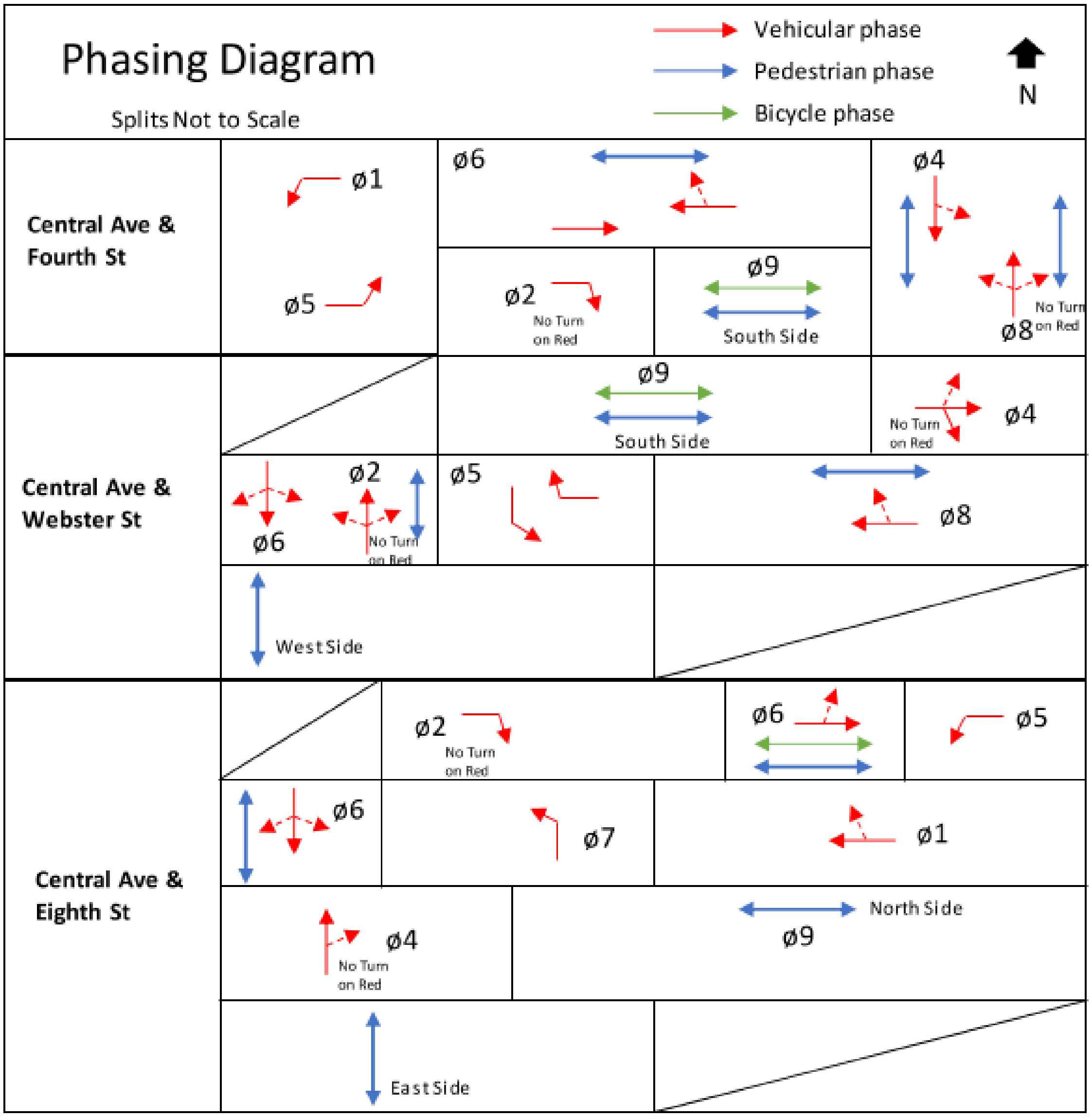

Figure 5-4
Proposed Phasing Diagram for Intersections with Bicycle Signal Phase

Also, a cycle length of 90 seconds was set for the signalized study intersections along Central Avenue, and the intersections of Central Avenue & Webster Street and Central Avenue & Eighth Street were set to be coordinated. The signal timings, including splits and offsets for the coordinated intersections along Central Avenue and Webster Street, were re-optimized by Synchro.

In addition, three intersections are proposed to be converted into roundabouts in the 2045 Build scenario: Central Avenue & Main Street/Pacific Avenue, Central Avenue & Third Street/Taylor Avenue, and Central Avenue & Encinal Avenue/Sherman Street.

5.3 Traffic Operations Analysis

The results from the Synchro/SimTraffic traffic operations analysis are presented in this section. Intersection delays, LOS, and 95th-percentile queue lengths (for signalized intersections only) at the study intersections are reported from the Synchro models. The travel times along Central Avenue between Pacific Avenue/Main Street and Webster Street (City of Alameda portion) and between Webster Street and Encinal Avenue/Sherman Street (Caltrans portion) during the PM peak hour are reported using SimTraffic.

5.3.1 Intersection Operating Conditions

Table 5-1 shows the control type and delay and LOS results from the Synchro models for the 2045 No Build and Build scenarios during the AM peak hour. The Synchro reports with delay/LOS reports are shown in **Appendix B**.

During the AM peak hour in the 2045 No Build scenario, the increased through traffic along Central Avenue causes the operations of the Central Avenue & Main Street/Pacific Avenue intersection to degrade to LOS F. The southbound side-street approach at the Central Avenue & Third Street/Taylor Avenue intersection already operates at LOS F in the existing conditions. The increased through traffic significantly increases the delay due to it is more difficult for drivers to find a gap to proceed.

The all-way stop-controlled Central Avenue & Fifth Avenue intersection operates at LOS E (compared to LOS C under existing conditions), while the Central Avenue & Eighth Street intersection operates at LOS D (no change from existing conditions). The Central Avenue & Webster Street intersection operates at LOS D, improved from existing conditions due to signal timing optimization. All other intersections operate at LOS C or better during the AM peak hour.

Comparing Build to No Build conditions, at most of the study intersections, the LOS either remains the same or improves. Due to conversion to roundabouts, average delays for the Central Avenue & Main Street/Pacific Avenue, Central Avenue at Third Street/Taylor Avenue, and Central Avenue & Encinal Avenue/Sherman Street intersections reduce noticeably, and the LOS is either A or B. The average delay for the Central Avenue & Webster Street intersection increases but the LOS does not exceed E.

At the Central Avenue & Eighth Street intersection, the proposed design includes a through lane on each approach and turn storage bay for the eastbound-left, eastbound-right, westbound-left, northbound-left, and southbound-left movements. As for the Central Avenue & Webster Street intersection, the average delay increases but the LOS does not exceed E. This is mainly attributable to increased delays for the westbound-through, northbound-left, and southbound-through movements.

These delay increases are primarily attributable to geometry changes and corresponding signal phases, including the need to provide a protected bicycle signal phase for the two-way cycle track.

It is expected that at the Central Avenue & Fifth Street intersection, there will be a delay increase of approximately 8.4 seconds comparing Build to No Build conditions, and LOS will change from E to F. The forecasted reduction in through traffic could not compensate for the lane reduction at this all-way stop controlled intersection. It is recommended this intersection be signalized as part of the Alameda Point development project.

The delay also increases at the intersections of Lincoln Avenue & Webster Street and Lincoln Avenue & Eighth Street due to traffic diversion onto Lincoln Avenue, Webster Street, and Eighth Street. However, the LOS at these intersections under Build AM peak conditions does not exceed LOS D. All other intersections operate at LOS C or better.

Table 5-1 Intersection Delay and LOS - 2045 AM Peak Hour - No Build and Build Condition

ID	Location	No Build			Build		
		Control Type	Delay (sec)	LOS	Control Type	Delay (sec)	LOS
1	Central Ave & Main St/Pacific Ave	Signalized	195.6	F	Roundabout	7.2	A
2	Central Ave & Third St/Taylor Ave	Side-Street Stop	946.2 (SB)*	F	Roundabout	8.1	A
3	Central Ave & Fourth St	Signalized	10.6	B	Signalized	17.7	B
4	Central Ave & Fifth St	All-Way Stop	42.5	E	All-Way Stop	50.9	F
5	Central Ave & Webster St	Signalized	35.7	D	Signalized	78.8	E
6	Central Ave & Eighth St	Signalized	45.5	D	Signalized	73.9	E
7	Central Ave & Encinal Ave/Sherman St	Signalized	24.1	C	Roundabout	9.1	A
8	Santa Clara Ave & Webster St	Signalized	10.0	A	Signalized	8.5	A
9	Santa Clara Ave & Eighth St	Signalized	16.1	B	Signalized	16.3	B
10	Santa Clara Ave & Sherman St	All-Way Stop	23.0	C	All-Way Stop	22.8	C
11	Lincoln Ave & Webster St	Signalized	14.6	B	Signalized	46.1	D
12	Lincoln Ave & Eighth St	Signalized	25.8	C	Signalized	34.3	C
13	Lincoln Ave & Sherman St	Signalized	14.5	B	Signalized	14.6	B

Source: Study team analysis

*Side-street stop-controlled intersection. Worst delay of the stop-controlled approaches (southbound in this case) is reported.

Table 5-2 shows the delay and LOS results from the Synchro models for the 2045 No Build and Build scenarios during the PM peak hour.

During the PM peak hour in the 2045 No Build scenario, the Central Avenue & Main Street/Pacific Avenue and Central Avenue & Eighth Street intersections operate at LOS F, the same as for existing conditions. The Central Avenue & Third Street/Taylor Avenue intersection degrades to LOS F. As for the AM peak hour, increased through traffic makes it more difficult for the drivers from the southbound stop-controlled approach to find a gap and proceed.

At the turning movement level, the eastbound-right turn movement at the Central Avenue/Eighth Street intersection has a delay of over 500 seconds. All other intersections operate at LOS C or better during the PM peak hour.

Comparing Build to No Build conditions, as for the AM peak hour, the LOS at most of the study intersections either remains the same or improves from No Build to Build PM peak conditions. Due to conversion to roundabouts, the average delay at the intersections of Central Avenue &

Main Street/Pacific Avenue, Central Avenue at Third Street/Taylor Avenue, and Central Avenue & Encinal Avenue/Sherman Street reduces noticeably, and these intersections operate at LOS A or B under Build PM conditions. The average delay at the Central Ave at Webster St intersection increases but the LOS does not exceed E.

