Appendix A

TRAFFIC OPERATIONS ANALYSIS REPORT/ INTERSECTION CONTROL EVALUATION REPORT

KINGS BEACH WESTERN APPROACH PROJECT

Kings Beach Western Approach

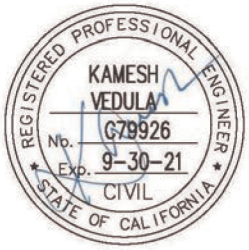
Traffic Operations Analysis Report (TOAR) and Intersection Control Evaluation (ICE)

Placer County
Caltrans EA: 0C932

Final Draft

January 2020

This Traffic Operations Analysis Report (TOAR) and Intersection Control Evaluation (ICE) has been prepared under the direction of the following registered engineer. The registered civil engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.



REGISTERED CIVIL ENGINEER

January 7, 2020
DATE

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Appendix A Synchro Reports
Appendix B Sidra Reports

1. Introduction

This report presents the results of the traffic operations analysis and Intersection Control Evaluation (ICE) performed by GHD for Placer County. The term “project” as utilized in this report refers to the proposed modifications to the existing signalized intersection State Route (SR) 28 and SR 267 in the unincorporated community of Kings Beach, Placer County, CA. This report was completed in consultation with a Project Development Team (PDT) consisting of Placer County, Tahoe Regional Planning Association (TRPA), and Caltrans.

The purpose of the project is to improve overall accessibility, mobility and safety for all roadway users while providing a continuous complete street corridor, connecting to the Kings Beach downtown core. The County desires to provide better connectivity between the downtown core and the west side of the community that extends to all transportation modes. The project is needed to provide safer facilities for cycling and walking. While the existing intersection has bicycle lanes, sidewalks and crosswalks along SR 28, they are narrow, adjacent to traffic and are obstructed by the existing signal infrastructure and therefore need to be expanded to provide safer, dedicated facilities for local residents and visitors.

Goals and objectives of the project include: 1) improve safety and mobility for bicyclists and pedestrians; 2) provide a complete street corridor that connects to the Kings Beach Commercial Core Improvement Project (KBCCIP); and 3) consistency with local, regional and state planning. In support of the ICE and TOAR analysis, traffic data was collected Wednesday November 7, 2018 through Tuesday November 13, 2018, excluding Monday, to determine peak day and hour traffic conditions in the off peak season. This data was then adjusted to summer volumes based on historic traffic data and used to develop forecasts for Year 2045 (Cumulative Conditions). The resulting forecasts along with the methodology and assumptions used to develop the forecasts for each alternative in the analysis will be presented later within this report.

Four project build alternative concepts were initially developed early in the Preliminary Analysis and Environmental Document (PA/ED) phase and were analyzed to compare the impacts to the study intersection and surrounding areas. Impacts assessed included connectivity, accessibility, environmental, maintenance, operations and right-of-way implications to development. The following alternatives were presented to the PDT:

- Alternative 1 – Single Lane Roundabout (centered on the existing intersection)
- Alternative 2 – Three Leg Hybrid Roundabout (centered on the existing intersection)
- Alternative 3 – Four Leg Hybrid Roundabout (moved west of the existing intersection)
- Alternative 4 – Enhanced Signal

Alternative 1 and 2 would cause major right-of-way impacts to the northeast corner of the SR 28/SR 267 intersection, resulting in impacts to buildings and eliminating access and buildings which would result in full take of two existing businesses. These alternatives also resulted in impacts to access to the fire station.

Therefore, the PDT recommended elimination of Alternatives 1 and 2 and advanced Alternatives 3 and 4 for further consideration. Alternatives 3 and 4 were identified as viable and have been included in this report for further operational analysis.

Given that the form of intersection control can dramatically influence and define a corridor's operational efficiency as well as the connectivity and safety of pedestrians and bicyclists, an intersection control evaluation consistent with Caltrans Traffic Operation Policy Directive (TOPD) #13-02 was performed for the intersection of SR 28/SR 267. The traffic operations portion of the ICE analysis is based in the static traffic operational tools Synchro and Sidra. Therefore, this traffic operations analysis report (TOAR) includes the required supplemental Intersection Control Evaluation (ICE) Step 2 analysis and information.

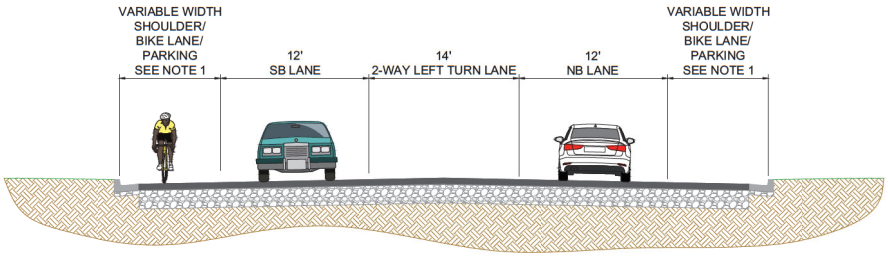
As part of the intersection improvements, a road diet was also considered between East Agatam Avenue and Secline Street. The road diet is intended to provide a consistent experience for the motoring public given that SR 28 is a three-lane roadway (one through lane in each direction and a two way left turn lane) except for the fore-mentioned segment. The existing limited four-lane segment creates challenges on the corridor as motorists have been observed taking advantage of the opportunity to pass slower-moving vehicles at high speeds. This activity has caused safety concerns particularly at a mid-block pedestrian and bicycle crosswalk.

The alternatives analyzed are as follows:

- Alternative 3 – Four Leg Hybrid Roundabout
- Alternative 4 – Signalized Intersection

Figure 1 presents the project overview.

Project Overview



Typical Section
N Lake Blvd Road Diet

Note 1:
Minimum 5' bike lane provided at all locations

Legend:
- Sidewalk
- Bike Lane/Shoulder
- Two-Way Left Turn Lane

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2. Operations Analysis Methodology and Technical Parameters

The following section outlines the analysis methodology and technical parameters used to quantify operations in the TOAR.

2.1 Traffic Operations Analysis

Traffic operations have been quantified through the determination of “Level of Service” (LOS). LOS definitions for different types of intersection controls are outlined in Table 2.1.

Caltrans publishes Traffic Concept Reports (TCR) for various State Highway facilities. TCRs are system planning documents that outline the existing and future operating and geometric conditions of a given state highway. The TCR includes proposed projects to address safety, capacity increases, and other potential improvements. Caltrans District 3 published a TCR for SR 28 in 1997 identifying LOS F as the concept objective for Kings Beach for Year 2016. There was no mention of capacity increases at the time of publishing. At the time of the TCR development, the LOS for SR 28 was LOS B.

2.2 Level of Service Methodologies

LOS is a qualitative measure of traffic operating conditions, whereby a letter grade "A" through "F" is assigned to an intersection or roadway segment representing progressively worsening traffic conditions. LOS was calculated for all intersection control types using the methods documented in the Transportation Research Board Publication *Highway Capacity Manual, 6th Edition* (HCM). The HCM methodologies for intersections, as well as 95th percentile queues, were implemented using Synchro (Version 10) and SIDRA 7.0 software. The Synchro, SimTraffic and SIDRA outputs can be found in the Technical Appendix provided under separate cover.

Table 2.1 – Level of Service Definitions

Level of Service	Type of Flow	Delay	Maneuverability	Stopped Delay/Vehicle		
				Signalized	Un-signalized	Round-about
A	Stable Flow	Very slight delay. Progression is very favorable, with most vehicles arriving during the green phase not stopping at all.	Turning movements are easily made, and nearly all drivers find freedom of operation.	<10.0	<10.0	<10.0
B	Stable Flow	Good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.	Vehicle platoons are formed. Many drivers begin to feel somewhat restricted within groups of vehicles.	>10.0 and <20.0	>10.0 and <15.0	>10.0 and <15.0
C	Stable Flow	Higher delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant, although many still pass through the intersection without stopping.	Back-ups may develop behind turning vehicles. Most drivers feel somewhat restricted	>20.0 and <35.0	>15.0 and <25.0	>15.0 and <25.0
D	Approaching Unstable Flow	The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high volume-to-capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.	Maneuverability is severely limited during short periods due to temporary back-ups.	>35.0 and <55.0	>25.0 and <35.0	>25.0 and <35.0
E	Unstable Flow	Generally considered to be the limit of acceptable delay. Indicative of poor progression, long cycle lengths, and high volume-to-capacity ratios. Individual cycle failures are frequent occurrences.	There are typically long queues of vehicles waiting upstream of the intersection.	>55.0 and <80.0	>35.0 and <50.0	>35.0 and <50.0
F	Forced Flow	Generally considered to be unacceptable to most drivers. Often occurs with over saturation. May also occur at high volume-to-capacity ratios. There are many individual cycle failures. Poor progression and long cycle lengths may also be major contributing factors.	Jammed conditions. Back-ups from other locations restrict or prevent movement. Volumes may vary widely, depending principally on the downstream back-up conditions.	>80.0	>50.0	>50.0

2.3 Technical Analysis Parameters and Assumptions

- A Peak Hour Factor (PHF) was calculated based on the traffic counts conducted for this study for each approach. These PHFs were used for existing and Cumulative Conditions. For Existing conditions, the observed PHF was used. For Cumulative conditions, a PHF of at least 0.92 was used unless the Existing observed PHF was greater for the Opening Year and the Cumulative conditions.
- The environmental factor in SIDRA was based on the guidelines provided by Caltrans in a memorandum titled *SIDRA Settings and Related Parameters for US HCM and SIDRA Roundabout Capacity Model (Dec 20, 2017)* (Appendix E).
- Peak hour heavy vehicle percentages for SR 28 and SR 267 were estimated from the existing traffic counts conducted at the study intersection. The peak hour heavy vehicle factor is consistent with the most recent Caltrans data.
- A free flow speed of 40 mph was used for SR 267 and 30 mph for SR 28 in this analysis. Speeds on local roadways (used for intersection analysis) were based on the current posted speed limit and supplemented with field data.
- Intersection traffic signal timings were obtained from Caltrans and implemented in the Existing Year conditions. The maximum operating cycle length per the provided signal timings is 100 seconds.

Table 2.2 presents additional key technical parameters assumed for the evaluation of the study intersections for the analysis scenarios. All parameters not listed should be assumed as default or calculated values based on HCM methodology.

Table 2.2 – Technical Parameters and Assumptions

Technical Parameters	Assumptions
1. Intersection Peak Hour Factor (PHF)	Intersection overall, Based on Existing Counts
2. Intersection Heavy Vehicle Percentage	Intersection overall, Based on Existing Counts with min.
3. Signal Timing	Based on current Caltrans Signal Timing Plans
4. Sidra Environmental Factor	1.05 per Caltrans SIDRA settings and related parameters

3. Existing Conditions

To establish baseline traffic conditions in the proposed project study area, existing turning movement count data was collected in November 2018 (winter) between Tuesday and Sunday PM peak hours. The data was compared to about 12 weekends of historical data during summer and winter. The comparison indicated that the summer peak hour traffic occurs during Friday and is greater than the winter traffic at this intersection. An average highest demand was derived at the intersection for vehicular traffic for the Friday PM peak. The winter counts were adjusted based on historical traffic data received from Caltrans to account for the seasonal variation between summer and winter. The PDT reviewed the average Friday summer peak hour data and agreed the adjustment of winter traffic counts was an adequate representation of summer traffic expectations. Thus, all analysis herein is based on the factored winter counts.

3.1 Existing Conditions

Existing conditions analysis for the study intersection under Friday PM peak hour is presented in Table 3.1.

Table 3.1 – Existing Friday PM Summer Peak Hour Conditions

SR 28/SR 267	Control Type[1]	PM Peak Hour	
		Delay	LOS
Friday	Signal	17.8	B
Eastbound	Signal	14.5	B
Westbound	Signal	15.4	B
Northbound	Signal	26.8	C
Southbound	Signal	24.4	C

Notes:

1. LOS = Delay based on average of all approaches for Signal

As presented in Table 3.1, the current intersection operates at LOS B with the worst approach operating at LOS C.

