ATTACHMENT E
EXISTING CONDITIONS TRAFFIC MODEL CALIBRATION METHODOLOGY AND RESULTS TECHNICAL MEMORANDUM

FEHR & PEERS

ATTACHMENT E

Date: November 22, 2013

To: Caltrain Electrification EIR Project Team

From: Ian Barnes and Matt Haynes, Fehr & Peers

Subject: Existing Conditions VISSIM and SimTraffic Models Calibration and Validation

SJ13-1440

Introduction

Fehr & Peers developed traffic microsimulation models that will be used to analyze the environment impacts of the proposed Caltrain Electrification project. The study area for the microsimulation models included 82 intersections along the Caltrain line in San Francisco, San Mateo, and Santa Clara Counties. Most of these intersections (64) were modeled using the Synchro/SimTraffic software package. The remaining 18 intersections were modeled using the VISSIM software package which has the ability to account for more complex intersection operations. VISSIM was used at intersections where there are high levels of congestion, frequent transit service, high automobile volumes, high pedestrian or bicycle volumes, or special traffic signal systems (such as transit signal priority). **Table 1** lists the study intersections, the jurisdiction the intersection is located in and the analysis software package.

The remainder of this memorandum describes the development of the microsimulation models for existing conditions, including the model calibration and validation processes. The model development process includes three basic components: (1) network coding, (2) model calibration and (3) model validation. This memorandum also summarizes key existing conditions analysis results produced by the model.

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TABLE 1
STUDY INTERSECTIONS

Int. ID	Intersection	Jurisdiction[1]	Modeling Tool
1	4th Street/King Street	SF	VISSIM
2	4th Street/Townsend Street	SF	VISSIM
3	Mission Bay Drive/7th Street	SF	SimTraffic
4	Mission Bay Drive/Berry Street	SF	SimTraffic
5	7th Street/16th Street	SF	VISSIM
6	16th Street/Owens Street	SF	VISSIM
7	22nd Street/Pennsylvania Street	SF	SimTraffic
8	22nd Street/Indiana Street	SF	SimTraffic
9	Tunnel Avenue/Blanken Avenue	SF	SimTraffic
10	Linden Ave/ Dollar Avenue	SSF	SimTraffic
11	East Grand Avenue/Dubuque Way	SSF	SimTraffic
12	S Linden Avenue/San Mateo Avenue	SSF	SimTraffic
13	Scott Street/Herman Street	SB	SimTraffic
14	Scott Street/Montgomery Avenue	SB	SimTraffic
15	San Mateo Ave/San Bruno Avenue East	SB	SimTraffic
16	El Camino Real/Millbrae Avenue	MB	SimTraffic
17	Millbrae Avenue/Rollins Road	MB	SimTraffic
18	California Drive/Broadway	BG	VISSIM
19	Carolan Avenue/Broadway	BG	VISSIM
20	California Drive/Oak Grove Avenue	BG	SimTraffic
21	Carolan Avenue/Oak Grove Avenue	BG	SimTraffic
22	California Drive/North Lane	BG	SimTraffic
23	Carolan Avenue/North Lane	BG	SimTraffic
24	Anita Road/Peninsula Avenue	BG	SimTraffic
25	Woodside Way/Villa Terrace	SM	SimTraffic
26	North San Mateo Drive/Villa Terrace	SM	SimTraffic
27	Railroad Avenue/1st Avenue	SM	SimTraffic
28	S B St and 1st Ave	SM	SimTraffic
29	9th Ave and S Railroad Ave	SM	SimTraffic
30	S B St and 9th Ave	SM	SimTraffic

TABLE 1
STUDY INTERSECTIONS

Int. ID	Intersection	Jurisdiction[1]	Modeling Tool
31	Transit Center Wy and 1st Ave	SM	SimTraffic
32	Concar Dr and SR 92 WB Ramps	SM	SimTraffic
33	S Delaware St and E 25th Ave	SM	SimTraffic
34	E 25th Ave and El Camino Real	SM	SimTraffic
35	31st Ave and El Camino Real	SM	SimTraffic
36	E Hillsdale Blvd and El Camino Real	SM	SimTraffic
37	E Hillsdale Blvd and Curtiss St	SM	SimTraffic
38	Peninsula Avenue/Arundel Rd/Woodside Wy	SM	SimTraffic
39	El Camino Real and Ralston Ave	BL	SimTraffic
40	El Camino Real and San Carlos Ave	SC	SimTraffic
41	Maple Street/Main Street	RC	SimTraffic
42	Main Street/Beech Street	RC	SimTraffic
43	Main Street/Middlefield Road	RC	SimTraffic
44	Broadway and California	RC	SimTraffic
45	El Camino Real and Whipple Ave	RC	VISSIM
46	Arguello St and Brewster Ave	RC	SimTraffic
47	El Camino Real and Broadway	RC	SimTraffic
48	Arguello St and Marshall St	RC	SimTraffic
49	El Camino Real and James Ave	RC	SimTraffic
50	El Camino Real and Fair Oaks Ln	AT	SimTraffic
51	El Camino Real and Watkins Ave	AT	SimTraffic
52	Fair Oaks Lane/Middlefield Road	AT	SimTraffic
53	Watkins Avenue/Middlefield Road	AT	SimTraffic
54	Glenwood Avenue/Middlefield Road	AT	SimTraffic
55	El Camino Real and Glenwood Ave	MP	SimTraffic
56	El Camino Real and Oak Grove Ave	MP	SimTraffic
57	El Camino Real and Santa Cruz Ave	MP	SimTraffic
58	Merrill St and Santa Cruz Ave	MP	SimTraffic
59	Ravenswood Ave/Alma St	MP	VISSIM
60	El Camino Real and Ravenswood Ave	MP	VISSIM

TABLE 1
STUDY INTERSECTIONS

Int. ID	Intersection	Jurisdiction[1]	Modeling Tool
61	Ravenswood Avenue/Laurel Street	MP	SimTraffic
62	Alma Street/Palo Alto Avenue	PA	VISSIM
63	Meadow Drive/Alma Street	PA	VISSIM
64	El Camino Real/Alma/Sand Hill Road	PA	VISSIM
65	High St and University Ave	PA	SimTraffic
66	Alma St and Churchill Ave	PA	VISSIM
67	W Meadow Dr and Park Blvd	PA	VISSIM
68	Alma St and Charleston Rd	PA	VISSIM
69	Showers Dr And Pacchetti Way	MV	SimTraffic
70	Central Expressway and N Rengstorff Ave	MV	VISSIM
71	Central Expressway and Moffett/Castro	MV	VISSIM
72	W Evelyn Ave and Hope St	MV	SimTraffic
73	Rengstorff Avenue/California Street	MV	SimTraffic
74	Castro Street/Villa Street	MV	SimTraffic
75	W Evelyn Ave and S Mary Ave	SV	VISSIM
76	W Evelyn Ave and Frances St	SV	SimTraffic
77	Kifer Rd and Lawrence Expressway	SCC	SimTraffic
78	Reed Ave-Monroe St and Lawrence Expy	SCC	SimTraffic
79	El Camino Real and Railroad Ave	SC	SimTraffic
80	W Santa Clara St and Cahill St	SJ	SimTraffic
81	S Montgomery St and W San Fernando St	SJ	SimTraffic
82	Lick Ave and W Alma Ave	SJ	SimTraffic

Notes:
1. Jurisdictions:

SF	San Francisco	SM	San Mateo	MV	Mountain View
SSF	South San Francisco	BL	Belmont	SV	Sunnyvale
SB	San Bruno	SC	San Carlos	SC	Santa Clara
MB	Millbrae	RC	Redwood City	SCC	Santa Clara County
BG	Burlingame	AT	Atherton	SJ	San Jose
MP	Menlo Park	PA	Palo Alto		

Source: Fehr & Peers, November 2013

Model Development Process

The VISSIM and SimTraffic models were constructed by digitizing the roadway networks using aerial photography as the background. The number of lanes and the location of lane additions, turn pockets and lane drops were confirmed by field observations. Additional detail, such as speed limits and vehicle turning speeds, was incorporated into the networks to better reflect observed field conditions. At signalized intersections, traffic signal timing plans (i.e., phasings, green times, transit signal priority, railroad preemption, etc.) were entered into the Synchro/SimTraffic and VISSIM models to reflect current conditions.

The SimTraffic and VISSIM models were validated to existing conditions using criteria suggested by the California Department of Transportation (Caltrans), the Federal Highway Administration (FHWA), and additional criteria developed by Fehr & Peers. A number of iterations were required to successively adjust the default SimTraffic and VISSIM parameters for geometrics and driver behavior until the model was validated to observed conditions. Validation criteria and results are presented later in this memorandum.

Once the model was successfully calibrated and validated, it was used to generate measures of corridor performance such as vehicle and transit average speeds, vehicle hours of delay and other performance measures consistent with the Highway Capacity Manual (HCM) (Transportation Research Board, 2000) such as intersection delay and level of service.