The Central Avenue & Eighth Street intersection operates at LOS F in both the Build and No Build PM conditions; however, the average delay is significantly reduced in the Build scenario. This is mainly attributable to the expected reduced volume for the eastbound-right movement, a protected right turn phase to avoid conflict between the eastbound-right movement and bicycles and pedestrians, and the redesigned phasing to allow more split time for the northbound-through movement in a cycle.

On parallel streets, the delay and LOS remain the same at most of the intersections, except for the Lincoln Avenue & Webster Street and Lincoln Avenue & Eighth Street intersections. Even though the delay increases, the LOS at these intersections does not exceed D. All other intersections operate at LOS C or better.

Table 5-2 Intersection Delay and LOS - 2045 PM Peak Hour - No Build and Build Condition

ID	Location	No Build			Build		
		Control Type	Delay (sec)	LOS	Control Type	Delay (sec)	LOS
1	Central Ave at Main St/Pacific Ave	Signalized	241.5	F	Roundabout	6.1	A
2	Central Ave at Third St/Taylor Ave	Side-Street Stop	405.1 (SB)*	F	Roundabout	6.2	A
3	Central Ave at Fourth St	Signalized	9.8	A	Signalized	14.2	B
4	Central Ave at Fifth St	All-Way Stop	22.4	C	All-Way Stop	19.7	C
5	Central Ave at Webster St	Signalized	41.9	D	Signalized	74.1	E
6	Central Ave at Eighth St	Signalized	191.5	F	Signalized	138.3	F
7	Central Ave at Encinal Ave/Sherman St	Signalized	22.8	C	Roundabout	11.6	B
8	Santa Clara Ave at Webster St	Signalized	7.6	A	Signalized	6.2	A
9	Santa Clara Ave at Eighth St	Signalized	16.2	B	Signalized	16.6	B
10	Santa Clara Ave at Sherman St	All-Way Stop	19.9	C	All-Way Stop	20.2	C
11	Lincoln Ave at Webster St	Signalized	16.6	B	Signalized	44.1	D
12	Lincoln Ave at Eighth St	Signalized	28.4	C	Signalized	45.2	D
13	Lincoln Ave at Sherman St	Signalized	19.1	B	Signalized	18.6	B

Source: Study team analysis

*Side-street stop-controlled intersection. Worst delay of the stop-controlled approaches (southbound in this case) is reported.

5.3.2 Queuing Analysis

This section focuses on the 95th-percentile queue lengths as reported from the Synchro models for the signalized intersections. The Synchro queuing reports are shown in **Appendix A**.

Table 5-3 shows the 95th-percentile queue lengths and turn bay storage capacity at the signalized intersections for the 2045 No Build and Build scenarios during the AM peak hour. The queue lengths that exceed storage lengths are highlighted in red.

In 2045 No Build conditions, the longest queues are reported at the Central Avenue & Webster Street and Central Avenue & Eighth Street intersections. At the Central Avenue & Webster Street intersection, the westbound-through movement queue length exceeds 400 feet.

At the Central Avenue & Eighth Street intersection, the northbound-left movement queue length exceeds 400 feet. As under existing conditions, the northbound-left storage length is significantly shorter than the queue length.

Queue lengths are no longer reported for the roundabouts in the Build scenario. Compared to No Build conditions, queue lengths under Build conditions are either shorter or do not increase significantly at any study intersection. The only exception is the westbound-through movement at the Central Avenue & Eighth Street intersection, where the queue length increases from 367 to 710 feet. However, the queue does not back up to the upstream Central Avenue & Encinal Avenue/Sherman Street intersection.

Table 5-3 95th-Percentile Queue Lengths (in feet) at Signalized Intersections for 2045 No Build and Build in AM Peak Hour

		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NWL
	1. Central Ave at Main St/Pacific Ave													
No Build	Storage													
	Queue		49			99	100		383	0	140	523		
Build	Storage	Roundabout												
	Queue													
	3. Central Ave at Fourth St													
No Build	Storage	50			95									
	Queue	43	113		60	177			42	23		73		
Build	Storage	80		80	100									
	Queue	49	174	19	67	294			124			101		
	5. Central Ave at Webster St													
No Build	Storage													
	Queue		283			436			136		184	161		
Build	Storage	140			80									
	Queue	149	285		4	324			122		254	57		
	6. Central Ave at Eighth St													
No Build	Storage			100				85						
	Queue		138	67		367		443	286			308		
Build	Storage	50		400				85						
	Queue	5	217	281	31	710		423	270		78	366		
	7. Central Ave at Encinal Ave/Sherman St													
No Build	Storage		50											
	Queue		126	58		167			130			126		130
Build	Storage	Roundabout												
	Queue													
	8. Santa Clara Ave at Webster Street													
No Build	Storage													
	Queue		61			90			71			89		

		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NWL
Build	Storage													
	Queue		63			90			61			10		
	9. Santa Clara Ave at Eighth St													
No Build	Storage													
	Queue		98			123			249			147		
Build	Storage													
	Queue		103			127			244			198		
	11. Lincoln Ave at Webster St													
No Build	Storage	165			140									
	Queue	157	60		16	99			127			185		
Build	Storage	165			140									
	Queue	201	66		17	125			130			287		
	12. Lincoln Ave at Eighth St													
No Build	Storage										200			
	Queue		194			297			283		90	193		
Build	Storage										200			
	Queue		231			317			365		90	193		
	13. Lincoln Ave at Sherman St													
No Build	Storage	60												
	Queue	26	96			114			173			94		
Build	Storage	60												
	Queue	27	97			117			172			93		

Source: Study team analysis

Note:

1. Storage length information is provided for all approaches where turn bays are available. When there is no turn bay, the cell is left blank.

Unit: feet

Table 5-4 shows the 95th-percentile queue lengths and turn bay storage capacity at the signalized intersections for the No Build and Build scenarios during the PM peak hour. The queue lengths that exceed storage lengths are highlighted in red.

In 2045 No Build conditions, the longest queues are reported at the Central Avenue & Webster Street and Central Avenue & Eighth Street intersections. At the Central Avenue & Webster Street intersection, the eastbound-through, westbound-through, southbound-left, and southbound-through queue lengths exceed 400 feet.

At the Central Avenue & Eighth Street intersection, the eastbound-right movement queue length exceeds 500 feet, while the queue lengths for the northbound-left and southbound through movements exceed 400 feet. As under existing conditions, at this intersection the eastbound-right and northbound left storage length is significantly shorter than the queue lengths.

As for the AM peak hour, queue lengths are no longer reported for the roundabouts under the Build scenario. Compared to No Build conditions, queue lengths under Build conditions are either shorter or do not increase significantly at any study intersection. The only exception is the Central Avenue & Webster Street intersection, where southbound-left queue length increases from 451 to 719 feet. This is attributable to the diverted traffic to Lincoln Avenue via Webster Street and the lane configuration in the proposed design (only one lane for the southbound-left movement). Even though the queue length for this specific movement increases significantly and the queue backs up to the upstream Santa Clara Avenue & Webster Street intersection, the overall intersection operates at a LOS not exceeding E.

Table 5-4 95th-Percentile Queue Lengths (in feet) at Signalized Intersections for 2045 No Build and Build in PM Peak Hour

		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NWL
	1. Central Ave at Main St/Pacific Ave													
No Build	Storage													
	Queue		308			34	18		326	0	233	605		
Build	Storage	Roundabout; not a signalized intersection												
	Queue													
	3. Central Ave at Fourth St													
No Build	Storage	50			95									
	Queue	5	194		158	117			33	31		32		
Build	Storage	80		80	100									
	Queue	5	212	43	125	158			93			42		
	5. Central Ave at Webster St													
No Build	Storage													
	Queue		442			430			106		451	427		
Build	Storage	140			80									
	Queue	122	447		16	323			100		719	60		
	6. Central Ave at Eighth St													
No Build	Storage			100				85						
	Queue		222	583		253		479	243			407		
Build	Storage	50		400				85						
	Queue	12	356	707	44	385		340	443		95	515		
	7. Central Ave at Encinal Ave/Sherman St													
No Build	Storage		50											
	Queue		117	76		204			58			203		152
Build	Storage	Roundabout; not a signalized intersection												
	Queue													
	8. Santa Clara Ave at Webster Street													
No Build	Storage													
	Queue		46			67			58			82		

		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NWL
Build	Storage													
	Queue		49			73			44			23		
	9. Santa Clara Ave at Eighth St													
No Build	Storage													
	Queue		144			139			168			237		
Build	Storage													
	Queue		152			145			270			249		
	11. Lincoln Ave at Webster St													
No Build	Storage	165			140									
	Queue	67	81		40	65			89			242		
Build	Storage	165			140									
	Queue	93	80		37	120			70			433		
	12. Lincoln Ave at Eighth St													
No Build	Storage										200			
	Queue		271			220			228		345	567		
Build	Storage										200			
	Queue		344			231			302		373	588		
	13. Lincoln Ave at Sherman St													
No Build	Storage	60												
	Queue	40	197			144			68			236		
Build	Storage	60												
	Queue	41	197			145			74			286		

Source: Study team analysis

Note:

1. Storage length information is provided for all approaches where turn bays are available. When there is no turn bay, the cell is left blank.

Unit: feet

5.3.3 Corridor Travel Time

The corridor travel times in the eastbound and westbound directions along Central Avenue between Pacific Avenue/Main Street and Webster Street (City of Alameda portion) and between Webster Street and Encinal Avenue/Sherman Street (Caltrans portion) during the PM peak hour for No Build and Build conditions were reported from the SimTraffic models. The results of five runs were averaged and shown in **Table 5-5**.

In the eastbound direction, the travel times along Central Avenue from Pacific Avenue/Main Street to Webster Street and from Webster Street to Encinal Avenue/Sherman Street during the PM peak hour decrease by approximately 2 minutes under Build conditions. The travel time along the entire Central Avenue corridor decreases by approximately 4 minutes.