Table 3.2 presents the existing 95th percentile queues.

Table 3.2 – Existing Friday PM Summer Peak Hour 95th Percentile Queues

SR 28/SR267	Control Type	95th Percentile Queue (ft) Hour	Available Storage (ft)
Friday			
Eastbound Left	Signal	***163***	125
Eastbound Thru		234	
Eastbound Thru/Right		98	
Westbound Left		0	55
Westbound Thru		129	
Westbound Right		***111***	95
Northbound Left/Thru/Right		27	
Southbound Left/Thru		242	
Southbound Right		***143***	40

Note: ***Bold*** text indicates queues that exceed available storage

As presented in Table 3.2, the current 95th percentile queues exceed available storage for the eastbound left, westbound right, and southbound right movements.

3.1.1 Existing AADT

Caltrans publishes average annual daily traffic (AADT) volumes throughout the state of California for highway facilities. Within the project area, there are two locations on SR 28 and one on SR 267 that record AADT volumes. The most recently published volumes are from 2017. Table 3.3 provides the AADT for each approach of SR 28 and SR 267.

Table 3.3 – Existing AADT

District	Route	Cross Street	Back AADT	Ahead AADT
3	28	Kings Beach, Jct. RTE. 267 North	14,400	19,200
3	267	Jct. Rte. 28	10,200	N/A

Note:

1. Back AADT implies the count is either north/west of the identified junction.

2. Ahead AADT implies the count is either south/east of the identified junction.

3.1.2 Active Transportation

Kings Beach sees a high number of active transportation users. This is primarily due to the recreational characteristics of the area (i.e. beach, lake, and scenic views). Pedestrian and bicycle counts were collected to reflect the use of these modes near the project intersections. Pedestrian and bicycle counts were collected between 3 pm and 7 pm on Friday November 9, 2018. From the count data, the observed peak hour for pedestrians was 6 pm to 7 pm with 27 pedestrians observed crossing the intersection. The peak hour for bicycles was 3:15 pm to 4:15 pm with 7 bicycles observed traveling through the intersection.

Summer counts were collected and showed an increase in pedestrian and bicycle traffic at the study intersection. The summer observed peak hour for both modes was from 4:15 pm to 5:15 pm where 90 pedestrians and 17 bicyclists were seen either crossing or traveling through the intersection. With the substantial increase in summer active transportation modes, the summer pedestrian and bicycle counts formed the bases for analysis within this report.

4. Project Analysis Conditions

An Alternative Comparison Memorandum dated March 25, 2019 was presented to Placer County, Caltrans, and TRPA which included three roundabout alternatives and one signal alternative. One roundabout alternative and one signal alternative were selected for further analysis within the Environmental Document and Project Report, due to reasons stated above.

Kings Beach is a summer and winter tourist destination. As such, traffic counts were conducted in both Summer 2019 and Winter 2018 to capture both peaking characteristics. The traffic counts collected show that the summer peak month is substantially higher than the winter peak month. Therefore, this ICE report will focus on the summer peak month using the factored winter counts as previously agreed to by the PDT.

Additionally, peak hours were analyzed from Tuesday through Sunday. From the traffic counts collected, the intersection of SR 28/SR 267 experiences the heavies traffic on Friday during the PM peak time between 3 pm to 6 pm. Therefore, this analysis focuses on the traffic operations during the Summer Peak Month Friday Peak Hour conditions.

4.1 Sensitivity Analysis

A sensitivity analysis was completed to test whether the proposed geometry for both alternatives can accommodate variations in traffic as cumulative development in the area occurs while handling

the changes between winter and summer traffic patterns within the region. Cumulative analysis is typically a 20-year horizon. This is consistent with Caltrans stipulation for design which is typically 20 years after construction of the facility. The cumulative volumes were obtained from the Placer County Tahoe Basin Area Plan (January 2017). The expected growth in traffic as represented in this plan was added to the peak summer traffic counts established in section 3 to derive the cumulative volumes.

4.1.1 Cumulative Conditions

As previously mentioned, the Cumulative Conditions is an analysis scenario that would exist following approximately twenty years of growth and development in Kings Beach and surrounding areas.

4.2 Project Design Alternatives

This study included analysis of two different build alternatives. The first is the traffic signalization alternative with modified lane geometries consistent with the road diet on SR28. The second is the roundabout alternative at the intersection with the road diet on SR 28. Both alternatives would reduce the roadway width west of the intersection from a five-lane section down to three lanes with additional roadway improvements including buffered bike lanes, seasonal on-street parking, enhanced crosswalk treatments at the midblock crosswalk on SR28 west of the intersection, and a sidewalk along the east side of SR267 from SR 28 to Dolly Varden.

4.2.1 Alternative 3 – Four Legged Roundabout

This alternative features the construction of a hybrid four-legged modern roundabout shifted slightly west of the existing intersection and will incorporate Brassie Avenue as a leg of the intersection. The roundabout will also include the road diet east and west of the intersection. The current full access driveway connected as the south leg of SR 28/SR 267 will be converted to a right in/right out only.

4.2.2 Alternative 4 – Traffic Signalization

This alternative features modifications to the existing lane geometrics to accommodate the road diet, add buffered bicycle lanes and modifications to existing signal at SR 28/SR 267 to accommodate the modified lane geometries and move the signal poles out of the existing sidewalks. This alternative would require the following lane geometry changes:

- Restrict Brassie Avenue to right in/right out only
- Reduce the eastbound and westbound travel lanes from two lanes each to one lane in each direction
- Extension of the southbound right turn pocket
- Extension of the eastbound left turn pocket
- Extension of the westbound right turn pocket

5. Capacity Assessment/Analysis

As noted previously, the intersection experiences highest traffic during the Friday PM peak period. This section provides a summary of the intersection operations associated with the identified alternatives for Summer Friday PM peak hour conditions. The analysis includes the observed pedestrian and bicycle volumes.

5.1 Alternative 3 – Roundabout

Table 5.1 presents the projected traffic operations during Summer Friday PM peak hour if the roundabout alternative was chosen and constructed under Cumulative Conditions condition.

Table 5.1 – Cumulative Conditions for Roundabout Alternative

SR 28/SR 267	Control Type	Delay (sec)[1]	Level Of Service[1]	95th Percentile Queue (ft)	Available Storage (ft)
Cumulative Year (2045)		***12.6***	***B***	**-**	**-**
Eastbound Left/Thru	Roundabout	9.4	A	61	90
Eastbound Right				153	
Westbound Left		6.7	A	80	90
Westbound Thru/Right				64	
Southbound Left/Thru/Right		24.2	C	447	
Brassie Ave		11.3	B	9	

1. Worst lane movement (of the approach) value stated.

As presented in Table 5.1, Alternative 3 is projected to provide LOS B for overall intersection operations and LOS C for the southbound approach.

5.2 Alternative 4 – Signal

Table 5.2 presents the projected traffic operations during Summer Friday PM peak hour if the signal alternative was chosen and constructed under Cumulative Conditions condition.

Table 5.2 – Cumulative Conditions for Signal Alternative

SR 28/SR 267	Control Type	Delay (sec)[1]	Level Of Service[1]	95th Percentile Queue (ft)	Available Storage (ft)
Cumulative Year (2045)		***38.7***	***D***	**-**	**-**
Eastbound Left	Roundabout	22.7	C	202	250
Eastbound Thru/Right				297	
Westbound Left		33.6	C	-	55
Westbound Thru				719	
Westbound Right				250	300
Northbound Left/Thru/Right		65.3	E	28	
Southbound Left/Thru		37.4	D	603	
Southbound Right				272	300

1. Worst lane movement (of the approach) value stated.

As presented in Table 5, Alternative 4 is projected to provide LOS D for overall intersection operations and LOS E for the northbound approach, which is a driveway access for the condominiums. Additionally, queues are projected to be significant and potentially spillback into adjacent intersections on the southbound, eastbound, and westbound approaches.

6. Intersection Control Evaluation (ICE) Supplemental Information

SR 28 is a Terminal Access STAA Route and SR 267 is a 65' California Legal Route. Per the designations on the Truck Networks on California State Highways published by Caltrans (June 5, 2018), the roundabout alternative would be designed to accommodate an STAA vehicle. The signal alternative would be designed to accommodate STAA for eastbound and westbound through but California Legal for movements to and from SR 267.

6.1 Footprint Development & Assessment

The following section provides schematics of the roundabout and signal alternatives. Also included in this section are exhibits that illustrate the truck turns.

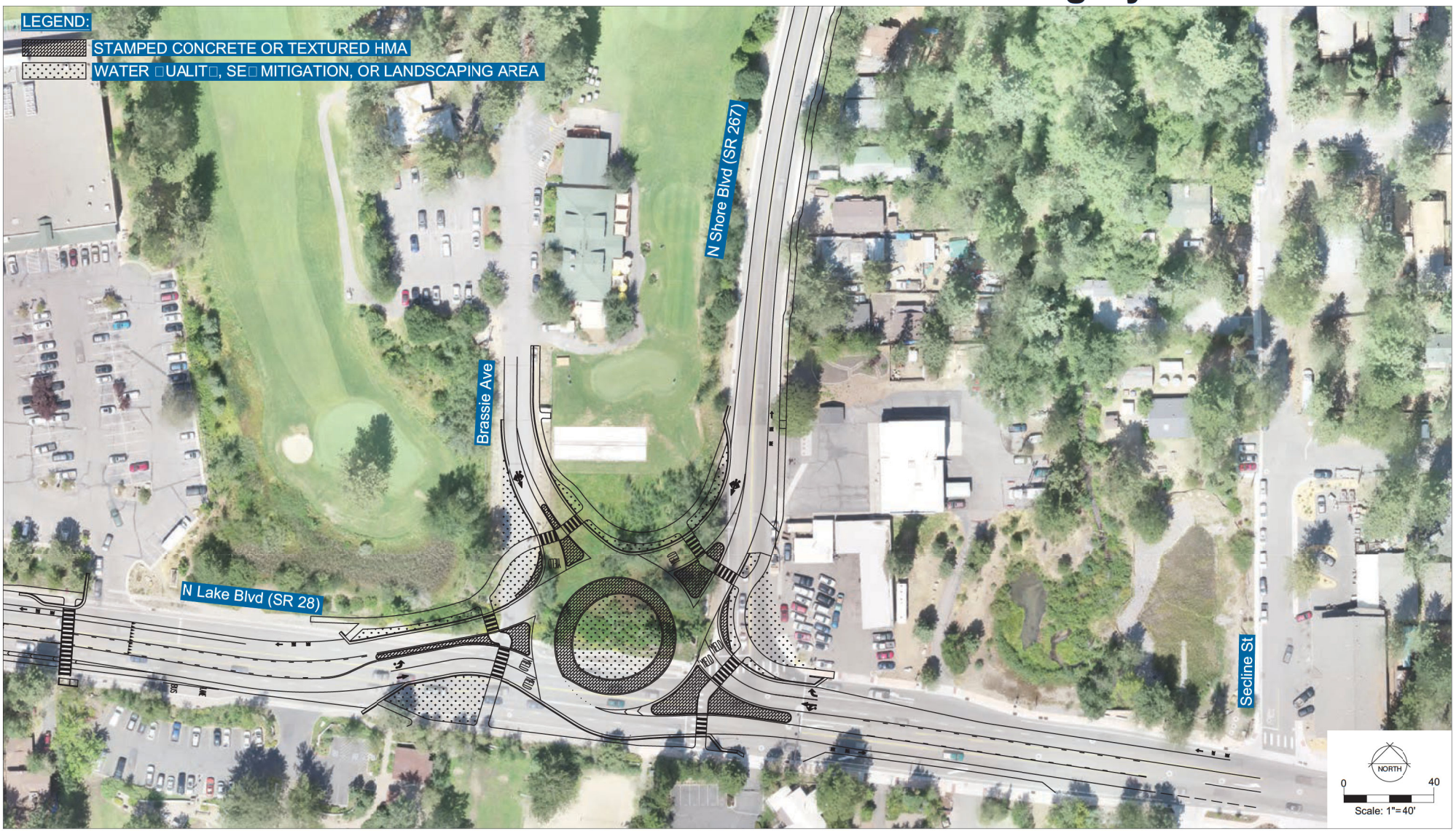
6.1.1 Alternative 3 – Roundabout

Figure 2 presents the conceptual layout of Alternative 3. Figure 3A, 3B, and 3C present the STAA truck turns for Alternative 3.

