DKS Associates
TRANSPORTATION SOLUTIONS

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EXECUTIVE SUMMARY

To help redevelopment efforts, Carson City is exploring changes in the circulation system that serves its downtown core area once the full Carson City Freeway is completed. The proposed Carson Street Narrowing project would involve reducing the number of lanes on Carson Street from four to two between 5th Street and William Street. The narrowing project would allow on-street parallel parking along most of this 0.6 mile stretch of Carson Street and still accommodate left-turn lanes at major intersections.

This report documents a traffic operations analysis of the proposed Carson Street Narrowing project under 2015 and 2030 conditions. The key conclusions from that analysis are as follows:

- The Carson City Freeway will substantially reduce traffic volumes, especially trucks, on Carson Street in the downtown core area. However, after the freeway is completed, traffic demand on Carson Street will increase due to growth in the central area of the City and by 2030 traffic volumes on a four-lane Carson Street would reach over 31,000 daily vehicles, or 85 percent of today's levels.

- To accommodate the reduction in travel lanes on Carson Street, enough north-south traffic must be diverted onto Stewart Street and Roop Street, and the two-lane portion of Carson Street must have adequate turn lanes at key intersections and proper signal timing.

- The narrowing of Carson Street between William Street and 5th Street from four to two lanes would cause a shift in traffic from Carson Street to alternate parallel roadways. A significant shift in traffic would be possible for the following reasons:

    1) Stewart Street would have substantial spare traffic-carrying capacity to accommodate traffic diverted from Carson Street.
    2) Also, east-west "cross-street" volumes are relatively low, which would facilitate traffic shits to Stewart Street.
    3) Once the full Carson City Freeway is completed, fewer trips using Carson Street would be long-distance trips and a significant portion of the remaining local trips using Carson Street could readily shift to parallel roadways, like Stewart Street, since they would provide comparable travel times for certain movements.

- Due to low traffic volumes on most cross-streets, all signalized intersections along Carson Street would still operate within the City's level of service standard with the narrowing of Carson Street, however, queue lengths would increase at some key intersections

- The intersection of Carson Street and William Street would experience the longest queues, with northbound queues averaging three blocks in length during the AM and PM peak hours, and stretching upwards of four blocks at times. Although the longest queues would not happen every peak hour, long queue lengths would be experienced a number of times during the average week.

- To minimize queue lengths and improve traffic flow, the following improvements could be made within the existing curb-to-curb width at the intersection of Carson Street and William Street:

  - One of the two southbound lanes on Carson Street at William Street could become a second left turn lane to increase capacity for this critical movement and to encourage southbound traffic to use Stewart Street instead of Carson Street through downtown.

  - The second northbound through lane on Carson Street between William Street and Sophia Street could be maintained, but this would preclude on-street parking along the east side of this one block.

- Average vehicle speeds on Carson Street would be lower with the proposed project, which would cause the diversion of traffic to parallel streets. The slower traffic speeds, coupled with reduced crossing distances, would promote safer pedestrian access along the Carson Street corridor.

In summary, the City should be able to reasonably accommodate anticipated traffic volumes along Carson Street, Stewart Street, and Roop Street with the proposed Carson Street Narrowing project if the following occurs:

1) The full Carson City Freeway is implemented

2) Left turn lanes are maintained at all signalized intersections along the two-lane section of Carson Street

3) Signals along Carson Street are properly coordinated and timed

4) To minimize queuing, adequate traffic lanes at the intersection of Carson Street and William Street should be provided.

1.0 INTRODUCTION

To help redevelopment efforts, Carson City is exploring changes in the circulation system that serves its downtown core area once the full Carson City Freeway is completed. The proposed Carson Street Narrowing project (the Project) would involve reducing the number of lanes on Carson Street from four to two between 5th Street and William Street. The narrowing project should allow on-street parallel parking along most of this 0.6 mile stretch of Carson Street and still accommodate left-turn lanes at major intersections.

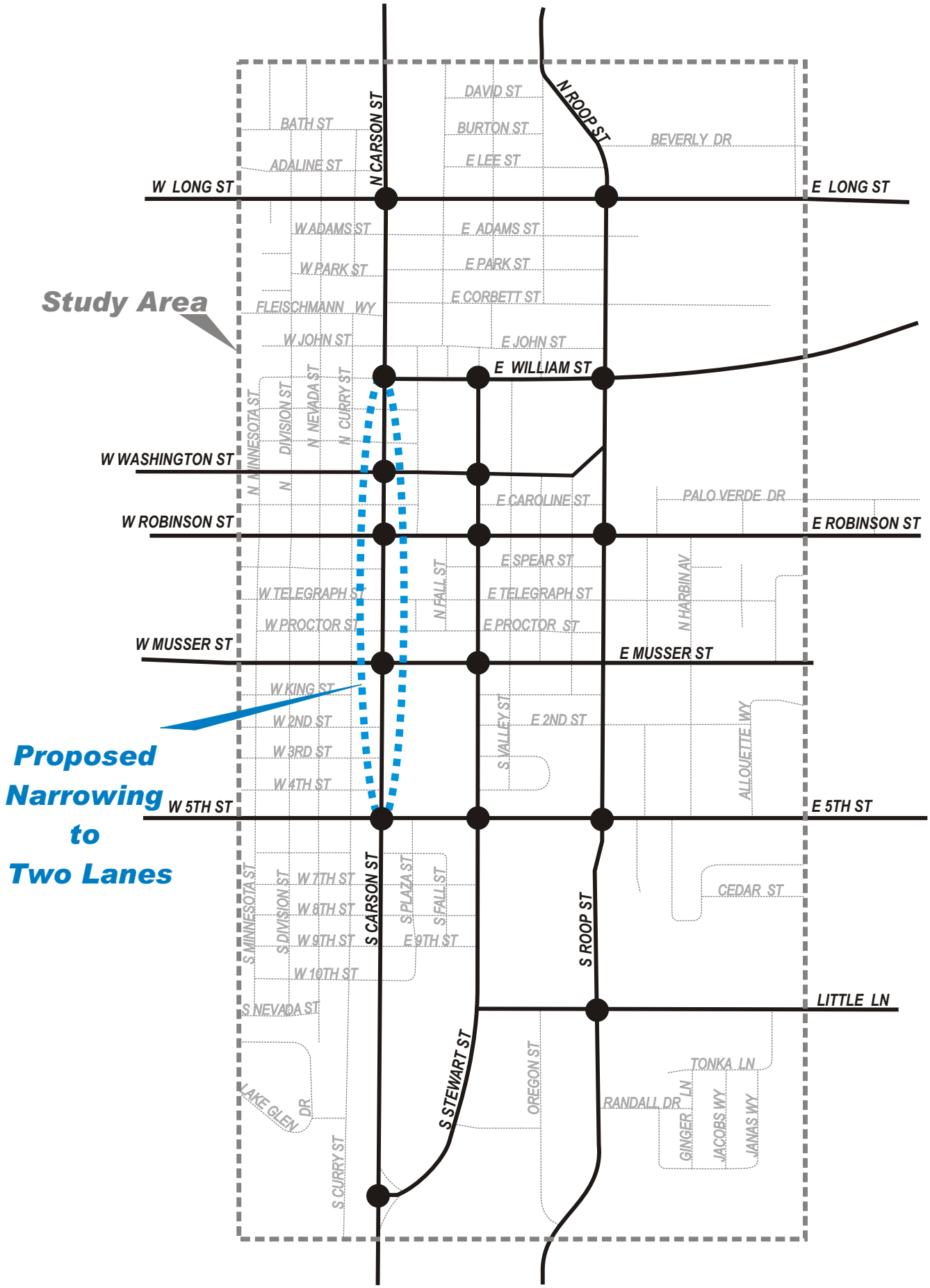
The peak period capacity and level of service (LOS) of the downtown grid system of streets is controlled by the capacity of its major signalized intersections and the timing of an interconnected signal system. To analyze the effect that the narrowing of Carson Street will have on peak period traffic operations, a traffic simulation model using the Synchro/Simtraffic software was developed covering the downtown street system.

