STATE ROUTE 227
OPERATIONS STUDY

SLOCOG
SAN LUIS OBISPO COUNCIL OF GOVERNMENTS

SR 227 OPERATIONS STUDY

December 7, 2016

Prepared for:

San Luis Obispo Council of Governments

Prepared in partnership with:
Caltrans District 5
County of San Luis Obispo
City of San Luis Obispo

Prepared by:
Kimley Horn & Associates, Inc.
555 Capitol Mall, Suite 300
Sacramento, California 95814
Project Manager: Jim Damkowitch

In association with Wallace Group, Kittelson & Associates, Rincon Consultants, Regional Government Services, Digiwest and Quality Counts

Key SLOCOG Project Staff

Executive Director . . . . . Ronald L. De Carli
Division Chief, Programming . . . . . Richard Murphy
Transportation Planner III (Project Manager) . . . . . Jeff Brubaker
Public Information Officer . . . . . Stephanie Hicks

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EXECUTIVE SUMMARY

Congestion and safety issues on SR 227 from Tank Farm Road to Price Canyon Road (approximately 3.3 miles) have been raised by both residents living adjacent to SR 227 as well as motorists who regularly use SR 227 as a regional throughway between the City of San Luis Obispo and the Five Cities areas of San Luis Obispo County. As an important alternative parallel route to US 101, the future role and functionality of SR 227 has been a key policy issue for Caltrans, the San Luis Obispo Council of Governments (SLOCOG), the City and the County of San Luis Obispo. Particularly challenging is that SR 227 currently serves as the primary collector for several unincorporated area neighborhoods whose only access in or out is by side-street or driveway access directly onto SR 227. Outreach efforts performed for SLOCOG's 2014 Regional Transportation Plan & Sustainable Community Strategy (RTP/SCS) revealed that public expectations for action to remedy the operational and safety issues being experienced on SR 227 have elevated to a high priority need for the region.

In response, SLOCOG, in coordination with Caltrans and the City and County of San Luis Obispo, commissioned this SR 227 Operations Study. The purpose of the study is to identify a preferred SR 227 corridor concept and associated infrastructure improvements that will best meet both the local and regional goals of the region while providing the highest return on investment of limited regional transportation funding over the next 20 years. The SR 227 improvements that implement the preferred corridor concept will be considered for amendment into the 2016 State Transportation Improvement Program (STIP) which currently includes a funding earmark of $1.75 million for SR 227 improvements ("To-Be-Determined"). Given that the funding amount currently programmed in the STIP for SR 227 improvements is limited, programming of additional transportation funds yet to be identified will be required. As such, improvement recommendations from this study are phased (i.e., immediate-, short-, medium- and long-term) to allow additional/alternative funding sources to be identified and funds incrementally programmed over time.

Study Approach

The SR 227 Operations Study included the following primary objectives:

- Apply advanced data collection technology and resources such as video and Bluetooth data collection to establish accurate baseline vehicle/bicyclist/pedestrian counts, vehicle queue lengths, vehicle speeds, travel behavior and travel time trends in the corridor;
- Develop feasible corridor concept alternatives that: 1) maximize efficiency and safety; 2) achieve acceptable operating conditions relative to projected future demand; 3) improve multi-modal connectivity; 4) improve air quality; 5) accord with SR 227's rural and scenic character; 6) minimize potential impacts to the natural environment; and,
- Consistent with Caltrans Smart Mobility Framework process, perform an objective performance-based analysis to identify a preferred corridor concept using advanced intersection and highway analysis tools to calculate life-cycle benefit-costs that will support infrastructure investment decisions made by SLOCOG, Caltrans, and other stakeholders.

Alternative Corridor Concepts

Two feasible corridor concepts were developed and analyzed. Both are projected to achieve acceptable vehicular and multi-modal operations under future year conditions. The two corridor concepts are: 1) SR 227 Widening with Coordinated Signal Control; and, 2) SR 227 Roundabout Corridor. Both alternatives assume the planned Edna-Price Canyon multi-purpose trail for enhanced the multi-modal corridor capacity and a recommendation for providing secondary access to the Rolling Hills community. Descriptions of these two corridor alternatives are provided below.

SR 227 Widening with Coordinated Signal Control

The SR 227 Widening with Coordinated Signal Control Corridor Concept is consistent with the planned improvements already identified in the 2014 RTP/SCS, the County's General Plan and Caltrans SR 227 Transportation Concept Report. This would entail signalizing the currently non-signalized intersections at Farmhouse Lane and Crestmont Drive and coordinating/interconnecting these signals with the existing signals at Buckley and Los Ranchos. All four intersections would require added channelization/widening to include at minimum: a dedicated left-turn, a through-lane, and a shared through-right lane. Desired/posted speeds on SR 227 would remain at 45-55

mph depending on the section with signal priority being provided (i.e., green time) to maximize through movements during peak periods. Given the high design speeds and the close relative proximity of the four intersections, widening SR 227 from two to four through lanes with left turn channelization south of Kendall Road to Los Ranchos Road would be required. Motorists accessing SR 227 from side-streets onto SR 227 would continue to incur delays, but conflicting movements would be protected thereby improving motorist safety. All signals would provide phasing for pedestrian/bicycle crossings; however, crossing distances would be increased as a result of widening SR 227. Additional design treatments such as right-in/right-out/left-in turn restrictions at Kendall Road and possibly other side streets/driveways are recommended. Rumble strip treatments along the outside travel lanes are also recommended on SR 227 (from Buckley to Price Canyon Road). By widening SR 227 (to a 5-lane facility), the preferred alignment of the Edna-Price Canyon multi-purpose trail along the west side of SR 227 would not likely be feasible. An alternative alignment along the east side of SR 227 would need to be considered. Based on an Environmental Constraints Analysis performed as part of this study, an east-side alignment would result in potentially greater environmental effects.

SR 227 Roundabout Corridor

The Roundabout Corridor Concept focusses on providing additional capacity at only the most constrained locations within the corridor – at intersections. The roundabouts would be designed to naturally reduce vehicle speeds to 20 to 30 mph (or less) as vehicles approach the intersection. The lower design speeds entering and exiting the roundabouts would obviate the need to widen SR 227 to accommodate two through lanes in each direction south of Kendall Road. This concept would not preclude a possible future widening of SR 227. To maximize nodal capacity, the roundabouts would be constructed as multilane roundabouts and be located at intersections of Farmhouse Lane; Buckley Road; Crestmont Drive; and, Los Ranchos Road. To accommodate multilane roundabouts, SR 227 will be widened at 200 feet plus taper up/down stream to provide a transition from two-circulatory through lanes at each roundabout to one through lane along SR 227. The spacing between the Buckley Road, Crestmont Drive, and Los Ranchos Road intersections is approximately 1,300 and 1,400 feet respectively. Per NCHRP Report 772: *Evaluating the Performance of Corridors with Roundabouts*, there are over 50 roundabout corridors currently operating in the US that include intersection spacing of less than 1,300 feet. All multilane roundabouts would provide signage, illumination, and striping for pedestrian/bicycle crossings. This would include island refuge areas to allow staged pedestrian crossings to minimize both the crossing distances and conflict points. Additional treatments such as right-in/right-out/left-in turn restrictions at Kendall Road and possibly other side streets/driveways are recommended. Rumble strip treatments along the outside travel lanes are also recommended on SR 227 (from Buckley to Price Canyon Road). By retaining SR 227 as a two-lane facility from Kendall Road south to Los Ranchos Road, the preferred alignment of the Edna-Price Canyon Trail (Class I path) along the west side of SR 227 would not be compromised.

Secondary Access for Rolling Hills

Establishing a secondary access to the Rolling Hills community via a connection with Buckley Road to the north is a key recommendation of this study – independent of the corridor concept evaluation. The connection would be functionally classified as a "Local" street and include traffic calming treatments to ensure that design speeds do not encourage cut-through traffic. A secondary access would provide Rolling Hills residents the choice to avoid the left turn egress onto SR 227 if desired – improving safety, travel time reliability and emergency response times for Rolling Hills residents. However, establishing such an access would not obviate the need for increased capacity on SR 227 nor alter the ultimate facility sizing recommendations of either alternative corridor concept described above.

Role of Transit

Based on the travel characteristics of the corridor, it was determined that short of enhancing the existing San Luis Obispo Regional Transit Authority (RTA) Route 10X commuter express service or establishing a new regional commuter express service between Santa Maria and San Luis Obispo – transit or provision of park-and-ride lots would provide marginal operational benefits in the corridor. A peripheral or fringe park-and-ride lot that intercepts

commuters closer to their destinations holds the most promise. With buildout of the Edna-Price Canyon Trail as well as other bicycle infrastructure connecting to downtown San Luis Obispo, a peripheral lot may hold some appeal as a "park-and-bike" location. Implementation of either corridor concept would ensure safe pedestrian/bicycle access to existing/new transit stops and would not preclude transit enhancements or provision of park-and-ride lots in the future. The study recommends that SLOCOG continue to work with RTA, the City and County of San Luis Obispo to identify opportunities for enhancing the role of transit along the SR 227 corridor.

Planning Level & Right-of-Way Cost Estimates

Planning level cost opinions were developed for both corridor concepts. Project costs were developed for the Widening and Signal Coordination Corridor Concept using a format based on Caltrans preparation guidelines for project planning cost estimates. A one-page worksheet was created to identify and calculate estimated construction, capital support, and right of way costs. The one-page worksheet is based on the project planning cost estimate format from the Caltrans 11-page cost estimate template and supporting documentation outlined in the Caltrans Project Development Procedures Manual (PDPM), Chapter 20. The worksheet groups related work items in a standardized format that captures primary cost items common in transportation roadway projects. A combination of current unit costs for known, calculable quantities as well as percentages for minor and common items was used. Capital support costs were estimated as percentages of the combined roadway and structure construction costs and could include costs for the following phases: Project Initiation Document (PID), Project Engineering (PA&ED and PS&E), Construction Support / Construction Management, and Right of Way Support.

For the Roundabout Corridor Concept, planning level cost opinions were based on the actual costs of constructing analogous/similar multilane roundabout conversion projects completed in California.

The planning level capital cost estimates for each corridor concept alternative is provided below and reflects an order of magnitude capital cost that covers the spectrum of potential improvements associated with each corridor concept.

- SR 227 Widening with Coordinated Signal Control Initial Capital Cost: $11.3 Million
- SR 227 Roundabout Corridor Initial Capital Cost: $10.8 Million

With signalization, the SR 227 Widening with Coordinated Signal Control Corridor Concept will entail greater life-cycle Operations and Maintenance (O&M) costs (20-year) relative to the Roundabout Corridor Concept (e.g., power, signage, signal heads, cabinet etc.). Estimated 20-year intersection O&M costs for intersection control only are shown below.

- SR 227 Widening with Coordinated Signal Control Intersection O&M Cost: $650,000
- SR 227 Roundabout Corridor Intersection O&M Cost: $250,000

Given the greater coverage of pavement (i.e., five-lane vs. three-lane footprint), roadway O&M for the SR 227 Widening with Coordinated Signal Control Corridor Concept will entail greater life-cycle O&M costs (20-year) relative to the Roundabout Corridor Concept. Life-cycle (20-year) pavement O&M cost estimates are provided below.

- SR 227 Widening with Coordinated Signal Control Segment O&M Cost: $4.0 Million
- SR 227 Roundabout Corridor Segment O&M Cost: $2.4 Million

Total estimated planning level capital and O&M life-cycle costs for each corridor concept alternative is as follows:

- SR 227 Widening with Coordinated Signal Control Initial Capital + O&M Cost: $15.95 Million
- SR 227 Roundabout Corridor Initial Capital Cost + O&M Cost: $13.45 Million

Given that they are part of both corridor concept alternatives, the cost of constructing a secondary access for the Rolling Hills community and the Edna-Price Canyon Trail is not reflected above nor in the benefit/cost analysis used to evaluate each corridor concept. The cost of constructing a secondary access route connecting the Rolling Hills

neighborhood north to Buckley Road is estimated at approximately $2.3 million (Source: San Luis Obispo County Public Works). This cost estimate would be the same for either corridor concept alternative. The estimated cost for constructing the portion of the preferred Edna-Price Canyon multi-purpose trail alignment within the SR 227 study corridor is approximately $8.1 million (based on costing information from the *Edna/Price Canyon Trail Feasibility Study*, SLOCOG, March 2016). This cost would likely be greater for SR 227 Widening with Coordinated Signal Control Corridor Concept than the Roundabout Corridor Concept given that it would entail widening SR 227 from three to five lanes and necessitate an east-side versus west-side trail alignment. The latter would potentially have greater Right-of-Way and environmental mitigation costs relative to the preferred west-side alignment. This would create a greater cost differential than what is reflected above planning level capital expenditure comparison.