6.1.2 Alternative 4 – Signal

Figure 4 presents the conceptual layout of Alternative 4. Figure 5A, 5B, and 5C present the California Legal turns for Alternative 4.

Alternative 3: Four Leg Hybrid Roundabout



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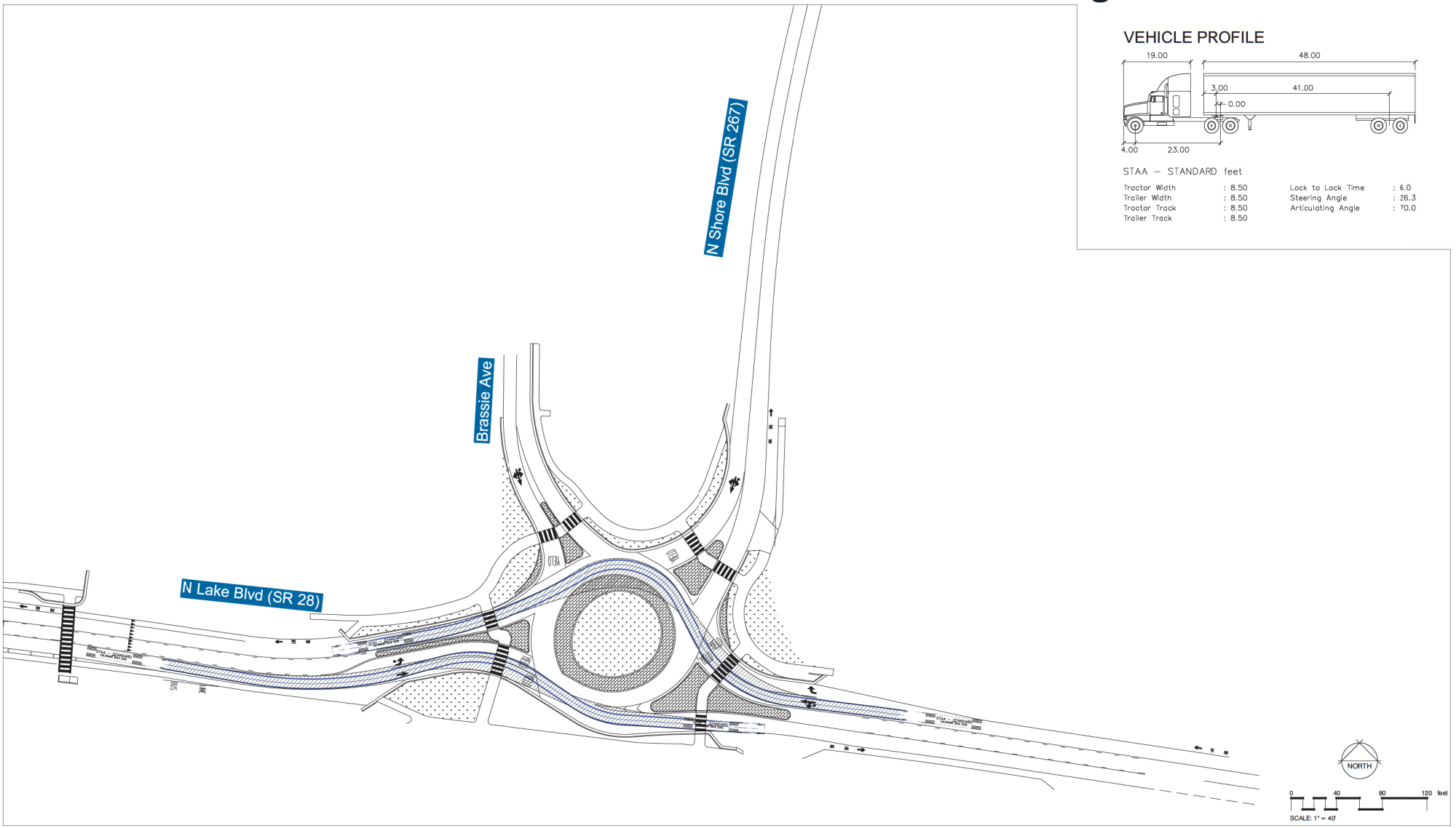
Alternative 3: Truck Through East/West bound



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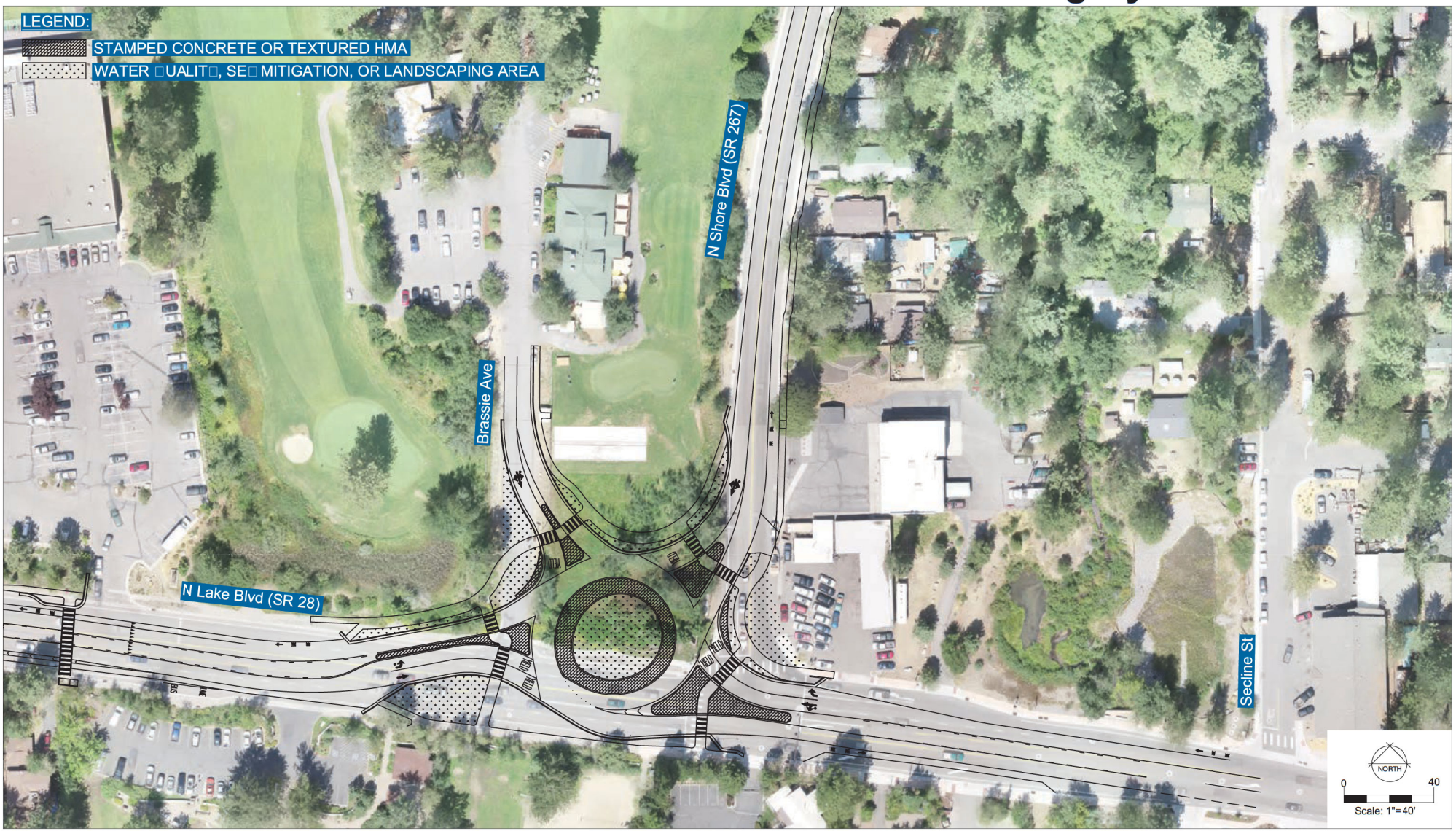
Alternative 3: Four Leg Hybrid Roundabout



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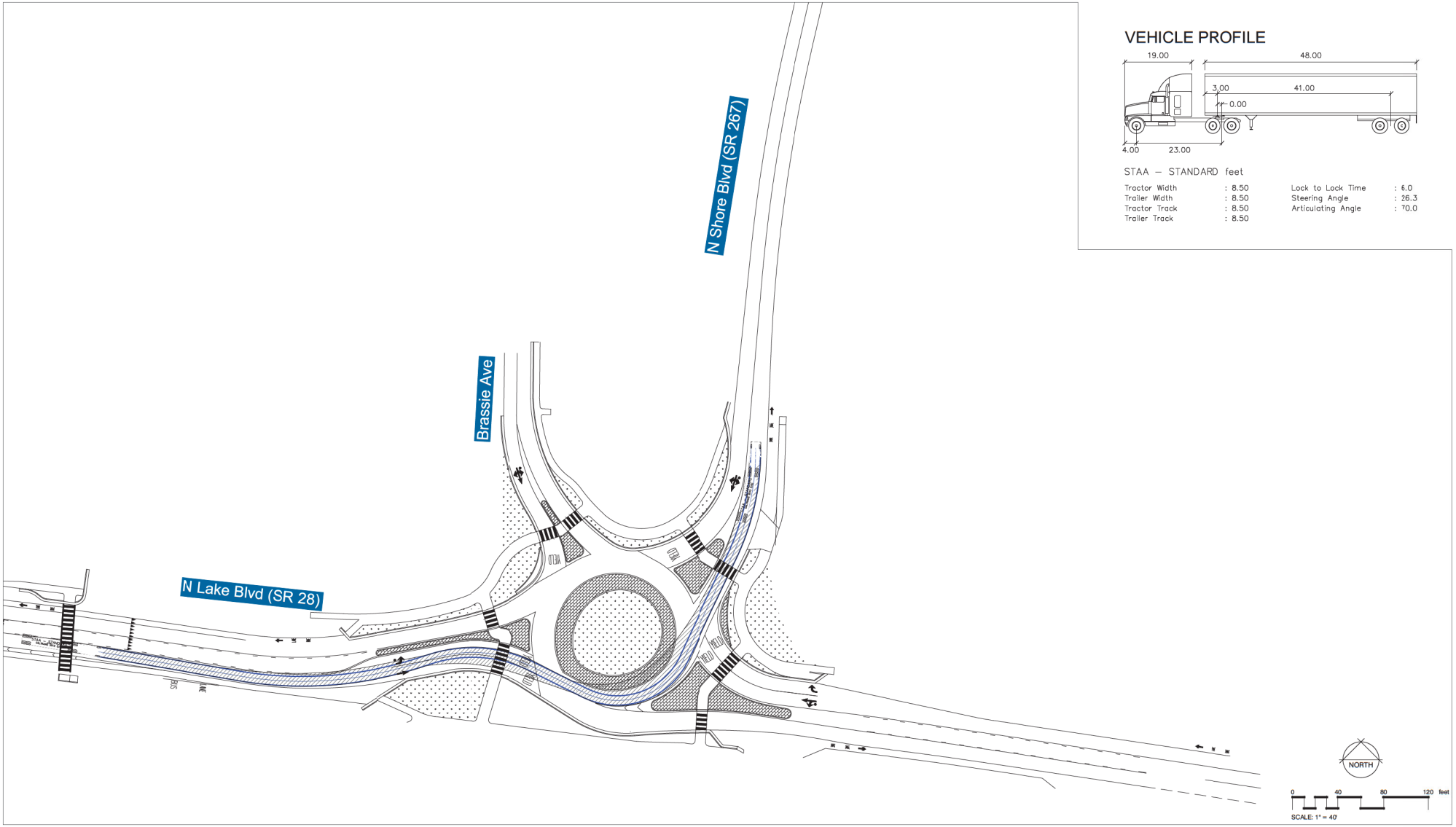
Alternative 3: Eastbound Left Truck Turn