Traffic volumes that are used in the Synchro/Simtraffic traffic simulation model were provided by a detailed downtown travel demand forecasting model, which is a "focused version" of the recently developed CAMPO Travel Demand Model. The new CAMPO Travel Demand Model, which covers all of Carson City plus northern Douglas County and western Lyon County, was used to reflect updated development forecasts for 2015 and 2030and to predict traffic volumes after the full Carson City Freeway is constructed.

The CAMPO Travel Demand Model includes all of the arterial and collector roadways in the Carson City but it does not include all of the streets in the downtown grid system. To adequately evaluate the impact of the Carson Street Narrowing Project, a detailed "focus area" model was created from the CAMPO model.

Figure 1 shows the approximate Downtown Study Area, which covers an area from north of Long Street to Fairview Drive and from west of Carson Street to east of Roop Street. The major north/south "study corridors" are Carson Street, Stewart Street and Roop Street. Major east/west roadways within the study area include (from north to south) Long Street, William Street, Washington Street, Robinson Street, Musser Street, 5th Street, and Little Lane.

To develop the traffic simulation model and conduct the detailed traffic operations analysis, peak period traffic counts were conducted at 47 downtown intersections (17 signalized and 30 un-signalized) in the downtown grid system. While the Synchro/Simtraffic analysis uses data at all major and minor intersections along the north-south study corridors, the analysis focuses on operations at the 17 major signalized intersections along Carson Street, Stewart Street, and Roop Street shown in Figure 1.



LEGEND

● Study Intersections

NO SCALE

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Figure 1
STUDY AREA & INTERSECTIONS

This analysis covers the following scenarios:

- **Existing Conditions** based on 2005/2006 traffic count data

- **2015 No Project Conditions** that reflect the current Carson Area Transportation Plan, which includes the following key projects that will effect traffic in the downtown area:
  - Completion of the Carson City Freeway
  - Widening of Roop Street to 4 lanes from Washington Street to Beverly Drive.
  - Extension of Stewart Street from William Street to Roop Street
  - The conversion of William Street west of Carson Street to one way westbound

- **2015 Plus Project**, which assumes the following changes to the 2015 Base Conditions:
  - Reducing lanes on Carson Street to two through lanes from 5th Street to William Street.
  - Maintain left turn lanes at signalized intersections on Carson Street between 5th Street and William Street
  - Potential changes in geometrics for William Street intersections with Carson Street and Stewart Street

- **2030 No Project Conditions** that reflect the current Carson Area Transportation Plan, which includes the following key projects that will effect traffic in the downtown area:
  - Completion of the Carson City Freeway
  - Widening of Roop Street to 4 lanes from Little Lane to Beverly Drive
  - Extension of Stewart Street from William Street to Roop Street
  - The conversion of William Street west of Carson Street to one way westbound

- **2030 Plus Project**, which assumes the following changes to the 2030 Base Conditions:
  - Reducing lanes on Carson Street to two through lanes from 5th Street to William Street.
  - Maintain left turn lanes at signalized intersections on Carson Street between 5th Street and William Street
  - Potential changes in geometrics for William Street intersections with Carson Street and Stewart Street

The results of the analysis of each scenario are described in detail in the following sections.

2.0 EXISTING CONDITIONS

2.1 Travel Lanes

The number of existing travel lanes on the street system in the downtown study area are shown in Figure 2. Carson Street currently has four travel lanes through downtown area with left-turn lanes at most intersections. Stewart Street has two lanes north of William Street and four lanes south of William Street. However, there are no left turn lanes at intersections on Stewart Street between William Street and 5th Street. Roop Street currently has two lanes between Beverly Drive and Little Lane and four lanes north of Beverly Drive and south of Little Lane.