Preferred Corridor Concept

Based on the technical analyses performed as part of this study, the effectiveness of the corridor to accommodate existing and future vehicular demand was determined to be currently constrained by the inefficiency of the existing intersection control types. Per the Smart Mobility Framework process, a detailed Benefit-Cost (B/C) analysis of the operational, safety, emissions, and costing characteristics at each study intersections indicate that the Roundabout Corridor Concept yields the greatest estimated return on investment (highest B/C). Based on the B/C results, roundabouts will provide the most efficient intersection control through the corridor that best balances operations and capacity in concert with resource preservation, safety, emissions, maintenance, and overall cost.

Phasing of Improvements

Given the uncertainty of future funding availability and the identified funding shortfall associated with implementing the preferred corridor concept ($1.75 million available versus $10.8 million capital only), recommended phasing of the specific improvements that implement the Roundabout Corridor concept are prioritized into immediate- short-medium- and long-term phases. The key decision point for the preferred corridor concept is what order should the four proposed roundabouts be constructed to provide the greatest immediate and interim benefit.

Based on the Benefit-Cost (B/C) analysis, the two locations that provide the greatest overall benefit by converting to roundabout control are the currently signalized intersections at Los Ranchos Road and Buckley Road. Los Ranchos is currently failing and Buckley is projected to fail by 2025 – both create significant queueing on SR 227. The monetized benefits of converting these two intersections to roundabout control covers the cost (i.e., pays for itself) in less than five years of operation. Establishing these two roundabouts first will provide immediate safety and operational benefits to the Rolling Hills community as motorists exiting Crestmont Drive will have the flexibility/option to avoid making the difficult permitted left-turn movement and instead make a right-turn onto SR 227 and execute a U-turn at either the Los Ranchos Road or Buckley Road roundabout depending on direction. At Crestmont Drive, installation of interim operational improvements consistent with the Highway Design Manual at Crestmont Drive and subject to Caltrans safety evaluation and determination, engineering discretion and approval for the purpose of safe ingress and egress through this intersection is a recommended interim improvement prior to conversion to a roundabout control. Given the high approach speeds, converting Crestmont Drive to a roundabout prior to converting Los Ranchos and Buckley to roundabouts is not recommended.

Analysis of the AM, midday, and PM peak hour volumes reveal that Crestmont Drive meets peak hour warrants only during the AM peak hour throughout the forecast horizon. Farmhouse Lane is not projected to meet PM peak hour warrants until 2025 and not until 2035 for the AM and midday peak hours. This is an indicator that a full warrant analysis should be considered at both these locations prior to 2025. Staging improvements for these two intersections after the improvements to Buckley Road and Los Ranchos Road is recommended to allow for further evaluation/deliberation of what control type is preferred at Farmhouse Lane and Crestmont Drive. Additionally, provision of a secondary access to the Rolling Hills community via a connection with Buckley Road to the north could delay the need for “quantum” improvement at Crestmont Drive (i.e., converting to either a roundabout or signalized intersection). For instance, northbound motorists leaving Rolling Hills would be provided three choices – the secondary access route; right-turn followed by a U-turn at the Los Ranchos roundabout; or, a permitted left turn onto

SR 227. Although roundabouts at both Farmhouse Lane and Crestmont Drive are the most cost-effective control type and therefore recommended as part of the preferred corridor concept, staging improvements at these two intersections after the roundabouts at Los Ranchos Road and Buckley Road are implemented will more effectively reduce vehicle speeds through the Crestmont Drive intersection, increase safety, and provide maximum flexibility for the consideration of other alternatives with potential cost savings.

The recommended phasing of Roundabout Corridor improvements and associated capital costs are detailed below. Note that these planning-level capital costs do not reflect the cost estimates for providing secondary access to Rolling Hills ($2.3 million) or constructing the northern portion of the Edna-Price Canyon Trail ($8.1 million). To manage public expectations, the phasing of improvements is based on actual implementation (opening day) time frames. Also note that the short- and medium-term time horizons all begin at time "zero" indicating that the improvements listed should be implemented sooner if funding is available. Converting the deficient intersection at Los Ranchos to a multilane roundabout is considered the top priority, followed by the Buckley Road roundabout, channelization improvements at Crestmont Drive and the provision of a secondary access to Rolling Hills.

Immediate-Term Actions (0-1 years) Cost Assumed as part of Capital Cost

- Coordinate with Caltrans to determine if the roundabout at SR 227 and Los Ranchos Road can be installed via an encroachment permit and permit engineering evaluation report (PEER). Subject to this determination, continue to coordinate with Caltrans to develop roundabout layout and preliminary engineering designs.
- Coordinate with Caltrans to develop roundabout layout and preliminary engineering designs for SR 227 at Buckley Road and a preferred project development process for expediting the SR 227 at Buckley Road roundabout.
- Coordinate with Caltrans and the County on the feasibility, layout and preliminary engineering designs for implementing interim operational improvements consistent with the Highway Design Manual at Crestmont Drive/SR 227, subject to Caltrans safety evaluation and determination, engineering discretion and approval, to provide safe ingress and egress through this intersection.
- Coordinate with the Rolling Hills community on development of layout and preliminary engineering designs for creating a secondary access connecting the Rolling Hills community with Buckley Road north.
- Proceed with development of layout and preliminary engineering designs for Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road based on the Preferred Alignment and associated recommendations of the Edna-Price Canyon Trail Feasibility Study adopted by SLOCOG.

Short-Term Improvements (0-5 years) Capital Cost: $3.1 Million

- Los Ranchos Road/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings).
- Crestmont Drive/SR 227 – subject to immediate-term coordination, install operational improvements consistent with the Highway Design Manual (considered an interim improvement prior to roundabout control) subject to Caltrans safety evaluation and determination, engineering discretion and approval to provide safe ingress and egress through this intersection.
- Buckley Road/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings). This roundabout would include City of San Luis Obispo Gateway signage and treatments.
- Rehabilitate pathway from Los Ranchos Road to Crestmont Drive to become part of the Edna-Price Canyon Trail. Install signage warning bicyclists of private driveway/s south of Crestmont Drive (cost not reflected)
- Construct Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road based on the Preferred Alignment adopted by SLOCOG (cost not reflected).
- Install rumble strip along the SR 227 outside travel lanes between Airport Drive and Price Canyon Road with breaks/gaps provided near bus stops and pull-outs.

- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This would entail creating a small parallel driveway west of the Edna Trail alignment. Restrict turn movements from consolidated driveway to right-in/right-out and left-in, and provide median channelization to restrict left-out movements (cost not reflected).
- Airport Drive: close off access to SR 227 and realign west leg of Airport Drive with Farmhouse Lane to provide new access to SR 227 at Farmhouse Lane. This realignment would not reduce access to the airport.
- Convert SR 227/Farmhouse Lane to a four-legged intersection (convert to two-way stop control in interim).
- Replace the bus stop currently on Aero Drive with a new bus stop and amenities (i.e., lighting, shelter etc.) near the new four-legged intersection at Farmhouse Lane. Consideration for placing the new stop on either Kendall Road or Farmhouse Lane would require concurrence from the business park owners who own and maintain both roads.
- Restripe northbound SR 227 for two through lanes between Farmhouse Lane to just south of Kendall Road (widening would not entail any additional ROW).
- Restrict turn movements from Kendall Road to right-in/right-out and left-in, and provide median channelization to restrict the left-out movement.

Mid-Term Improvements (0-10 years) Capital Cost: $2.7 Million

- Construct a secondary access connecting the Rolling Hills community with Buckley Road north. Will include traffic calming treatments to reduce speeds and cut-through traffic. (cost not reflected)
- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This could entail creating small parallel driveways west of the Edna Trail alignment. Restrict turn movements from consolidated driveways to right-in/right-out and left-in, and provide median channelization to restrict left-out movements (cost not reflected).
- Construct Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road on the Preferred Alignment adopted by SLOCOG (cost not reflected).

Long-Term Improvements (10-20 years) Capital Cost: $5 Million

- Farmhouse Lane/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings).
- Crestmont Drive/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings). Note: striping for east side SR 227 pedestrian/bicycle crossings is not recommended (allowed per DIB-82, Sec. 4.2) but may be required by Caltrans. Striping will be included for the Edna-Price Canyon Trail crossings.
- Widen southbound SR 227 for four through lanes from Farmhouse Lane to just south of Kendall Road.
- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This could entail creating small parallel driveways west of the Edna Trail alignment. Restrict turn movements from consolidated driveways to right-in/right-out and left-in, and provide median channelization to restrict left-out movements (cost not reflected).

Relinquishment Cost Assessment Tool

A relinquishment cost assessment was developed as part of this study to help facilitate and inform future planning level SR 227 relinquishment discussions between Caltrans and the County of San Luis Obispo. A preliminary planning-level review process is currently examining a potential relinquishment of SR 227 from the current northern limit with the City of San Luis Obispo to a yet to be defined southern limit. To help inform this process, scalable 20-year planning-level preventative maintenance cost information was developed based on per-lane-mile cost estimates for Fog Seal, Micro-surfacing and Grind and Overlay needs and inflated on a 2.5% basis per year for all future years beyond 2016. Given that Caltrans has recently completed rehabilitating the portion of SR 227 between Price Canyon Road (PM 7.1) to the San Luis Obispo City limits (PM 10.3), the planning-level preventative maintenance cost

estimates assume that SR 227 is currently in a state of "good repair". For costing and presentation purposes only, the following two segments were delineated and 20-year preventative maintenance cost estimates developed:

- Segment Area No. 1: City Limits to Buckley Road Cost: $1,282,100
- Segment Area No. 2: Buckley Road to Los Ranchos Road Cost: $1,059,550

The relinquishment cost assessment of $2.34 million should not be construed to constitute or contribute to a full Relinquishment Assessment Report. Caltrans is under no statutory obligation to place a facility into a state of good repair, construct improvements or betterments, or incur a financial obligation of any kind to relinquish a state highway to a local agency. If Caltrans and the County of San Luis Obispo decide to initiate a relinquishment process, the steps outlined in the Caltrans Project Development Procedure Manual would be followed, and Caltrans would be responsible for facilitating the negotiation of the actual relinquishment limits and terms of a mutually beneficial relinquishment agreement.

Relinquishment of either segment will add to the total roadway centerline miles owned by the County of San Luis Obispo, which will increase the County's annual gas tax revenue allocation (apportioned by formula). Based on the current $7,000 per year per mile (per existing tax formula), the County can anticipate approximately $448,000 in additional gas tax revenue over the same 20-year horizon (assumes both Segment Area No. 1 and No. 2 combined) to offset the estimated $2.34 million relinquishment cost.

INTRODUCTION

The SR 227 Operations Study examines the existing and future operational and safety performance of SR 227 from Tank Farm Road to Price Canyon Road (approximately 3.3 miles: post mile 6.52 to post mile 9.82). A performance-based alternatives analysis was performed to evaluate two corridor improvement concepts using a detailed benefit-cost approach. The results of this analysis informed the recommendation for a preferred SR 227 corridor concept with associated improvements that best meets both the local and regional goals of the region while providing the highest return on investment of limited regional transportation funding over the next 20 years.