In the westbound direction along Central Avenue from Encinal Avenue/Sherman Street to Webster Street and from Webster Street to Pacific Avenue/Main Street, the travel times decrease by approximately 4 minutes and 1 minute respectively. The travel time along the entire Central Avenue corridor decreases by approximately 4 minutes. The SimTraffic arterial reports are shown in **Appendix A**.

Table 5-5 Corridor Travel Time

Direction	Corridor Segment	Distance (mi)	SimTraffic Output (min)		
			2045 No Build	2045 Build	Difference
Eastbound	From Pacific Ave/Main St to Webster St	1.0	5.1	3.1	-2.0
	From Webster St to Encinal Ave/ Sherman St	0.7	4.6	2.4	-2.2
	Total	**1.7**	**9.7**	**5.5**	**-4.2**
Westbound	From Encinal Ave /Sherman St to Webster St	0.7	6.4	2.8	-3.6
	From Webster St to Pacific Ave/ Main St	1.0	3.3	2.7	-0.6
	Total	**1.7**	**9.7**	**5.5**	**-4.2**

Source: Study team analysis

Section 6

Parking Analysis

The number of available parking spaces were counted for the Existing/No Build conditions and Build conditions. There is no difference in available parking spaces between existing and future No Build conditions. Each parking space takes approximately 20 feet in length. Driveways, loading and no-parking zones, and bus stop zones were considered not available for parking. The comparison of available on-street parking spaces between the No Build and Build conditions by major block and by direction is shown in **Table 6-1**.

In the eastbound direction, from Pacific Avenue/Main Street to Lincoln Avenue, there is currently no parking observed and parking is not assumed in the proposed design. From Lincoln Avenue to Fourth Street, about one third of the available parking spaces would be removed due to placement of a center turn lane, the roundabout at the Central Avenue & Third Street intersection, and a dedicated right-turn lane approaching Fourth Street. From Fourth Street to Webster Street, most of the available parking spaces would be removed in the proposed design due to the lane reconfiguration. The most significant reduction in available parking spaces occurs on the block from Fourth Street to Fifth Street – changing from 21 to 5. There are no retail businesses on this block and the apartments and Paden Elementary School south of Central Avenue provide off-street parking. Within one block of Webster Street (from McKay Ave to Webster Street), all of the available parking spaces would be removed. The commercial stores on this block provide off-street parking and can still be accessed via Central Avenue in the proposed design. From Webster Street to Page Street, one third of the available parking spaces would be preserved in the proposed design. In other sections, the number of available parking spaces on Central Avenue generally remains the same or is slightly reduced. Additional parking spaces are removed on side streets as they approach Central Avenue, due to lane reconfiguration, pedestrian bulb-outs, visibility improvements and/or additional space taken by roundabouts. Overall, the number of parking spaces decreases from 225 to 152 in the eastbound direction.

In the westbound direction, the number of parking spaces on the blocks generally remains the same between No Build and Build conditions except for visibility and bus stop improvements at intersections. From Encinal Avenue/Sherman Street to Bay Street, the number of available parking spaces increases slightly as a result of the road diet providing additional cross-sectional width for on-street parking. From Page Street to Webster Street, parking becomes unavailable on the entire block due to the lane reconfiguration and a new consolidated bus stop. Off-street parking is available in this area, allowing access to the commercial stores on this block. From Webster Street to Sixth Street, all of the available parking spaces would be preserved in the proposed design. From Fifth Street to Fourth Street, a few more parking spaces are available due to no stopping zone east of Fourth Street converted to parking allowed. From Fourth Street to Third Street, there are additional parking spaces available on the side of the proposed landscaped island just west of Fourth Street. Additional parking spaces are removed on side streets as they approach Central Avenue, due to lane reconfiguration, pedestrian bulb-outs, visibility improvements and/or additional space taken by roundabouts. Overall, the number of parking spaces decreases slightly from 301 to 252 in the westbound direction.

Table 6-1 Parking Spaces Available

Roadway	Location	Eastbound		Westbound	
		Existing/ No Build	Build	Existing/ No Build	Build
Pacific Ave	SW Side	0	4	-	-
	SE Side	-	-	6	4
	NE Side	-	-	8	4
Main St	NE Side	-	-	1	0
Central Ave	Pacific Ave – Lincoln Ave	0	0	31	28
Lincoln Ave	NW Side	-	-	4	3
	NE Side	-	-	4	2
Central Ave	Lincoln Ave – Third St	7	4	20	19
Third St	SW Side	4	1	-	-
	SE Side	4	2	-	-
	NW Side	-	-	2	1
	NE Side	-	-	3	1
Taylor Ave	S Side	-	-	1	1
	N Side	-	-	3	1
Central Ave	Third St – Fourth St	27	19	14	19
Fourth St	SW Side	2	1	-	-
	SE Side	2	2	-	-
	NW Side	-	-	1	0
Central Ave	Fourth St – Fifth St	21	5	24	30
Fifth St	NW Side	-	-	1	0
	NE Side	-	-	1	0
Hoover Ct	-	Propose conditions same as existing conditions			
Central Ave	Fifth St – Sixth St	20	15	22	22
Sixth St	-	Propose conditions same as existing conditions			
McKay Ave	-	0	0	-	-
Central Ave	Sixth St – Webster St	21	9	22	22
Webster St	SW Side	1	1	-	-
	SE Side	1	1	-	-
	NW Side	-	-	2	2
Central Ave	Webster St – Page St	9	3	13	0
Page St	-	Propose conditions same as existing conditions			
Central Ave	Page St – Eighth St	19	12	16	16

Roadway	Location	Eastbound		Westbound	
		Existing/ No Build	Build	Existing/ No Build	Build
Eighth St	NW Side	-	-	8	2
	NE Side	-	-	6	1
Central Ave	Eighth St – Burbank St	6	4	7	4
Burbank St	SW Side	1	1	-	-
	SE Side	2	1	-	-
Central Ave	Burbank St – Ninth St	8	8	8	8
Ninth St	SW Side	2	1	-	-
	SE Side	2	1	-	-
	NE Side	-	-	1	0
Central Ave	Ninth St – Weber St	11	11	9	9
Weber St	SW Side	2	2	-	-
	SE Side	2	0	-	-
Central Ave	Weber St – Caroline St	6	6	8	7
Caroline St	SW Side	1	0	-	-
	SE Side	1	0	-	-
	NW Side	-	-	1	0
	NE Side	-	-	1	0
Central Ave	Caroline St – St. Charles St	15	14	17	17
St. Charles St	-	Propose conditions same as existing conditions			
Central Ave	St. Charles St – Bay St	6	6	7	7
Bay St	-	Propose conditions same as existing conditions			
Central Ave	Bay St – Sherman St	3	0	4	5
Sherman St	SW Side	3	2	-	-
	SE Side	3	3	-	-
	NW Side	-	-	3	1
	NE Side	-	-	5	3
Encinal Ave	SE Side	13	13	-	-
	NE Side	-	-	9	9
Central Ave E Of Roundabout	SE Side	-	-	4	2
	NE Side	-	-	4	2
Total – Central Ave		**179**	**116**	**222**	**213**
Total – Side Streets		**46**	**36**	**79**	**39**
Grand Total		**225**	**152**	**301**	**252**

Source: Study team analysis

Section 7

Safety Assessment

The results of the safety assessment, including analyzing the crash history and calculating the expected reduction of crashes as a result of implementing countermeasures are presented in this section.

7.1 Background

As mentioned in Part D of Caltrans' Article 5 – Traffic Engineering Performance Assessment[4] document, the objectives of a traffic engineering study for the PA&ED phase should include the following safety-related items:

- Identify performance deficiencies - both existing and potential - based on the review, evaluation and analysis of collision data
- Predict and/or estimate the safety performance of proposed highway geometric design (for new infrastructure)
- Predict and/or estimate the safety performance impacts (i.e. benefits and disbenefits) of specific modifications to existing highway infrastructure or a base design
- Quantify the impact (benefits and disbenefits) of proposed infrastructure reconstruction, expansion, modification, etc. on the operational and safety performance of a highway segment, corridor or system

In this TOAR, safety effectiveness of the proposed improvements is evaluated based on the HSM's method (described as Method 4 under Section C.7) for estimating the safety effectiveness of a proposed project.

7.2 Crash History

The crash data were collected from two sources - For the corridor under Caltrans jurisdiction (SR-61, from Webster Street to Sherman Street), the crash records collected by Caltrans' Traffic Accident Surveillance and Analysis System (TASAS)[5] were compiled and analyzed for a five-year period from January 2014 to December 2018. For the corridor under the City jurisdiction (from Pacific Avenue to Webster Street), the crash records provided by the City of Alameda were compiled and analyzed for a five-year period from January 2014 to December 2018. The raw crash data are shown in **Appendix C**.

7.1.1 SR-61 Portion

A summary of the crash records within the SR-61 portion of the study corridor are presented in **Table 7-1**. A total of 47 crashes occurred along the SR-61 portion during the five-year period. No fatal crashes were found but there were 13 crashes with injuries reported, and a total 19 people injured. Three crashes occurred in wet conditions and 12 crashes occurred in dark conditions. The annual daily traffic for this SR-61 is 12,600 (rounded to 100s), while the total million vehicle miles (number of vehicles multiplied by distance expressed in miles) within the five-year period is 16.11.

Table 7-1 Summary of Number and Significance of Crashes

Location Milepost	Number of Crashes / Significance									ADT Main X-St	Total MVM
	Tot	Fatal	Injury	F+I	Multi Veh	Wet	Dark	Pers Kld	Pers Inj		
ALA 061 021.267 – ALA 061 021.966	47	0	13	13	36	3	12	0	19	12,600	16.11

Source: Caltrans TASAS data, Table B - Selective Accident Rate Calculation
Note: F+I: Fatal+Injury; ADT: Annual Daily Traffic; Total MVM: Total Million Vehicle Miles

The crash rates are shown in **Table 7-2**. During this study period, the total crash rate of 2.92 per million vehicle miles (MVM) is higher than the statewide average of 1.98. However, the total fatal and injury combined crash rate of 0.81 is lower than the statewide average of 0.85.