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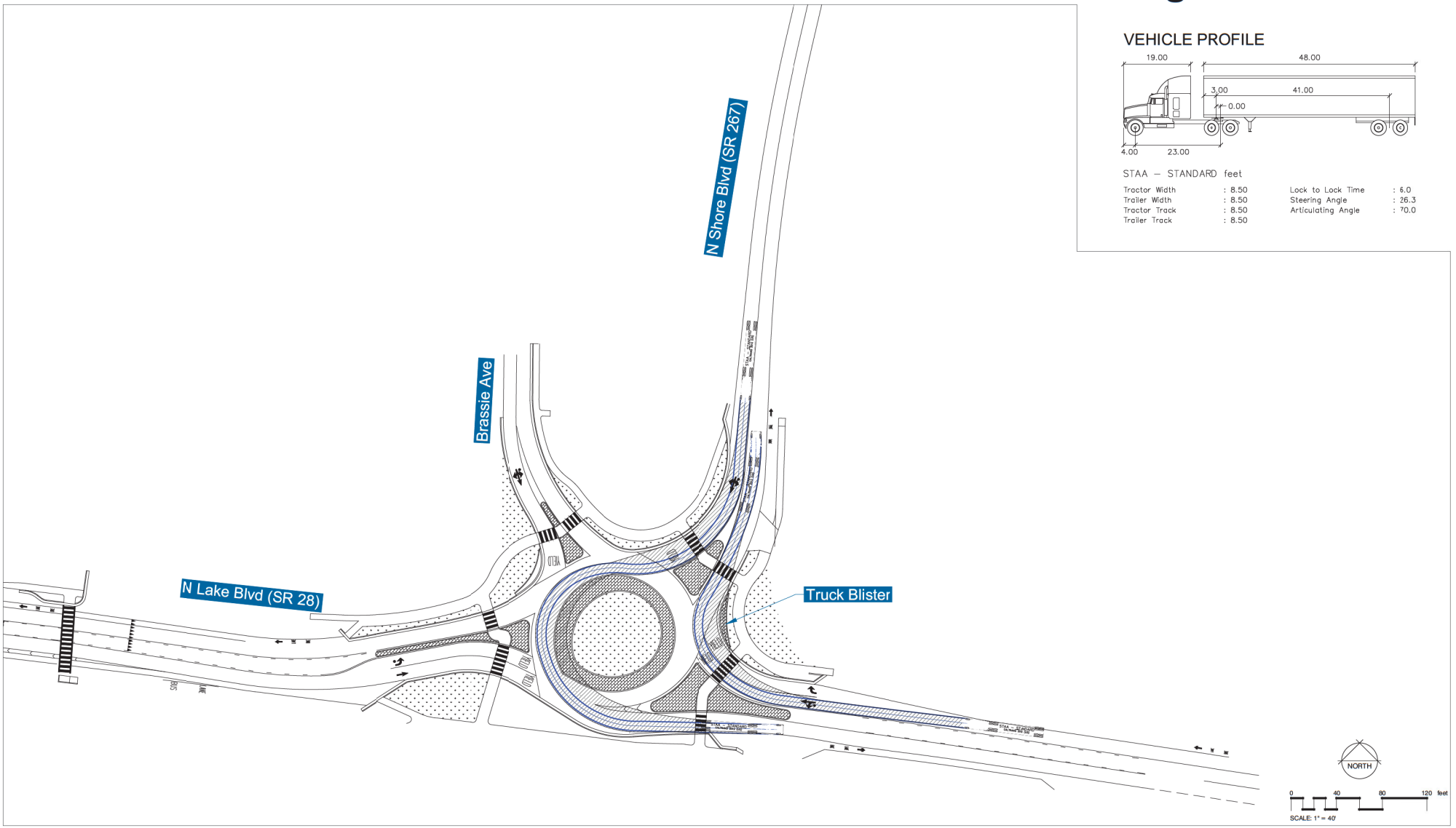
Alternative 3: Left and Right Truck Turns



VEHICLE PROFILE

STAA – STANDARD feet

Tractor Width	: 8.50	Lock to Lock Time	: 6.0
Trailer Width	: 8.50	Steering Angle	: 26.3
Tractor Track	: 8.50	Articulating Angle	: 70.0
Trailer Track	: 8.50		

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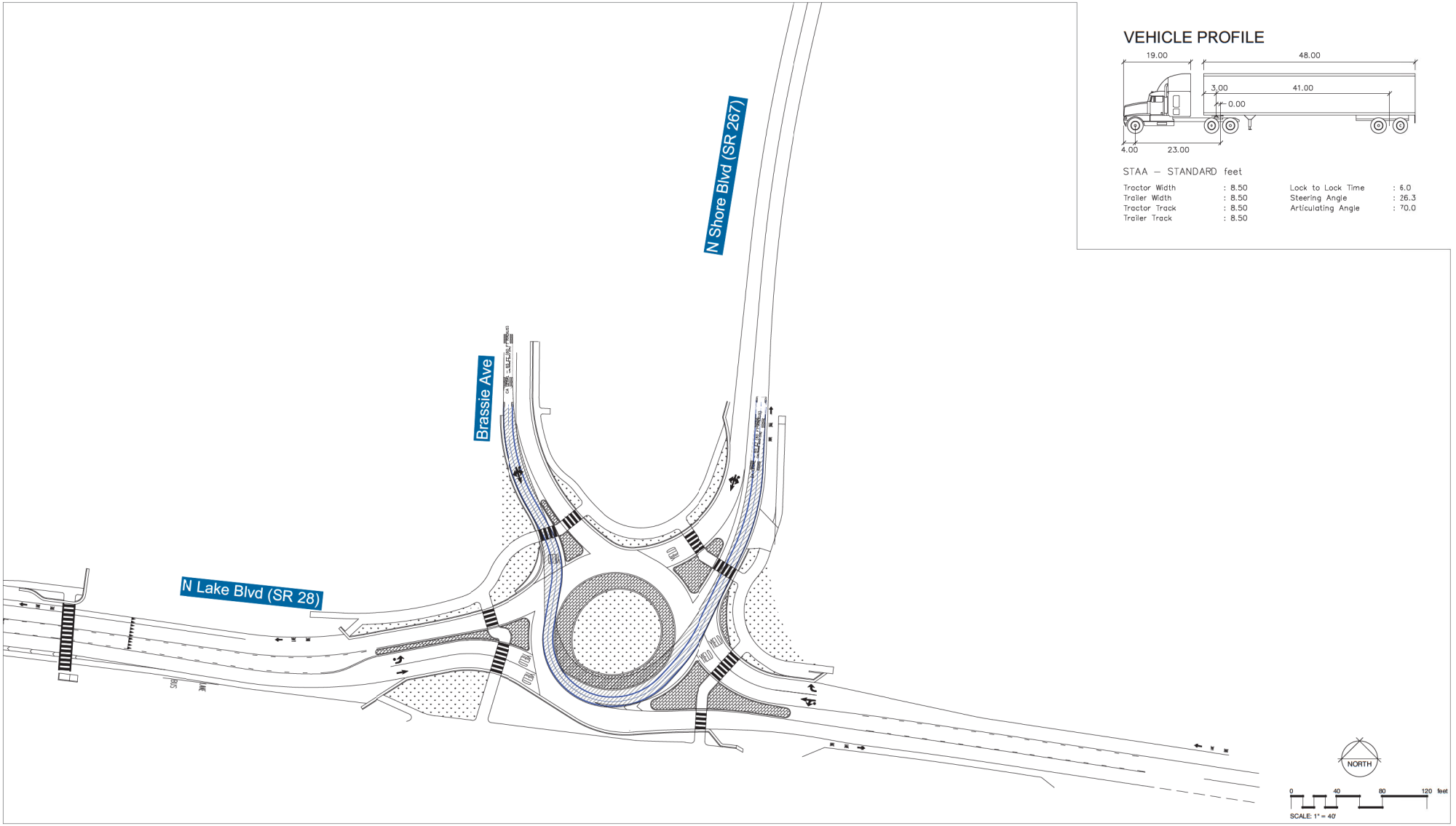
Alternative 3: Brassie Left Truck Turn



VEHICLE PROFILE

STAA – STANDARD feet

Tractor Width	: 8.50	Lock to Lock Time	: 6.0
Trailer Width	: 8.50	Steering Angle	: 26.3
Tractor Track	: 8.50	Articulating Angle	: 70.0
Trailer Track	: 8.50		

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Alternative 4: Signalized Alternative

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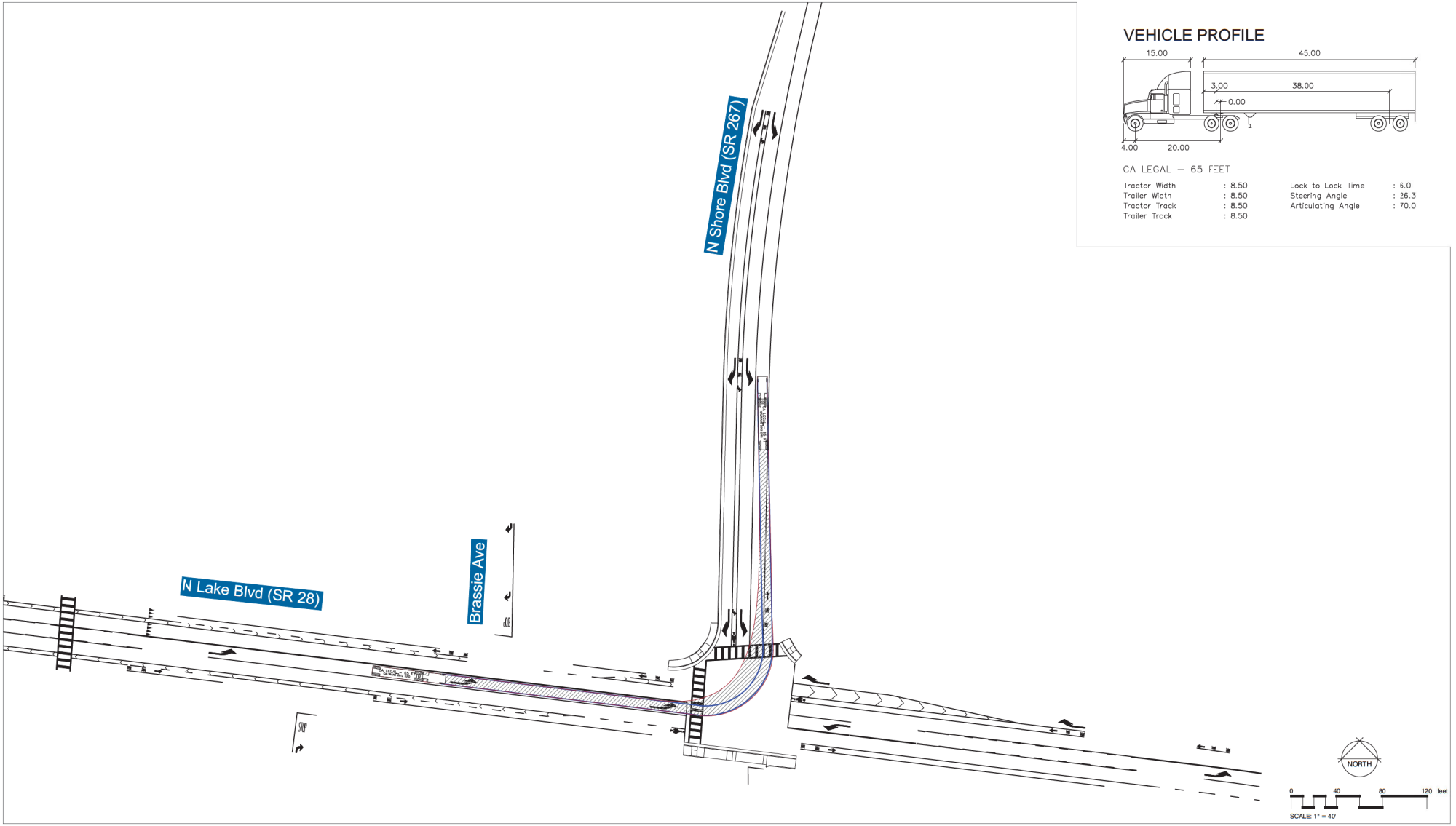
Alternative 4: Eastbound Truck Turns