Background

Respective system planning documents authored by Caltrans, the San Luis Obispo Council of Governments (SLOCOG), and the County of San Luis Obispo all currently list/reference the widening of SR 227 to four-lanes with right- and left-turn channelization at major intersections south to Los Ranchos Road. However, no formal operational study has been performed to determine if widening SR 227 is the most cost-effective solution for resolving the various operational and safety needs in the corridor. During development of SLOCOG's 2014 Regional Transportation Plan & Sustainable Community Strategy (RTP/SCS), public input was received citing the following safety and operational concerns on SR 227:

- during peak hours, queueing on SR 227 routinely spills back blocking upstream driveway access;
- during peak hours, motorists on side-street driveways typically experience unacceptable delays waiting for acceptable gaps in the SR 227 traffic stream to enter;
- during peak hours, the congestion and resulting operational issues create unsafe conditions for motorists as well as for pedestrians and bicyclists;
- compromised emergency response times;
- lack of secondary access into Rolling Hills; and,
- lack of bicycle connectivity.

Public Participation

Three public workshops were held to receive input from the public. The first two public workshops helped inform the ultimate recommendations presented in this study and are described below. The third workshop provided an overview of the study recommendations. Materials from the public workshops are provided in **Appendix A**.

Public Workshop #1

The purpose of the first workshop was to: 1) inform the public of the study and how to stay actively engaged during its development; and, 2) receive input from the public on what they perceive as the critical operational and safety problems in the corridor. Based on automated polling, the four biggest issues in priority order cited by workshop participants were: 1) vehicular congestion; 2) motorist safety; 3) bicycle safety; and, 4) pedestrian safety. Feedback from residents indicated a preference for maintaining the rural character of the corridor coupled with increased concern over congestion and safety issues caused by SR 227's importance as an alternative route to US 101.

Public Workshop #2

For the second workshop, analysis results and findings were presented and public input received on alternative corridor improvement concepts. All participants considered that a longer-term fix to SR 227 was needed. Over 70% supported establishing lower speeds on SR 227 as well as turn restrictions at Kendall Road and private and commercial driveways along SR 227 between Farmhouse Lane and Los Ranchos Road. Approximately 57% supported roundabouts with 25% undecided while 67% supported signalization with 5% undecided. Conversely, 28% of respondents did not support signalizing the intersections at Farmhouse Lane and Crestmont Drive while 19% did not support roundabouts at these locations. A majority of respondents did not support or consider increased transit service or park-and-ride lot development as a potential fix to SR 227 congestion. The majority did support providing secondary access to the Rolling Hills community and considering the Edna-Price Canyon multi-purpose trail as a key component to the study.

PLANNNG CONTEXT

Caltrans System Planning

The portion of SR 227 within the study corridor is part of the National Highway System and is classified by Caltrans as a rural minor arterial. The Caltrans System Planning Transportation Concept Report (TCR) for SR 227 indicates that the Level of Service (LOS) concept for this segment of SR 227 is LOS C. The SR 227 TCR includes the following proposed improvements within the study corridor:

- Widen to four-lanes with right- and left-turn channelization at major intersections
- Provision of a Class II bike facility
- Provision of auxiliary merge lanes as needed

San Luis Obispo Council of Governments

Similarly, the SLOCOG 2014 RTP/SCS lists the widening of SR 227 from two to four through-lanes (with left turn channelization) from Aero Drive to Los Ranchos Road in its financially constrained Tier I list of capital improvements.

County of San Luis Obispo

The County General Plan classifies SR 227 within the unincorporated area as an "Arterial" and indicates that if demand or system management strategies cannot maintain acceptable service levels (i.e., LOS D) within the study corridor that SR 227 should be widened to four travel lanes from Tank Farm Road to Price Canyon Road, with turn lanes or pockets at intersections with Airport Drive, Buckley Road, Crestmont Drive, Los Ranchos Road, Biddle Ranch Road and Price Canyon Road.

The County General Plan includes several policies pertinent to the SR 227 study corridor. Namely the number of commercial uses along SR 227 south of Aero Drive should be minimized; and where they are developed, they should be integrated with the rural agricultural and residential context through attention to building design, landscape screening and signing. As a scenic corridor, it is also a priority for the County to preserve the high-quality visual experience for motorists that drive SR 227 south of Aero Drive and that the County Planning Department should continue to explore alternative methods of protecting scenic vistas in the corridor.

Airport Area Specific Plan

A portion of the corridor is included as part of the Airport Area Specific Plan. Although the Airport Area is outside the limits of the City of San Luis Obispo, it is within the City's Urban Reserve. The Airport Area Specific Plan suggests the following improvements to the study corridor:

- Installation of gateway features at the intersection of SR 227 and Buckley Road to mark the transition between the county and city jurisdictions;
- signalize the intersection of SR 227 and Aero Drive;
- widen to four lanes and add medians to SR 227 between Buckley Road and Tank Farm Road;
- extend City Transit Route 3 to provide transit service along SR 227 to serve the airport;
- provision of Class II bicycle lanes north of Buckley Road;
- right of way preservation for SR 227 to accommodate an eventual widening in the future
- development of an access management strategy for SR 227; and,
- prohibition of on-street parking.

Edna/Price Canyon Trail Feasibility Study

The Edna-Price Canyon Trail Feasibility Study (SLOCOG, 2016) analyzed alternative alignments for a nine-mile Class I multipurpose trail that would provide a vital link between the Coastal Trail in Pismo Beach to the City of San Luis Obispo. The preferred alignment traverses the study corridor from Los Ranchos Road and runs along the west side of SR 227 to the City of San Luis Obispo. Currently, there is sufficient clearance on the west side of SR 227 to accommodate the trail without encroaching within state right-of-way or the San Luis Obispo airport right-of-way. The preferred alignment would largely preclude any expansion of SR 227 to the west.

ROADWAY NETWORK

A description of the characteristics of the roadway system within the study corridor is provided below.

State Route 227 (SR 227) is a north-south state highway that runs between Higuera Street (where it runs east-west and is classified as South Street) and the US 101 and East Grand Avenue intersection. The portion of the route within the San Luis Obispo City Limits has been relinquished to the City of San Luis Obispo and is no longer maintained by Caltrans. South of Aero Drive, SR 227 is a two (2)-way highway with one (1) 12-foot wide travel lane in each direction and an 18-foot wide two-way left-turn lane median. SR 227 is designated as an arterial in the San Luis Obispo County General Plan. It is also identified in the City's General Plan as an existing Surface Transportation Assistance Act (STAA) truck route. Within County jurisdiction, SR 227 is identified as a High or Medium Scenic Value Roadway. This requires that development and infrastructure, including signs, in the view shed of a scenic roadway be considered as "sensitive" and require architectural review. There is currently a Class II bicycle lane along SR 227 within City limits. The posted speed limit within the SR 227 study corridor (post mile 6.52 to post mile 9.82) is 45 mph.

Airport Drive is a minor east-west road that runs between SR 227 and the San Luis Obispo County Regional Airport. The San Luis Obispo General Plan identifies Airport Drive as a local street. From SR 227 to the airport, Airport Drive is a two (2)-way street with one (1) 12-foot wide travel lane in each direction. 18-feet of angled parking is provided on the south side of the street for San Luis Jet Center employees only. There are no existing bicycle facilities and discontinuous sidewalks along Airport Drive. The speed limit along Airport Drive is unposted. There is a proposal to realign Airport Drive to intersect with SR 227 at Farmhouse Lane, eliminating the current offset.

Farmhouse Lane is a privately owned and maintained minor east-west road that runs approximately 0.25 miles east from SR 227. The San Luis Obispo County General Plan identifies Farmhouse Lane as a local street. From SR 227 east of Allene Way, Farmhouse Lane is a two (2)-way street with a 35-foot wide ROW. There is parking allowed on both sides of Farmhouse Lane. The speed limit along Farmhouse Lane is unposted.

Kendall Road is a privately owned and maintained minor east-west road that runs approximately 0.30 miles east of SR 227. The San Luis Obispo County General Plan identifies Kendall Road as a local street. From SR 227 east of Allene Way, Kendall Road is a two (2)-way street with a 50-foot wide ROW which narrows to 35-feet north of Prospect Street. Parking is allowed on both sides of Kendall Road. The speed limit along Kendall Road is unposted.

Buckley Road is a major east-west road that runs between SR 227 and Vachell Lane. The County's General Plan identifies Buckley Road as a collector street while the City of San Luis Obispo classifies the portion within the City Limit as an arterial. From SR 227 to Vachell Lane, Buckley Road is a two (2)-way street with one (1) 12-foot wide travel lane in each direction with 2-10 foot shoulders on both sides of the street. Parking is not provided on Buckley Road. Buckley Road is identified in the City's General Plan as a STAA truck route and a high or medium scenic value roadway. Extending Buckley Road west to align with Higuera Street is listed as a planned project in the City's General Plan and Airport Area Specific Plan. The City's Bicycle Transportation Plan has proposed a Class I bicycle path on the north side of Buckley Road and a Class II bicycle lane on the south side. The posted speed limit on Buckley Road ranges between 40 mph and 55 mph.

Crestmont Drive is a minor east-west road that runs between SR 227 and Caballeros Avenue. The San Luis Obispo County General Plan identifies Crestmont Drive as a local street. From SR 227 to Caballeros Avenue, Crestmont Drive is a two (2)-way street with one (1) 12-foot wide travel lane in each direction with 10-foot shoulders on both sides of the street. There are portions of Crestmont Drive with 8-foot angled parking on both sides of the street. Crestmont Drive is also the only access route for a residential neighborhood. No speed limit is posted.

Los Ranchos Road is a minor north-south road that runs between SR 227 and south of Country Club Drive. The San Luis Obispo County General Plan identifies Los Ranchos Road as a local street. From SR 227 south of Hacienda Avenue, Los Ranchos Road is a two (2)-way street with one (1) 12-foot wide travel lane and eight (8)-foot

wide Class II bicycle lanes in each direction. There is no parking allowed on Los Ranchos Road from Hacienda Avenue to Country Club Drive. The posted speed limit along Los Ranchos Road is 40 mph.

DATA COLLECTION

Data collection efforts performed within the study corridor included: field observations; traffic counts; Bluetooth detection and collision data. These are described in more detail below.

Field Observations

Field observations were performed to record road widths, number of lanes, number and location of driveways with direct access onto SR 227, striping and signing, identification of bike lanes, number of lanes and allowable movements, existing right-of-way (ROW) and access control. Data for intersections included, at a minimum, control type, signal phasing, number and type of lanes entering the intersection, turn bays and storage lengths, presence of turn restrictions and allowable movements, sight distance measurements, apparent right-of-way allowances, and multi-modal connectivity characteristics.

Traffic Counts

Traffic counts were performed on SR 227, side streets, and at intersections during the week of January 25, 2016. For roadway segments, seven-day 24-hour continuous segment counts were performed on Los Ranchos Road, Crestmont Drive and along four segments of SR 227. Hose counts included full classification to discern the proportion of heavy-duty vehicles. Video counts were performed for all six study intersections on Tuesday, January 26th. Due to an equipment malfunction, the intersection of SR 227 at Los Ranchos required a recount on Wednesday, January 27th. All video was processed to tabulate turning movement vehicle counts, pedestrian and bicycle crossings, and heavy-duty vehicle classification counts during AM/Midday/PM peak hours. Maximum vehicle queue lengths and gap acceptance measurements for left-turning vehicles at Crestmont Drive and Kendall Road was also documented during video data processing.

All traffic count sheets are provided in **Appendix C**.

Bluetooth Detection (Travel Speeds and Trip Distribution)

Four months of speed and travel time data was collected at six locations through automated Bluetooth signal detection using BlueMac devices developed by Digiwest. Bluetooth devices in vehicles (or on vehicle occupants) traveling along the corridor were detected and logged with a timestamp at BlueMac locations strategically located within the corridor. This data was used to compute travel time and to provide context on where vehicles typically enter and exit the corridor. Bluetooth signatures are collected from various sources including on-board vehicle devices, passenger cell phones and video games. The signatures are received in an encrypted format that prevents personal identification of users.

Figure 1 shows the location of traffic count and Bluetooth data collected for this study. **Figure 2** shows the SR 227 study corridor including intersection locations and current lane geometrics.

Collisions

The collision history is based on the three most recent year of available Statewide Integrated Traffic Records System (SWITRS) data (2012-2014) and Caltrans Traffic Accident Surveillance and Analysis System (TASAS) collision rates (2011-2013). All collision data sheets are provided in **Appendix C**.

TRAFFIC VOLUME SETS

This section describes how the traffic volume sets under both existing and future conditions were developed for both intersections and roadway segments for operational determinations.