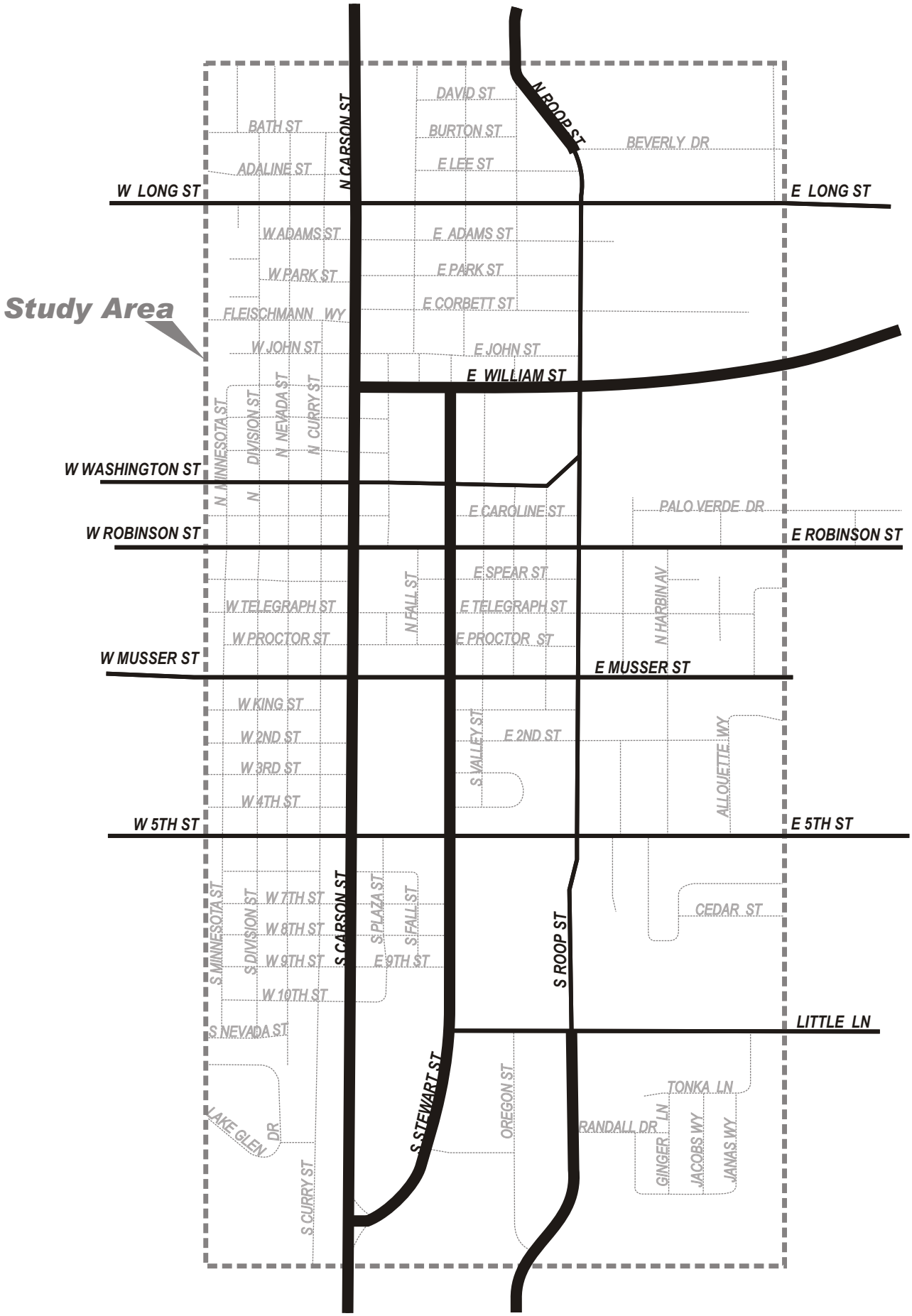
2.2 Traffic Volumes

Daily traffic volume data were compiled from the Nevada Department of Transportation's (NDOT) 2005 Annual Traffic Report. Figure 3 and Table 1 show existing daily two-way traffic volumes on the major north-south study area roadways. Daily traffic volumes on Carson Street currently range from approximately 35,500 vehicles south of Robinson Street to approximately 40,500 vehicles north of Long Street.

Table 1:
Existing Daily and Peak Hour Volumes on Key Roadway Segments

Roadway	Location	Volume Type	Volume
Carson Street	North of Washington Street	Daily Volume PM Peak Hour Peak Hour %	36,000 2,700 8%
	North of Musser Street	Daily Volume PM Peak Hour Peak Hour %	35,500 2,700 8%
Stewart Street	South of William Street	Daily Volume PM Peak Hour Peak Hour %	13,000 1,200 9%
	North of 5th Street	Daily Volume PM Peak Hour Peak Hour %	14,100 1,500 11%
	South of 5th Street	Daily Volume PM Peak Hour Peak Hour %	15,400 1,700 11%
Roop Street	South of Robinson Street	Daily Volume PM Peak Hour Peak Hour %	13,400 1,200 9%

Sources: NDOT 2005 Annual Traffic Report and peak hour counts conducted by DKS Associates



LEGEND

- **Existing 4 Lane Arterial**
- **Existing 2 Lane Arterial**
- **Existing 2 Lane Local**

NO SCALE

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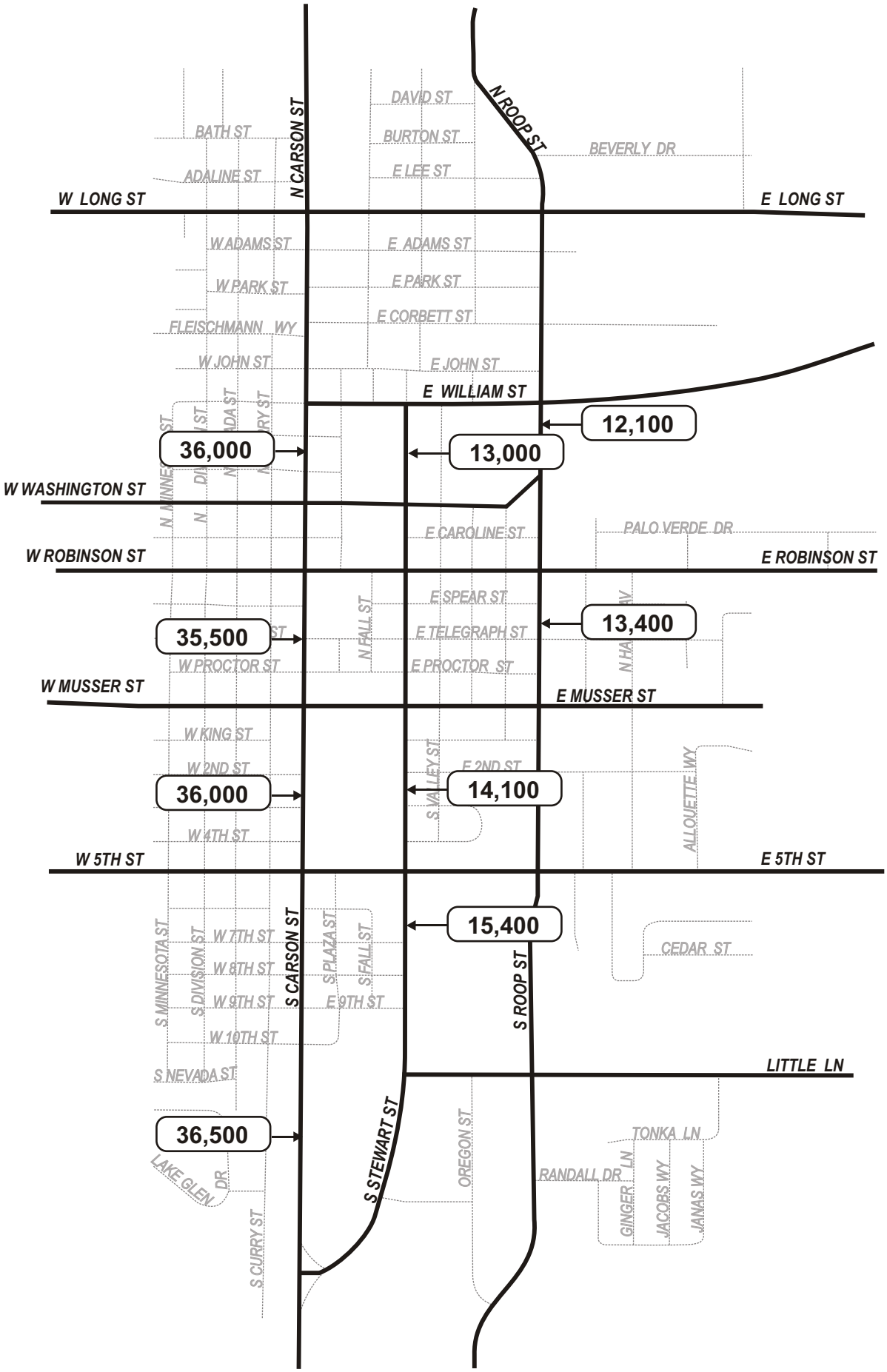
Figure 2
Existing Roadway Travel Lanes