Because micro-simulation models like SimTraffic and VISSIM rely on the random arrival of vehicles, multiple runs are needed to provide a reasonable level of statistical accuracy and validity. The models were run twenty times (each using a different random seed number), and then the ten most typical runs were selected and averaged to determine model results. The selection of ten typical runs is designed to remove outliers from the process.

Model Network Coding

Development of the street network and automobiles, trains, bicyclists, and pedestrians that comprise the SimTraffic and VISSIM models required the input of geometric, traffic control and traffic flow data, each of which is described in this section. An overview of the micro-simulation model development process is described below.

Geometric Data

Roadway geometric data (traffic lanes, turn pockets, bus lanes, bus stop locations, etc.) were gathered using aerial photographs and field observations. Lane configurations were initially taken from aerial photographs and were then confirmed or revised based on field observations.

Traffic Control Data

Various City and County agencies provided signal timing plans for the traffic signals in the study area. The signal timing settings include vehicle and pedestrian signal phases and railroad preemption for several intersections. The posted speed limits for streets in the study area were collected during field observations. Maximum vehicle speeds in the model are consistent with posted speed limits, although random speed variability is assigned to each vehicle, causing them to drive above or below the speed limit, to mimic prevailing driver behavior.

Traffic Flow Data

Vehicle Volumes

Fehr & Peers collected or was provided with intersection AM peak period (7:00 to 9:00 AM) and PM peak period (4:00 to 6:00 PM) vehicular turning movement counts at the study intersections. For each model file, the peak one hour of flow in the AM and PM were used as the analysis period. The volumes from this data were then balanced between intersections using the Synchro program. Balancing is the adjustment of turning movement volumes to reduce unexpected changes in through-volumes between adjacent intersections. Where balancing was performed, the volumes were balanced to the higher volume to provide for a conservative analysis.

Pedestrian and Bicycle Volumes

For VISSIM models, pedestrian and bicycle volumes were directly modeled through use of pedestrian crossing counts and bicycle turning movement counts. For SimTraffic models, pedestrian counts were used where available; in situations where counts were not available, pedestrian crossing volumes were assumed to range from 10-50 pedestrians per hour, depending on proximity to major pedestrian travel generators (Caltrain stations, schools, etc.).

Transit Data

For VISSIM intersections, railroad crossing preemption and gate down events were triggered using data from the Caltrain schedule. For SimTraffic intersections, railroad crossing preemption and gate down events were triggered using random arrivals that approximate the train schedule.

Because of high bus frequencies and interactions between buses, automobiles, pedestrians and bikes, the VISSIM model covering the intersections of 4th Street/King Street and 4th Street/Townsend Street in San Francisco was coded with MUNI bus schedule data for the 10 Townsend, 30 Stockton, 45 Union-Stockton, and 47 Van Ness lines were input into the model to reflect the frequent bus movements near the San Francisco-4th Street Caltrain station. Additionally, transit frequencies for the N-Judah and T-Third light rail transit lines were input into the model to reflect at-grade rail movements through the 4th Street/King Street intersection.

Model Calibration

During calibration of a microsimulation model, individual components are adjusted to match collected and field-observed data. Once developed, calibration of a model is necessary to ensure that the model provides a visually accurate depiction of the field-observed condition and that model outputs can be trusted to inform the best possible analysis.

Adjustments to the SimTraffic and VISSIM models focus on the model components related to driver behavior including yielding right-of-way at intersections, driver performance such as aggressiveness, vehicle fleet mix, and vehicle performance. The following SimTraffic and VISSIM model parameters are subject to adjustment:

- Vehicle fleet composition (passenger cars, pickup trucks, SUVs, heavy trucks, etc.)
- Vehicle headways
- Distance between stopped vehicles (standstill distance)
- Driver behavior when changing lanes

Generally speaking, only the lane change behavior was modified to better reflect real world lane changing conditions. This involves changing setting such that vehicles start to make lane changes earlier than the default distance (approximately 650 feet). For congested conditions where late lane changes were the primary cause of congestion developing, the lane change distance was set to 1,500 feet per lane change required.

As an additional calibration step, driver yield behavior to pedestrians at right turn locations was calibrated in the VISSIM models to match observed conditions. Fleet composition, vehicle headways and standstill distance were not changed for calibration of all models.

Model Validation

During validation, the VISSIM model output is compared against field data to determine if the output is within acceptable levels. Caltrans and the FHWA suggest the following validation criteria: (*Guidelines for Applying Traffic Microsimulation Modeling Software*, California Department of Transportation, 2002; *Volume III - Guidelines for Applying Traffic Microsimulation Modeling Software*, Federal Highway Administration, 2003).

- Link volumes for more than 85 percent of cases meet the following criteria:
  - For volumes less than 700 vph, within 100 vph
  - For volumes between 700 and 2,700 vph, within 15 percent
  - For volumes greater than 2,700 vph, within 400 vph

- Link volumes for more than 85 percent of cases have a GEH[1] statistic less than 5 (a measure of how well the model replicates actual conditions)
- Sum of link volumes within 5 percent
- Sum of link volumes have a GEH statistic less than 4
- Average travel times within 15 percent (or one minute, if higher) of measured/reported travel times, for more than 85 percent of measured travel time paths
- Bottlenecks create visually acceptable queuing and agree with observed conditions

Fehr & Peers has developed the following additional validation criterion, which has a narrower tolerance for intersection volumes (which are aggregated link volumes) than the criteria suggested by FHWA and Caltrans.

- Peak-hour volumes for more than 85 percent of intersections within 5 percent of traffic counts

Given the isolated nature of the models, a goal was set to meet 100% of the targets (beyond the requirements of FHWA and Caltrans). **Table 2** shows how the results for the existing conditions SimTraffic and VISSIM models compare to the validation criteria thresholds recommended in the FHWA and Caltrans guidelines and intersection volume validation developed by Fehr & Peers. The results reflect the average of 10 of 20 micro-simulation model runs.

[1] GEH, which received its name from its inventor Geoffrey E. Havers, is a validation statistic that is used to interpret the correlation of two sets of traffic volumes. With respect to the validation of traffic model, the two volumes present in the GEH computation formulae are observed traffic volumes and model estimated traffic volumes.

TABLE 2
VALIDATION CRITERIA THRESHOLDS COMPARISON

Criteria	Criteria Threshold	FHWA/ Caltrans Target for % Met	% Met	Pass/Fail
Link Volumes				
< 700 vph	100 vph	> 85%	100%	Pass
between 700 & 2,700 vph	15%			
> 2,700 vph	400 vph			
GEH Statistic	< 5.00	> 85%	100%	Pass
Sum of Link Volumes				
Sum of All Links	+/- 5%	-	100%	Pass
GEH Statistic	< 4.00	-	100%	Pass
Aggregated Volumes				
Intersections[1]	+/- 5%	>85%	100%	Pass
Visual Inspection				
Queuing	match observations		-	Pass

Notes: **Bold** and underline font indicates that the criteria are not met.
1. Fehr & Peers developed criterion.

Source: Fehr & Peers, 2013

Existing Conditions Results

Traffic operations results were determined using the validated AM and PM peak hour VISSIM and SimTraffic models. The intersection analysis results include a descriptive term known as level of service (LOS). LOS is a measure of traffic operating conditions, which varies from LOS A, which represents free flow conditions, with little or no delay, to LOS F, which represents congested conditions, with extremely long delays. **Table 3** below gives the LOS designations for signalized intersections, and **Table 4** gives the LOS designations for unsignalized intersections.

TABLE 3
SIGNALIZED INTERSECTION LEVEL OF SERVICE DEFINITIONS

Level of Service	Description	Average Control Delay Per Vehicle (Seconds)
A	Operations with very low delay occurring with favorable progression and/or short cycle lengths.	≤ 10.0
B	Operations with low delay occurring with good progression and/or short cycle lengths.	10.1 – 20.0
C	Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear.	20.1 – 35.0
D	Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, and high volume-to-capacity (V/C) ratios. Many vehicles stop and individual cycle failures are noticeable.	35.1 – 55.0
E	Operations with high delay values indicating poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences.	55.1 – 80.0
F	Operations with delays unacceptable to most drivers occurring due to over-saturation, poor progression, or very long cycle lengths.	> 80.0

Source: *2010 Highway Capacity Manual* and Fehr & Peers, November 2013

TABLE 4
UNSIGNALIZED INTERSECTION LEVEL OF SERVICE DEFINITIONS

Level of Service	Description	Average Control Delay Per Vehicle on Worst Approach (Seconds)
A	Little or no delays	≤ 10.0
B	Short traffic delays	10.1 – 15.0
C	Average traffic delays	15.1 – 25.0
D	Long traffic delays	25.1 – 35.0
E	Very long traffic delays	35.1 – 50.0
F	Extreme traffic delays with intersection capacity exceeded	> 50.0

Source: *2010 Highway Capacity Manual* and Fehr & Peers, November 2013

For signalized intersections, delay and LOS are calculated for the whole intersection average. For unsignalized, side-street stop-controlled intersections, the delay and LOS are calculated for the average of the worst approach. For all-way stop-controlled intersections, the delay and LOS are calculated for the whole intersection average. For intersection analysis purposes, these results are compared to a LOS standard for the intersection. **Table 5** lists the intersections, software analysis package, LOS standard and calculated delay and LOS for existing conditions.