Existing Traffic Volume Set

Existing traffic volumes were based on empirical traffic counts as described under Data Collection. All other inputs including intersection lane configurations, traffic controls, etc., were based on visual observations from site visits, video detection or Google Earth.

Turn movement counts were checked for "balancing" between each consecutive pair of intersections. Traffic volumes between intersections with no intermediate access were fully balanced, whereas those with intermediate minor accesses (such as scattered residential/commercial driveways) imbalances were accepted. Given the lack of intermediate access, volumes between Farmhouse Lane and Airport Road, and Buckley Road and Crestmont Drive, were fully balanced. Traffic volumes between Crestmont Drive and Los Ranchos Road reflect imbalances commensurate with segment hose count data. The adjustments primarily entailed adjusting volumes to the though movements on SR 227. Average weekday 24-hour segment traffic counts and AM/PM/Midday turn movement volumes are shown in **Figure 3** and **Figure 4**.

2025 Traffic Volume Set

Interim year traffic volumes were estimated using linear interpolation of the empirical traffic counts and post-processed 2035 travel forecasts for both roadway segments and intersections. Average weekday 2025 segment traffic volumes and AM/PM/Midday intersection turn movement forecasts are shown in **Figure 5** and **Figure 6**.

2035 Traffic Volume Set

All 2035 out-year forecasts were based on the most recent update of the SLOCOG travel demand model. Future year land use assumptions reflect the preferred land use of SLOCOG's adopted 2014 RTP/SCS. Future roadway improvements were limited to only those that are currently programmed (i.e., have an identified funding source and are listed in the approved Federal Transportation Improvement Program for San Luis Obispo County). As such, the future year volume projections reflect SR 227 as a two-lane facility. The traffic projections also do not reflect the potential circulation changes that could result from the planned but yet programmed Prado Road Extension within the City of San Luis Obispo. Model output (i.e., segment volumes) reflecting the 2035 out-year was generated for post processing.

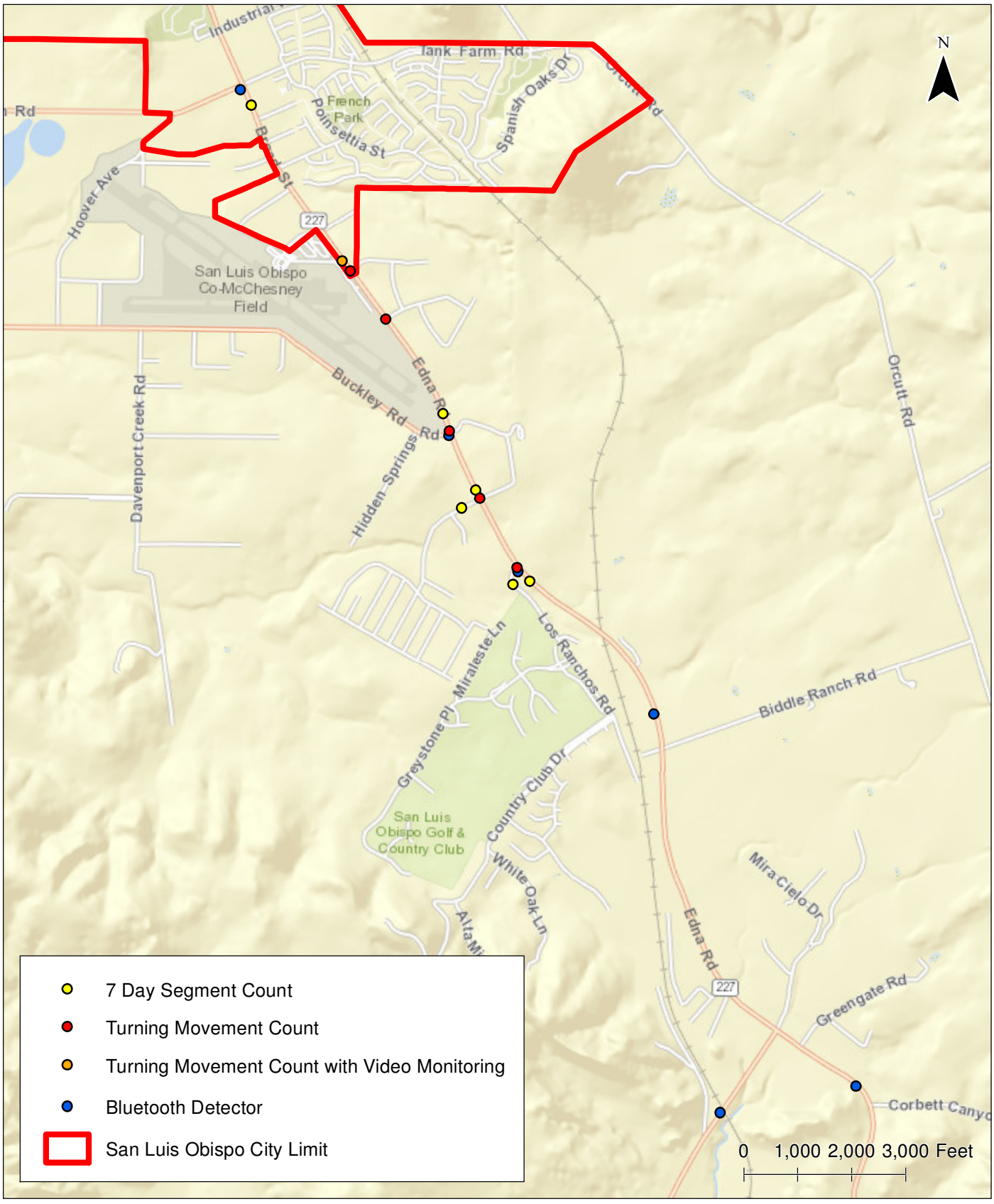
Before "raw" model output is considered suitable for operational determinations, post-processing adjustments must be performed. The recommended procedure is based on the NCHRP Report 255, 1982. NCHRP-255 adjustments entail using model generated link-based growth factors (computed variation between base year and forecast year model link volumes) to adjust baseline traffic counts to reflect future conditions. For each count location, AM/PM traffic growth estimates were generated using both the Ratio and the Difference method and taking the average between the two methods. Based on this process, final adjusted AM/PM segment volume forecasts were developed. Given that the SLOCOG travel demand model is not set up to generate a midday peak hour assignment, the midday traffic counts were adjusted to reflect a 2035 condition based on modeled growth from the SLOCOG 2035 PM peak hour assignment.

At intersections, a refinement process called the Furness Method is applied. This adjustment is required given that travel models are calibrated to produce accurate results on road segments than on individual turn movements. The Furness Method iteratively adjusts the AM/PM peak hour turn movement counts until the directional sum of the movements balance to the NCHRP-255 adjusted AM/PM future segment volumes. This factoring process will produce forecast turn distributions that resemble the intersection count distribution, but turn movement proportions will change in response to different growth rates projected for each intersection leg by SLOCOG's regional travel demand model. Given that the SLOCOG travel demand model is not set up to generate a midday peak hour

assignment, the midday turn movement counts were adjusted to reflect a 2035 condition based on modeled growth from the SLOCOG 2035 PM peak hour assignment.

Additional "spot" adjustments were performed for the 2035 turn movement projections to ensure that no individual AM/Midday/PM peak hour turning movement was less than its base year turning movement count. This is a logical assumption given the conservative "programmed only" assumption for future roadway improvements, one would not expect significant traffic diversion resulting in less turning movement volumes in 2035. In the rare occasion that a 2035 approach volume was less than the 2016 approach count, individual turning movements were simply adjusted upward to match the turning movement count.

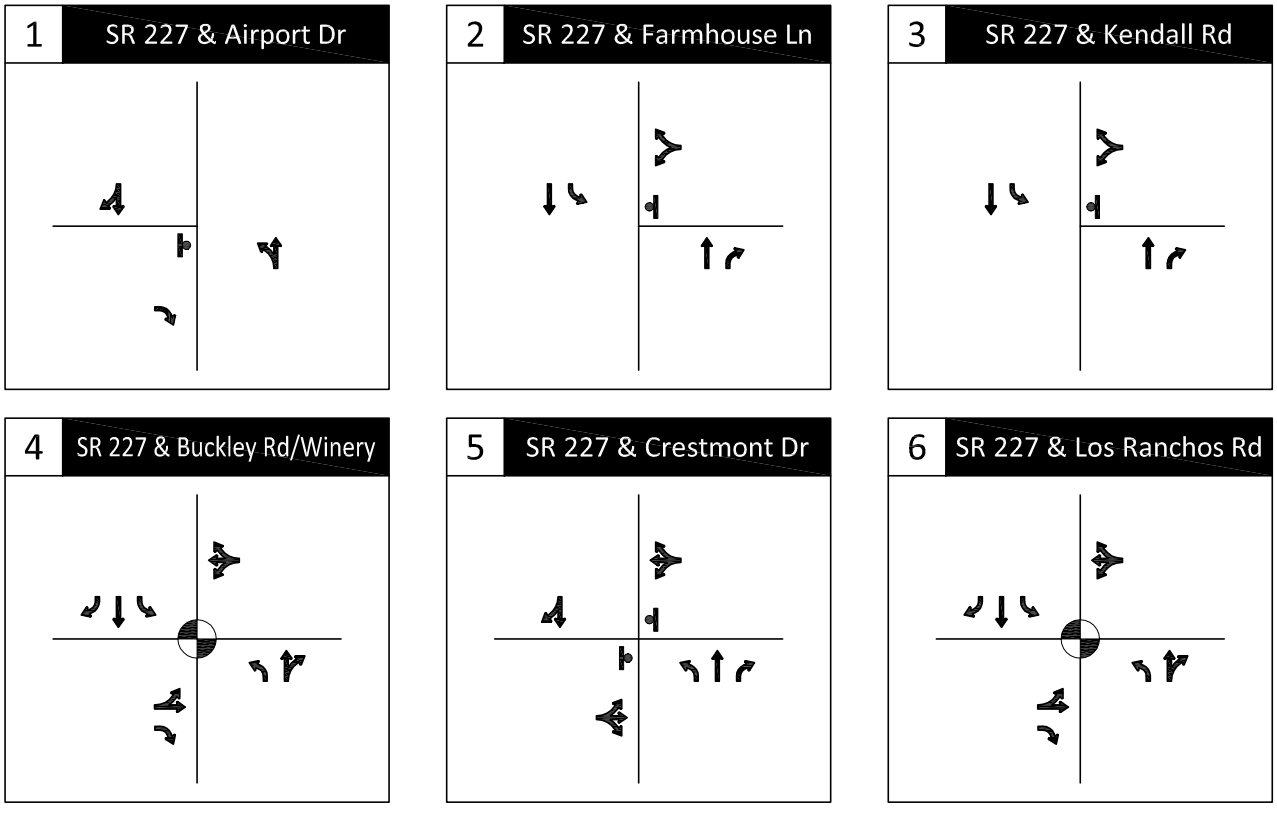
Average weekday 2035 segment volumes and AM/PM/Midday intersection turn movement forecasts are shown in **Figure 7** and **Figure 8**.