VEHICLE PROFILE

CA LEGAL – 65 FEET

Tractor Width	: 8.50	Lock to Lock Time	: 6.0
Trailer Width	: 8.50	Steering Angle	: 26.3
Tractor Track	: 8.50	Articulating Angle	: 70.0
Trailer Track	: 8.50		

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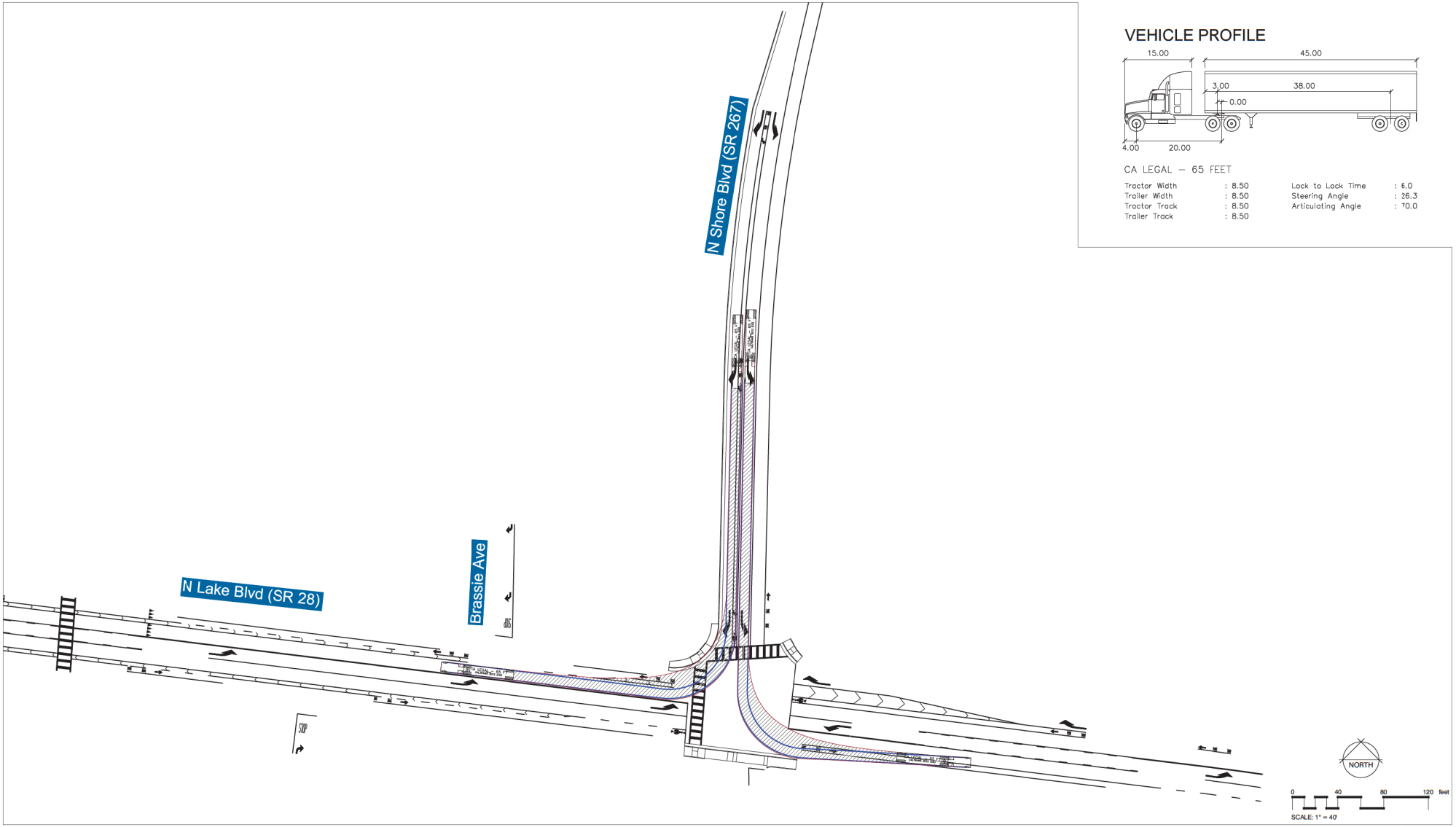
Alternative 4: Southbound Truck Turns



Kings Beach Western Approach Project

Placer County

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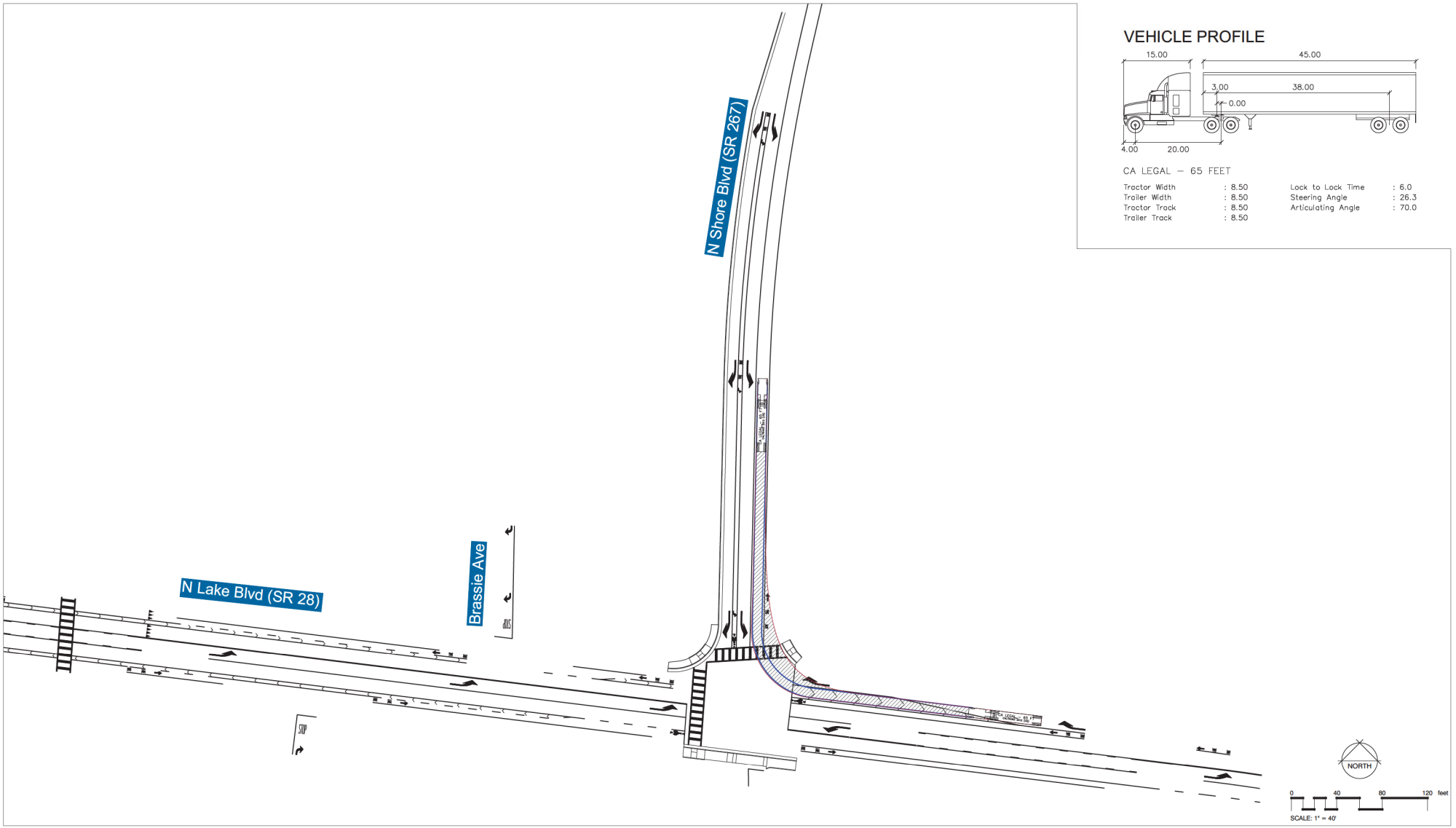
Alternative 4: Westbound Truck Turns



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6.2 Pedestrian and Bike Accommodation

Alternative 3 will accommodate pedestrians and bicycles with buffered (paint only) Caltrans Class II bike lanes, shared use paths, and intersection crossings as identified in Figure 6. The roundabout would be able to provide full connectivity for pedestrians and bicyclists as every leg has been designed to accommodate a crosswalk. This alternative provides two options for bicyclists, riders can exit the bicycle lane and traverse the roundabout as a vehicle or they can exit the bike lane onto the shared use path and bypass the intersection or utilize the crosswalks to cross SR 267 or SR 28. This alternative will improve the midblock crosswalk west of the existing intersection by shortening the crossing distance through the use of curb bulb-outs on the north side of SR 28 and adding either a pedestrian hybrid beach (PHB) or rectangular rapid flashing beacons (RFFB). With this being said, the County would like to explore the possibility of potentially consolidating pedestrian crossing in the final design phase.

Alternative 4 will accommodate pedestrians and bicycles with a mix of buffered (paint only) Caltrans Class II bike lanes , sidewalks, shared use paths, and intersection crossings as previously shown in Figure 5. The signal alternative will not provide a crosswalk on the east leg of the intersection, consistent with the current layout. If a pedestrian or bicyclist wants to cross from the south to the north on the east side of the intersection, they would first need to cross to the west side of the intersection, cross SR 28 using the crosswalk on the west leg, and then return to the east side of the intersection. There are no bicycle accommodations through the intersection and cyclists wishing to make left turns would need to take the lane and traverse as a vehicle. This alternative will improve the midblock crosswalk west of the existing intersection by shortening the crossing distance through striping only and adding in either a PHB or RRFBs.