LEGEND

xx,xxx — Daily Two-Way Volume

NO SCALE

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Figure 3
EXISTING DAILY TRAFFIC VOLUMES

Daily two-way traffic volumes on Stewart Street range from approximately 11,800 south of Little Lane to 15,400 south of 5th Street and approximately 13,000 vehicles south of William Street. The daily two-way volume on Roop Street south of Robinson Street is approximately 13,400 vehicles.

DKS collected AM and PM peak period (7AM to 9 AM and 4 PM to 6 PM) traffic counts at 17 signalized intersections and 30 un-signalized intersections in the downtown area in October 2006. Figure 4 shows the locations of the 17 signalized and 30 un-signalized intersections. Figures 5 and 6 show the existing turning movement volumes at each of the signalized intersections in the study area for the AM and PM peak hour, respectively.

As shown in Table 1, in the PM peak hour there are about 2,700 vehicles per hour on Carson Street, about 1,500 vehicles per hour on Stewart Street and about 1,200 vehicles per hour on Roop Street. Approximately eight percent of the daily trips on Carson Street occur in the PM peak hour. This percentage is somewhat lower than a typical urban roadway due to the large number of inter-regional vehicles traveling through Carson City on Highway 395. The peak hour percentage of daily trips on Stewart Street is eleven percent. This is higher than typical since a large percentage of traffic on Stewart Street stems from state employees commuting to offices along Stewart Street. Approximately 9 percent of daily trips on Roop Street occur during the PM peak hour. This represents a more average percentage of daily trips.

2.3 Levels of Service

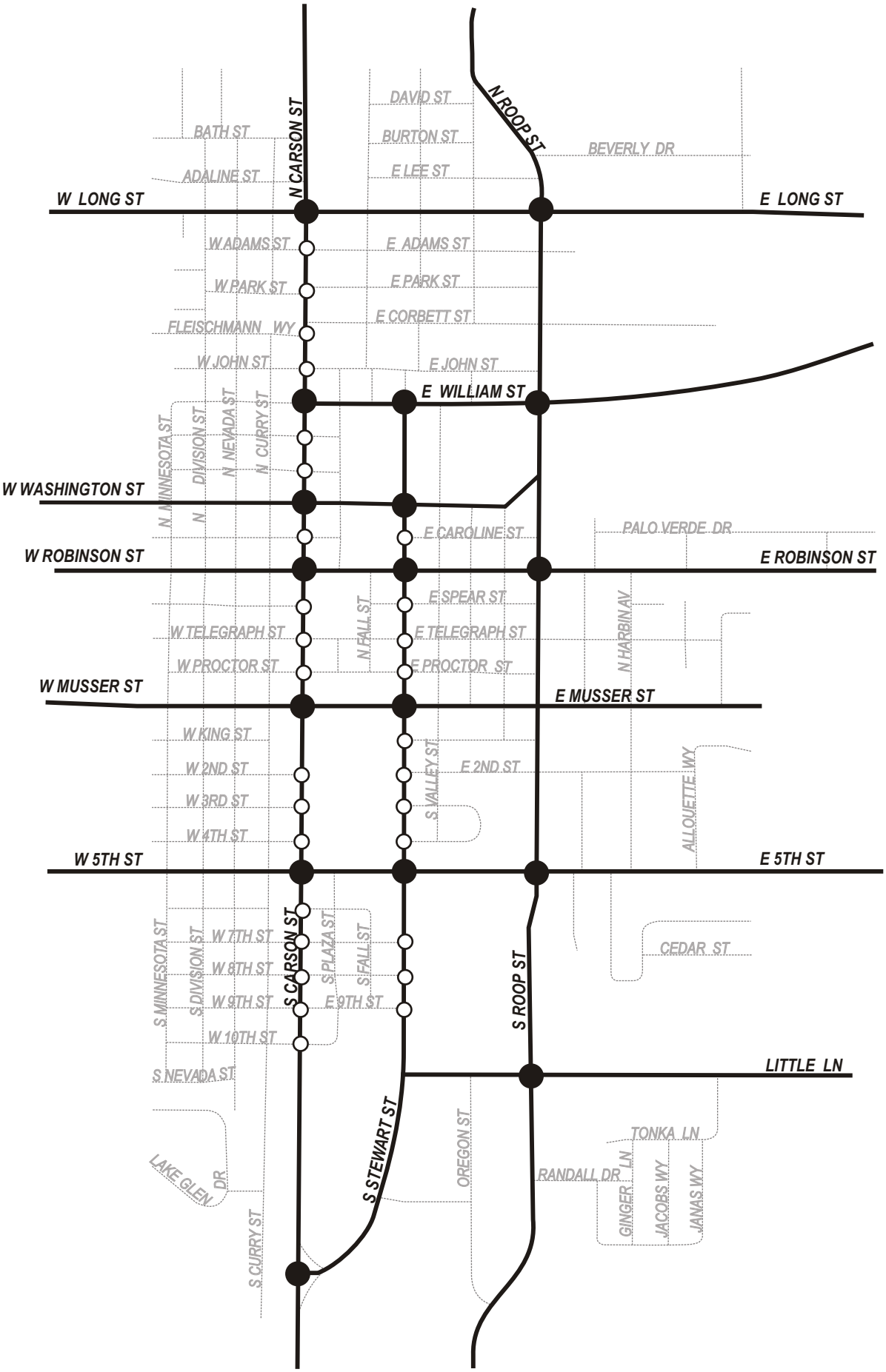
The peak period traffic simulation model and level of service analysis of the downtown area requires a substantial amount of input data including

- Peak hour turning movement volumes at all intersections
- Lane geometry, signal phasing and signal timing at all signalized intersections
- Other factors that affect capacity, including peak hour factors, trucks factors, etc.