Data Collection Sites
SR 227 Corridor
San Luis Obispo County, California

Figure
1

Kimley»Horn

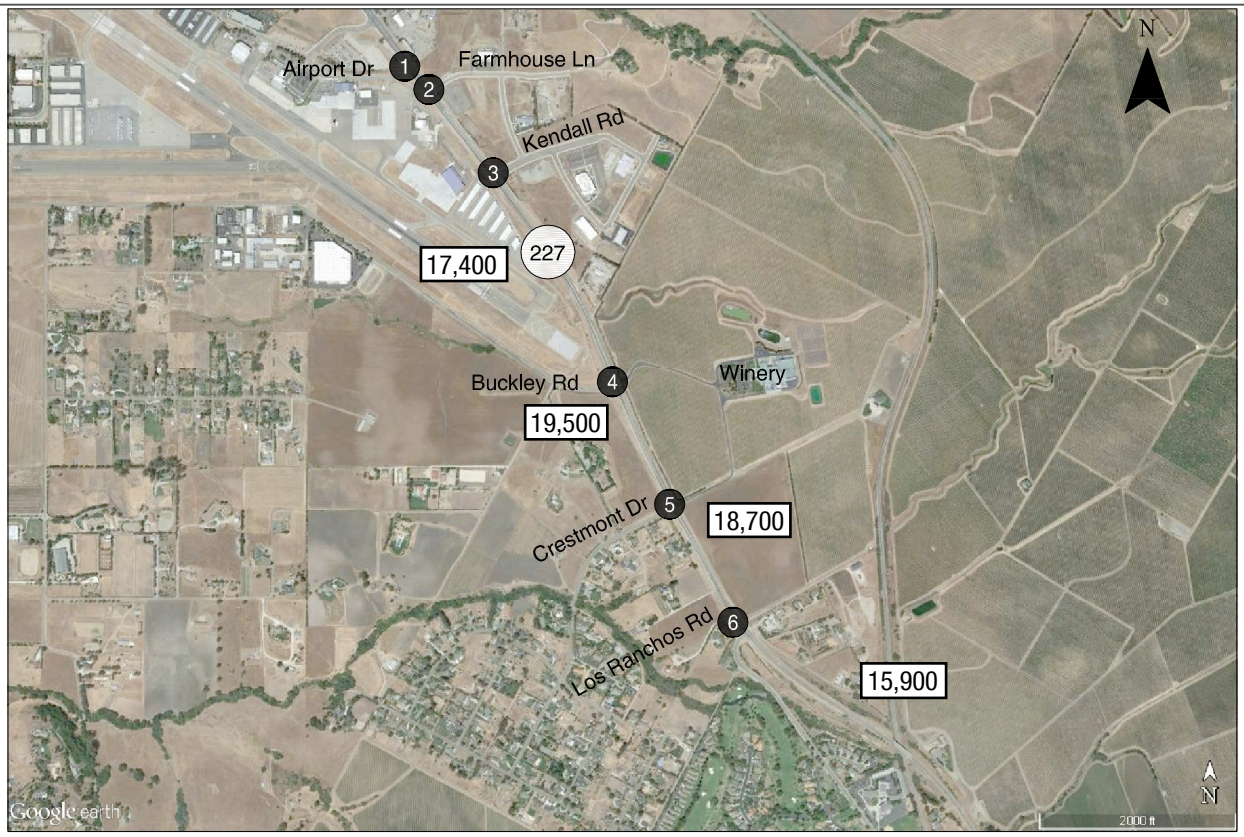


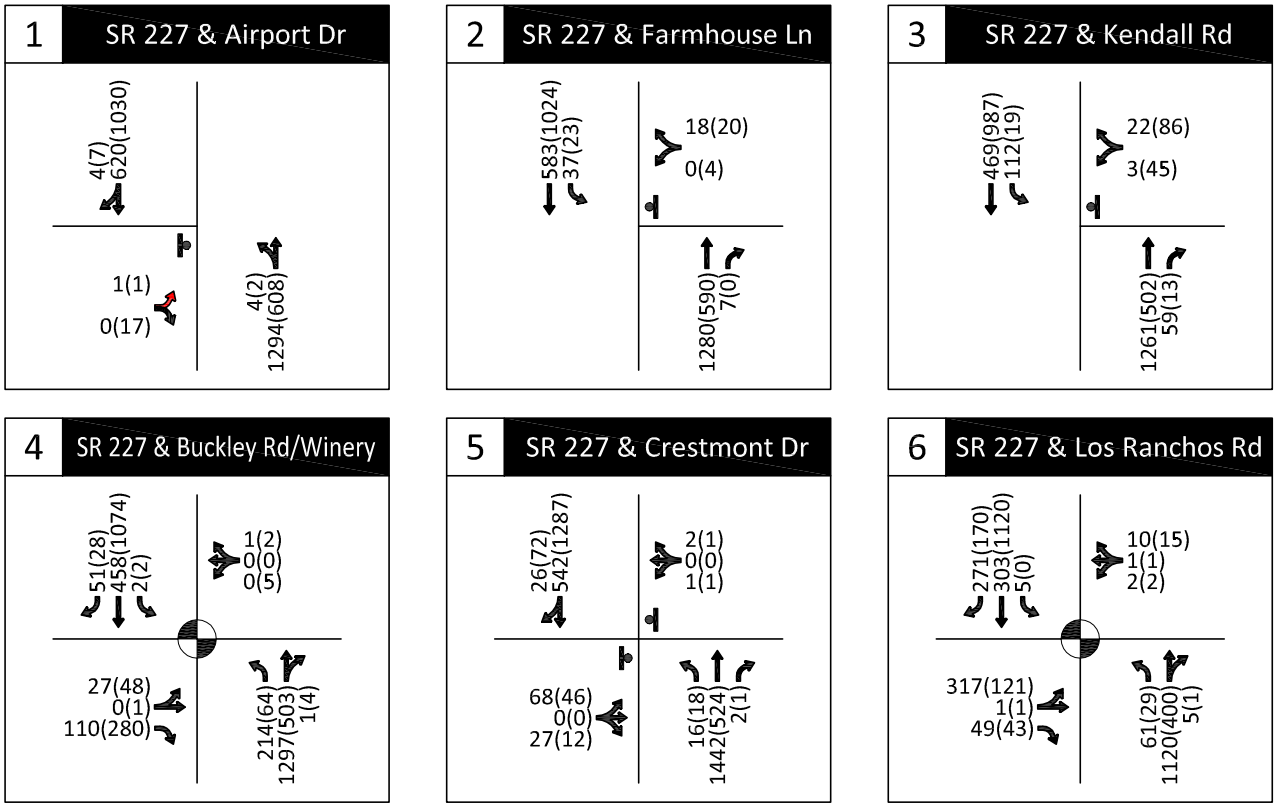
- Stop Sign
- Traffic Signal
- Study Intersections

Existing Lane Configurations
San Luis Obispo County, CA

Figure
2

Kimley»Horn



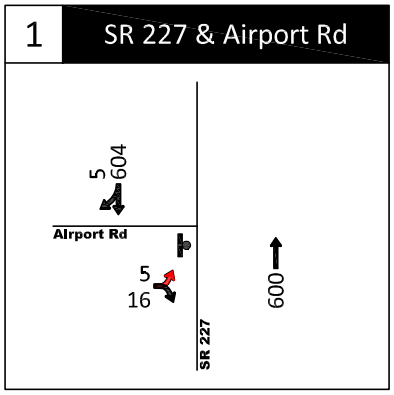


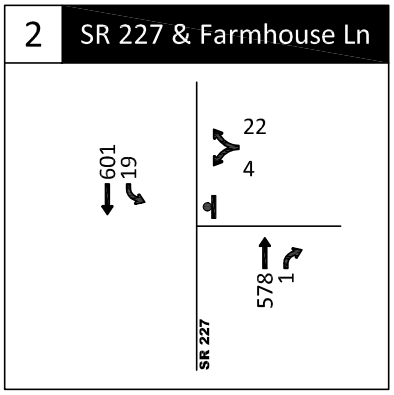
- Illegal Turn
- Stop Sign
- Traffic Signal
- Study Intersections

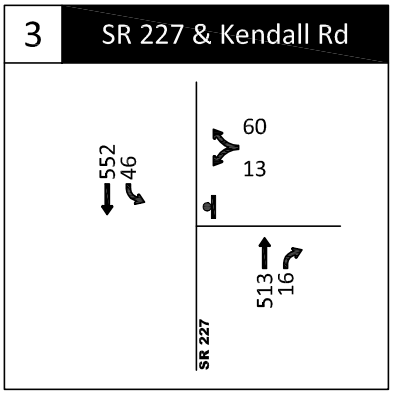
Existing Conditions Volumes [AM(PM)]
San Luis Obispo County, CA

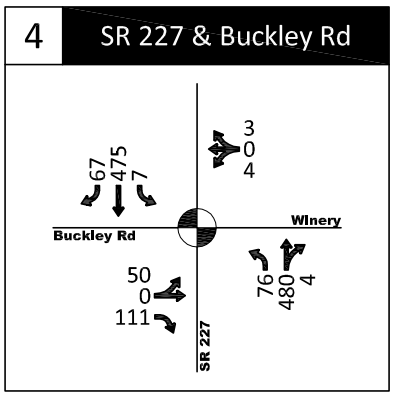
Figure
3

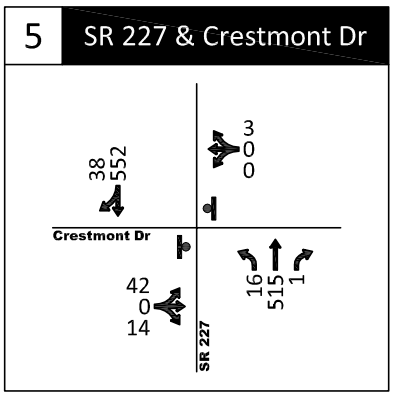
Kimley»Horn

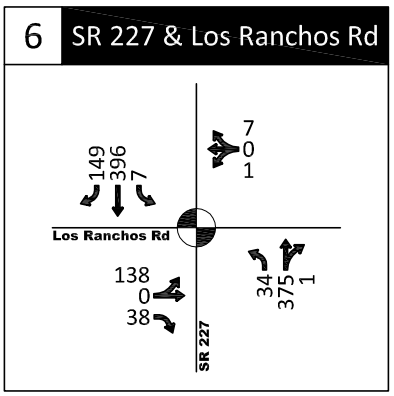










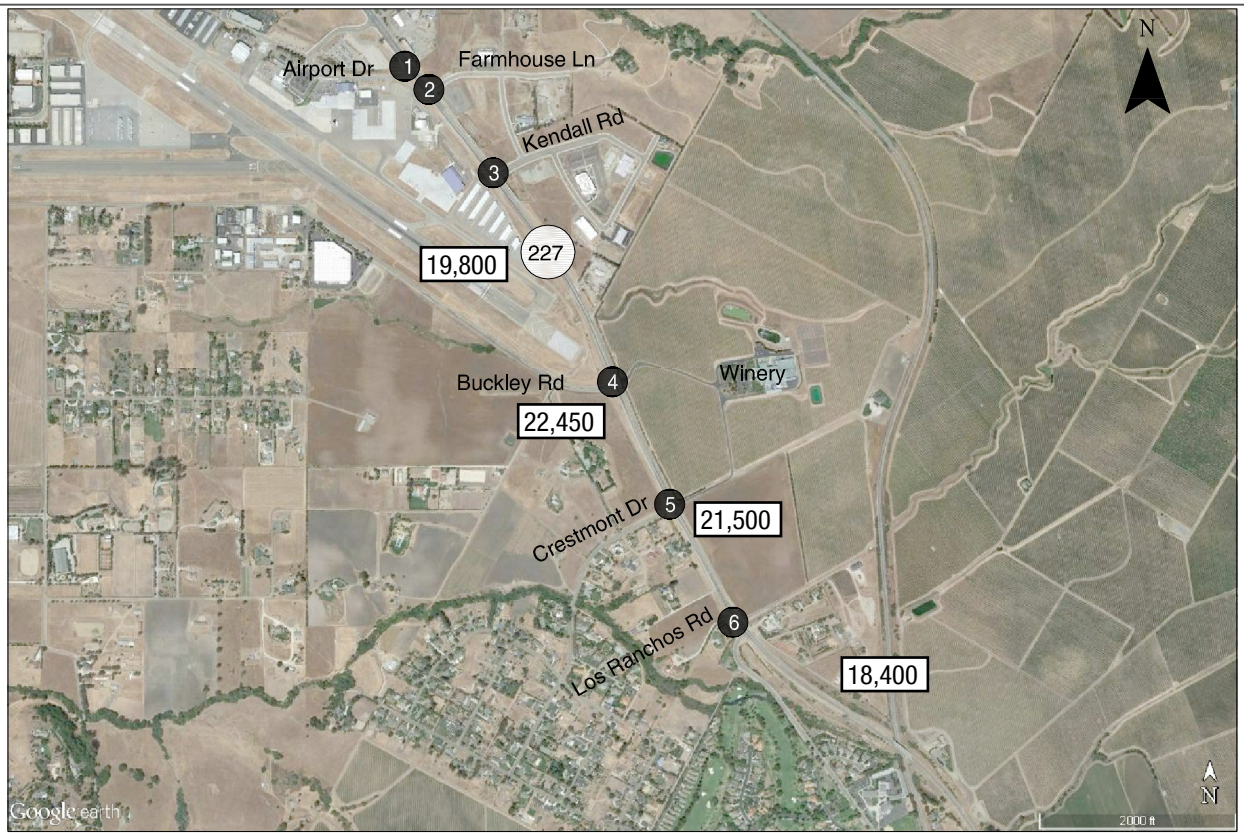


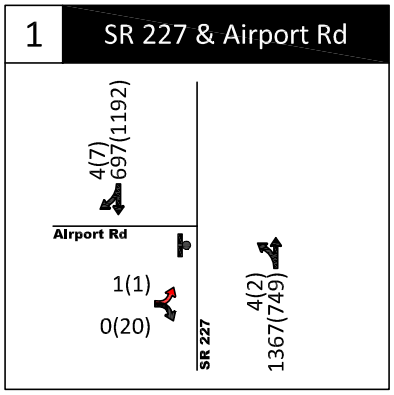
- Illegal Turn
- Stop Sign
- Traffic Signal
- Study Intersections