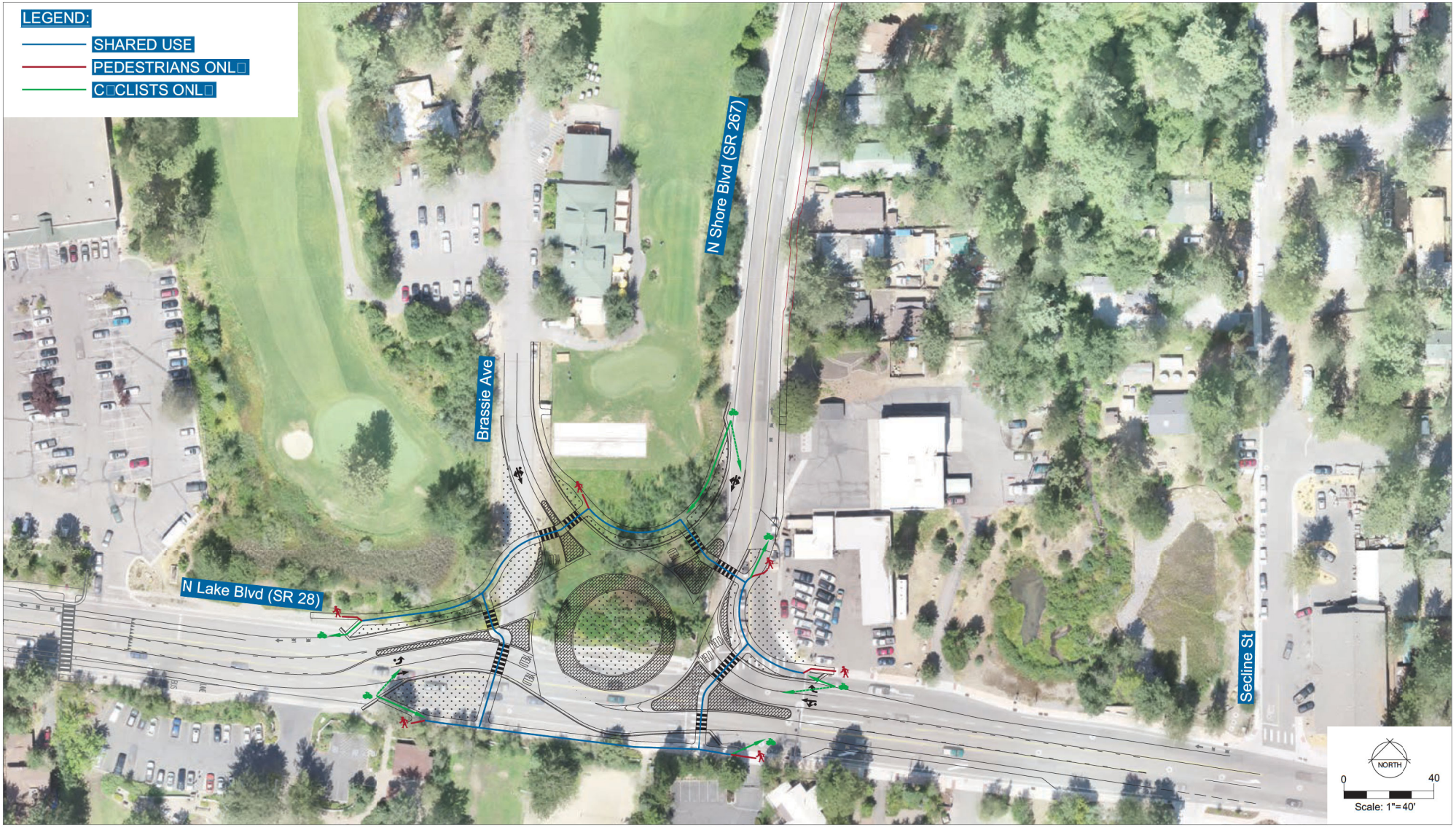
6.3 Winter Maintenance Operations

Alternative 3, the roundabout, has been designed with the variance in weather in mind. The expected snow fall every year will require snow removal equipment to be used to ensure constant operations of the intersection.

The roundabout has been designed with a larger inscribed circle diameter (ICD) so that snow removal equipment can easily traverse the circulatory roadway in one smooth circular motion. Additionally, during discussion with Caltrans maintenance it was determined the snow removal operations are divided at the intersection and the routes for the snow removal crews terminate at the intersection. The roundabout alternative will allow snow removal equipment to easily make a U-turn and plow the other direction of travel.

The signal alternative was designed to accommodate snow removal efforts by making the lane reductions through the use of pavement delineation only. This allows snow removal equipment to operate as they do with the existing signal.

Alternative 3: Pedestrian Movements



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March 21, 2019 2556EX010.dwg

7. Safety Considerations

7.1 Historic Collision Data

Historic collision data for a five year interval (from January 2013 to December 2017) was obtained from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS) – Transportation Systems Network (TSN). Table 4 presents a summary of the type of collisions that occurred in that time period at the study intersections.

Table 7.1 – Collision Data by Severity

Intersection	Property Damage Only	Injury		Severe Injury	Fatality	Grand Total
		Complaint of Pain	Visible			
SR 28/Brassie Ave	2	1	0	1	0	2
SR 28/SR 267	8	2	2	0	0	4
Grand Total	10	3	2	1	0	6

As presented in Table 7.1, there were a total of 16 collisions consisting of 10 property damage only, five complaint of pain or visible injury, and one severe injury. Of the two visible injury collisions, one involved a vehicle failing to yield to a pedestrian right-of-way. The other visible injury collision was a hit object with driving under the influence as the primary collision factor. The only severe injury within the study limits involved a broadside vehicle-vehicle collision with unsafe speeds as the primary collision factor.

Table 7.2 provides a comparison of the total number of collisions compared to a statewide average at similar intersections.

Table 7.2 – Collision Data Comparison to Statewide Average

Study Intersections	Facility Type ID	2018 Daily Entering Volume	Total Collisions (5 year)	# Fatality (F)	# Injury (I)	F+I (5 Year)	% F + I	Statewide Average % F + I	Collision Rate (ACC/MVE)	Statewide Basic Average Rate
ROADWAY NAME										
SR 28 & Bassie Ave	I22	16,200	4	0	2	2	50.0%	39.3%	0.135	0.14
SR 28 & SR 267	I29	21,445	12	0	2	2	16.7%	47.1%	0.31	0.19

As presented in Table 7.2, the two intersections have higher than average collision rates (shown in red) when compared to a statewide average of similar intersections.

7.2 Safety Analysis

This section looks at the affects to collision rates with conversion of the intersection from the current configuration into one of the alternatives.

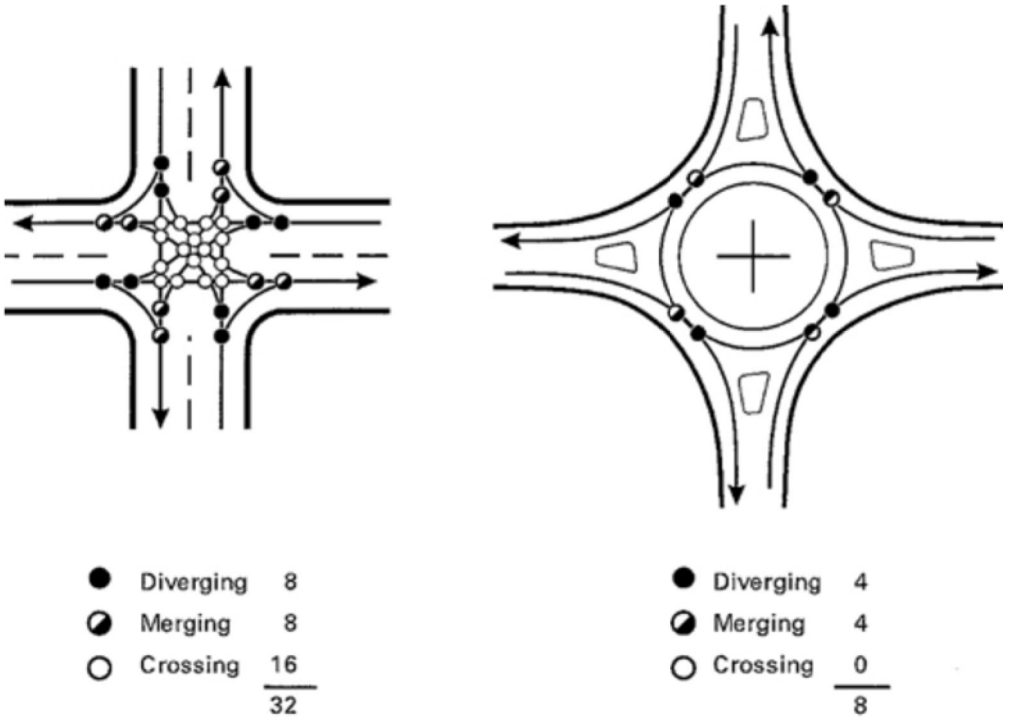
7.2.1 Crash History

This report utilizes the Crash Modification Factors (CMF) Clearinghouse website and Local Roadway Safety Manual published by Caltrans in conjunction with the United States Federal Highway Administration. The publications contain CMFs for converting signalized intersections to roundabouts. The existing conditions at the study intersections are as follows:

- State Route 28/State Route 267 – Signalized
- State Route 28/Brassie Avenue – Unsignalized

7.2.1.1 Number of Conflicting Points

The number of conflicting points within an intersection directly correlates to the risk of an incident, especially at intersections. Conflicting points are locations at which a roadway user can cross, merge, and diverge, etc. with another roadway user. A diagram of conflict locations at typical intersections is provided below.



The number of conflicting points for the roundabout and signal alternative can be understood from the insert above. The analysis above illustrates the advantages that the roundabout alternative provides by significantly reducing the number of conflict points between vehicles and further justifies the higher CMF values as the exposure to risk is significantly reduced at roundabout intersections.

Typically, the roundabout design forces the driver to reduce their speed in the intersection to 20 miles per hour. At signalized intersections, drivers can often travel faster than posted speed limits due to lack of geometric constraints.

Due to reduced travel speeds through the intersection and fewer conflict points, the roundabout alternative is expected to eliminate most severe crash types.

8. Cost Estimates

There are two types of costs associated within any project. Capital or actual costs reflect the total amount of money required to construct and maintain the improvement. These costs are typically paid for by the agency that governs the area (in this case Placer County/Caltrans). The costs range from construction to operation and maintenance of the improvement identified.

The second set of costs are indirect or public/societal costs. These costs range from collisions to amount of time waiting at an intersection (i.e. delay costs, emission costs, wasted fuel). These costs are not apparent once the identified improvement has been constructed and users are benefiting from the improvement. For the purpose of this report/analysis, only the public/societal costs are discussed below.

All costs have been calculated based on a 22 design life of the project.

8.1 Collision Costs

Costs associated with collision anticipated for each proposed intersection improvement was quantified using the Caltrans Intersection Control Evaluation Collision Cost Analysis spreadsheet. The Economic Analysis Branch of the Transportation Planning Department of Caltrans provides the costs associated with collision types in Life-Cycle Benefit-Cost Analysis Economic Parameter 2016 (http://www.dot.ca.gov/hq/tpp/offices/eab/benefit_cost/LCBCA-economic_parameters.html). These costs (in 2016 Current Dollar Value) are as follows:

- Fatal Accident: $10,800,000
- Injury Accident: $148,800
- Property Damage (PDO) Accidents: $10,200
- Average Cost per Accident: $185,600

To compute the existing collision rate, existing collision data over a five year period was utilized. The intersection ADT was converted to a million vehicle (MV) per year. The number of collisions were then divided by the total number of vehicles to obtain a collision rate (collision/MV). This determines the base cost of collisions for existing conditions. The collision rate along with the projected increase in traffic over the project was used over a 22 year period to determine the anticipated number of future collisions. These were modified based on Caltrans collision reduction factors for the roundabout alternative to obtain the total collision costs.

8.2 Delay Costs

The value of travel time was quantified for each proposed build alternative. The delay costs were computed using Existing and Cumulative delays for the AM and PM peak hour periods of both the Alternatives. In assessing the delay costs, the weighted-average for costing the value of time for automobiles and trucks was used.

An average delay cost of $18.95/person hours is published data by Caltrans for Vehicle Operation Costs Parameters for 2016 (https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics/vehicle-operation-cost-parameters).

8.3 Delay Costs and Environmental Costs

To calculate the fuel cost for the alternatives, the vehicle operating costs were quantified. An average fuel price for regular unleaded automobile fuel of $3.86 was used based on the last year's average price at the pump adjusted to rates.

To calculate the environmental cost, the greenhouse gas emissions costs were quantified for the project.

The health cost of Carbon Monoxide (CO) in a rural/suburban California town is $80/ton. The health cost of Nitrogen Oxide is $18,700/ton.

8.4 Maintenance Costs

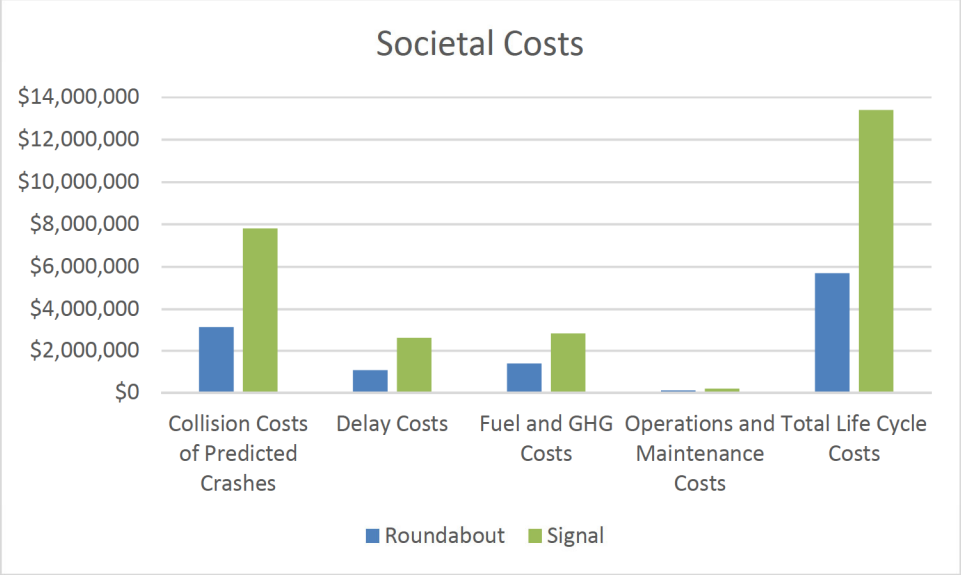
Operation and maintenance costs are other important components of the cost associated within both alternatives. The operation and maintenance costs for a traffic signal include providing power service to the signal and street lighting ($600/year), signal retiming ($500/year), and signal maintenance for power outages/new detector loops/etc. ($10,000/year).