TABLE 5
EXISTING INTERSECTION DELAY AND LEVELS OF SERVICE (2013)

Int. ID	Intersection	Jurisdiction	Peak Hour	Intersection Control	Delay	LOS
			ZONE 1			
1	4th Street and King Street	SF	AM PM	Signal	56.6 84.5	E F
2	4th Street and Townsend Street	SF	AM PM	Signal	28.9 28.8	C C
3	Mission Bay Drive and 7th Street	SF	AM PM	Signal	8.3 12.7	A B
4	Mission Bay Drive and Berry Street	SF	AM PM	Signal	2.3 8.4	A A
5	7th Street and 16th Street	SF	AM PM	Signal	67.3 49.5	E D
6	16th Street and Owens Street	SF	AM PM	Signal	10.6 10.7	B B
7	22nd Street and Pennsylvania Street	SF	AM PM	All-way Stop	7.6 7.3	A A
8	22nd Street and Indiana Street	SF	AM PM	All-way Stop	5.3 5.4	A A
9	Tunnel Avenue and Blanken Avenue	SF	AM PM	All-way Stop	7.9 7.2	A A
10	Linden Avenue and Dollar Avenue	SSF	AM PM	Signal	15.1 48.9	B D
11	East Grand Avenue and Dubuque Way	SSF	AM PM	Signal	7.5 7.5	A A
12	S Linden Avenue and San Mateo Avenue	SSF	AM PM	Signal	6.7 7.4	A A
13	Scott Street and Herman Street	SB	AM PM	Side-Street Stop	9.8 14.0	A B
14	Scott Street and Montgomery Avenue	SB	AM PM	Side-Street Stop	4.8 5.7	A A
15	San Mateo Avenue and San Bruno Avenue	SB	AM PM	Signal	10.9 >120	B F
			ZONE 2			
16	El Camino Real and Millbrae Avenue	MB	AM PM	Signal	43.4 42.7	D D
17	Millbrae Avenue and Rollins Road	MB	AM PM	Signal	33.0 38.8	C D
18	California Drive and Broadway	BG	AM PM	Signal	60 52.5	E D
19	Carolan Avenue and Broadway	BG	AM PM	Signal	16.6 42.1	B D
20	California Drive and Oak Grove Avenue	BG	AM PM	Signal	34.3 24.2	C C
21	Carolan Avenue and Oak Grove Avenue	BG	AM PM	Side-Street Stop	>120 92.1	F F

TABLE 5
EXISTING INTERSECTION DELAY AND LEVELS OF SERVICE (2013)

Int. ID	Intersection	Jurisdiction	Peak Hour	Intersection Control	Delay	LOS
22	California Drive and North Lane	BG	AM PM	Side-Street Stop	14.7 11.4	B B
23	Carolan Avenue and North Lane	BG	AM PM	Side-Street Stop	23.0 17.8	C C
24	Anita Road and Peninsula Avenue	BG	AM PM	Side-Street Stop	15.6 >120	C F
25	Woodside Way and Villa Terrace	SM	AM PM	Side-Street Stop	5.1 4.7	A A
26	North San Mateo Drive and Villa Terrace	SM	AM PM	Side-Street Stop	11.7 12.8	B B
27	Railroad Avenue and 1st Avenue	SM	AM PM	Side-Street Stop	10.4 19.0	B C
28	S B Street and 1st Avenue	SM	AM PM	Signal	22.6 30.5	C C
29	9th Avenue and S Railroad Avenue	SM	AM PM	Side-Street Stop	34.7 21.4	D C
30	S B Street and 9th Avenue	SM	AM PM	Signal	15.0 14.4	B B
31	Transit Center Way and 1st Avenue	SM	AM PM	Uncontrolled	5.1 26.7	A D
32	Concar Drive and SR 92 Westbound Ramps	SM	AM PM	Signal	6.0 6.1	A A
33	S Delaware Street and E 25th Avenue	SM	AM PM	Signal	19.1 20.6	B C
34	E 25th Avenue and El Camino Real	SM	AM PM	Signal	32.0 80.6	C F
35	31st Avenue and El Camino Real	SM	AM PM	Signal	19.2 68.7	B E
36	E Hillsdale Boulevard and El Camino Real	SM	AM PM	Signal	43.7 67.1	D E
37	E Hillsdale Blvd. and Curtiss Street	SM	AM PM	Signal	12.0 14.7	B B
38	Peninsula Avenue and Arundel Road and Woodside Way	SM	AM PM	Side-Street Stop	14.3 >120	B F
39	El Camino Real and Ralston Avenue	BL	AM PM	Signal	>120 85.4	F F
40	El Camino Real and San Carlos Avenue	SC	AM PM	Signal	25.6 47.1	C D
41	Maple Street and Main Street	RC	AM PM	Side-Street Stop	10.9 14.3	B B
42	Main Street and Beech Street	RC	AM PM	Side-Street Stop	5.2 8.6	A A
43	Main Street and Middlefield Road	RC	AM PM	Signal	12.5 20.1	B C

TABLE 5
EXISTING INTERSECTION DELAY AND LEVELS OF SERVICE (2013)

Int. ID	Intersection	Jurisdiction	Peak Hour	Intersection Control	Delay	LOS
44	Broadway Street and California Street	RC	AM PM	Signal	60.0 >120	F F
45	El Camino Real and Whipple Avenue	RC	AM PM	Signal	74.7 48.3	E D
46	Arguello Street and Brewster Avenue	RC	AM PM	Signal	14.7 39.4	B D
47	El Camino Real and Broadway Street	RC	AM PM	Signal	27.5 45.5	C D
48	Arguello Street and Marshall Street	RC	AM PM	Signal	15.1 48.7	B D
49	El Camino Real and James Avenue	RC	AM PM	Signal	26.2 33.7	C C
			ZONE 3			
50	El Camino Real and Fair Oaks Lane	AT	AM PM	Signal	33.6 27.6	C C
51	El Camino Real and Watkins Avenue	AT	AM PM	Side-street stop	34.5 48.1	D E
52	Fair Oaks Lane and Middlefield Road	AT	AM PM	Side-Street Stop	>120 41.3	F E
53	Watkins Avenue and Middlefield Road	AT	AM PM	Side-Street Stop	31.6 28.3	D D
54	Glenwood Avenue and Middlefield Road	AT	AM PM	Side-Street Stop	49.2 >120	E F
55	El Camino Real and Glenwood Avenue	MP	AM PM	Signal	34.1 29.6	C C
56	El Camino Real and Oak Grove Avenue	MP	AM PM	Signal	17.9 30.9	B C
57	El Camino Real and Santa Cruz Avenue	MP	AM PM	Signal	9.1 12.5	A B
58	Merrill St and Santa Cruz Avenue	MP	AM PM	All-way Stop	7.3 8.9	A A
59	Ravenswood Avenue and Alma Street	MP	AM PM	Side-Street Stop	24.4 17.1	C C
60	El Camino Real and Ravenswood Avenue	MP	AM PM	Signal	39.3 119.0	D F
61	Ravenswood Avenue and Laurel Street	MP	AM PM	Signal	31.0 26.3	C C
62	Alma Street and Palo Alto Avenue	PA	AM PM	Side-Street Stop	11.2 14.6	B B
63	Meadow Drive and Alma Street	PA	AM PM	Signal	72.6 62.0	E E
64	El Camino Real and Alma Street and Sand Hill Road	PA	AM PM	Signal	60.7 49.1	E D
65	High Street and University Avenue	PA	AM PM	Signal	12.6 14.1	B B

TABLE 5
EXISTING INTERSECTION DELAY AND LEVELS OF SERVICE (2013)

Int. ID	Intersection	Jurisdiction	Peak Hour	Intersection Control	Delay	LOS
66	Alma Street and Churchill Avenue	PA	AM PM	Signal	66.0 64.0	E E
67	W Meadow Drive and Park Blvd.	PA	AM PM	Side-Street Stop	>120 29.3	F D
68	Alma Street and Charleston Road	PA	AM PM	Signal	63.5 80.5	E F
69	Showers Drive and Pacchetti Way	MV	AM PM	Signal	4.5 3.7	A A
70	Central Expressway and N Rengstorff Avenue	MV	AM PM	Signal	108.0 85.0	F F
71	Central Expressway and Moffett Boulevard and Castro Street	MV	AM PM	Signal	100.2 83.0	F F
72	W Evelyn Avenue and Hope Street	MV	AM PM	Signal	3.0 4.0	A A
73	Rengstorff Avenue and California Street	MV	AM PM	Signal	50.3 55.6	D E
74	Castro Street and Villa Street	MV	AM PM	Signal	11.8 21.2	B C
75	W Evelyn Avenue and S Mary Avenue	SV	AM PM	Signal	62.4 61.5	E E
76	W Evelyn Avenue and Frances Street	SV	AM PM	Signal	16.1 23.4	B C
		ZONE 4				
77	Kifer Road and Lawrence Expressway	SCL	AM PM	Signal	96.6 >120	F F
78	Reed Avenue and Lawrence Expressway	SCL	AM PM	Signal	97.3 93.7	F F
79	El Camino Real and Railroad Avenue	SCL	AM PM	Signal	26.6 21.3	C C
80	W Santa Clara Street and Cahill Street	SJ	AM PM	Signal	10.4 12.7	B B
81	S Montgomery Street and W San Fernando Street	SJ	AM PM	Signal	7.9 9.6	A A
82	Lick Avenue and W Alma Avenue	SJ	AM PM	Signal	15.8 20.8	B C

Notes:
1. Jurisdictions:
SF San Francisco
SSF South San Francisco
SB San Bruno
MB Millbrae
BG Burlingame
SM San Mateo

LOS designation per *2010 Highway Capacity Manual*

BL Belmont
SC San Carlos
RC Redwood City
AT Atherton
MP Menlo Park
PA Palo Alto
MV Mountain View
SV Sunnyvale
SCL Santa Clara

SCC Santa Clara County
SJ San Jose

AM = morning peak hour, PM = afternoon peak hour
LOS designation as per 2010 Highway Capacity Manual

Delay measured in seconds.