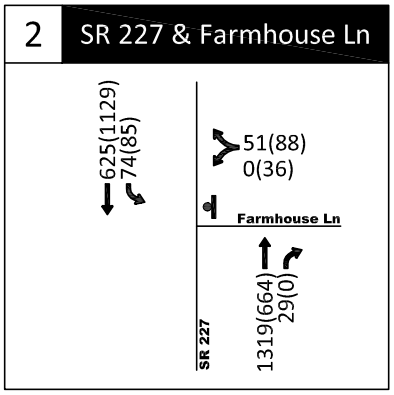
Existing Conditions Volumes [Mid-Day]
San Luis Obispo County, CA

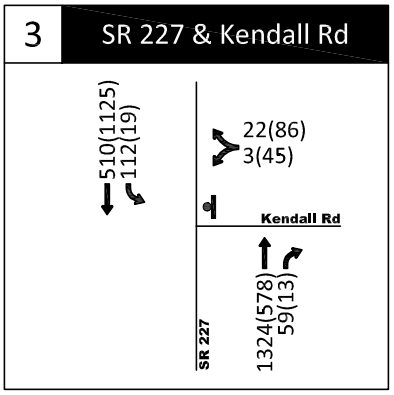
Figure
4

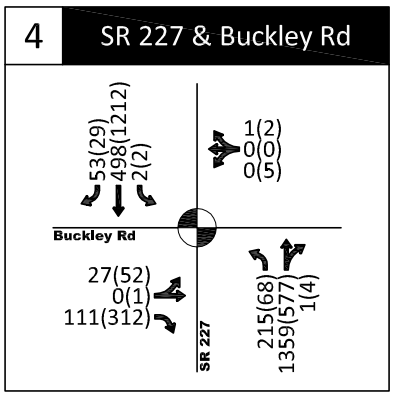
Kimley»Horn

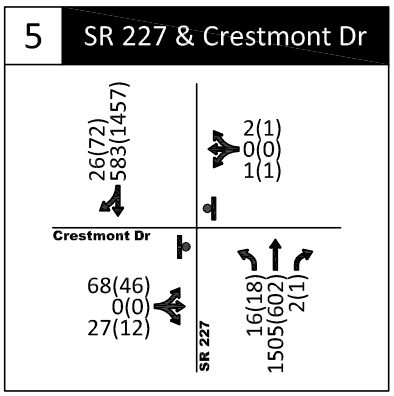


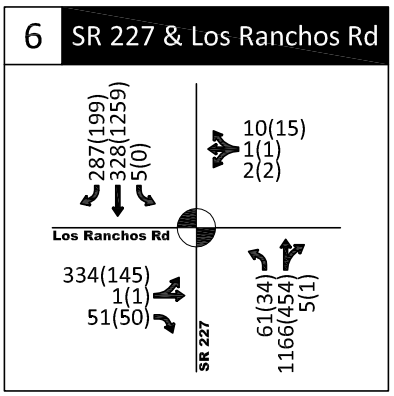










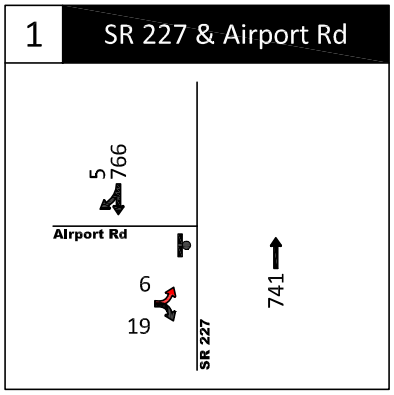


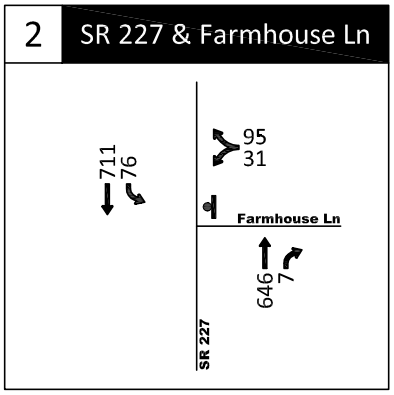
- Illegal Turn
- Stop Sign
- Traffic Signal
- Study Intersections

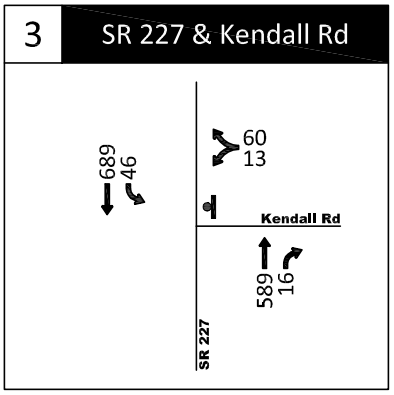
2025 Interim Traffic Volumes [AM(PM)]
San Luis Obispo County, CA

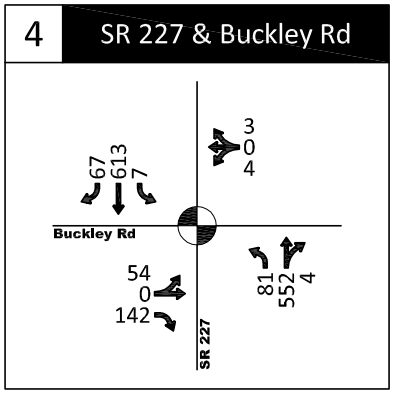
Figure **5**

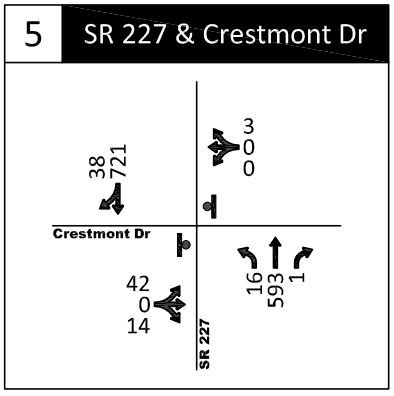
Kimley»Horn

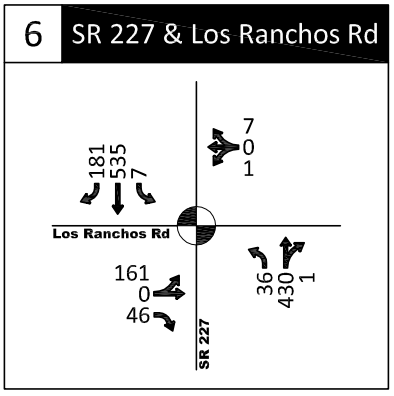










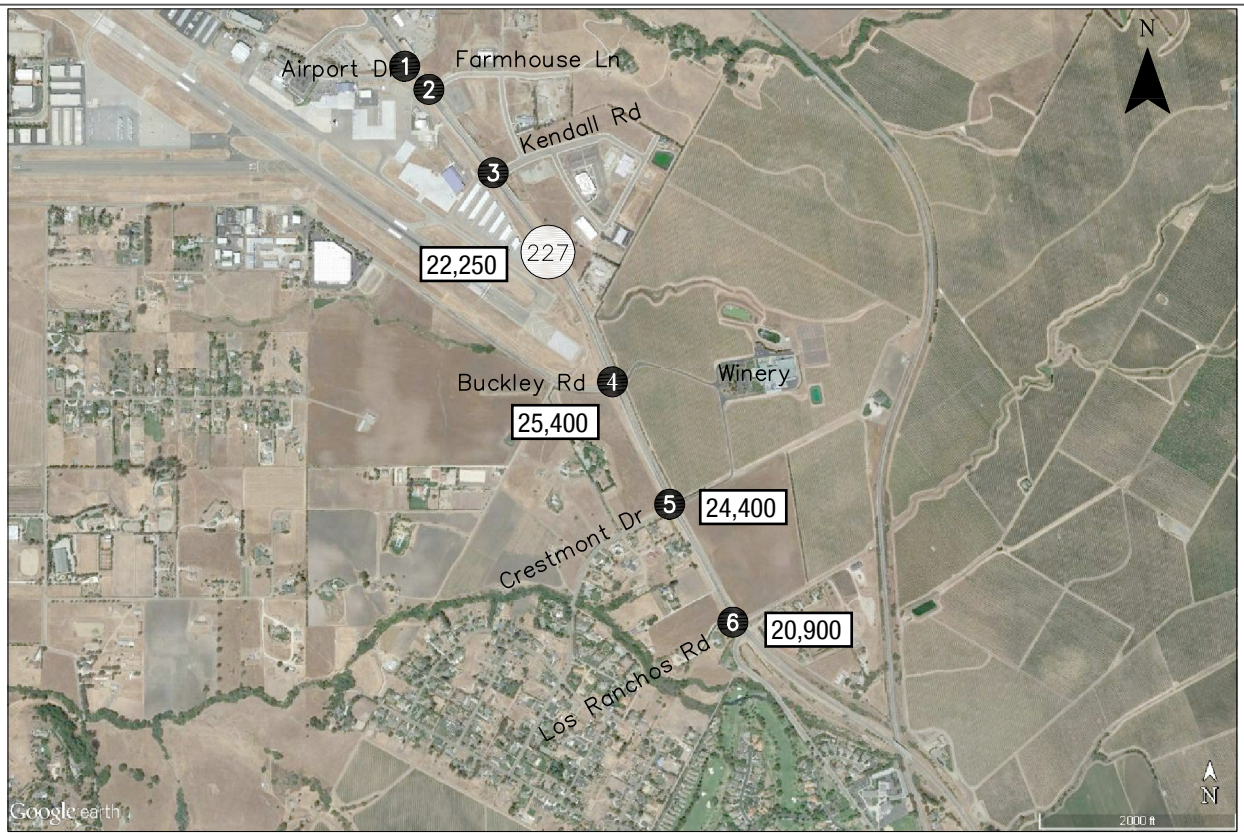


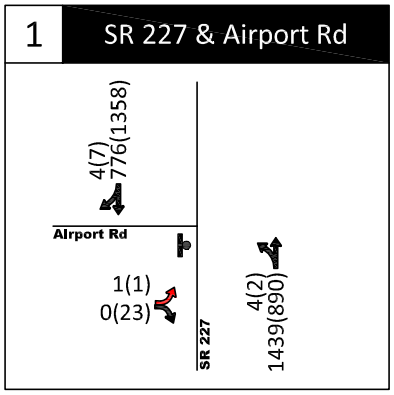
- Illegal Turn
- Stop Sign
- Traffic Signal
- Study Intersections

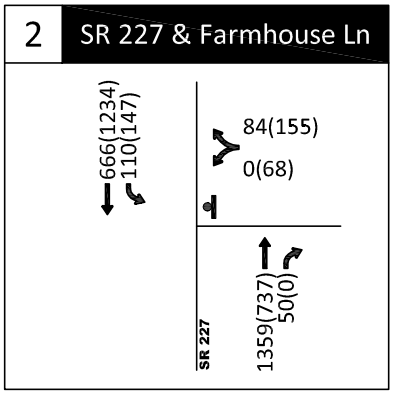
2025 Interim Traffic Volumes (Mid-Day)
San Luis Obispo County, CA