Table 7-2 Summary of Crash Rates

Location Milepost	Crash Rates					
	Actual			Average		
	Fatal	Fatal + Injury	Total	Fatal	Fatal + Injury	Total
ALA 061 021.267 – ALA 061 021.966	0.000	0.81	2.92	0.014	0.85	1.98

Source: Caltrans TASAS data, Table B - Selective Accident Rate Calculation
Note: Accident rates expressed as number of accidents per million vehicle miles

Table 7-3 shows the total number and percentages of the collision types of the crash records. The highest number of collisions were sideswipes, which included 20 crashes or 42.6 percent of the total crashes. Broadside collisions accounted for 10 crashes or 21.3 percent of the total crashes, while rear end collisions accounted for 7 crashes, or 14.9 percent of the total crashes. These are typical intersection-related collisions. It is worth noting that the summary table provided in the TASAS Selective Accident Retrieval (TSAR) – Accident Summary, included four auto-pedestrian crashes, but the TSAR – Accident Detail data notes that one crash identified as 'head on' is actually a vehicle hitting a pedestrian. Therefore, this crash is considered as an auto-pedestrian crash instead of a head-on collision crash. As a result, there were a total of 5 auto-pedestrian collisions, accounting for 10.6 percent of the total crashes.

Table 7-3 Collision Types

Collision Type	Number	Percentage
Sideswipe	20	42.6%
Broadside	10	21.3%
Rear End	7	14.9%
Auto-Pedestrian	5	10.6%
Head-On	2	4.3%
Hit Object	3	6.4%
Overturn	0	0.0%
Other	0	0.0%
Total	**47**	**100%**

Note: TASAS data, TSAR - Accident Summary, TSAR – Accident Detail, Study team analysis

Thirteen injury crashes occurred within the SR-61 portion during 2014-2018. Of these injury crashes, eleven occurred at an intersection, while two occurred on a mid-block segment.

One injury crash occurred at the Central Avenue/Sherman Street intersection involving two vehicles T-boning each other (broadside type of collision). One injury crash occurred just west of the Central Avenue/Sherman Street intersection. It involved a single vehicle traveling eastbound and hitting the curb as a result of the driver under the influence of alcohol. This crash occurred in the curve section between Bay Street and Sherman Street; improvements such as road diet and channelization that could potentially reduce travel speeds would help drivers navigate through this curve section more safely.

Four injury crashes occurred at the Central Avenue/Webster Street intersection. One involved a vehicle making a westbound left turn, failing to yield to a through-traveling vehicle. One involved a vehicle making a southbound left turn, failing to yield to a through-traveling vehicle. Both crashes were broadside collisions. Another two are pedestrian-related crashes. One involved a eastbound-right turn vehicle hitting a pedestrian, and another involved a northbound through traveling vehicle hitting two pedestrians traveling in the eastbound direction. The primary contributing factor for both is failure to yield.

Two injury crashes at St. Charles Street were the result of failure to yield, one of which was a pickup/panel truck hitting a pedestrian while making a left turn and the other was a northbound passenger vehicle failing to yield at the stop sign. It resulted in broadside collision and involved other two vehicles, including one parked car.

One injury crash occurred at the Caroline Street intersection involved a driver traveling southbound with an unknown impairment hitting a bicyclist traveling westbound. Another injury crash occurred at the Ninth Street intersection involved two vehicles hitting each other as a result of a driver under the influence of alcohol.

One injury crash at the Burbank Street intersection was a broadside collision caused by a northbound left turning vehicle failing to yield to a vehicle traveling westbound. One injury crash occurred just west of Burbank Street was a result of westbound-traveling bus rear-ending a stopped passenger car, and then getting two additional stopped vehicles involved.

Of the head-on crashes, one crash at Eighth Street involved a southbound left-turning vehicle hitting an eastbound through-traveling vehicle on the south side of Central Avenue. One at Webster Street involved an eastbound left-turning vehicle hitting a westbound through traveling vehicle on the north side. The primary contributing factor for all these three crashes is failure to yield. No injuries were reported from these head-on crashes.

Six pedestrians were hit by vehicles as a result of drivers failing to yield on the SR-61 portion of the study corridor during the period of 2014-2018, three of them reported injuries. One bicyclist was hit and injured by a driver with an unknown impairment. Another bicyclist was hit but not injured as a result of a driver making an improper turn.

7.1.2 City of Alameda Portion

The crash data for the City portion of the project segment were obtained from the City database[6] which includes primary road and secondary road information. Sixteen crashes were reported along the City portion of the study corridor and a summary of the crash data is shown in **Table 7-4**. Of these crashes, three included visible injuries, nine included a complaint of pain (possible injury), and four were property damage only (PDO) crashes. No fatalities were reported. Three crashes involved bicyclists while one crash involved a pedestrian. Eleven occurred at intersections, while five occurred on a mid-block segment.

Table 7-4 Summary of Number and Significance of Crashes

Primary Road	Secondary Road	Total	Fatal	Visible Injury	Complaint of Pain	PDO	Pedestrian-Related	Bicycle-Related
Central Ave	Third St	11	0	2	5	4	0	2
	Fifth St	3	0	1	2	0	1	1
	Sixth St	2	0	0	2	0	0	0
	Total	**16**	**0**	**3**	**9**	**4**	**1**	**3**

Source: City of Alameda

The ADT and Total MVM numbers were estimated from the available daily traffic count data, and the crash rates expressed as number of accidents per million vehicle miles were calculated accordingly, as shown in **Table 7-5**. Compared to the Caltrans' SR 61 portion, the injury crash rate is slightly lower, while the total crash rate is less than half of the crash rate for the SR-61 portion.

Table 7-5 Summary of Crash Rates

Location Milepost	ADT*	Total MVM**	Crash Rates		
			Fatal	Fatal + Injury	Total
Pacific Ave/Main St to Webster St	8,300	14.95	0.000	0.80	1.07

Source: City of Alameda, Study team analysis

*Estimated from adding the 2020 daily northbound approach count at Pacific Ave/Main St and eastbound approach count at Webster St, rounded to the nearest 100s

**Calculated from the estimated ADT and distance from Pacific Ave/Main St to Webster St

Note: Accident rates expressed as number of accidents per million vehicle miles

Of the crashes that occurred at or close to the Third Street intersection, one involved the driver being under the influence of alcohol or drugs and resulted in an overturned vehicle located approximately 240 feet from the intersection. The other crashes at Third Street were caused by right-of-way violations that led to broadside collisions, and included two bicycle related crashes.

Of the crashes that occurred at or close to the Fifth Street intersection, the contributing factor to one crash is improper turning that resulted in a rear end collision. A crash caused by a driver violating the right-of-way of a cyclist resulted in a broadside type of collision. Another crash involving a driver violating the pedestrian right-of-way and hitting a pedestrian.

Of the two crashes that occurred at or close to the Sixth Street intersection, one crash involved a driver traveling at unsafe speed rear-ending another vehicle, while the cause of another broadside collision is unknown.

7.1.3 Corridor-wide

The corridor-wide crash data are summarized by location (at or nearby an intersection) in **Table 7-6**. Overall sixty three crashes occurred along the study corridor, with nearly half of them including an injury or possible injury (as identified as "compliant of pain") crashes.

It was found that the highest number of crashes (thirteen) occurred at or near the Webster Street intersection. Seven of these crashes were primarily caused by failing to yield, five by improper turning movements, and one by another violation. Multiple collision types included:

- Four sideswipe collisions, no injuries reported;
- Three broadside collisions, two injuries reported;
- Three auto-pedestrian collisions, two injuries reported;
- Two hit object collisions, no injuries reported; and
- One head-on collisions, no injuries reported

A total of two pedestrians were injured in the three auto-pedestrian collisions, all caused by vehicles failing to yield to pedestrians.

Six pedestrian-related crashes, (a total of seven pedestrians were involved) were reported along the study corridor. All of these crashes occurred at intersections and were a result of violating pedestrian right-of-way (failure to yield).

As to bicycle-related crashes, one occurred at the Third Street intersection while one occurred close to the Third Street intersection. One occurred close to the Fifth Street intersection, and one occurred at the Caroline Street intersection. The collision type of all these bicycle-related crashes are broadside collision. Three were caused by right-of-way violations while one was caused by an unknown driver impairment.

Table 7-6 Summary of Crashes along the Corridor

Location	Total	Fatal	Injury	PDO	Pedestrian-Related	Bicycle-Related
Third St	11	0	7	4	0	2
Fifth St	3	0	3	0	1	1
Sixth St	2	0	2	0	0	0
Webster St	13	0	4	9	3	0
Page St	4	0	0	4	0	0
Eighth St	7	0	0	7	1	1
Burbank St	7	0	2	5	0	0
Ninth St	2	0	1	1	0	0
Caroline St	4	0	1	3	0	1
St Charles St	5	0	2	3	1	0
Bay St	2	0	1	1	0	0
Sherman St	3	0	2	1	0	0
Total	**63**	**0**	**25**	**38**	**6**	**5**

Source: TASAS data, City of Alameda, Study team analysis

7.2 Evaluation of Proposed Improvements

Five elements of the proposed improvements are considered countermeasures in the evaluation of expected reduction in number of crashes – road diet, bicycle facility, pedestrian crossing treatment, high-visibility crosswalk, and roundabout. The applicable crash modification factors (CMFs) for these countermeasures are discussed below.

Road diet

Road diet typically refers to converting a four-lane undivided highway into a three-lane highway – two through lanes plus a center two-way left-turn lane. The remaining roadway width may be used as bicycle lanes, sidewalks, or on-street parking. Chapter 13 of Highway Safety Manual (HSM)[2] includes road diet as a crash countermeasure for roadway segments. The effect on crash frequency of removing two through lanes on urban four-lane undivided roads and adding a center two-way left-turn lane is shown in **Table 7-7**.

Table 7-7 Potential Crash Effect of Road Diet

Treatment	Road Type	Traffic Volume	Crash Type (Severity)	CMF	Std. Error
Four to three lane conversion	Urban (Arterials)	Unspecified	All types (All severities)	0.71	0.02
Base Condition: Four-lane roadway cross section					

Source: Table 13-6 of Highway Safety Manual, First Edition with Supplement 2014

This CMF will be applied to the observed crash frequencies on the roadway segments where the road diet is proposed to estimate crash reductions attributable to these proposed improvements.