The peak hour volumes and lane geometrics at signalized intersections are shown in Figures 5 and 6. Traffic signal timing for the downtown signal system was provided by City staff.

To accurately reflect peak hour traffic conditions, a “peak hour factor” was used. The peak hour factor is the ratio of the peak fifteen minute volumes to the total peak hour volumes. Table 2 shows the peak hour factors for Carson Street, Stewart Street and Roop Street in the downtown area based on traffic count data.

The average AM peak hour factor for Carson Street is 0.89, meaning the average AM peak fifteen minute flow rate is twelve percent higher than the hourly flow rate. The average PM peak hour factor for Carson Street is 0.95, meaning the average PM peak fifteen minute flow rate is five percent higher than the hourly flow rate.



LEGEND

● Signalized Intersections

○ Un-Signalized Intersections

NO SCALE

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Figure 4
INTERSECTION PEAK HOUR TURNING MOVEMENT COUNTS

Table 2:
Peak Hour Factors

	Peak Hour	Carson Street	Stewart Street	Roop Street
Peak Hour Factor	AM	0.89	0.77	0.84
Percent that peak fifteen minute flow rate is greater than average hourly flow rate		12%	31%	20%
Peak Hour Factor	PM	0.95	0.81	0.88
Percent that fifteen minute flow rate is greater than average hourly flow rate		5%	23%	14%

Source: DKS Associates, 2007

The peak hour factor on Stewart Street is quite low in both the AM and PM peak hours (0.77 and 0.81)), indicating that there is a "peak" within the peak hour when workers in offices along Stewart Street arrive and leave work.

Other factors that have been used in the intersection LOS calculation are the "heavy vehicle" or truck factor and the Central Business District (CBD) factor.

The heavy vehicle factor is the percentage of truck traffic relative to the total number of vehicles. Based on NDOT data for urban street types a heavy vehicle percentage of five percent was used for Carson Street and William Street (both are major arterials and are state highways); four percent was used for Stewart Street and Roop Street (both are minor arterials) and two percent was used for all other local streets.

The "CBD factor" was used on Carson Street signals from William Street to 5th Street, because this area displays the characteristics of a CBD such as tight intersection spacing, no building setbacks and retail stores.

The level of service policy in Carson City's Transportation Plan calls for maintaining a level of service (LOS) "D" or better conditions. This means that LOS "D" or better is considered acceptable while LOS "E" or "F" is considered unacceptable. For this analysis of the downtown area, the Highway Capacity Manual methods are used for signalized intersections, which bases LOS on the average vehicle delay for all intersection approaches, not the delay of individual vehicles or roadway approaches.

Currently the signalized intersections along Carson Street, Stewart Street and Roop Street all operate at an acceptable level of service in the downtown area. The AM and PM intersection levels of service are reported in Table 3. While most signalized intersections currently operate at level of service "C" or better, some intersections along William Street operate at LOS "D." At the worst intersection, Carson Street and William Street, the average queues for northbound and southbound Carson Street extend for about one block.

Table 3:
Existing Level of Service: Signalized Intersections

Intersection	AM Peak Hour		PM Peak Hour	
	Delay	LOS	Delay	LOS
Carson St and Long St	9.0	A	8.4	A
Carson St and William St	38.7	D	40.9	D
Carson St and Washington St	10.0	B	10.7	B
Carson St and Robinson St	10.6	B	10.3	A
Carson St and Musser St	6.5	A	6.6	A
Carson St and 5th St	22.2	C	19.6	B
Carson St and Stewart St	19.8	B	23.9	C
Stewart St and William St	35.0	C	37.9	D
Stewart St and Washington St	9.5	A	11.5	B
Stewart St and Robinson St	12.1	B	12.8	B
Stewart St and Musser St	8.2	A	7.9	A
Stewart St and 5th St	30.6	C	34.6	C
Roop St and Long St	12.6	B	16.4	B
Roop St and William St	35.7	C	37.1	D
Roop St and Robinson St	12.5	B	13.1	B
Roop St and 5th St	26.8	C	33.5	C
Roop St and Little Ln	14.0	B	16.5	B

Note: delay (in seconds) represents average delay for all approaches

Source: DKS Associates, 2007

Arterial level of service is defined by average vehicle speed along an arterial roadway segment and is calculated by adding the travel time between intersections and the delays at intersections, and then dividing by the total arterial segment distance. The average speeds and intersection delay were measured by the traffic simulation model for the downtown area.

Table 4 shows the arterial level of service along Carson Street, Stewart Street, and Roop Street within the study area. The table shows that all three roadways currently operate at LOS C or D with average speeds ranging between a low of 16 miles per hour and a high of 23 miles per hour. This shows that, on average, these streets are operating below their posted speed limits but at acceptable speeds per City LOS standards.

Table 4:
Existing Arterial Level of Service

Roadway Segment	AM Peak Hour		PM Peak Hour	
	Average Speed (mph)	LOS	Average Speed (mph)	LOS
NB Carson St - Stewart St to Long St	22.6	C	21.9	C
SB Carson St - Long St to Stewart St	22.3	C	22.5	C
NB Stewart St - Carson St to William St	23.2	C	22.4	C
SB Stewart St - William St to Carson St	16.6	D	17.2	D
NB Roop St - Little Ln to Long St	18.0	D	17.5	D
SB Roop St - Long St to Little Ln	18.0	C	16.0	D

2.4 Existing Travel Patterns

To gain insights into travel patterns along the major north-south roadways through downtown, the travel demand model was used to map the trip origins, destinations, and route choices for traffic traversing the segments of Carson Street and Stewart Street north of 5th Street.

The estimated existing distribution of daily traffic using those two roadway segments are shown in blue on Figures 7 and 8. In these figures, the selected roadway segment is shown in black. These figures indicate the following:

- Most of the trips using Carson Street near 5th Street are long-distance trips on US 395 that either remain on Carson Street through downtown or are destined to the downtown.

- Most people use Stewart Street to either access destinations along Stewart Street or to bypass Carson Street to reach destinations east of Stewart Street.

3.0 PROJECT DESCRIPTION

The proposed Carson Street Narrowing project (the Project) consists of reducing the number of through lanes on Carson Street from four lanes to two between William Street and 5th Street. Center left turn lanes would be preserved at all the signalized intersections to maintain efficient traffic operations, but may be removed at most minor intersections to make room for on-street parking. The on-street parking would consist of parallel parking.