The roundabout alternative would have lower operation and maintenance costs that are limited to power street lighting ($250/year). These values are typical industry averages and could potentially adjusted to local data, if available.

8.5 Summary of Societal Costs

Insert 8.1 identifies the indirect or public/societal costs for the two identified improvement alternatives for the intersection of SR 28/SR 297.

Insert 8.1 – Societal Costs



As seen in the graph, the societal costs for the roundabout are approximately $7.7 million less than the signal alternative. This huge savings to the public comes from less intense and frequency of collisions as well as saving in delay and fuel/emissions costs.

9. Potential Right of Way Impacts

The following discusses the potential right of way impacts associated with the two build alternatives. It should be noted that with both of the alternatives, there will be temporary right of way impacts to the properties along the east side of SR 267 due to the construction of the proposed sidewalk

9.1 Alternative 3 – Roundabout Concept

This alternative shifts the intersection to the west of the existing intersection and realigns Brassie Avenue to be a fourth leg of the intersection. This also requires realignment of SR 267 and Brassie Avenue to accommodate the shifted intersection alignment. The shifting of the intersection will require right of way acquisition from one property located on the northwest corner of SR 267 and SR 28. Temporary construction easements and/or permits to enter and construct will also be needed from the two parcel on the northeast corner, the property on the south side of the intersection and the Safeway property.

9.2 Alternative 4 – Signal Concept

This alternative would require the extension of the southbound right turn pocket approximately 400 feet. The southbound approach widening would require right of-way along SR 267 approximately 400 feet to the north of the study intersection which would require removal of several trees. Additional right-of-way would be required on all quadrants for new signal poles and mast arms.

10. Water Quality Considerations

10.1 Alternative 3 – Roundabout Concept

On the existing private property on the northwest corner of the intersection there is an existing man-made stormwater facility which will be impacted due to the realignment of the intersection. The PDT has identified a location adjacent to the existing facility where a new stormwater basin can be constructed to replace the impacted facility.

This alternative provides opportunities to install additional water quality/low impact development components within the various areas of the roundabout including but not limited to, the landscape butters between the sidewalk and circulatory roadway, in the splitter islands and the central island.

10.2 Alternative 4 – Signal Concept

This alternative does not impact any of the existing water quality features but also does not provide opportunity to add additional water quality features.

11. Access

The intersection of SR 28/SR 267 is within close proximity of various residences and businesses. When considering an improvement to an intersection, access should be considered to determine the impacts to business, emergency response times, housing, and recreational area. This section identifies the access benefits and restrictions caused by each alternative.

11.1 Roundabout Alternative

The roundabout alternative would realign the intersection of SR 28/SR 267 to include Brassie Avenue. With the realignment, access to Brassie Avenue would be enhanced by providing access at the intersection. In the existing condition, while it has full access, existing queueing at the SR 28/SR 267 light spills back past the intersection, making it challenging to make lefts out of the road.

This alternative would restrict access to the condominium complex to the south of the intersection of SR 28/SR 267. The driveway is currently the south leg of the signalized intersection, but with the realignment of the intersection, the driveway will no longer be a leg of the intersection and will be located just east of the roundabout. Due to geometrics and safety considerations, this driveway would be restricted to right-in/right-out only.

The two businesses located on the northeast corner would each have full access. The business directly on the corner would have full access on SR 267 while the business just to the east of that would have full access onto SR 28. North Tahoe Beach and Safeway properties would remain full access driveways.

The fire station located approximately 125 feet north of the intersection would maintain its current full access to SR 267.

With the roundabout alternative, emergency response times are anticipated to be shorter (faster) than they are in the current condition. This is due to the fact this alternative will experience less queuing and delays compared to the existing signal and the signal alternative.

11.2 Signal Alternative

The signal alternative would keep a similar footprint with extensions to some turn pockets. These extensions would require Brassie Avenue and the North Tahoe Beach property to be restricted to right-in/right-out only. This would require traffic that typically accesses the golf course via Brassie Avenue to use alternate residential streets to get to and from the golf course.

The North Tahoe Beach property is a parking for a variety of recreational activities and with this alternative would restrict access to only westbound traffic. Eastbound SR 28 traffic would be required continue east until it was possible to make a legal U-turn, which there is not accommodations for a U-turn within the project limits. The businesses to the northeast would be restricted to right-in/right-out movements only for both the driveway on SR 28 and the driveway on SR 267.

With the signal alternative, emergency response times are anticipated to be longer (slower) than they are in the current condition. This is due to the fact this alternative will experience more queuing and delays compared to the existing conditions, resulting in slower response times.

12. Emergency Evacuation Routes

SR 267 is a primary access route to and from the Kings Beach area. SR 267 has been identified in the *Emergency Preparedness and Evacuation Guide* by North Tahoe Fire Protection District and Meeks Bay Fire Protection District in coordination with Cal Fire. In the event of an emergency, SR 267 could be turned into a one-way roadway that would take the southbound lane and contraflow travel to the north providing two lanes northbound. This could be achieved in both proposed alternatives and is described further below.

12.1 Roundabout Alternative

During an emergency situation that requires evacuation of Kings Beach and the surrounding areas, the roundabout could accommodate a contraflow condition to feed SR 267. This would be achieved by channelizing westbound traffic to only make right turns to northbound SR 267. The eastbound traffic could be diverted to the westbound lane before the splitter island on the north side of the roundabout. The eastbound traffic could become contraflow through the roundabout and exit the roundabout into the southbound lane of SR 267 where they would travel northbound in the southbound lane. Brassie Avenue would be closed south of the golf course and vehicles could travel north to Tiger Way to SR 267 north of the project location.

12.2 Signal Alternative

With this alternative, the westbound traffic would be restricted to right turns only and vehicles could travel northbound in the existing northbound travel lane. The eastbound traffic could be restricted to

only left turns at the intersection of SR 28/SR 267 and could be diverted to the southbound lane of SR 267. Due to the restricted access Brassie Avenue could be required to use the same detour as the roundabout alternative and use Tiger Way to access SR 267. Additionally, the signal could be placed into flashing red mode. This would inform drivers that the intersection needs to be treated as a four-way stop controlled intersection. The flashing red is likely to slow progress and evacuation times due to the driver confusion.

13. Recommendations

Table 13.1 below summarizes the outcome of each alternative comparison analysis documented in sections 5 through 12 of this report. A full circle indicates a significantly improved condition for one alternative compared to the other, while a half circle indicates a moderately improved condition.

Table 13.1 – Summary of Alternatives Comparison

Analysis	Alternative 3 – Roundabout	Alternative 4 – Signal
5. Capacity Assessment	●	
6.1 ICE – Footprint Development & Assessment		●
6.2 ICE – Pedestrian & Bicyclist Accommodation	●	
7. Safety – Crash Modification Factors	◒	
8. Estimated Cost	●	
9. Potential Impacts		◒
10. Environmental Impacts		◒
11. Access	●	
12. Emergency Evacuation Routes	◒	

● Significantly Improved Condition ◒ Moderately Improved Condition

As stated above, the roundabout and signal alternatives would provide acceptable service through the Year 2045. However, the roundabout alternative provides substantially less queuing during the Summer Friday PM peak hour compared to the signal alternative. The roundabout would potentially provide faster evacuation times and less driver confusion.

Based on the analysis done, the roundabout alternative offers improved conditions across more analysis outcomes than the signal alternative. Furthermore, the roundabout alternative wholly meets the project's stated Purpose and Need while the signal alternative fails to meet the need and purpose. Therefore, based on this analysis, it is recommended the signalized alternative be dropped from further analysis.

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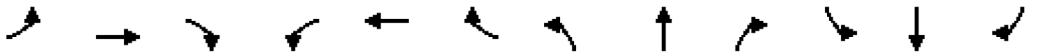
Appendix

Appendix A – Synchro Reports

Appendix B – Sidra Reports

Appendix A – Synchro Reports



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	230	515	0	0	450	325	0	5	0	380	0	220
Future Volume (veh/h)	230	515	0	0	450	325	0	5	0	380	0	220
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856
Adj Flow Rate, veh/h	242	542	0	0	506	365	0	20	0	437	0	253
Peak Hour Factor	0.95	0.95	0.95	0.89	0.89	0.89	0.25	0.25	0.25	0.87	0.87	0.87
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	3	3	3
Cap, veh/h	293	1592	0	3	786	785	0	71	0	499	0	444
Arrive On Green	0.17	0.45	0.00	0.00	0.22	0.22	0.00	0.04	0.00	0.28	0.00	0.28
Sat Flow, veh/h	1767	3618	0	1767	3526	1529	0	1856	0	1767	0	1572
Grp Volume(v), veh/h	242	542	0	0	506	365	0	20	0	437	0	253
Grp Sat Flow(s),veh/h/ln	1767	1763	0	1767	1763	1529	0	1856	0	1767	0	1572
Q Serve(g_s), s	7.4	5.6	0.0	0.0	7.3	8.6	0.0	0.6	0.0	13.1	0.0	7.7
Cycle Q Clear(g_c), s	7.4	5.6	0.0	0.0	7.3	8.6	0.0	0.6	0.0	13.1	0.0	7.7
Prop In Lane	1.00		0.00	1.00		1.00	0.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	293	1592	0	3	786	785	0	71	0	499	0	444
V/C Ratio(X)	0.83	0.34	0.00	0.00	0.64	0.47	0.00	0.28	0.00	0.88	0.00	0.57
Avail Cap(c_a), veh/h	634	1592	0	317	1582	1130	0	400	0	634	0	564
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	22.5	9.9	0.0	0.0	19.6	9.0	0.0	26.1	0.0	19.1	0.0	17.1
Incr Delay (d2), s/veh	2.3	0.0	0.0	0.0	0.3	0.2	0.0	0.8	0.0	9.3	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.9	1.7	0.0	0.0	2.7	4.4	0.0	0.3	0.0	5.8	0.0	2.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	24.7	9.9	0.0	0.0	20.0	9.1	0.0	26.8	0.0	28.4	0.0	17.5
LnGrp LOS	C	A	A	A	B	A	A	C	A	C	A	B
Approach Vol, veh/h		784			871			20			690	
Approach Delay, s/veh		14.5			15.4			26.8			24.4	
Approach LOS		B			B			C			C	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	0.0	29.8		20.3	12.7	17.0		5.6				
Change Period (Y+Rc), s	3.5	4.6		4.6	3.5	4.6		3.5				
Max Green Setting (Gmax), s	10.0	25.0		20.0	20.0	25.0		12.0				
Max Q Clear Time (g_c+I1), s	0.0	7.6		15.1	9.4	10.6		2.6				
Green Ext Time (p_c), s	0.0	1.3		0.6	0.1	1.4		0.0				

Intersection Summary		
HCM 6th Ctrl Delay		17.8
HCM 6th LOS		B

Notes

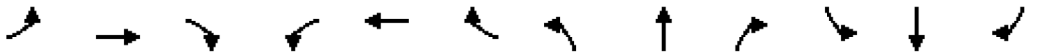
User approved pedestrian interval to be less than phase max green.