Source: Fehr & Peers, 2013

These results are incorporated into the EIR for the Proposed Project. The resulting Existing Conditions models will be used as the basis for the Year 2020 and Year 2040 scenarios for No Project and Project conditions.

ATTACHMENT F
FUTURE CONDITIONS TRAFFIC MODEL RESULTS TECHNICAL MEMORANDUM

ATTACHMENT F

Date: January 27, 2014

To: Caltrain Electrification EIR Project Team

From: Katie Leung and Matt Haynes, Fehr & Peers

Subject: Future Conditions Process and Results

SJ13-1440

Introduction

This memorandum describes the methodology and results of an analysis of 82 intersections along the Caltrain line in San Francisco, San Mateo, and Santa Clara Counties under Year 2020 and Year 2040 conditions with and without the proposed Peninsula Corridor Electrification Project (PCEP). Fehr & Peers developed traffic microsimulation models to analyze the environmental impacts of the proposed project. Most of the intersections (64) were modeled using the Synchro/SimTraffic software package. The remaining 18 intersections were modeled using the VISSIM software package. The process consisted of the following key steps:

- Future Volume Forecast
- Future Caltrain Gate Down Times
- Model Development
- Model Analysis

Future traffic volumes, train frequencies, and crossing times served as inputs for the microsimulation models under future conditions. The remainder of this memorandum describes these steps in more detail and provides the results of the analysis.

Future Volumes Forecast

Vehicle Volumes

Fehr & Peers forecasted AM and PM peak hour vehicular turning movement volumes at the study intersections. The forecasts were completed using the Valley Transportation Authority (VTA) model. Additional adjustments were made based on the results of the Fehr & Peers' Direct Ridership model (DRM). The DRM fine-tunes the ridership estimates produced by the VTA model for station-level detail. Recalibration of the number of individuals accessing Caltrain stations via park-and-ride and kiss-and-ride were reflected in the turning movement forecasts.

Existing and future AM and PM peak hour turning movement volumes are shown in Figures 1-5 appended to the end of this memorandum.

Pedestrian and Bicycle Volumes

Future pedestrian and bicycle volumes around Caltrain stations were developed from the DRM. The DRM provides estimates for the number of riders accessing and egressing Caltrain stations by walking and biking. Using these volumes, an approximate pedestrian and bike growth factor was estimated around each Caltrain station for both the no project and project scenarios. Bicycle volumes were not modeled in SimTraffic.

Future Caltrain Gate Down Times

For VISSIM intersections, railroad crossing preemption and gate down events were triggered using data from the prototypical 2020 and 2040 schedules. For SimTraffic intersections, railroad crossing preemption and gate down events were triggered using random arrivals that approximated the prototypical schedules.

For the 2020 and 2040 scenarios, the average single-train gate down time per event was calculated and inputted into the models. The average was calculated over the vehicular peak hour for the study intersections at or near each grade crossing. The AM vehicular peak hour of travel is the greatest 60 minute period of vehicular traffic from 7:00-9:00 AM. The PM vehicular peak hour of travel is the greatest 60 minute period of vehicular traffic from 4:00-6:00 PM. Only single-train events were used to calculate the average. Since VISSIM models have a higher level of detail and allow for the input of the actual train schedule, the VISSIM models can more exactly replicate 2-for-1 events.[1] While SimTraffic models do not allow for the input of the actual train schedule, these models are capable of estimating 2-for-1 events by using random train arrivals that approximate the train schedule.

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[1] A 2-for-1 event is when two trains traveling in opposite directions (one southbound and one northbound) pass through an at-grade crossing at the same time, triggering a joint gate down-time event.

Future Conditions Model Development

The development of VISSIM and SimTraffic models under Existing Conditions is described in the Existing Conditions Memorandum. These models were also used for 2020 and 2040 No Project Conditions with adjustments made for:

- Future vehicle, pedestrian, and bicyclist volumes
- Optimized intersection signal timing
- Future train frequency, pre-emption times, and crossing times when applicable

The 2020 and 2040 No Project models were then used for the 2020 and 2040 Plus Project Conditions models with adjustments made for:

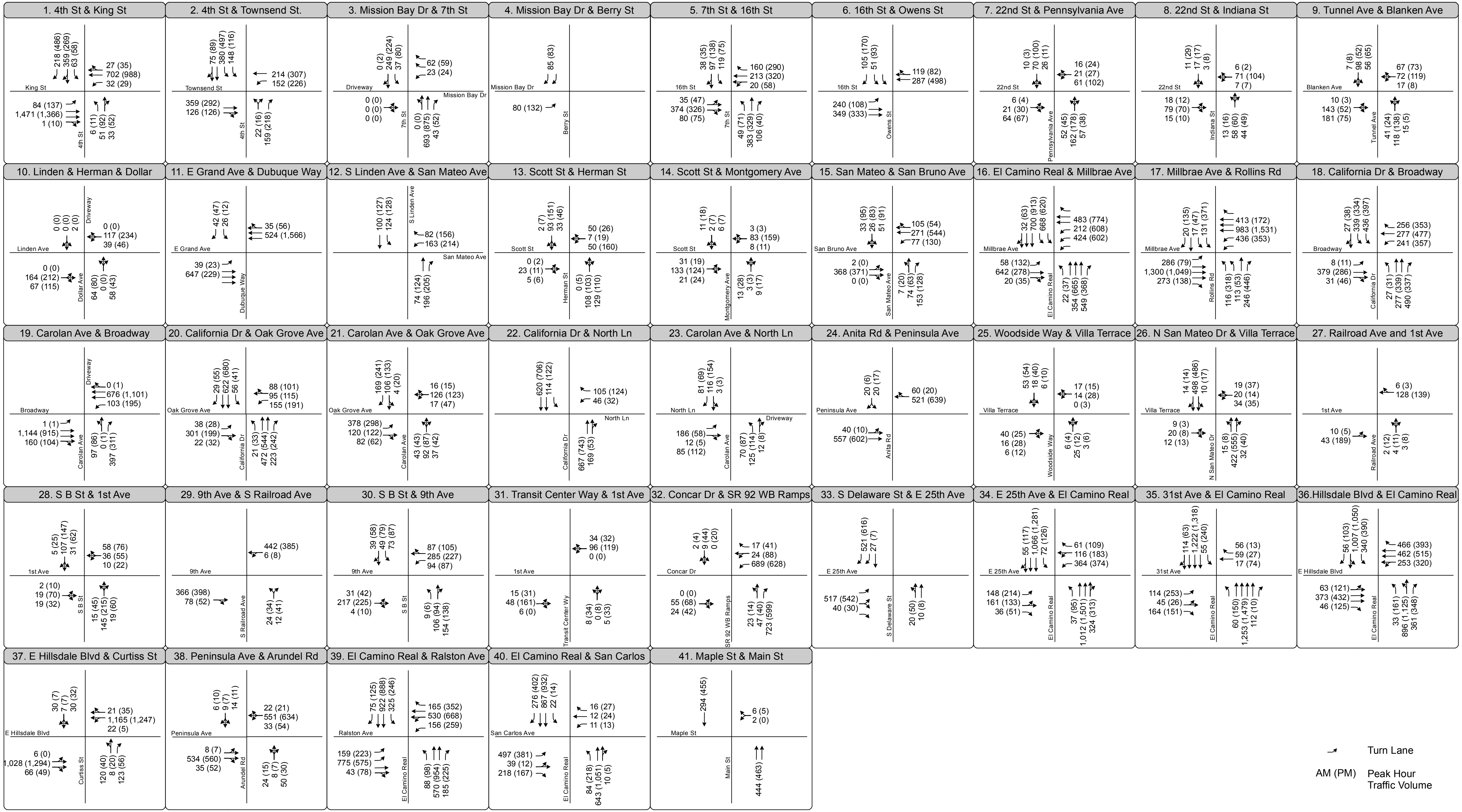
- Future vehicle, pedestrian, and bicyclist volumes *with* the Project
- Future train frequency, pre-emption times, and crossing times *with* the Project, when applicable

No changes were made to the signal timings from the corresponding year under No Project Conditions, since it was assumed that the signal timings would not change with the addition of the Project.