Bicycle facility

Providing dedicated bicycle lanes is listed as a countermeasure in Chapter 13 of HSM; however, no CMF is provided. The following qualitative analysis on potential trends in crashes and user behavior is provided: "installing pavement markings to delineate a dedicated bicycle lane appears to reduce erratic maneuvers by drivers and bicyclists. Dedicated bicycle lanes may also lead to higher levels of comfort for both bicyclists and motorists."

It is also mentioned that three types of bicycle-vehicle crashes may be unaffected by bicycle lanes: (1) where a bicyclist fails to stop or yield at a controlled intersection, (2) where a driver fails to stop or yield at a controlled intersection, and (3) where a driver makes an improper left-turn.

The CMF for installing bicycle lanes was therefore collected from the Crash Modification Factors Clearinghouse[7], a resource repository of CMFs funded by the FHWA and maintained by the University of North Carolina Highway Safety Research Center. The identified CMF (CMF ID: 4103) was from a study conducted in Montreal, Canada based on a sample size of 256 crashes during a period from 1999 to 2008 and is shown in **Table 7-8**.

Table 7-8 Potential Crash Effect of Installing Bike Lanes

Treatment	Area Type	Road Type	Road Type	Crash Type	Severity	Number of Lanes	CMF
Cycle Tracks, Bike Lanes, or On-Street Cycling	Urban	Unspecified	Urban	Vehicle/bicycle	A (serious injury), B (minor injury), C (possible injury)	1 to 3	0.41

Source: CMF Clearinghouse (CMF ID: 4103)

This CMF will be applied to the observed vehicle/bicycle crash frequencies on the roadway segments where bicycle sharrow markings, bike lanes, or a two-way cycle track is proposed to estimate crash reductions attributable to these proposed improvements.

It should be noted that even though the CMF used for bicycle facility does not differentiate among cycle tracks, bike lanes, and sharrow bike lanes (on-street cycling), there are still differences among these types of bicycle facilities. Research suggests that separated bike lanes often receive the most support from bicyclists, and in some cases drivers, due to the increased protection and comfort that these types of facilities can provide. These facilities are generally considered to be the safest on-street corridor treatment for bicyclists, both in terms of proven safety outcomes and perceived safety.[8]

The proposed preferred alternative provides a two-way protected cycle track between Pacific/Main Street and Eighth Street, and bike lanes between Eighth Street and Sherman Street.

Pedestrian Crossing Treatment

Dedicated pedestrian crossing treatments, such as rectangular rapid flashing beacons (RRFBs) are listed as countermeasures in Chapter 13 of HSM; however, no CMF is provided. Therefore, the CMF for RRFBs was obtained from the Crash Modification Factors Clearinghouse. The identified CMF (CMF ID: 9024) was from a study conducted in multiple states (AZ, FL, IL, MA, NY, NC, OR, VA, and WI) based on a sample size of 1928 site-years during a period from 2004 to 2013, and is shown in **Table 7-9**.

Table 7-9 Potential Crash Effect of Installing RRFB

Treatment	Area Type	Road Type	Road Type	Crash Type	Severity	Number of Lanes	CMF
Installing Rectangular Rapid Flashing Beacon (RRFB)	Urban/ suburban	Minor Arterial	Urban/ suburban	Vehicle/pedestrian	All	2 to 8	0.526

Source: CMF Clearinghouse (CMF ID: 9024)

This CMF will be applied to the observed vehicle/ pedestrian crash frequencies on the roadway segments where RRFBs are proposed to estimate crash reductions attributable to these proposed improvements.

High-Visibility Crosswalk

The CMF for installing a high-visibility crosswalk was also obtained from the Crash Modification Factors Clearinghouse. The identified CMF (CMF ID: 4123) was from a study conducted in New York City based on a sample size of 63 crash records before and 15 crashes after during a period from 1998 to 2008, and is shown in **Table 7-10**.

Table 7-10 Potential Crash Effect of Installing High-Visibility Crosswalk

Treatment	Area Type	Road Type	Crash Type	Severity	Number of Lanes	CMF
Install high-visibility crosswalk	Urban	Not Specified	Vehicle/pedestrian	All	Not Specified	0.6

Source: CMF Clearinghouse (CMF ID: 4123)

This CMF will be applied to the observed vehicle/ pedestrian crash frequencies on the roadway segments where high-visibility crosswalks are proposed to estimate crash reductions attributable to these improvements.

Roundabout

The CMFs for converting a signalized intersection and a minor-road stop-controlled intersection into a modern roundabout were obtained from Chapter 14 of the HSM and are shown in **Tables 7-11** through **7-12**.

Table 7-11 Potential Crash Effect of Converting Signalized Intersection into Roundabout

Treatment	Road Type	Traffic Volume	Crash Type (Severity)	CMF	Std. Error
Convert signalized intersection to modern roundabout	Urban (One or two lanes)	Unspecified	All types (All severities)	0.99	0.1
			All types (Injury)	0.40	0.1
Base Condition: Signalized intersection					

Source: Table 14-3 of Highway Safety Manual, First Edition with Supplement 2014

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Table 7-12 Potential Crash Effect of Converting Minor-Road Stop-Controlled Intersection into Roundabout

Treatment	Road Type	Traffic Volume	Crash Type (Severity)	CMF	Std. Error
Convert intersection with minor-road stop control to modern roundabout	Urban (One lane)	Unspecified	All types (All severities)	0.61	0.1
			All types (Injury)	0.22	0.1
Base Condition: Stop-controlled intersection					

Source: Table 14-4 of Highway Safety Manual, First Edition with Supplement 2014

This CMF will be applied to the observed all crash frequencies of injuries and property damage only (PDO) types at the intersections where roundabouts are proposed to estimate crash reductions attributable to these improvements.

7.3 Analysis Results

The following sections present the results of the crash reduction analysis.

7.3.1 Expected Crash Reduction

The road diet (converting four-lane highway to three-lane highway, including a TWLTL) is proposed for the segment between Third Street and Sherman Street (the proposed TWLTL extends to Lincoln Avenue, yet the segment between Lincoln Avenue and Third Street is a two-lane section currently). The CMF for the road diet countermeasure was applied to the crashes that occurred within this portion of the corridor to derive the estimated reduction in crashes, excluding the crashes that occurred within the Third Street intersection and Sherman Street intersection. 50 crashes were found to be applicable for potential reduction as a result of implementing road diet.

Bicycle facilities are proposed to be installed for the entire corridor. Even though the facility type is different in the section between McKay Avenue and Eighth Street (bike lane vs. cycle track), the CMF does not differentiate between the two. Therefore, the two options are evaluated based on the same CMF for bike lanes/cycle track. As noted in the HSM, bicycle-vehicle crashes where a driver fails to yield to bicyclists at a controlled intersection, or when a driver makes an improper left-turn, may be unaffected by bicycle facilities. Therefore, the applicable vehicle/bicycle crashes were only those that involved a vehicle and bicycle traveling in the same direction of the roadway. Two applicable vehicle/bicycle crashes were found - one near the Third St intersection and one near the Fifth St intersection.

The RRFB treatment is proposed to be installed at the following three locations:

- At Lincoln Avenue
- At Page Street
- At Caroline Street

No crashes related to pedestrians crossing Central Avenue were found at these locations; therefore, no crash reduction estimate resulting from the installation of the RRFB treatments was possible.

In addition to the proposed improvements along the corridor, roundabouts are proposed at the following three intersections:

- At Pacific Avenue/Main Street
- At Third Street
- At Sherman Street/Encinal Avenue

The CMFs for the countermeasure of converting signalized intersection and side-street stop-controlled intersection into modern roundabout were applied to the crashes by severity type that occurred within these intersections to derive the estimated crash reductions. Six injury crashes and five PDO crashes were found to be applicable for potential reduction attributable to converting intersection to roundabout.

The expected reductions resulting from the implementation of the countermeasures described above, and based on the 2014-2018 crash data, are presented in **Tables 7-13** and **7-14**.

Table 7-13 Expected Crash Reductions due to Countermeasures along the Corridor Based on the 2014-2018 Crash Data

Counter-measure	Road Diet		Bike Lane/ Cycle Track		RRFB		High-Visibility Crosswalk	
Applicable Crash Type	All Types		Vehicle/Bicycle		Vehicle/ Pedestrian		Vehicle/ Pedestrian	
CMF	0.71		0.41		0.526		0.6	
Location	Applicable Crashes	Expected Reduction	App. #	Exp. #	App. #	Exp. #	App. #	Exp. #
Third St	0	0	1	0.6	0	0	0	0
Fifth St	3	0.9	1	0.6	0	0	0	0
Sixth St	2	0.6	0	0	0	0	0	0
Webster St	13	3.8	0	0	0	0	0	0
Page St	4	1.2	0	0	0	0	0	0
Eighth St	7	2.0	0	0	0	0	1	0.4
Burbank St	7	2.0	0	0	0	0	0	0
Ninth St	2	0.6	0	0	0	0	0	0
Caroline St	4	1.2	0	0	0	0	0	0
St Charles St	5	1.5	0	0	0	0	0	0
Bay St	2	0.6	0	0	0	0	0	0
Sherman St	1	0.3	0	0	0	0	0	0
Total	**50.0**	**14.5**	**2.0**	**1.2**	**0**	**0**	**1.0**	**0.4**

Source: TASAS data, City of Alameda, Study team analysis

Table 7-14 Expected Crash Reductions due to Roundabouts Based on the 2014-2018 Crash Data

Counter-measure	Convert Signalized Intersection to Modern Roundabout				Convert Intersection with Minor-Road Stop Control to Modern Roundabout			
Applicable Crash Type	Injury Crashes		PDO Crashes		Injury Crashes		PDO Crashes	
CMF	0.40		0.99		0.22		0.61	
Location	Applicable Crashes	Expected Reduction	App. #	Exp. #	App. #	Exp. #	App. #	Exp. #
Pacific Ave/ Main St*	0	0	0	0	-	-	-	-
Third St	-	-	-	-	5	3.9	4	1.6
Sherman St	1	0.6	1	0.0	-	-	-	-
Total	**1**	**0.6**	**1**	**0.0**	**5**	**3.9**	**4**	**1.6**

Source: TASAS data, City of Alameda, Study team analysis
Note: No crash records were found at this intersection

The expected crash reductions of all types due to the countermeasures based on the 2014-2018 crash data are presented in **Figure 7-1** graphically. It is expected that road diet would significantly reduce crashes along the corridor, while the roundabouts would significantly reduce the crashes at the three intersections where roundabouts are proposed.