Sidewalks would be widened along Carson Street between William Street and 5th Street and curbs may "bulb out" at intersections with pedestrian cross-walks.

For the purpose of this analysis it was assumed that a second right turn lane for traffic to turn from northbound Carson Street onto Stewart Street would be constructed to encourage northbound traffic to use Stewart Street instead of Carson Street through downtown.

On Carson Street at 5th Street the second "curb" northbound lane would become a right turn lane. The assumed intersection geometrics with the proposed Carson Street Narrowing project can be seen in Figure 9.

Another aspect of the proposed project is that signal cycle lengths: the number of seconds between successive green lights for a particular turning movement. Currently cycle lengths are about 110 seconds, which is longer than typical, especially for central business districts. Most of the "green time" is given to north-south traffic on Carson Street, which increases delay for cross-street traffic and does not facilitate pedestrians crossing Carson Street.

As discussed in the following sections, traffic volumes could be reduced enough with the narrowing of Carson Street to allow cycle lengths to be reduced to 60 seconds for all signalized intersections in the two-lane section of Carson Street except at William Street where a 120 second cycle length could be used. Using exactly double the cycle length of other intersections along Carson Street allows signal coordination to be maintained. The shorter 60 second cycle length would reduce delay fro traffic on cross streets and foster improved pedestrian access and safety on Carson Street.

4.0 TRAFFIC VOLUME FORECASTS

DKS has recently completed development of the new CAMPO Travel Demand Model. The area modeled by the previous Carson City Travel demand Model was expanded to include western Lyon County and northern Douglas County. The model was validated to 2005 traffic conditions.

4.1 Land Use Forecasts

The data sources for the 2005 land use data are:

- Carson City – generated from the City's parcel database
- North Douglas County – taken from the US 395 Corridor Study model
- Western Lyon County – estimated from aerial photographs

Table 5 shows the estimated growth in housing and employment between 2005 and 2030. The development forecasts, which were based on extensive input from local jurisdictions, show a substantial growth in multi-family housing as well as in retail, office and industrial employment within the CAMPO area by 2030.

4.2 Planned Transportation Improvements

Figure 10 shows the future roadway improvements from the Carson City Transportation Master Plan (TMP) that were assumed to be in place in the downtown area in 2015 and 2030. The planned 2-lane extension of Stewart Street from William Street to Roop Street is assumed to be in place by 2015. Roop Street is assumed to be widened to 4 lanes between Beverly Drive and Washington Street by 2015 and between Washington Street and Little Lane by 2030. The conversion of William Street west of Carson Street to one way westbound is assumed by 2015. Not shown in the figure is the full Carson City Freeway, which is assumed to be complete by 2015.

4.3 Traffic Forecasts

Table 6 and Figures 11 and 12.show 2015 and 2030 daily traffic volume forecasts on key study area roadways with and without the proposed project. Traffic volumes on Carson Street and Stewart Street are predicted to decrease in the 2015 and 2030 base scenarios (with a four-lane Carson Street) due to the opening of the full Carson City Freeway, which will provide a diversion for many vehicles traveling north/south through Carson City. It is also expected that a large percentage of truck traffic will divert from downtown Carson City to the Carson City Freeway.

The narrowing of Carson Street would significantly reduce traffic volumes on Carson Street, slightly increases traffic volumes on Stewart Street and slightly increases traffic volumes on Roop Street.

Table 5:
Projected Growth in CAMPO Land Use

Year	Housing Units		Employees				
	Multi-Family	Single Family	Retail	Office	Industrial	Hotel	School
Carson City							
2005	6,961	16,454	11,759	11,734	6,779	1,647	735
2030	12,786	18,945	18,705	19,744	10,320	2,063	968
Growth	**5,825**	**2,491**	**6,946**	**8,010**	**3,541**	**416**	**233**
	84%	**15%**	**59%**	**68%**	**52%**	**25%**	**32%**
Western Lyon County[1]							
2005	0	558	48	52	1,007	0	0
2030	0	697	60	78	1,512	0	0
Growth	**0**	**139**	**12**	**26**	**505**	**0**	**0**
	0%	**25%**	**25%**	**50%**	**50%**	**0%**	**0%**
Northern Douglas County[2]							
2005	0	5,025	1,571	324	269	6	87
2030	0	8,066	2,865	318	263	6	87
Growth	**0**	**3,041**	**1,294**	**-6**	**-6**	**0**	**0**
	0%	**61%**	**82%**	**-2%**	**-2%**	**0%**	**0%**
Total CAMPO Area[2]							
2005	6,961	22,037	13,378	12,110	8,055	1,653	822
2030	12,786	27,708	21,630	20,140	12,095	2,069	1,055
Growth	**5,825**	**5,671**	**8,252**	**8,030**	**4,040**	**416**	**233**
	84%	**26%**	**62%**	**66%**	**50%**	**25%**	**28%**

Note 1: Within the CAMPO boundary. Note 2: Within the CAMPO model area
Sources: Carson City, US 395 Corridor Study and DKS Associates

Table 6:
Daily and Peak Hour Roadway Volumes

Roadway	Volume	2005 Existing	2015		2030	
			No Project	Plus Project	No Project	Plus Project
Carson St North of Washington St	Daily Volume	36,000	30,000	19,200	31,300	19,500
	PM Peak Hour	2,700	2,500	1,600	2,700	1,600
Carson St North of Musser St	Daily Volume	35,500	28,100	18,300	30,600	18,500
	PM Peak Hour	2,700	2,400	1,500	2,600	1,600
Stewart St South of William St	Daily Volume	13,000	6,600	12,300	7,900	14,400
	PM Peak Hour	1,200	500	1,100	700	1,200
Stewart St North of 5th St	Daily Volume	14,100	11,000	14,400	12,900	16,200
	PM Peak Hour	1,500	900	1,300	1,100	1,400
Stewart St South of 5th St	Daily Volume	15,400	12,700	13,400	14,900	15,800
	PM Peak Hour	1,700	1,100	1,200	1,300	1,400
Roop St South of Robinson St	Daily Volume	13,400	12,200	13,300	19,300	22,200
	PM Peak Hour	1,200	1,000	1,100	1,700	1,900