As described in the *Existing Conditions VISSIM and SimTraffic Models Calibration and Validation* memorandum (Attachment E) these models were used to generate measures of corridor performance such as vehicle and transit average speeds, vehicle hours of delay and other performance measures consistent with the Highway Capacity Manual (HCM) (Transportation Research Board, 2000) such as intersection delay and level of service.

Future Conditions Results

Traffic operations results were determined using the AM and PM peak hour VISSIM and SimTraffic models. Year 2020 No Project and 2020 Project intersection delay and level of service are presented in **Tables 3-25 and 3-26** in the Transportation Impact Analysis.



Attachment Figure 1.A

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - Existing Conditions

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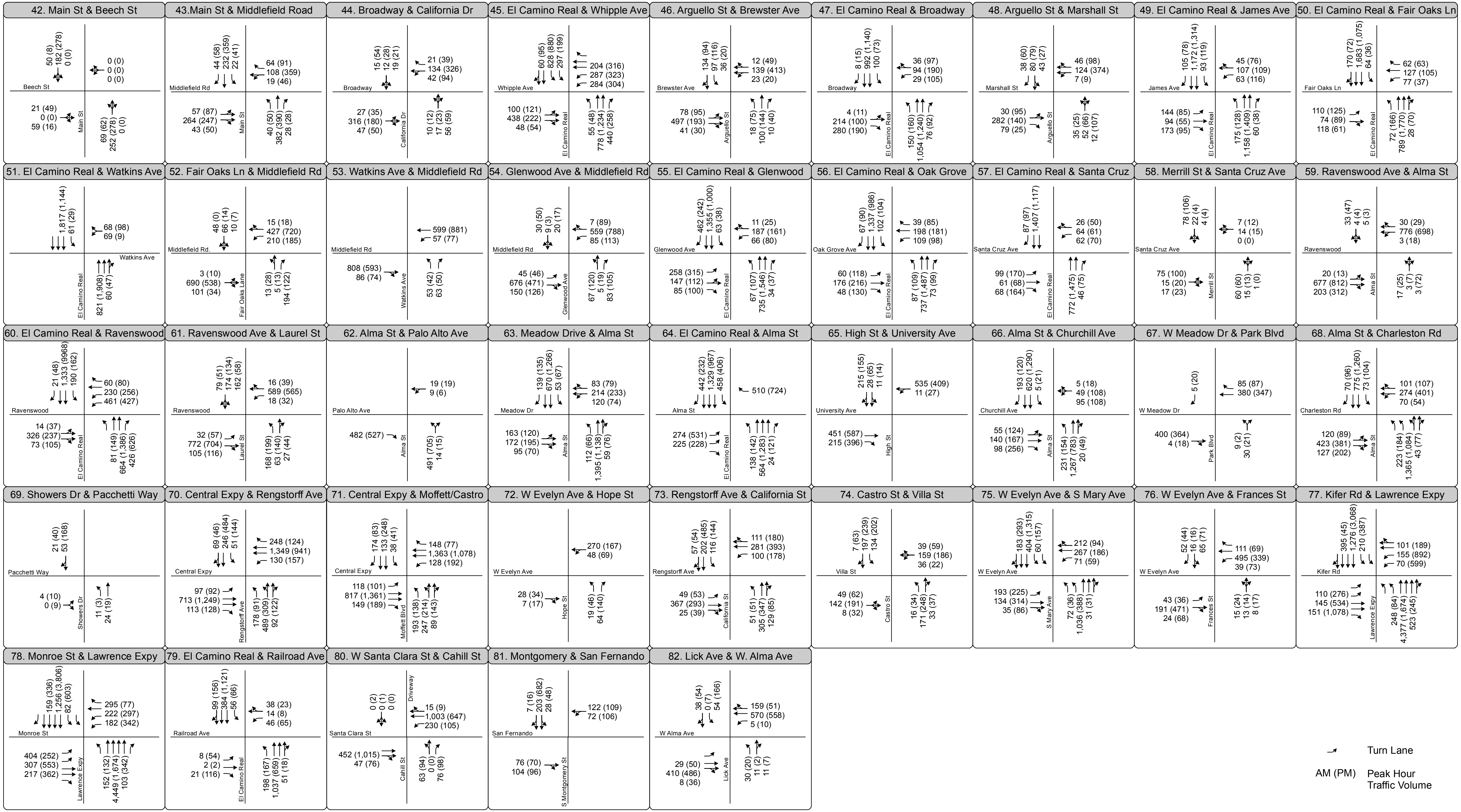

Attachment Figure 1.B

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - Existing Conditions

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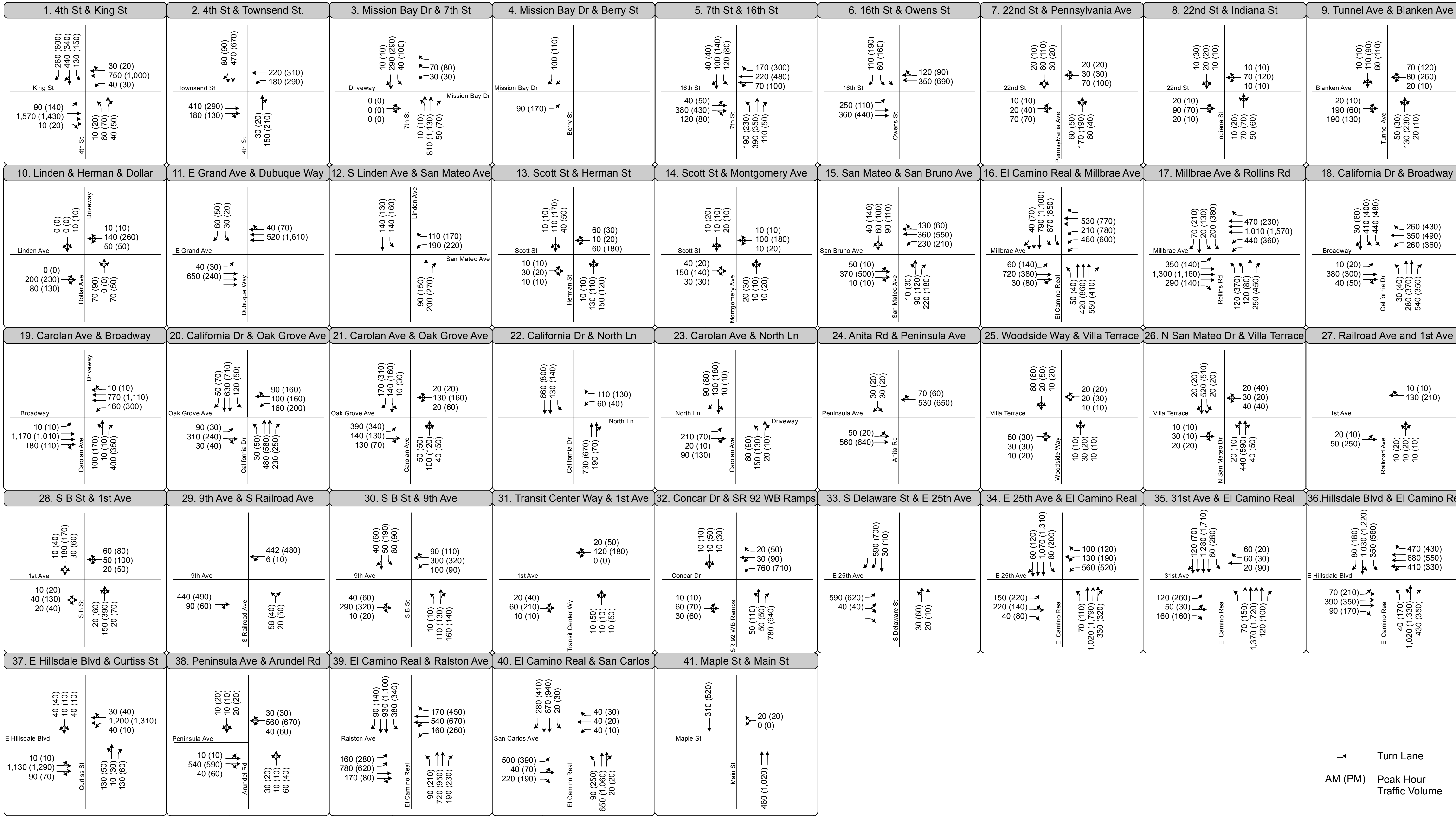