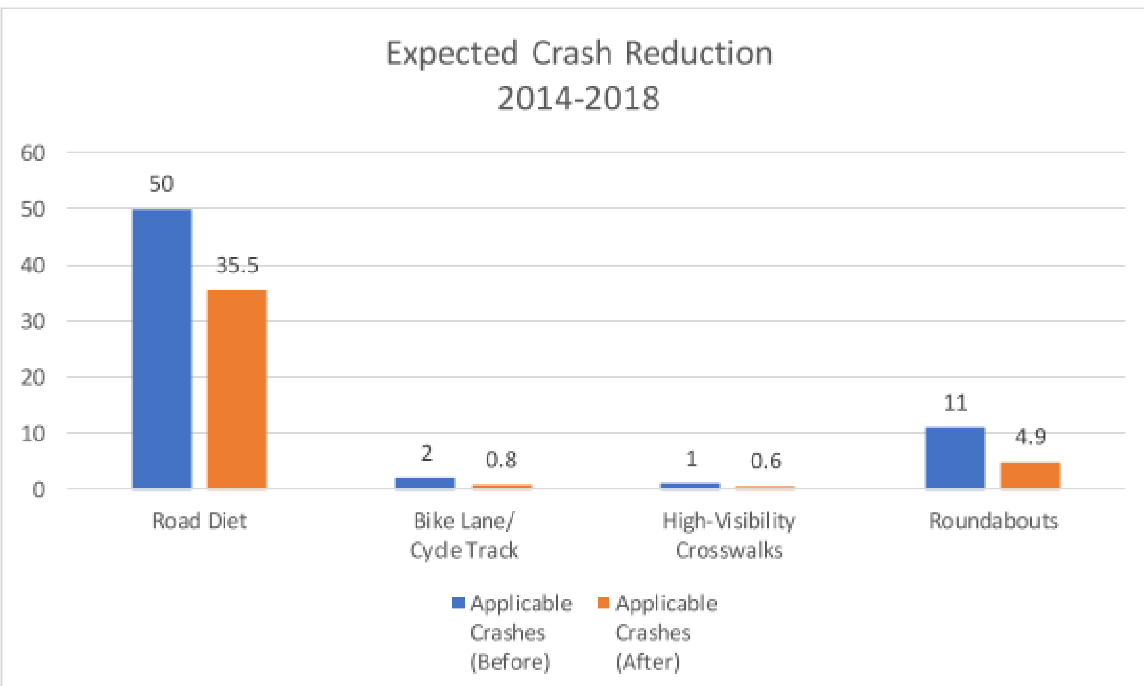

Figure 7-1 Expected Crash Reductions due to Countermeasures based on 2014-2018 Data

7.3.2 Expected Crash Reduction in 2045

In order to derive the expected number of crashes in the future horizon year 2045, the observed number of crashes need to be proportionately increased for the future year using the assumption that crash frequencies remain the same. Approach volumes at each intersection where crashes were observed in the AM and PM peak hours were compared, and a combined growth factor averaging the growth factors observed in the AM and PM peak hours was used to project the number of crashes for the future year at each intersection. **Table 7-15** shows the calculations and the growth factors used to grow the observed crashes into year 2045.

Table 7-15 Growth Factors for Projecting Crash Frequencies

Location	Approach	2020 AM	2045 Build AM	Growth Factor	2020 PM	2045 Build PM	Growth Factor	Combined Growth Factor
Third St	Eastbound	242	245	1.13	331	331	1.04	1.08
	Westbound	465	553		245	268		
Fifth St	Eastbound	573	583	1.02	457	457	1.01	1.02
	Westbound	557	575		433	443		
Sixth St	Eastbound	503	503	1.04	460	460	1.00	1.02
	Westbound	678	723		505	505		
Webster St	Eastbound	485	490	1.06	539	541	1.07	1.06
	Westbound	877	948		623	707		
Page St	Eastbound	758	792	1.07	1,064	1,198	1.12	1.09
	Westbound	868	942		649	722		
Eighth St	Eastbound	674	684	1.05	1,133	1,208	1.10	1.07
	Westbound	692	751		480	559		
Burbank St*	Eastbound	344	355	1.05	487	562	1.19	1.12
	Westbound	642	683		552	672		
Ninth St*	Eastbound	344	355	1.05	487	562	1.19	1.12
	Westbound	642	683		552	672		
Caroline St*	Eastbound	344	355	1.05	487	562	1.19	1.12
	Westbound	642	683		552	672		
St Charles St*	Eastbound	344	355	1.05	487	562	1.19	1.12
	Westbound	642	683		552	672		
Bay St*	Eastbound	344	355	1.05	487	562	1.19	1.12
	Westbound	642	683		552	672		
Sherman St	Eastbound	441	468	1.06	528	621	1.26	1.16
	Westbound	457	486		358	493		

Source: Study team analysis

*Traffic volumes were not developed for these non-study intersections. Volumes for the approach link and receiving link of the adjacent Eighth Street and Sherman Street intersections were used.

The expected crash reductions in 2045 resulting from the application of the proposed countermeasures are presented in **Tables 7-16** and **7-17**. Overall, it is expected that there will be a reduction of approximately 16 crashes as a result of implementing road diet. There will be a reduction of approximately one vehicle/bicyclist crash and one vehicle/pedestrian crash as a result of installing the bicycle and pedestrian safety treatments. There will be a reduction of nearly five injury crashes as a result of converting signalized intersection or side-road stop-controlled intersection into a roundabout.

Table 7-16 Expected Crash Reductions within a Five-Year Period in 2045 due to Countermeasures along the Corridor

Counter-measure	Road Diet		Bike Lane/ Cycle Track		RRFB		High-Visibility Crosswalk	
Applicable Crash Type	All Types		Vehicle/Bicycle		Vehicle/ Pedestrian		Vehicle/ Pedestrian	
CMF	0.71		0.41		0.526		0.6	
Location	Applicable Crashes	Expected Reduction	App. #	Exp. #	App. #	Exp. #	App. #	Exp. #
Third St	0	0	1.1	0.6	0	0	0	0
Fifth St	3.1	0.9	1.0	0.6	0	0	0	0
Sixth St	2.0	0.6	0	0	0	0	0	0
Webster St	13.8	4.0	0	0	0	0	0	0
Page St	4.4	1.3	0	0	0	0	0	0
Eighth St	7.5	2.2	0	0	0	0	1.1	0.4
Burbank St	7.8	2.3	0	0	0	0	0	0
Ninth St	2.2	0.6	0	0	0	0	0	0
Caroline St	4.5	1.3	0	0	0	0	0	0
St Charles St	5.6	1.6	0	0	0	0	0	0
Bay St	2.2	0.6	0	0	0	0	0	0
Sherman St	1.2	0.3	0	0	0	0	0	0
Total	**54.4**	**15.8**	**2.1**	**1.2**	**0**	**0**	**1.1**	**0.4**

Source: TASAS data, City of Alameda, Study team analysis

Table 7-17 Expected Crash Reductions within a Five-Year Period in 2045 due to Roundabouts

Counter-measure	Convert Signalized Intersection to Modern Roundabout				Convert Intersection with Minor-Road Stop Control to Modern Roundabout			
Applicable Crash Type	Injury Crashes		PDO Crashes		Injury Crashes		PDO Crashes	
CMF	0.40		0.99		0.22		0.61	
Location	Applicable Crashes	Expected Reduction	App. #	Exp. #	App. #	Exp. #	App. #	Exp. #
Pacific Ave/ Main St	0	0	0	0	-	-	-	-
Third St	-	-	-	-	5.4	4.2	4.3	1.7
Sherman St	1.2	0.7	1.2	0.0	-	-	-	-
Total	**1.2**	**0.7**	**1.2**	**0.0**	**5.4**	**4.2**	**4.3**	**1.7**

Source: TASAS data, City of Alameda, Study team analysis

The expected crash reductions of all types within a five-year period in 2045 due to the countermeasures are presented in **Figure 7-2** graphically. As in the existing year, it is expected that road diet would significantly reduce crashes along the corridor, while the roundabouts would significantly reduce the crashes at the three intersections where roundabouts are proposed.

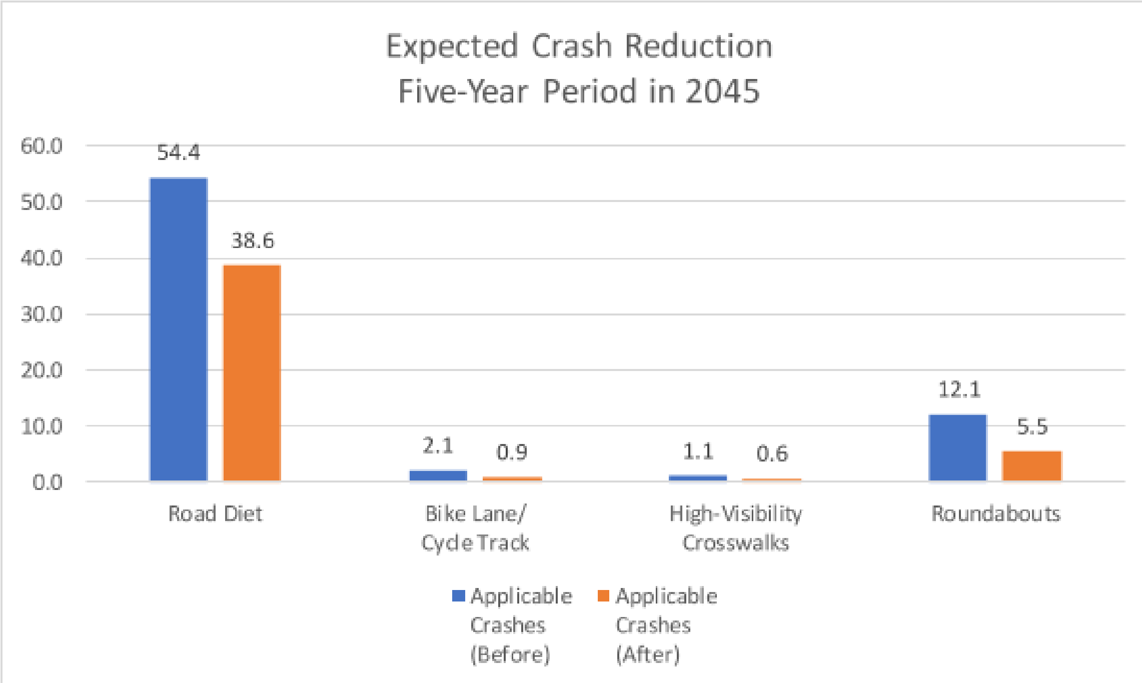

Figure 7-2 Expected Crash Reductions within a Five-Year Period in 2045 due to Countermeasures

7.3.3 Expected Benefits in 2020

Crash benefits in 2020 were derived by estimating the reduction in societal costs due to installing the countermeasures. The societal cost information was obtained from the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS 2017) Annual Report[9] and summarized into **Table 7-18**.