Source: DKS Associates, 2007

Table 7:
AM Peal Hour Signalized Intersections Level of Service: 2015

Intersection	No Project		Plus Project	
	LOS	Delay	LOS	Delay
Carson St and Long St	A	7.4	A	6.9
Carson St and William St	B	17.9	D	42.4
Carson St and Washington St	A	9.7	B	13.6
Carson St and Robinson St	A	6.6	A	8.1
Carson St and Musser St	A	7.1	A	7.8
Carson St and 5th St	B	16.0	B	16.4
Carson St and Stewart St	A	4.8	A	7.0
Stewart St and William St	B	17.2	B	16.4
Stewart St and Washington St	A	7.5	A	6.2
Stewart St and Robinson St	A	8.3	A	7.4
Stewart St and Musser St	A	5.9	A	7.9
Stewart St and 5th St	A	10.0	B	12.0
Roop St and Long St	B	11.0	B	10.9
Roop St and William St	C	30.3	C	31.2
Roop St and Robinson St	B	11.9	B	12.5
Roop St and 5th St	C	21.8	C	24.3
Roop St and Little Ln	B	13.8	C	29.1

Source: DKS Associates, 2007

The narrowing of Carson Street would result in significant queuing on northbound Carson Street at William Street, extending back to Washington Street. There would also be LOS "E" operation at the southbound left turn movement with queues extending past John Street.

Two potential mitigation measures have been identified to attempt to improve the queuing problems at the intersection of Carson Street and William Street:

- **Mitigation Measure 1** involves providing two southbound left turn lanes on the Carson Street.

- **Mitigation Measure 2** includes the dual southbound left turn lanes in Mitigation Measure 1 and also involves maintaining two northbound through lanes between William Street and Sophia Street as it does today, which would preclude on-street parking along the east side of that block.

Table 8:
PM Peak Hour Signalized Intersections Level of Service: 2015

Intersection	No Project		Plus Project	
	LOS	Delay	LOS	Delay
Carson St and Long St	A	5.3	A	5.2
Carson St and William St	C	30.7	D	49.6
Carson St and Washington St	A	8.7	B	11.5
Carson St and Robinson St	A	7.2	A	8.6
Carson St and Musser St	A	5.4	A	8.9
Carson St and 5th St	A	9.5	B	14.1
Carson St and Stewart St	A	9.4	A	9.5
Stewart St and William St	B	16.2	B	19.6
Stewart St and Washington St	A	7.8	A	6.9
Stewart St and Robinson St	A	8.3	A	6.6
Stewart St and Musser St	A	5.5	A	6.2
Stewart St and 5th St	A	9.9	B	14.6
Roop St and Long St	B	11.5	B	10.8
Roop St and William St	C	28.7	C	25.2
Roop St and Robinson St	B	11.6	B	11.6
Roop St and 5th St	C	23.5	C	23.2
Roop St and Little Ln	B	14.4	B	14.2

Source: DKS Associates, 2007

The results of these mitigation measures on the operations of the intersection of Carson Street and William Street are presented in Table 10.

With Mitigation Measure 1, the overall intersection level of service would improve from LOS "D" to LOS "C." The level of service on the northbound approach would improve from LOS "E" to LOS "C." Average and 95th percentile queue lengths would decrease significantly, with the exception of the southbound through movement, due to the lack of a second southbound through lane on Carson Street south of William Street.

Mitigation Measure 2 would improve on Mitigation Measure 1 by further reducing queue lengths on Carson Street. Northbound queues would be reduced by at least half.

Table 9:
Queue Lengths over 200 Feet on Carson, Stewart, and Roop Streets: 2015

		Through Traffic Queue Length								Left Turn Queue Length							
		Northbound				Southbound				Northbound				Southbound			
		50th Percentile		95th Percentile		50th Percentile		95th Percentile		50th Percentile		95th Percentile		50th Percentile		95th Percentile	
		Lanes on Carson Street Between William Street and 5th Street															
Street	Cross Street	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**
AM Peak Hour																	
Carson St	William St	160	**450**	200	**700**	110	**230**	220	**490**					110	**230**	180	**400**
	Washington St			80	**220**			70	**470**								
	5th St			160	**380**												
Roop St	Robinson St							220	**350**								
PM Peak Hour																	
Carson St	William St	300	**600**	440	**920**			210	**480**					170	**320**	320	**560**
	Washington St			130	**440**			230	**410**								
	Robinson St			250	**420**			60	**420**								
	5th St			180	**360**			30	**370**								
Stewart St	William St			240	**310**												
Roop St	5th St							140	**250**								

Note: Queue Lengths are only reported for queues over 200 feet *either* without or **with** the proposed project

Source: DKS Associates, 2007

Table 10:
Carson Street and William Street Intersection PM Peak Hour Performance: 2015

			Level of Service		50th Percentile Queue			95th Percentile Queue		
			Intersection Average	Approach (SB/NB)	SB Through	SB Left	NB Through	SB Through	SB Left	NB Through
Existing Conditions			D	C/C	**270**	110	**260**	**370**	**220**	**640**
2015	No Project		C	B/D	110	170	**300**	**210**	**320**	**440**
	Plus Project		D	C/**E**	180	**320**	**600**	**480**	**560**	**920**
	Mitigation 1	SB: 2 left turn lanes	C	B/C	140	150	**440**	**430**	**210**	**780**
	Mitigation 2	SB: 2 left turn lanes NB: 2 through lanes	C	B/C	140	110	**220**	**430**	160	**330**

Note: Queue lengths over 200 feet are shown in **bold**

Source: DKS Associates, 2007

Table 11 and Table 12 show 2015 arterial level of service for the AM and PM peak hour, respectively. The tables show that all study arterials would operate at LOS "C" or better with average speeds of at least 20 miles per hour without the proposed project and average speeds of at least 17 miles per hour with the proposed project. The narrowing of Carson Street would lower most average arterial speeds somewhat, but not enough to significantly change the arterial level of service.

Table 11:
AM Peak Hour Arterial Level of Service: 2015

Intersection	No Project		Plus Project	
	Average Speed (mph)	LOS	Average Speed (mph)	LOS
NB Carson St - Stewart St to Long St	24.3	B	17.2	C
SB Carson St - Long St to Stewart St	24.3	B	18.8	C
NB Stewart St - Carson St to William St	24.1	B	23.6	C
SB Stewart St - William St to Carson St	21.8	C	21.1	C
NB Roop St - Little Ln to Long St	20.0	C	19.9	C
SB Roop St - Long St to Little Ln	19.9	C	19.3	C

Source: DKS Associates, 2007

Table 12:
PM Peak Hour Arterial Level of Service: 2015

Intersection	No Project		Plus Project	
	Speed (mph)	LOS	Speed (mph)	LOS
NB Carson St - Stewart St to Long St	21.1	C	17	C
SB Carson St - Long St to Stewart St	23.3	C	19.1	B
NB Stewart St - Carson St to William St	23.7	C	22.5	C
SB Stewart St - William St to Carson St	21.6	C	21.4	C
NB Roop St - Little Ln to Long St	21.1	C	20.7	C
SB Roop St - Long St to Little Ln	20.2	C	19.6	C