Intersection: 1: N Shore Blvd (SR 267) & N Lake Blvd (SR 28)

Movement	EB	EB	EB	WB	WB	WB	NB	SB	SB
Directions Served	L	T	TR	T	T	R	LTR	LT	R
Maximum Queue (ft)	181	246	193	158	149	157	40	330	218
Average Queue (ft)	104	102	24	86	61	57	4	154	60
95th Queue (ft)	163	191	104	140	119	117	23	258	142
Link Distance (ft)		639	639	297	297		118	1185	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	125					95			40
Storage Blk Time (%)	4	3		19	2	1		47	10
Queuing Penalty (veh)	10	6		0	6	3		104	40

Network Summary

Network wide Queuing Penalty: 170



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	269	601	0	0	525	380	0	7	0	444	0	257
Future Volume (veh/h)	269	601	0	0	525	380	0	7	0	444	0	257
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856
Adj Flow Rate, veh/h	283	633	0	0	553	400	0	28	0	467	0	271
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.25	0.25	0.25	0.95	0.95	0.95
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	3	3	3
Cap, veh/h	321	1004	0	2	585	880	0	86	0	446	0	397
Arrive On Green	0.18	0.54	0.00	0.00	0.32	0.32	0.00	0.05	0.00	0.25	0.00	0.25
Sat Flow, veh/h	1767	1856	0	1767	1856	1532	0	1856	0	1767	0	1572
Grp Volume(v), veh/h	283	633	0	0	553	400	0	28	0	467	0	271
Grp Sat Flow(s),veh/h/ln	1767	1856	0	1767	1856	1532	0	1856	0	1767	0	1572
Q Serve(g_s), s	12.4	18.8	0.0	0.0	23.1	12.1	0.0	1.2	0.0	20.0	0.0	12.3
Cycle Q Clear(g_c), s	12.4	18.8	0.0	0.0	23.1	12.1	0.0	1.2	0.0	20.0	0.0	12.3
Prop In Lane	1.00		0.00	1.00		1.00	0.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	321	1004	0	2	585	880	0	86	0	446	0	397
V/C Ratio(X)	0.88	0.63	0.00	0.00	0.95	0.45	0.00	0.32	0.00	1.05	0.00	0.68
Avail Cap(c_a), veh/h	446	1004	0	223	585	880	0	281	0	446	0	397
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	31.6	12.7	0.0	0.0	26.5	10.0	0.0	36.6	0.0	29.6	0.0	26.8
Incr Delay (d2), s/veh	11.2	1.0	0.0	0.0	24.1	0.1	0.0	0.8	0.0	55.7	0.0	4.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.0	7.0	0.0	0.0	13.5	6.6	0.0	0.5	0.0	14.7	0.0	5.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	42.8	13.6	0.0	0.0	50.6	10.2	0.0	37.4	0.0	85.3	0.0	30.8
LnGrp LOS	D	B	A	A	D	B	A	D	A	F	A	C
Approach Vol, veh/h		916			953			28			738	
Approach Delay, s/veh		22.7			33.6			37.4			65.3	
Approach LOS		C			C			D			E	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	0.0	47.5		24.6	17.9	29.6		7.2				
Change Period (Y+Rc), s	3.5	4.6		4.6	3.5	4.6		3.5				
Max Green Setting (Gmax), s	10.0	25.0		20.0	20.0	25.0		12.0				
Max Q Clear Time (g_c+I1), s	0.0	20.8		22.0	14.4	25.1		3.2				
Green Ext Time (p_c), s	0.0	0.7		0.0	0.1	0.0		0.0				

Intersection Summary		
HCM 6th Ctrl Delay		38.7
HCM 6th LOS		D

Notes

User approved pedestrian interval to be less than phase max green.

Intersection: 1: N Shore Blvd (SR 267) & N Lake Blvd (SR 28)

Movement	EB	EB	WB	WB	B6	NB	SB	SB
Directions Served	L	TR	T	R	T	LTR	LT	R
Maximum Queue (ft)	190	360	395	190	426	43	626	240
Average Queue (ft)	134	162	260	137	70	6	271	133
95th Queue (ft)	202	297	425	250	294	28	603	272
Link Distance (ft)		640	299		400	130	1197	
Upstream Blk Time (%)			13		3			
Queuing Penalty (veh)			0		0			
Storage Bay Dist (ft)	125			95				40
Storage Blk Time (%)	11	7	47	1			59	23
Queuing Penalty (veh)	66	19	180	7			153	100

Network Summary

Network wide Queuing Penalty: 525

Appendix B – Sidra Reports

LANE SUMMARY

Site: 101 [2045 Friday - Realigned Golf course -Summer - SIDRA]

N Lake Blvd (SR 28)/N Shore Blvd (SR 267)
Site Category: (None)
Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
East: WB - N Lake Blvd (SR 28)													
Lane 1[d]	558	3.0	1354	0.412	100	6.6	LOS A	3.1	80.2	Full	400	0.0	0.0
Lane 2	400	3.0	1096	0.365	100	7.0	LOS A	2.5	64.0	Short	89	0.0	NA
Approach	958	3.0		0.412		6.7	LOS A	3.1	80.2				
North: SB - N Shore Blvd (SR 267)													
Lane 1[d]	733	3.0	887	0.826	100	24.2	LOS C	17.5	446.7	Full	400	0.0	8.4
Approach	733	3.0		0.826		24.2	LOS C	17.5	446.7				
NorthWest: RoadName													
Lane 1[d]	16	0.0	342	0.046	100	11.3	LOS B	0.3	8.7	Full	1600	0.0	0.0
Approach	16	0.0		0.046		11.3	LOS B	0.3	8.7				
West: EB - N Lake Blvd (SR 28)													
Lane 1	288	2.9	850	0.339	100	8.1	LOS A	2.4	60.8	Short	87	0.0	NA
Lane 2[d]	633	3.0	1131	0.560	100	10.0	LOS A	6.0	152.8	Full	400	0.0	0.0
Approach	921	3.0		0.560		9.4	LOS A	6.0	152.8				
Intersection	2627	3.0		0.826		12.6	LOS B	17.5	446.7				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).
Roundabout Capacity Model: SIDRA Standard.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

INTERSECTION SUMMARY

Site: 101 [2045 Friday - Realigned Golf course -Summer - SIDRA]

N Lake Blvd (SR 28)/N Shore Blvd (SR 267)
Site Category: (None)
Roundabout

Intersection Performance - Hourly Values				
Performance Measure	**Vehicles**		**Persons**	
Travel Speed (Average)	18.7	mph	18.7	mph
Travel Distance (Total)	475.5	veh-mi/h	570.6	pers-mi/h
Travel Time (Total)	25.4	veh-h/h	30.5	pers-h/h
Demand Flows (Total)	2627	veh/h	3153	pers/h
Percent Heavy Vehicles (Demand)	3.0	%		
Degree of Saturation	0.826			
Practical Spare Capacity	2.9	%		
Effective Intersection Capacity	3181	veh/h		
Control Delay (Total)	9.17	veh-h/h	11.00	pers-h/h
Control Delay (Average)	12.6	sec	12.6	sec
Control Delay (Worst Lane)	24.2	sec		
Control Delay (Worst Movement)	24.2	sec	24.2	sec
Geometric Delay (Average)	0.0	sec		
Stop-Line Delay (Average)	12.6	sec		
Idling Time (Average)	6.3	sec		
Intersection Level of Service (LOS)	LOS B			
95% Back of Queue - Vehicles (Worst Lane)	17.5	veh		
95% Back of Queue - Distance (Worst Lane)	446.7	ft		
Queue Storage Ratio (Worst Lane)	0.45			
Total Effective Stops	2068	veh/h	2481	pers/h
Effective Stop Rate	0.79		0.79	
Proportion Queued	0.78		0.78	
Performance Index	81.5		81.5	
Cost (Total)	549.71	$/h	549.71	$/h
Fuel Consumption (Total)	41.0	gal/h		
Carbon Dioxide (Total)	366.8	kg/h		
Hydrocarbons (Total)	0.037	kg/h		
Carbon Monoxide (Total)	0.383	kg/h		
NOx (Total)	0.533	kg/h		

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Site Model Variability Index (Iterations 3 to N): 5.1 %
Number of Iterations: 8 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 2.5% 1.3% 0.7%

Intersection Performance - Annual Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	1,261,137	veh/y	1,513,364	pers/y
Delay	4,400	veh-h/y	5,280	pers-h/y
Effective Stops	992,530	veh/y	1,191,036	pers/y
Travel Distance	228,222	veh-mi/y	273,867	pers-mi/y
Travel Time	12,213	veh-h/y	14,656	pers-h/y
Cost	263,861	$/y	263,861	$/y

Fuel Consumption	19,691	gal/y
Carbon Dioxide	176,070	kg/y
Hydrocarbons	18	kg/y
Carbon Monoxide	184	kg/y
NOx	256	kg/y

INTERSECTION SUMMARY

Site: 101v [Friday - Summer - No Golf Left Out - Conversion]

N Lake Blvd (SR 28)/N Shore Blvd (SR 267)
Site Category: (None)
Signals - Pretimed Isolated Cycle Time = 110 seconds (Site Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Intersection Performance - Hourly Values							
Performance Measure	**Vehicles**		**Pedestrians**		**Persons**		
Travel Speed (Average)	4.6	mph	0.8	mph	4.6	mph	
Travel Distance (Total)	525.3	veh-mi/h	0.1	ped-mi/h	630.5	pers-mi/h	
Travel Time (Total)	113.1	veh-h/h	0.2	ped-h/h	135.8	pers-h/h	
Demand Flows (Total)	2355	veh/h	9	ped/h	2835	pers/h	
Percent Heavy Vehicles (Demand)	2.0	%					
Degree of Saturation	1.258		0.002				
Practical Spare Capacity	-28.5	%					
Effective Intersection Capacity	1872	veh/h					
Control Delay (Total)	93.32	veh-h/h	0.11	ped-h/h	112.10	pers-h/h	
Control Delay (Average)	142.6	sec	46.4	sec	142.3	sec	
Control Delay (Worst Lane)	182.9	sec					
Control Delay (Worst Movement)	182.9	sec	46.4	sec	182.9	sec	
Geometric Delay (Average)	0.0	sec					
Stop-Line Delay (Average)	142.6	sec					
Idling Time (Average)	138.7	sec					
Intersection Level of Service (LOS)	LOS F		LOS E				
95% Back of Queue - Vehicles (Worst Lane)	54.1	veh					
95% Back of Queue - Distance (Worst Lane)	1374.0	ft					
Queue Storage Ratio (Worst Lane)	6.48						
Total Effective Stops	3168	veh/h	8	ped/h	3810	pers/h	
Effective Stop Rate	1.35		0.92		1.34		
Proportion Queued	0.99		0.92		0.99		
Performance Index	573.3		0.2		573.5		
Cost (Total)	1806.68	$/h	1.80	$/h	1808.48	$/h	
Fuel Consumption (Total)	67.4	gal/h					
Carbon Dioxide (Total)	601.7	kg/h					
Hydrocarbons (Total)	0.069	kg/h					
Carbon Monoxide (Total)	0.544	kg/h					
NOx (Total)	0.559	kg/h					

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Site Model Variability Index (Iterations 3 to N): 0.0 %
Number of Iterations: 3 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Main (Timing-Capacity) Iterations: 12.1% 3.6% 0.0%

Intersection Performance - Annual Values							
Performance Measure	**Vehicles**		**Pedestrians**		**Persons**		
Demand Flows (Total)	1,130,563	veh/y	4,174	ped/y	1,360,849	pers/y	
Delay	44,795	veh-h/y	54	ped-h/y	53,808	pers-h/y	
Effective Stops	1,520,724	veh/y	3,833	ped/y	1,828,701	pers/y	
Travel Distance	252,145	veh-mi/y	63	ped-mi/y	302,636	pers-mi/y	
Travel Time	54,272	veh-h/y	80	ped-h/y	65,207	pers-h/y	
Cost	867,205	$/y	864	$/y	868,069	$/y	

Fuel Consumption	32,362	gal/y
Carbon Dioxide	288,812	kg/y
Hydrocarbons	33	kg/y
Carbon Monoxide	261	kg/y
NOx	268	kg/y

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