Attachment Figure 2.A

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2020 No Project Scenario

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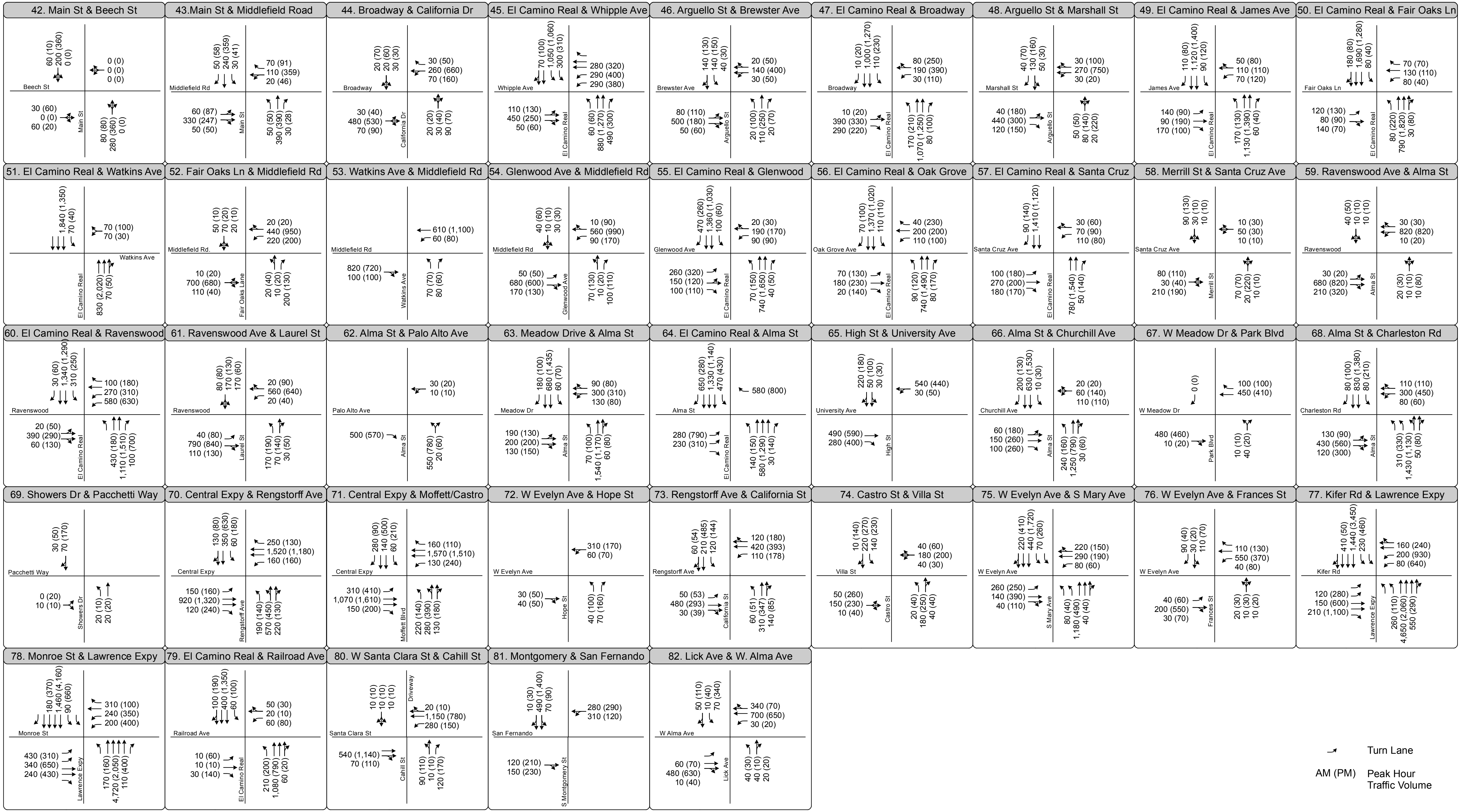

Attachment Figure 2.B

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2020 No Project Scenario

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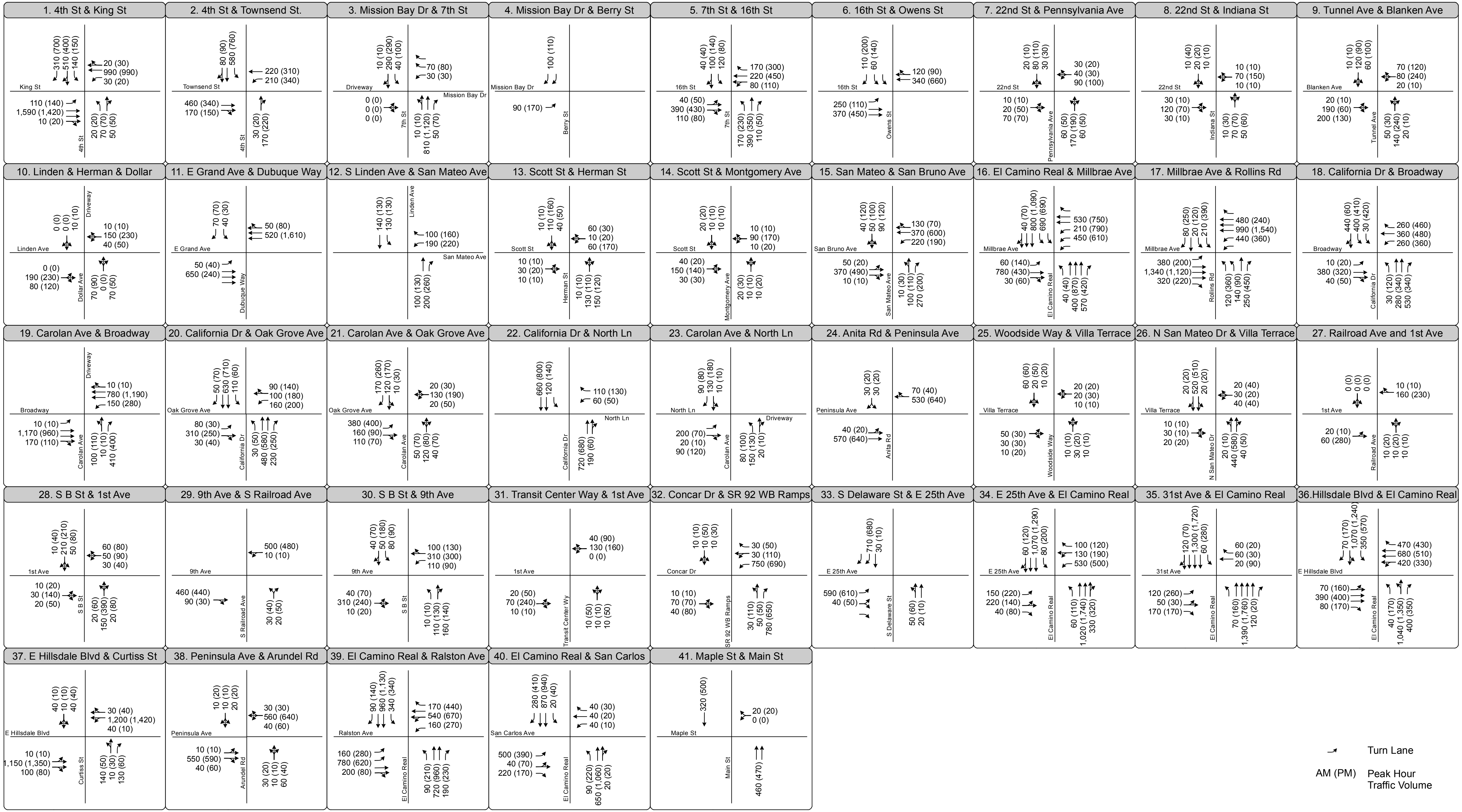