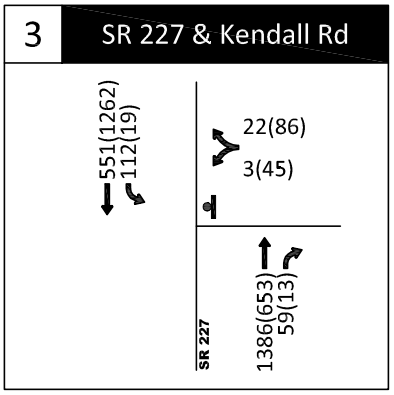
Figure
6

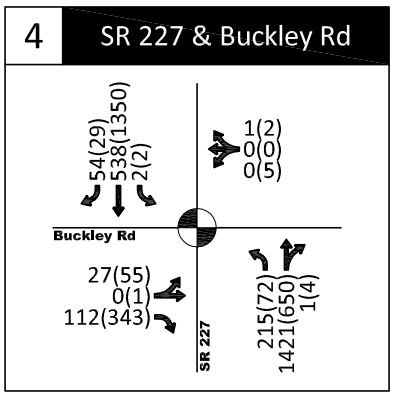
Kimley»Horn

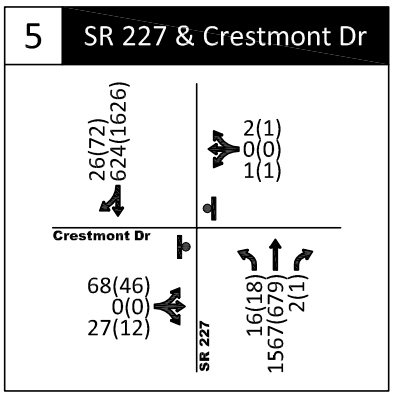


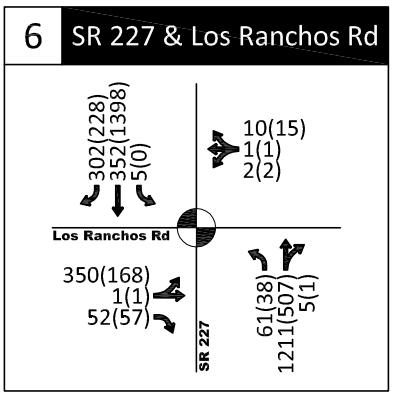










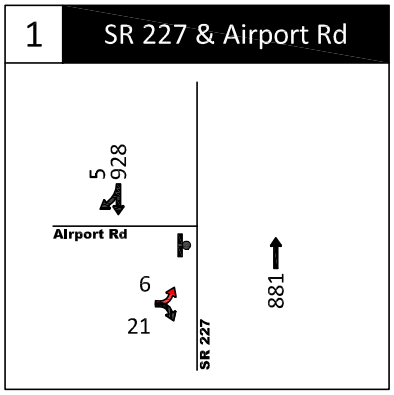


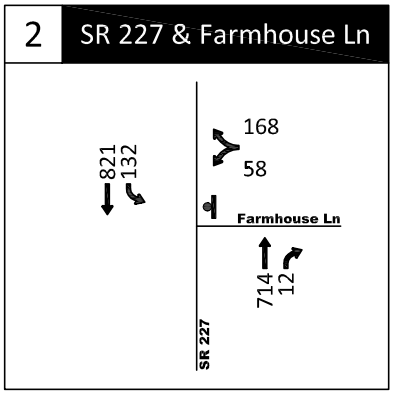
- Illegal Turn
- Stop Sign
- Traffic Signal
- Study Intersections

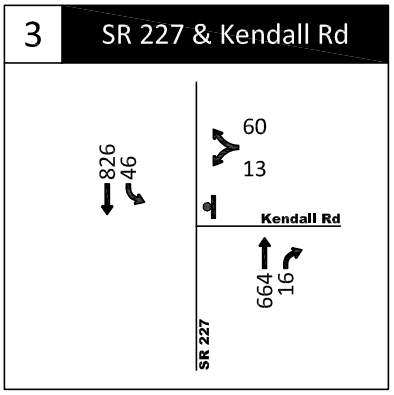
2035 Future Traffic Volumes [AM(PM)]
San Luis Obispo County, CA

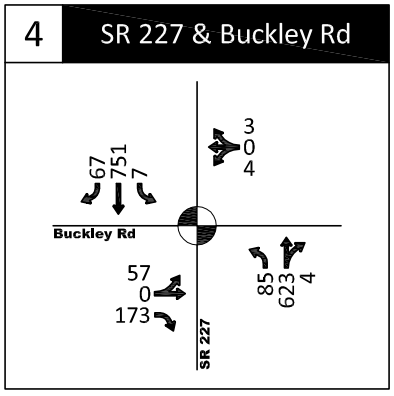
Figure
7

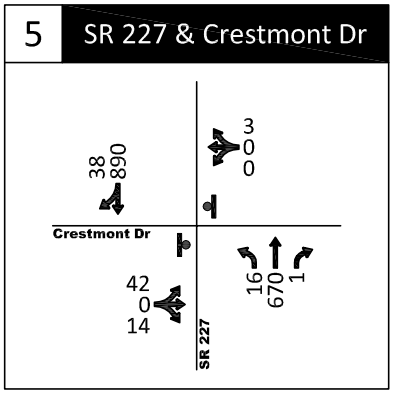
Kimley»Horn











- Illegal Turn
- Stop Sign
- Traffic Signal
- Study Intersections

2035 Future Traffic Volumes (Mid-Day)
San Luis Obispo County, CA

Figure
8

Kimley»Horn

ANALYSIS METHODOLOGY

Smart Mobility Framework

In February 2010, Caltrans released *Smart Mobility 2010: A Call to Action for the New Decade*. This document provides a broad planning framework to help guide multimodal and sustainable transportation planning and development along with providing tools and techniques to assess how well plans, programs, and projects meet 'smart mobility' goals throughout the state.

"Smart Mobility moves people and freight while enhancing California's economic, environmental, and human resources by emphasizing convenient and safe multimodal travel, speed suitability, accessibility, management of the circulation network, and efficient use of land."

The Smart Mobility Framework (SMF) was adopted by SLOCOG as a regional transportation planning policy in 2010. Consistent with both Caltrans and SLOCOG policy, the planning and analysis framework followed for this SR 227 Operations Study was based on the SMF. The fundamental premise of the SMF is to ensure that planning or programming decisions for transportation are performance based (i.e., quantitative), transparent, and address sustainable outcomes and objectives. The performance metrics selected for the SR 227 Operations Study match each of the SMF principles to ensure that the resulting improvement recommendations provide a balanced, sustainable, and multimodal assessment of current and forecast corridor conditions. These metrics are described in more detail below.

Vehicular Level of Service

Level of Service (LOS) is a qualitative metric that defines the experience of motorists. LOS is designated by the letters "A" through "F", with "A" being the best quality of service condition (little to no congestion) and "F" being the worst (highly congested). The measure of effectiveness (MOE) that defines LOS for a given facility type i.e., roadway segment, signalized intersection, non-signalized intersection etc.) as well as the means used to compute the MOE is described in this section. This includes facility types that currently are not present in the study corridor but were considered as potential options for future improvements – including converting SR 227 from a rural two-lane highway to a four-lane multilane highway or converting intersection control types (stop control, signal control or roundabout). Generalized descriptions of how LOS was computed for specific facility types is described below. More detailed descriptions including quantitative LOS criteria are included in **Appendix B**.

Roadway Segment Operations

SR 227 segment LOS was determined using the rural two-lane highway methodology outlined in Chapter 11 of the 2010 Highway Capacity Manual (HCM). For two-lane highways, LOS is determined based on the percent time spent following and the percent of vehicles traveling at free-flow speed conditions. The two-lane highway analysis was performed using the Highway Capacity Software (HCS). Multilane highway LOS is determined using the methodology outlined in Chapter 14 of the 2010 HCM. Density of the traffic stream determines LOS for multi-lane highways. Density measures the average proximity of vehicles to each other in the traffic stream expressed in passenger cars per mile per lane (pcpmpl) of roadway. Multilane highway operations were evaluated using the HCM 2010 compatible spreadsheet models.

Intersection Operations

Traffic operations at signalized intersections were analyzed using the procedures and methodologies contained in Chapter 21 of the 2010 HCM. For signalized intersections, the HCM operational method calculates the average control delay per vehicle (sec/veh), and assigns an LOS designation based upon the amount of delay.

Traffic operations at non-signalized intersections were analyzed using the procedures and methodologies contained in Chapter 20 of the 2010 HCM. The LOS criteria for non-signalized intersections are different than the criteria used for signalized intersections. While overall intersection LOS is calculated for all-way stop-controlled (AWSC) intersections, for TWSC intersections, LOS is only calculated for the minor street (i.e., no delay is assumed for the

uncontrolled major street through movements). LOS for both non-signalized and signalized intersections was computed using the Synchro/Sim-Traffic operational software (Version 9).

Roundabouts share the same basic control delay formulation with two-way and all-way STOP-controlled intersections, adjusting for the effect of YIELD control. LOS criteria specified in the 2010 HCM was used to establish the quality of service for the roundabout from a user's perspective. The 2010 HCM uses the average control delay (sec/veh) and volume-to-capacity ratio (v/c) to establish thresholds for LOS. Roundabout operations were analyzed using HCM 2010 model in SIDRA Intersections 6.0 software.

Vehicle Level of Service Standards

LOS criteria are established to determine whether a given roadway facility is providing the desired degree of service quality. Given that SR 227 is owned and maintained by the state, Caltrans operating standards were applied for this study. State facilities operating at the cusp of LOS C/D or better are considered to operate within state standards[1]. For two-lane state highway segments, deficient conditions occur if average travel speeds are less than 45 mph or a percent time spent following greater than 65% is experienced. Similarly, for a four-lane multilane highway the state standard is exceeded if vehicle densities of greater than 26 passenger cars per mile per lane are experienced.

State operated intersections experiencing movements with over 35 seconds of delay would exceed the state standard[1]. For roundabouts, v/c ratios in the range of 0.85 to 0.90 represent an approximate threshold for satisfactory operations. However, for purposes of this analysis, the same Caltrans standard for intersections was applied to roundabouts (i.e., over 35 seconds of delay indicates an exceedance of the standard).

Other Performance Metrics

To more comprehensively inform the operational analysis of SR 227, additional analyses were performed using different metrics than LOS. These analyses do not have established standards to determine performance. However, additional metrics facilitate a better understanding of the existing and future operational characteristics of SR 227 that can inform a comparative analysis of alternative corridor improvement concepts. Use of additional metrics other than LOS is consistent with the Smart Mobility Framework and with recent CEQA streamlining legislation (i.e., SB 743).

95th Percentile Queues

The 95th percentile queues are defined as the vehicle queue length that has only a 5-percent probability of being exceeded during the analysis period. Queue lengths are estimated by the operational software SYNCRHO. Several conditions can occur when intersections experience excessive queuing: 1) spill-back potential from the downstream intersection to the upstream intersection; 2) downstream queues affecting upstream saturation flow rates; and, 3) atypical dispersion or compression of the traffic stream between intersections – disrupting normal progression of vehicle platoons. These queue interactions create operational and safety issues for motorists.

Signal Warrants

At non-signalized intersections, the potential need for a traffic signal was evaluated. Traffic signal warrants are a series of standards that provide guidelines for determining if a traffic signal is appropriate. If one or more signal warrants are met, signalization of the intersection may be appropriate. However, a signal should not be installed if none of the warrants are met, since the installation of signals would increase delays on the previously uncontrolled major street and may increase particular types of accidents.

This study evaluated only two warrants – the peak 1-hour (Warrant #3) traffic signal warrant and collision history warrant (Warrant #7). Per the CA-MUTCD *"The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal."* This traffic analysis is a "planning level" analysis of a selected subset of warrants should not be considered to take the place of a full engineering signal warrant analysis. Hence, the application of these two warrants should be considered as indicators for the potential need for a more detailed "full" warrant analysis.

[1] Guide for the Preparation of Traffic Impact Studies, California Department of Transportation, December 2002.