Table 7-18 Societal Cost by Crash Severity Type

Unit	Severity Type	Cost per Unit
Per Person	Killed	$3,981,000
	Severe Injury	$276,000
	Other Visible Injury	$55,000
	Complaint of Pain	$29,000
Per Crash	Property Damage Only	$3,000

Source: SWITRS 2017 Annual Report, Table 7C
Cost in 2017 dollars

The number of injured victims and PDO crashes associated with the applicable crashes for the countermeasures were identified to estimate the benefits (societal cost savings) due to installing the countermeasures. Because the TASAS data for the Caltrans portion of the Alameda corridor does not further differentiate severity types under injury crash, the information of injury type distributions was gathered from the SWITRS 2017 Annual Report to estimate the number of crashes by injury severity type for the total crashes, pedestrian-related crashes, and bicycle-related crashes.

The number of injuries by severity type are presented in **Tables 7-19** through **7-21**.

Table 7-19 Persons Killed and Injured by Extent of Injury in Alameda County

County	Total Killed and Injured	Total Killed	Total Injured	Severe Injury	Visible Injury	Complaint of Pain	Suspected Serious Injury	Suspected Minor Injury	Possible Injury
Alameda	11,124	101	11,023	381	2,010	7,229	81	365	957

Source: SWITRS 2017 Annual Report, Table 8C

Table 7-20 Persons Killed and Injured by Extent of Injury in Statewide Pedestrian-Related Crashes

Crash Type	Total Killed and Injured	Total Killed	Total Injured	Severe Injury	Visible Injury	Complaint of Pain	Suspected Serious Injury	Suspected Minor Injury	Possible Injury
Auto/ Pedestrian	13,992	891	13,101	1,740	4,892	5,815	182	308	164

Source: SWITRS 2017 Annual Report, Table 4C

Table 7-21 Persons Killed and Injured by Extent of Injury in Statewide Bicycle-Related Crashes

Statewide Vehicle Type	Total Killed and Injured	Total Killed	Total Injured	Severe Injury	Visible Injury	Complaint of Pain	Suspected Serious Injury	Suspected Minor Injury	Possible Injury
Bicycle	11,278	162	11,116	870	5,282	4471	104	267	122

Source: SWITRS 2017 Annual Report, Table 4D

The calculated distribution of injuries by severity type for the total crashes, pedestrian-related crashes, and bicycle-related crashes are shown in **Table 7-22**. It should be noted that the injury status boxes of some data previously read "Severe Injury", "Other Visible Injury", and "Complaint of Pain" have been updated to "Suspected Serious Injury", "Suspected Minor Injury", and "Possible Injury" to be in compliance with the crash severity types in Model Minimum Uniform Crash Criteria (MMUCC) Guideline 5th Edition.[10]

Therefore, the calculated distribution of "Severe Injury" includes "Suspected Serious Injury", "Visible Injury" includes "Suspected Minor Injury", and "Complaint of Pain" includes "Possible Injury.

Table 7-22 Distribution of Injuries by Severity Type for Total Crashes

Severity Type	Percentage of Total Injuries		
	Total Crashes	Pedestrian-Related Crashes	Bicycle-Related Crashes
Severe Injury	4.2%	14.7%	8.8%
Other Visible Injury	21.5%	39.7%	49.9%
Complaint of Pain	74.3%	45.6%	41.3%

Source: Study team analysis

These distributions of injuries by severity type were applied to the injuries from the crashes associated with the countermeasures to estimate the number of crashes by injury type.

The societal cost by crash severity type shown in Table 7-18 was then applied to the number of injured persons and PDO crashes to calculate the "before" and "after" societal costs of the applicable crashes for each countermeasure. The resulting reduction in societal cost for Road Diet, Bike Lane/Cycle Track, RRFB, and High-Visibility Crosswalk countermeasures are shown in **Table 7-23**.

Table 7-23 Expected Societal Cost Reductions due to Countermeasures along the Corridor Based on the 2014-2018 Crash Data

Counter-measure	Road Diet	Bike Lane/ Cycle Track	RRFB	High-Visibility Crosswalk
Applicable Crash Type	All Types	Vehicle/Bicycle	Vehicle/ Pedestrian	Vehicle/ Pedestrian
CMF	0.71	0.41	0.526	0.6
Location	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost
Third St	$0	$22,550	$0	$0
Fifth St	$32,770	$22,550	$0	$0
Sixth St	$16,820	$0	$0	$0
Webster St	$59,977	$0	$0	$0
Page St	$3,480	$0	$0	$0
Eighth St	$6,090	$0	$0	$1,200
Burbank St	$69,534	$0	$0	$0
Ninth St	$13,907	$0	$0	$0
Caroline St	$15,647	$0	$0	$0
St Charles St	$67,794	$0	$0	$0
Bay St	$13,907	$0	$0	$0
Sherman St	$26,943	$0	$0	$0
Total	**$326,868**	**$45,100**	**$0**	**$1,200**

Source: TASAS data, City of Alameda, SWITRS 2017 Annual Report, Study team analysis
Values in 2017 dollars

The resulting reduction in societal cost for each countermeasure is shown in **Table 7-24**.

Table 7-24 Expected Societal Cost Reductions due to Countermeasures due to Roundabouts Based on the 2014-2018 Crash Data

Counter-measure	Convert Signalized Intersection To Roundabout		Convert TWSC Intersection To Roundabout	
Applicable Crash Type	Injury	PDO	Injury	PDO
CMF	0.4	0.99	0.22	0.61
Location	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost
Third St	$0	$0	$113,100	$4,680
Fifth St	$0	$0	$0	$0
Sixth St	$0	$0	$0	$0
Webster St	$0	$0	$0	$0
Page St	$0	$0	$0	$0
Eighth St	$0	$0	$0	$0
Burbank St	$0	$0	$0	$0
Ninth St	$0	$0	$0	$0
Caroline St	$0	$0	$0	$0
St Charles St	$0	$0	$0	$0
Bay St	$0	$0	$0	$0
Sherman St	$26,973	$30	$0	$0
Total	**$26,973**	**$30**	**$113,100**	**$4,680**

Source: TASAS data, City of Alameda, SWITRS 2017 Annual Report, Study team analysis
Values in 2017 dollars

The total reduction for a five-year period in 2020 is $517,951.

7.3.3 Expected Benefits in 2045

Similar to calculating the reductions in 2045, the growth factors for the intersections were applied to the "before" and "after" societal costs of the applicable crashes for each countermeasure to derive the "before" and "after" societal costs in 2045. The resulting reduction in societal cost for Road Diet, Bike Lane/Cycle Track, RRFB, and High-Visibility Crosswalk countermeasures for a five-year period in 2045 are shown in **Table 7-25**.

Table 7-25 Expected Crash Reductions within A Five-Year Period in 2045 due to Countermeasures along the Corridor

Counter-measure	Road Diet	Bike Lane/ Cycle Track	RRFB	High-Visibility Crosswalk
Applicable Crash Type	All Types	Vehicle/Bicycle	Vehicle/ Pedestrian	Vehicle/ Pedestrian
CMF	0.71	0.41	0.526	0.6
Location	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost
Third St	$0	$24,451	0	$0
Fifth St	$33,360	$22,956	0	$0
Sixth St	$17,140	$0	0	$0
Webster St	$63,870	$0	0	$0
Page St	$3,806	$0	0	$0
Eighth St	$6,535	$0	0	$1,288
Burbank St	$77,892	$0	0	$0
Ninth St	$15,578	$0	0	$0
Caroline St	$17,528	$0	0	$0
St Charles St	$75,943	$0	0	$0
Bay St	$15,578	$0	0	$0
Sherman St	$31,250	$0	0	$0
Total	**$358,481**	**$47,408**	**$0**	**$1,288**

Source: TASAS data, City of Alameda, SWITRS 2017 Annual Report, Study team analysis
Values in 2017 dollars

The resulting reduction in societal cost for each countermeasure is shown in **Table 7-26**.

Table 7-26 Expected Crash Reductions within A Five-Year Period in 2045 due to Roundabouts

Counter-measure	Convert Signalized Intersection To Roundabout		Convert TWSC Intersection To Roundabout	
Applicable Crash Type	Injury	PDO	Injury	PDO
CMF	0.4	0.99	0.22	0.61
Location	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost	Reduction in Societal Cost
Third St	$0	$0	$122,637	$5,075
Fifth St	$0	$0	$0	$0
Sixth St	$0	$0	$0	$0
Webster St	$0	$0	$0	$0
Page St	$0	$0	$0	$0
Eighth St	$0	$0	$0	$0
Burbank St	$0	$0	$0	$0
Ninth St	$0	$0	$0	$0
Caroline St	$0	$0	$0	$0
St Charles St	$0	$0	$0	$0
Bay St	$0	$0	$0	$0
Sherman St	$31,284	$35	$0	$0
Total	**$31,284**	**$35**	**$122,637**	**$5,075**

Source: TASAS data, City of Alameda, SWITRS 2017 Annual Report, Study team analysis
Values in 2017 dollars

The total reduction for a five-year period in 2045 is $566,206.

7.4 Summary

A total of sixty three crashes were reported within the project corridor between 2014 and 2018. Twenty nine of them included at least one injury, but no fatalities occurred. Six pedestrian-related crashes occurred, one at Fifth Street, three at Webster Street, one at Eighth Street, and one at Saint Charles Street. A total of four pedestrians were injured. A total of five bicycle-related crashes occurred, two at Third Street, one at Fifth Street, one at Eighth Street, and one at Caroline Street. Four of them involved a cyclist being injured.