Attachment Figure 3.A

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2020 Project Scenario

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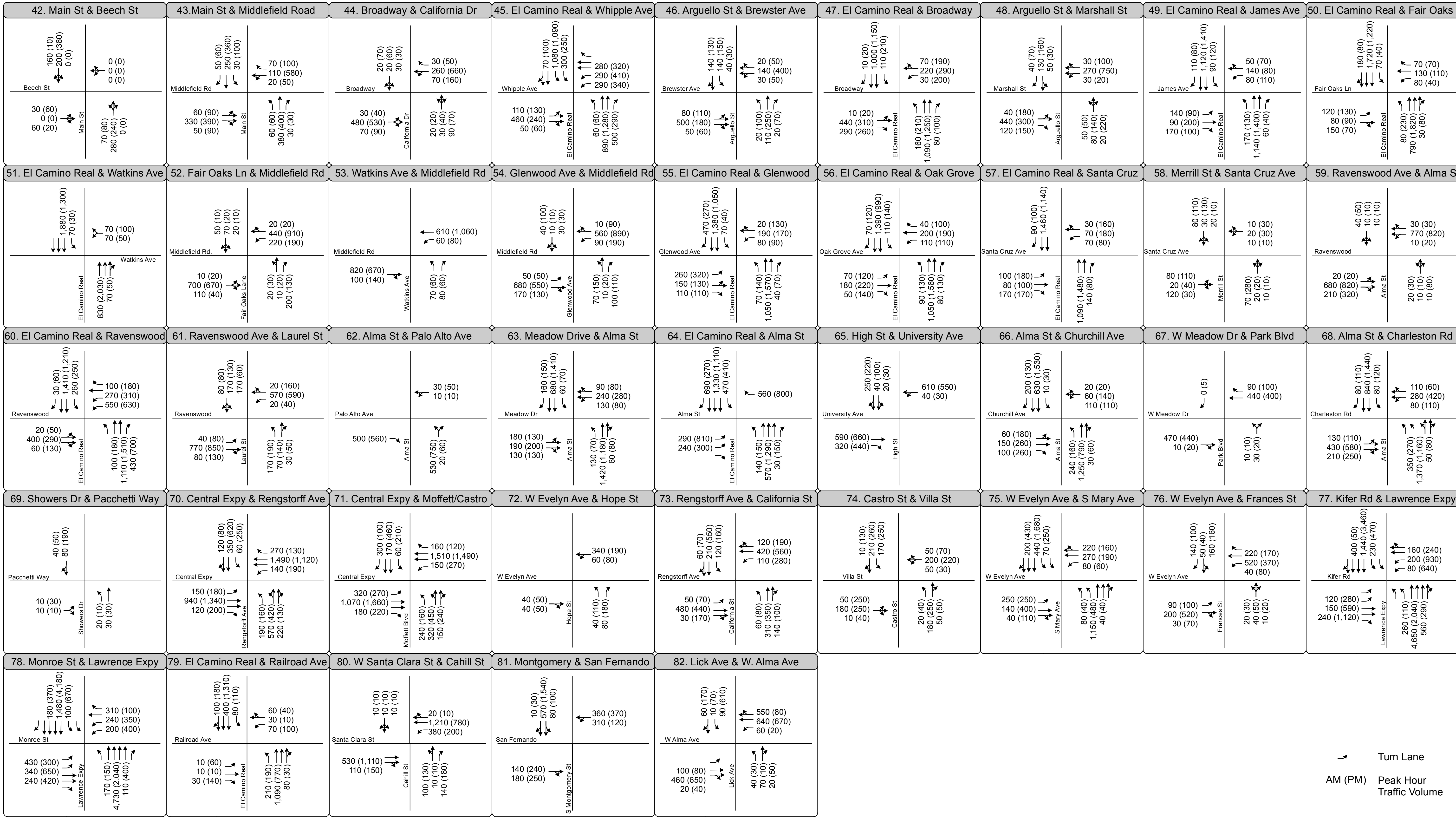

Attachment Figure 3.B

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2020 Project Scenario

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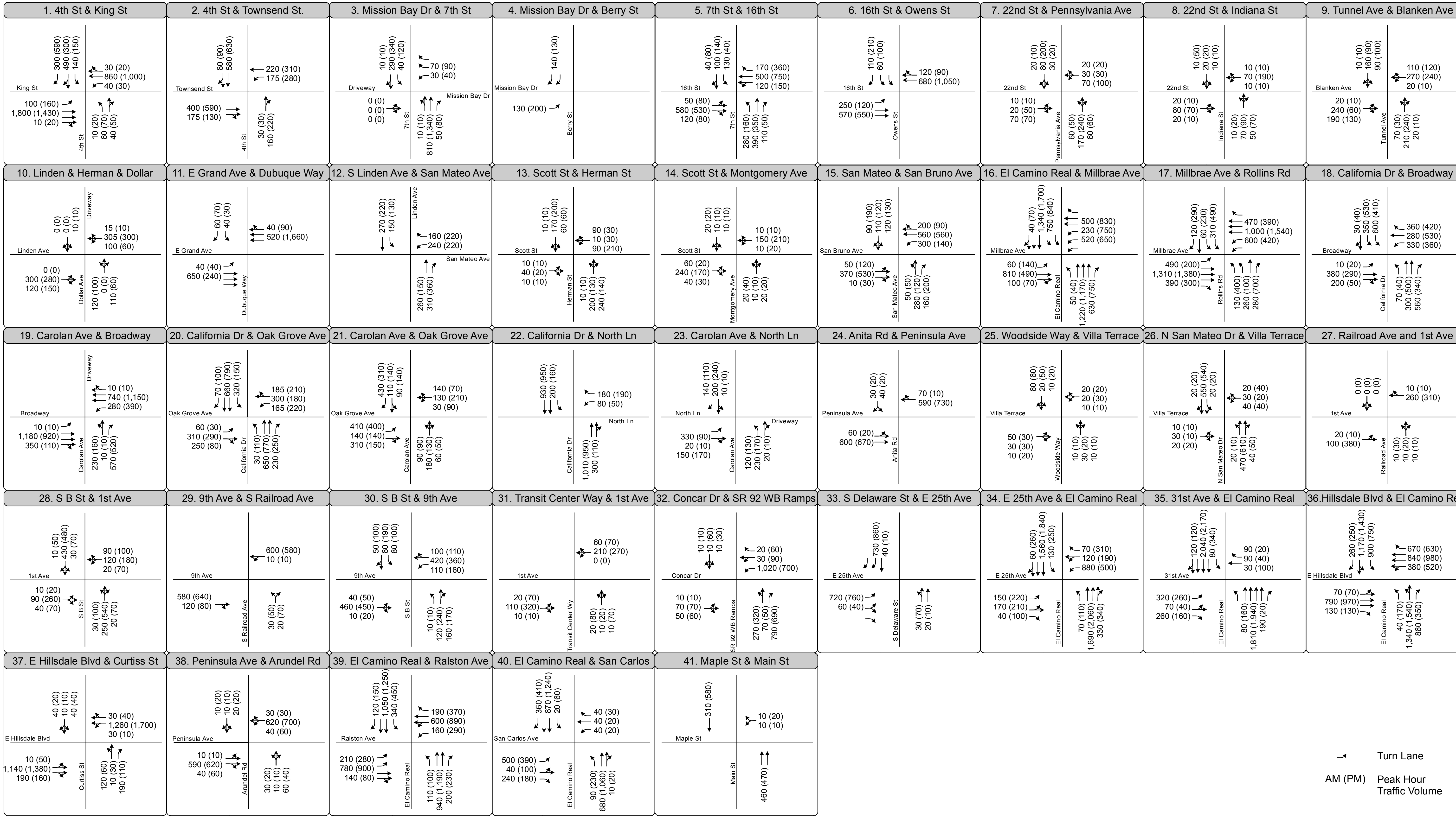

Attachment Figure 4.A

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2040 No Project Scenario

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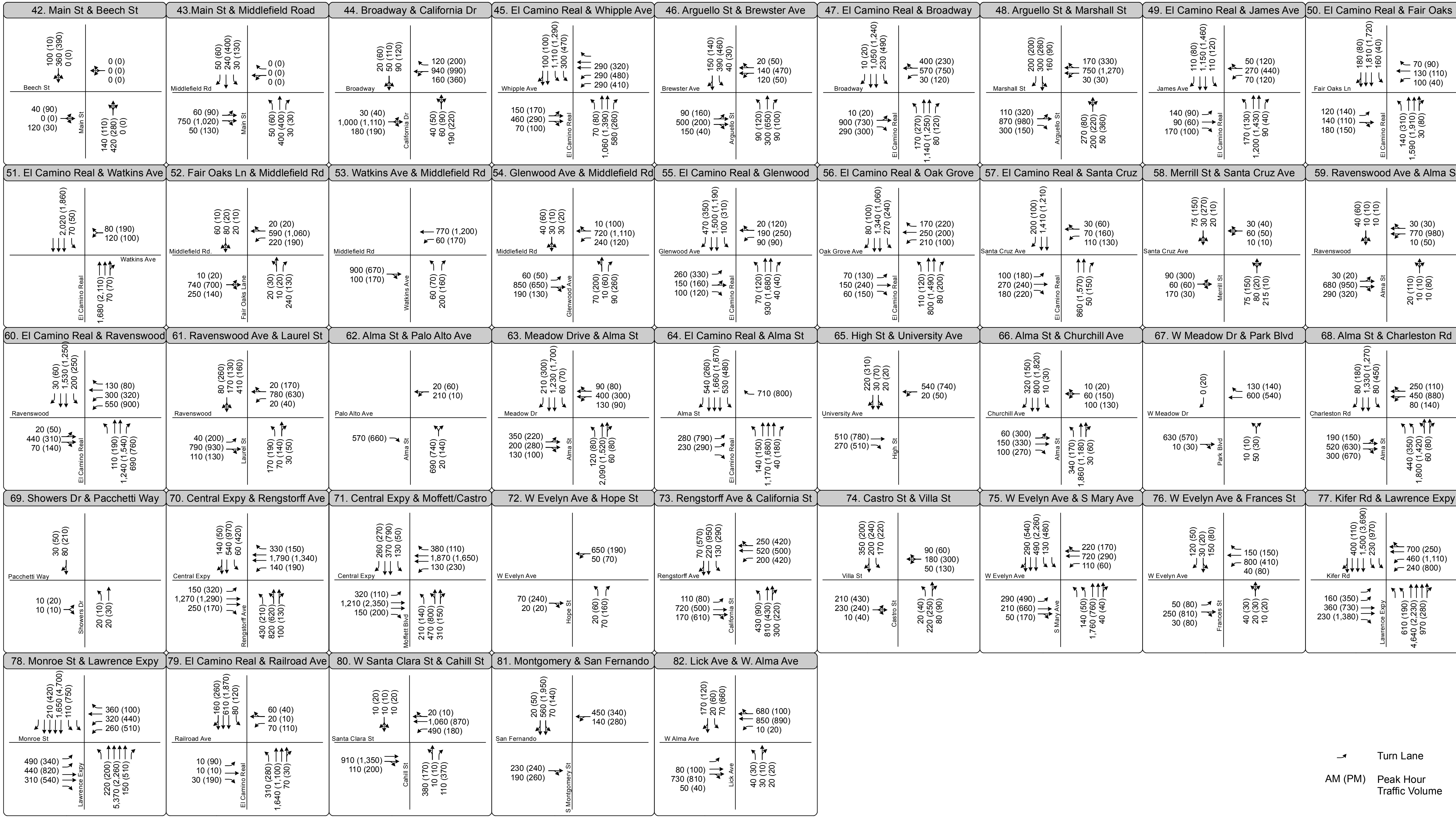