Source: DKS Associates, 2007

Table 13:
AM Peak Hour Signalized Intersections Level of Service: 2030

Intersection	No Project		Plus Project	
	LOS	Delay	LOS	Delay
Carson St and Long St	A	6.3	A	7.1
Carson St and William St	C	22.5	D	51.0
Carson St and Washington St	B	15.4	B	13.0
Carson St and Robinson St	B	10.2	B	10.0
Carson St and Musser St	A	8.1	A	8.8
Carson St and 5th St	B	15.1	B	18.0
Carson St and Stewart St	A	8.8	A	7.7
Stewart St and William St	C	23.6	C	28.3
Stewart St and Washington St	A	4.8	A	5.0
Stewart St and Robinson St	A	5.0	A	6.4
Stewart St and Musser St	A	4.7	A	7.2
Stewart St and 5th St	B	18.7	B	12.4
Roop St and Long St	B	14.6	B	10.8
Roop St and William St	D	35.1	D	40.6
Roop St and Robinson St	B	16.0	B	10.3
Roop St and 5th St	C	33.1	C	24.5
Roop St and Little Ln	B	14.2	B	11.9

Source: DKS Associates, 2007

Average northbound queue lengths on Carson Street at William Street are projected to degrade from approximately 250 feet (one block) to greater than 600 feet (two blocks) during both peak hours with the narrowing of Carson Street. Average southbound queue lengths on Carson Street at William Street are projected to degrade from less than 200 feet to approximately 250 feet (one block) during both peaks with the narrowing of Carson Street.

The 95th percentile queues are also projected to increase at a number of locations on Carson Street with the narrowing of Carson Street. The PM peak hour 95th percentile queue lengths are shown graphically in Figure 21 and numerically in Table 15. The figure shows that the northbound 95th percentile queue length is projected to extend from William Street to south of Robinson Street. The figure shows that delays at one major intersection could potentially cause gridlock at other intersections to the south.

The same mitigation measures discussed in Section 5 have been identified to attempt to improve the queuing problems at the intersection of Carson Street and William Street:

- **Mitigation Measure 1** involves providing two southbound left turn lanes on the Carson Street.

- **Mitigation Measure 2** includes the dual southbound left turn lanes in Mitigation Measure 1 and also involves maintaining two northbound through lanes between William Street and Sophia Street as it does today, which would preclude on-street parking along the east side of that block.

The results of these mitigation measures on the operations of the intersection of Carson Street and William Street are presented in Table 16. As under 2015 conditions, these measures would decrease average and 95th percentile queue lengths significantly. The results of these mitigation measures are displayed graphically in Figure 22. The figure shows that the northbound through queue length would decrease dramatically with the proposed mitigation measures. The figure also shows that the southbound left turn lane queues would decrease significantly, while the southbound through queue would not change significantly with the proposed mitigation measures.

Table 14:
PM Peak Hour Signalized Intersections Level of Service: 2030

Intersection	No Project		Plus Project	
	LOS	Delay	LOS	Delay
Carson St and Long St	A	5.3	A	5.3
Carson St and William St	C	24.2	D	53.2
Carson St and Washington St	B	13.9	B	12.5
Carson St and Robinson St	A	9.7	A	9.6
Carson St and Musser St	A	7.6	A	9.1
Carson St and 5th St	B	11.8	B	17.2
Carson St and Stewart St	B	10.6	B	10.7
Stewart St and William St	B	17.9	C	22.3
Stewart St and Washington St	A	5.6	A	5.4
Stewart St and Robinson St	A	7.7	A	7.5
Stewart St and Musser St	A	5.3	A	8.3
Stewart St and 5th St	B	11.9	B	12.6
Roop St and Long St	B	16.8	B	11.1
Roop St and William St	D	35.4	C	33.7
Roop St and Robinson St	B	11.1	A	9.4
Roop St and 5th St	C	22.2	C	28.2
Roop St and Little Ln	B	11.6	B	12.9

Source: DKS Associates, 2007

Table 15:
Queue Lengths over 200 Feet on Carson, Stewart, and Roop Streets: 2030

		Through Queue Length								Left Turn Queue Length							
		Northbound				Southbound				Northbound				Southbound			
		50th Percentile		95th Percentile		50th Percentile		95th Percentile		50th Percentile		95th Percentile		50th Percentile		95th Percentile	
		Lanes on Carson Street Between William Street and 5th Street															
Street	Cross Street	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**	4	**2**
AM Peak Hour																	
Carson St	William St	270	**610**	540	**870**	180	**250**	220	**510**					120	**300**	240	**490**
	Washington St			160	**390**			80	**460**			220	**20**				
	Robinson St	220	**30**	150	**410**			140	**210**								
	Musser St			240	**20**			50	**390**								
	5th St	190	**230**	320	**470**												
Stewart St	William St	220	**130**	320	**180**												
Roop St	William St							220	**120**							140	**230**
	Robinson St			210	**70**												
	5th St															260	**30**
PM Peak Hour																	
Carson St	Long St	200	**70**	260	**130**												
	William St	250	**660**	440	**930**	160	**260**	270	**600**					190	**360**	330	**580**
	Washington St			100	**440**			100	**460**								
	Robinson St			220	**40**			100	**410**								
	Musser St			40	**420**			60	**520**								
	5th St			210	**390**			220	**450**								
Stewart St	William St	180	**230**	260	**410**												
Roop St	William St							210	**150**								

Note: Queue Lengths are only reported for queues over 200 feet *either* without or **with** the proposed project

Source: DKS Associates, 2007

Table 16:
Carson Street and William Street Intersection PM Peak Hour Performance: 2030

			Level of Service		50th Percentile Queue			95th Percentile Queue		
			Intersection Average	Approach (SB/NB)	SB Through	SB Left	NB Through	SB Through	SB Left	NB Through
Existing Conditions			D	C/C	270	110	**260**	**370**	**220**	**640**
2030	No Project		C	B/D	160	190	**250**	**270**	**330**	**440**
	Plus Project		D	**E/F**	**260**	**360**	**660**	**600**	**580**	**930**
	Mitigation 1	SB: 2 left turn lanes	C	C/D	200	160	**470**	**590**	**220**	**820**
	Mitigation 2	SB: 2 left turn lanes NB: 2 through lanes	C	B/C	200	120	**240**	**590**	170	**350**

Note: Queue lengths over 200 feet are shown in **bold**

Source: DKS Associates, 2007