Four countermeasures related to the proposed design layouts along the study corridor were identified – Road Diet, Bike Lane/Cycle Track, Rapid Rectangular Flashing Beacon, and High-Visibility Crosswalk. Road diet has the most noticeable impact on expected crash occurrence – 29% reduction in crashes of all types. **Table 7-27** summarizes the crash reductions and benefits due to countermeasures along the corridor within a five-year period in 2020 and 2045.

Based on the observed number of applicable crashes, it is expected that there would be a reduction of close to 16 crashes of all types within a five-year period in 2045. Bicycle-related and pedestrian-related crashes would reduce by one each. It is expected the societal benefits due to the countermeasures along the corridor within a five-year period would be approximately $373,000 in 2020 and $407,000 in 2045.

Table 7-27 Expected Crash Reductions and Benefits due to Countermeasures along the Corridor within A Five-Year Period in 2020 and 2045

Countermeasure	2020		2045	
	Crash Reductions	Benefits*	Crash Reductions	Benefits*
Road Diet	14.5	$326,868	15.8	$358,481
Bike Lane/Cycle Track	1.2	$45,100	1.2	$47,408
RRFB	0	$0	0	$0
High-Visibility Crosswalk	0.4	$1,200	0.4	$1,288
Total	**16.1**	**$373,168**	**17.4**	**$407,177**

Source: TASAS data, City of Alameda, SWITRS 2017 Annual Report, Study team analysis
*in 2017 dollars

Even though there is no differentiation in terms of expected number of crashes due to the countermeasure among the types of bicycle facilities being evaluated, it is expected that separated bike lane facilities, such as the proposed two-way protected cycle track, provide the most comfort to both bicyclists and drivers and are generally considered to be the safest on-street corridor treatment for bicyclists.

Roundabouts are proposed at three intersections within the study corridor – Pacific Avenue/Main Street, Third Street, and Sherman Street/Encinal Avenue. Based on the CMFs from the HSM, converting a signalized or minor-road stop-controlled intersection to a roundabout would effectively reduce crash frequencies at the intersection, especially injury crashes. **Table 7-28** summarizes the crash reductions and benefits due to roundabouts within a five-year period in 2025 and 2045.

Based on the observed number of applicable crashes, it is expected that there would be a reduction of more than six crashes within a five-year period in 2045. It is expected the benefits due to roundabouts within a five-year period would be approximately $145,000 in 2020 and $159,000 in 2045.

Table 7-28 Expected Crash Reductions and Benefits due to Roundabouts within A Five-Year Period in 2020 and 2045

Countermeasure	2020		2045	
	Crash Reductions	Benefits*	Crash Reductions	Benefits*
Convert Signalized Intersection to Roundabout	0.6	$27,003	0.7	$31,319
Convert TWSC Intersection to Roundabout	5.5	$117,780	5.9	$127,712
Total	**6.1**	**$144,783**	**6.6**	**$159,031**

Source: TASAS data, City of Alameda, SWITRS 2017 Annual Report, Study team analysis
*in 2017 dollars

Section 8
Conclusions

This section summarizes the main findings from the traffic operations analysis, parking analysis, and safety assessment presented in this report.

8.1 Safety Assessment

The crash data analysis revealed that 63 crashes were reported within the project corridor between 2014 and 2018. Out of this total, 29 crashes involved at least one injured person, but no fatalities occurred. Six pedestrian-related crashes occurred, while five bicycle-related crashes occurred. The crash reductions expected from all the safety improvements within a five-year period would be approximately 22 crashes in 2020 and 24 crashes in 2045. The total societal benefits within a five-year period would be approximately $517,951 in 2020 and $566,206 in 2045.

The proposed project includes several elements expected to improve safety conditions: road diet, bike lane/cycle track, rapid rectangular flashing beacons, high-visibility crosswalks, and roundabouts. Among these elements, a road diet is expected to have the highest impact on expected crash occurrence, a 29 percent reduction in crashes of all types. Based on the crash history in the corridor and the CMFs, it is estimated that there could be a reduction of approximately 16 crashes of all types, one bicycle-related, and one pedestrian-related crash within a five-year period in 2045.

Based on the CMFs from the HSM, converting a signalized or minor-road stop-controlled intersection to a roundabout would effectively reduce crash frequencies at the intersection, especially injury crashes. Roundabouts are proposed at three intersections within the study corridor – Pacific Avenue/Main Street, Third Street/Taylor Avenue, and Encinal Avenue/Sherman Street. Based on the crash history and the CMF, it is expected that there would be a reduction of approximately five injury crashes within a five-year period in 2045.

8.2 Traffic Operations Analysis

The results of the traffic operations analysis show that 4 out of the 13 study intersections operate at LOS E or F during the AM or PM peak hour in the existing conditions, and there will be several more intersections at LOS E or F in the future year (2045) No Build scenario. Most notably, the Central Avenue & Pacific Avenue/Main Street and Central Avenue & Third Street/Taylor Avenue intersections will operate at LOS F during both AM and PM peak hours. Due to increase in through traffic along Central Avenue, traffic on the southbound side street approach at the Central Avenue & Third Street/Taylor Avenue intersection is expected to experience delays close to 1,000 seconds during the AM peak hour and 500 seconds during the PM peak hour. The Central Avenue & Eighth Street intersection will operate at LOS F with an overall delay of nearly 200 seconds during the PM peak hour.

In the Build scenario, delay increases at a few locations but decreases at most locations. Converting to roundabouts significantly reduces delays at the three intersections, especially the Central Avenue & Pacific Avenue/Main Street and Central Avenue & Third Street/Taylor Avenue intersections. The Central Avenue & Fifth Street intersection operates at LOS E during the AM peak hour. It is recommended that this intersection be signalized as part of the Alameda Point development project.

During the AM peak hour, compared to No Build, the delays for the Central Avenue & Webster Street and Central Avenue & Eighth Street intersections increase and LOS changes from D to E. This is primarily attributable to geometry changes and corresponding signal phases, including the need to provide a protected bicycle signal phase for the two-way cycle track.

During the PM peak hour, the Central Avenue & Webster Street intersection operates at LOS E, while the Central Avenue & Eighth Street intersection operates at LOS F. At the Central Avenue & Eighth Street intersection, the delay is reduced significantly compared to No Build. All other study intersections along Central Avenue operate at LOS C or better.

Due to the road diet implemented on Central Avenue between Third Street/Taylor Avenue and Encinal Avenue/Sherman Street, it is projected that some traffic would be diverted from Central Avenue to Lincoln Avenue, via Webster Street and Eighth Street. The diversion has little impact on Santa Clara Avenue and Taylor Avenue. Due to diversion, delay for the Lincoln Ave & Webster St and Lincoln Ave & Eighth St intersections increases during both AM and PM peak hours but LOS does not exceed D.

Therefore, even with diversion, there is no significant LOS impact found on key intersections on streets parallel to Central Avenue.

In the existing PM peak hour conditions, it takes approximately eight to nine minutes to travel along the entire Central Avenue. In the future PM peak hour No Build conditions, the corridor travel time is expected to increase slightly in each direction. The project is expected to decrease the corridor travel time by approximately four minutes in each direction.

8.3 Parking Analysis

The parking analysis results show that when comparing Build to No Build conditions, the number of available parking spaces are reduced in both eastbound and westbound directions.

In the eastbound direction, total parking spaces are reduced by approximately one third, from 225 to 152. The major difference is on the blocks from Fourth Street to Webster Street where most of the available parking spaces would be removed due to the geometry changes. From McKay Avenue to Webster Street, all of the available parking spaces would be removed. However, the commercial stores on this block provide off-street parking and all of the parking spaces on the westbound side are preserved in the proposed design. Additional parking spaces are removed on side streets as they approach Central Avenue, due to lane reconfiguration, pedestrian bulb-outs, visibility improvements and/or additional space taken by roundabouts.

In the westbound direction, the total number of available parking spaces reduces by approximately 16 percent from 301 to 252. On a block by block basis, parking spaces remain generally the same along Central Avenue. From Page Street to Webster Street, parking becomes unavailable on the entire block due to the lane reconfiguration and the new consolidated bus stop. Off-street parking is available in this area, providing access to the commercial stores on this block, and visitors can still utilize some remaining parking spaces on the eastbound side. From Fourth Street to Third Street, there are additional parking spaces available on the side of the proposed landscaped island just west of Fourth Street. As in the eastbound direction, additional parking spaces are removed on side streets as they approach Central Avenue, due to lane reconfiguration, pedestrian bulb-outs, visibility improvements and/or additional space taken by roundabouts.

Section 9

Bibliography of Data Sources

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[2] Highway Safety Manual, 1st Edition with Supplement 2014, published by American Association of State Highway and Transportation Officials (AASHTO)

[3] Guidelines for Applying Traffic Microsimulation Modeling Software, published by Federal Highway Administration: https://ops.fhwa.dot.gov/trafficanalysistools/tat_vol3/list_contents.htm, accessed February 26, 2020.

[4] Appendix S Chapter 5 Scoping Tools – Article 5 - Traffic Engineering Performance Assessment Preparation Guidelines for Project Study Report-Project Development Support (PSR-PDS) Project Initiation Documents, September 30, 2011, published by Caltrans

[5] Caltrans Traffic Accident Surveillance and Analysis System (TASAS) data, obtained from Caltrans on February 28, 2020

[6] Alameda Statewide Integrated Traffic Records System (SWITRS) data, obtained from City of Alameda on February 11, 2020

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[8] Research on Safety of Protected Bike Lanes, a memo from Toole Design to City of Alameda for the Alameda Active Transportation Plan project, obtained from City of Alameda on March 11, 2020

[9] Statewide Integrated Traffic Records System (SWITRS) 2017 Annual Report, published by California Highway Patrol: https://www.chp.ca.gov/programs-services/services-information/switrs-internet-statewide-integrated-traffic-records-system, accessed May 11, 2020

[10] Model Minimum Uniform Crash Criteria (MMUCC) Guideline, 5th Edition, published by National Highway Traffic Safety Administration (NHTSA)

Appendix A

SimTraffic Reports and Synchro Queue Reports

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Appendix B

Volume Throughput Calibration and Synchro Reports

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Appendix C

Crash Data

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