Attachment Figure 4.B

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2040 No Project Scenario

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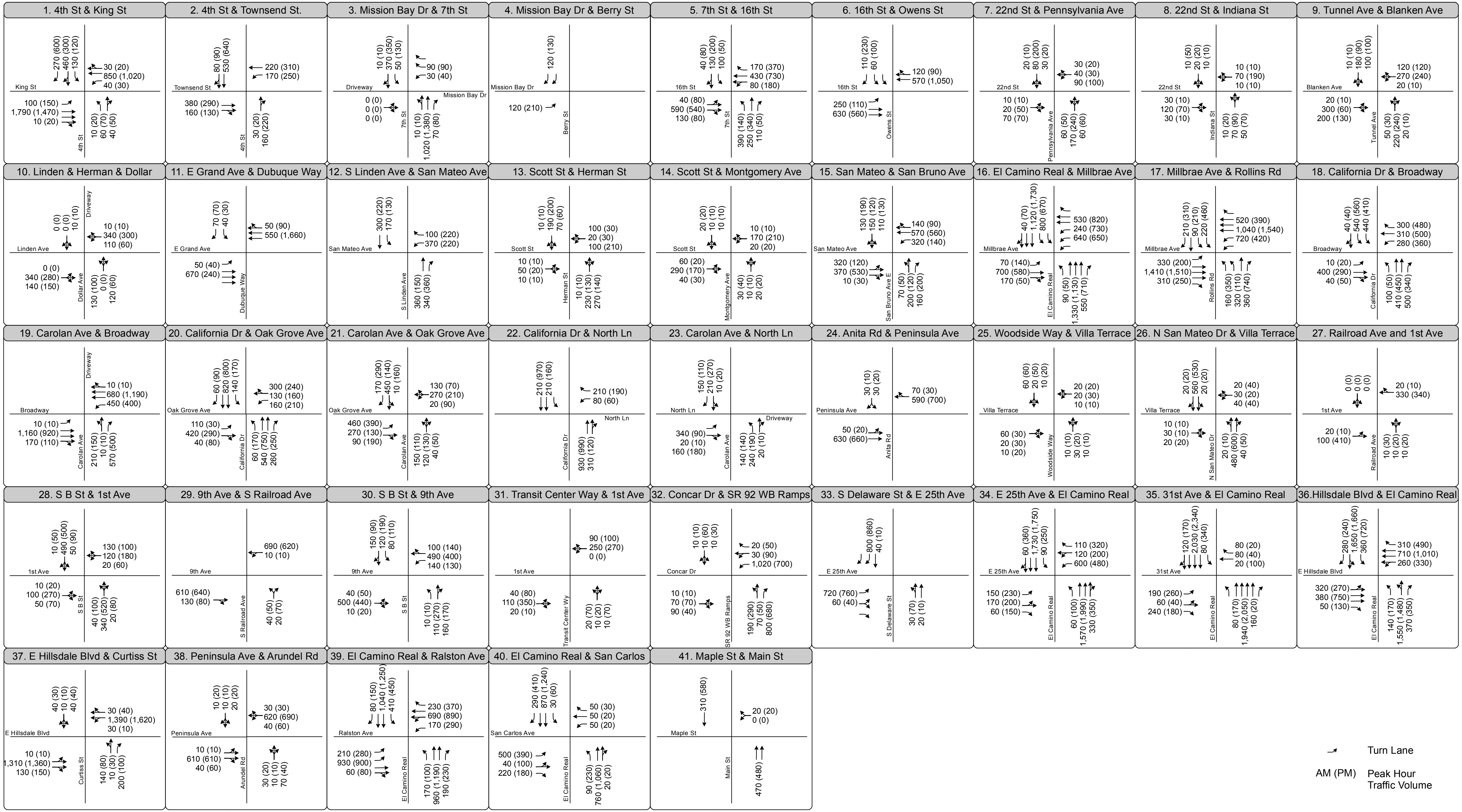

Attachment Figure 5.A

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2040 Project Scenario

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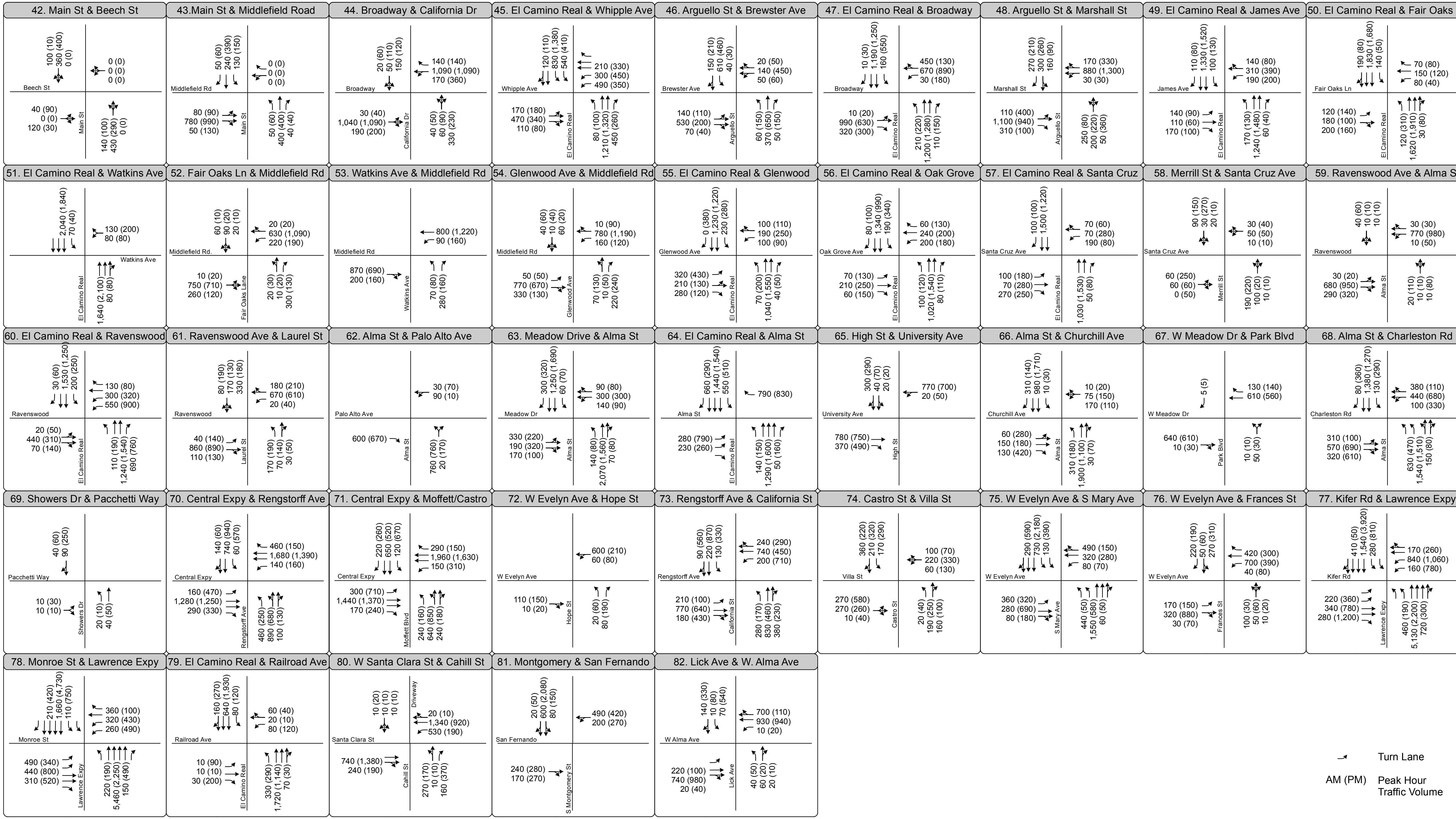

Attachment Figure 5.B

Lane Configurations, Traffic Control, and Peak Hour Traffic Volumes - 2040 Project Scenario

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