Travel Speeds, Travel Time and Travel Time Reliability

Continuous 7-day 24-hour real-time operational data on SR 227 was collected using BlueMac readers to determine baseline vehicle travel times, vehicle speeds, travel time reliability and trip distribution characteristics. These data established the empirical basis for future projections of roadway and network performance. Network/corridor LOS based on Speed Efficiency Ratio (i.e., ratio of average corridor travel speed to average corridor free flow speed) and Travel Time Index (i.e., ratio of average corridor travel time to average corridor free flow travel time) was determined based the HCM 2010 method. Using the output from the intersection LOS analyses as inputs, the SIDRA 6.0 Network LOS module was used to compute the relative change (delta) in average corridor travel speed and travel time between baseline and future baseline network performance as well as the relative differences in average travel speed and time between alternative future corridor concepts. These deltas were applied to grow/adjust the empirically based travel speeds and time from the BlueMac data as appropriate for network LOS determinations. Detailed descriptions of the HCM Network LOS including quantitative LOS criteria are included in **Appendix B**.

Safety

A systemic safety analysis of the existing conditions of SR 227 study corridor was performed. Based on the contributing factors from the baseline collision hot-spot assessment Parts B and D of the Highway Safety Manual 2010 and principles from FHWA's Road Safety Audits were applied to identify location-specific and corridor-wide countermeasures. At intersections, Part C of the HSM was applied to estimate the potential safety performance and crash reduction potential of identified infrastructure design treatments. The estimated reduction in collisions by collision type was then monetized and included in the benefit/cost analysis of the alternative corridor concepts.

Multi-modal Level of Service

To determine the LOS of pedestrians, bicyclists and transit riders, the HCM 2010 Multi-modal Level of Service (MMLOS) methodology was used. For purposes of this analysis, this procedure was only applied at intersections. Key factors contributing to these modes LOS and quantitative MMLOS criteria are included in **Appendix B**.

Benefit-Cost

To provide an indication of the projected a return on investment expressed over a 20-year life cycle, a holistic benefit-cost (B/C) metric was developed and applied as part of the intersection control evaluations of each corridor concept. For each intersection, an individual and composite B/C ratio was computed based on the net present value (i.e., life cycle duration using a discount rate of 4%) incorporating the following five measures of effectiveness:

- Safety Benefit
- Delay Reduction Benefit
- Emission Reduction Benefit
- Operations and Maintenance Costs
- Initial Capital Costs

Safety benefits were based on the same analysis approach described above (i.e., using Parts B, D, and C) to estimate the potential safety performance and crash reduction potential of identified infrastructure design treatments. Delay benefits were based on calculations performed using the operational software SYNCHRO (for non-signalized and signalized intersections) and SIDRA (for roundabouts and mid-block delays). On-road mobile source emissions for health-based criteria pollutants were quantified using vehicle emission rates and vehicle profiles resident in the California Air Resources Board EMFAC emissions model. Vehicle activity inputs (vehicle miles of travel and operating speeds) were based on intersection and roadway segment analysis outputs generated by this study. Vehicle inventory profiles (fleet mix and vehicle type and technology group) reflect San Luis Obispo County vehicle registration data. Monetized benefits were primarily based on the parameters resident in the Caltrans Cal-B/C (Version 5.0) model. Projects were costed using a format based on Caltrans preparation guidelines for project planning cost estimates. Key factors contributing to the B/C estimation are included in **Appendix B**.

MACRO CORRIDOR ASSESSMENT

This section summarizes the macro corridor assessment and multimodal analysis for SR 227 from south of Tank Farm to Price Canyon Road. This includes the operational results for six (6) intersections and four (4) corridor segments within the study area. Traffic operating conditions that are present today, and that are expected within the 2025 and 2035 timeframes, are summarized. Detailed results for intersection traffic operations are included in **Appendix D**. Corridor Segment detailed analysis worksheets are provided in **Appendix E**.

Intersection Operations

Existing Intersection Level of Service

Existing (2015) intersection LOS results are summarized in **Table 7** below. For signalized intersections, delay and LOS is provided for each movement to identify critical movements. Results indicate that all the study intersections fail to operate at acceptable conditions (LOS C or better) during weekday AM peak hour with the poorest operations (LOS F) occurring at the intersections at Crestmont Drive and Los Ranchos Road. The intersection of SR 227 and Crestmont Drive operates at LOS F during both the AM and PM peak hours. The intersection of SR 227 and Buckley Road operates at LOS D during both the AM and PM peak hours.

Table 7: Existing 2015 Intersection Traffic Operations

#	Intersection	Control	Movement	AM		MD		PM	
				Delay	LOS	Delay	LOS	Delay	LOS
1	SR 227 & Airport Rd	TWSC	Worst	**26.2**	**D**	14.0	B	20.3	C
2	SR 227 & Farmhouse Ln	TWSC	Worst	**27.2**	**D**	14.1	B	15.1	C
3	SR 227 & Kendall Rd	TWSC	Worst	**28.5**	**D**	14.1	B	21.9	C
4	SR 227 & Buckley Rd	Signalized	Average	**53.9**	**D**	12.2	B	**39.1**	**D**
			EBLT	37.8	D	28.1	C	40.5	D
			EBR	15.8	B	18.7	B	31.6	C
			WBLTR	38.4	D	29.2	C	42.8	D
			NBL	20.9	C	23.4	C	38.3	D
			NBTR	74.9	E	6.9	A	5.8	A
			SBL	39.7	D	34.2	C	44.1	D
			SBT	24.5	C	12.5	B	57.5	E
			SBR	15.1	B	8.6	A	6.5	A
5	SR 227 & Crestmont Dr	TWSC	Worst	**>300.0**	**F**	**32.5**	**D**	**279.7**	**F**
6	SR 227 & Los Ranchos Rd	Signalized	Average	**130.3**	**F**	13.4	B	25	C
			EBLT	34.7	C	17.8	B	68.5	E
			EBR	25.5	C	15.9	B	55.4	E
			WBLTR	51.2	D	24.8	C	66.6	E
			NBL	45.7	D	26.4	C	66	E
			NBTR	226.5	F	12.1	B	5.3	A
			SBL	57.6	E	28.2	C	0	A
			SBT	23.2	C	14.5	B	27.8	C
			SBR	5.1	A	4.6	A	3.1	A

Existing Intersection 95th Percentile Queues

Baseline estimated 95th percentile queue lengths (in feet) are summarized in **Table 8**. The number of queued vehicles can be surmised by assuming an average vehicle length of 25 feet. Based on the results, queues of greater than 50 vehicles on SR 227 are estimated to occur in both the northbound and southbound directions (depending on peak hour) at Buckley Road and Los Ranchos Road. For two approaches at these two intersections, estimated queue lengths extend beyond available storage creating the potential for queue spill-back conditions at the adjacent upstream intersection (see shaded cells). Side street queues in the eastbound direction are most pronounced at Crestmont Drive and Los Ranchos Road where estimated queues extend 10-12 vehicles in length. The latter queue lengths were validated in the field based on one day of video detection. Video detection also observed a maximum 5 vehicle queue on Kendall Road where vehicles waited for an adequate gap in traffic to turn left onto SR 227.

Table 8: Existing 2015 Intersection 95th Percentile Queues

#	Intersection	Control	Movements	Available Storage (ft)	95th Percentile Queues (ft)		
					AM	MD	PM
1	SR 227 & Airport Rd	TWSC	NBL	-	0	0	0
			EB	-	0	25	25
2	SR 227 & Farmhouse Ln	TWSC	WB	-	25	25	25
			SBL	190	25	25	25
3	SR 227 & Kendall Rd	TWSC	WB	-	25	25	48
			SBL	100	25	25	25
4	SR 227 & Buckley Rd	Signalized	EBLT	-	45	59	68
			EBR	135	35	35	60
			WBLTR	-	0	0	0
			NBL	345	202	80	83
			NBTR	430	#1,367	262	272
			SBL	465	8	16	8
			SBT	2,370	366	302	#1,137
			SBR	465	24	19	9
5	SR 227 & Crestmont Dr	TWSC	NBL	124	25	25	25
			EB	-	300	33	128
			WB	-	25	0	25
			SBL	-	0	0	0
6	SR 227 & Los Ranchos Rd	Signalized	EBLT	-	331	118	194
			EBR	330	21	8	20
			WBLTR	-	24	0	32
			NBL	225	98	44	67
			NBTR	> 2,500	#1,724	223	198
			SBL	110	19	15	0
			SBT	1,380	322	255	#1,502
			SBR	250	19	16	35

Bold and shaded cells indicate that queues exceed available storage
# indicates greater queue lengths can be experienced
Based on Synchro 9 operational models

Existing SR 227 Segment Level of Service

Existing (2015) corridor segment traffic operations are summarized in **Table 9**. All segments fail to operate at LOS C or better during one or both peak hours except north of Buckley Road (southbound AM), Los Ranchos Road to Crestmont Drive (AM/PM), and south of Los Ranchos Road (northbound PM). Northbound travel experiences poorer operating conditions in the AM peak hour, and the pattern reverses in the PM peak hour.

Table 9: Existing 2015 Corridor Segment Operations

Corridor Segment	Direction	AM Peak			PM Peak		
		LOS	% Free Flow[1]	% Time[2]	LOS	% Free Flow[1]	% Time[2]
SR 227 North of Buckley Road	Northbound	**E**	**64.6**	**93.4**	**D**	**68.1**	**71.5**
	Southbound	C	65.7	66.7	**E**	**64.7**	**90.1**
SR 227 North of Crestmont Drive	Northbound	**E**	**66.2**	**93.7**	**D**	**68.0**	**73.4**
	Southbound	**D**	**65.2**	**71.3**	**E**	**62.8**	**92.9**
SR 227 South of Crestmont Drive	Northbound	**E**	**67.1**	**92.5**	C	69.1	69.9
	Southbound	**D**	**65.9**	**71.7**	**E**	**63.6**	**93.9**
SR 227 South of Los Ranchos Road	Northbound	**E**	**72.5**	**91.6**	C	72.4	62.8
	Southbound	C	73.1	58.4	**E**	**66.4**	**94.5**

1 Percent of free flow speed; indicates how much traffic is slowed by peak congestion.
2 Percent of time following other vehicles; indicates the proportion of time speed is inhibited by other traffic.

Interim 2025 Intersection Level of Service

Interim (2025) intersection traffic operations are summarized in **Table 10**. All study intersections fail to operate at LOS C or better in the AM/PM peak hours. SR 227 at Buckley Road and Crestmont Drive operate at LOS E/F during AM/PM peak hours respectively. All other intersections operate at LOS D or worse during AM/PM peak hours.

Table 10: Interim 2025 Intersection Traffic Operations

#	Intersection	Control	Movement	AM		MD		PM	
				Delay	LOS	Delay	LOS	Delay	LOS
1	SR 227 & Airport Rd	TWSC	Worst	**28.5**	**D**	16.7	C	**25.2**	**D**
2	SR 227 & Farmhouse Ln	TWSC	Worst	**35.4**	**E**	22.2	C	**30.2**	**D**
3	SR 227 & Kendall Rd	TWSC	Worst	**31.1**	**D**	15.5	C	**26.1**	**D**
4	SR 227 & Buckley Rd	Signalized	Average	**57.0**	**E**	14.6	B	**58.8**	**E**
			EBLT	38.9	D	30.2	C	40.6	D
			EBR	16.9	B	20.8	C	31.6	C
			WBLTR	39.4	D	33.8	C	42.9	D
			NBL	22.1	C	27.2	C	38.4	D
			NBTR	79.9	E	7.6	A	6.2	A
			SBL	41.0	D	40.7	D	44.2	D
			SBT	24.2	C	16.6	B	94.4	F
			SBR	14.6	B	9.0	A	6.6	A
5	SR 227 & Crestmont Dr	TWSC	Worst	**>300**	**F**	58.0	**F**	>300	**F**
6	SR 227 & Los Ranchos Rd	Signalized	Average	**123.4**	**F**	15.5	B	45.0	**D**
			EBLT	34.7	C	22.8	C	70.4	E
			EBR	25.5	C	20.1	C	54.8	D
			WBLTR	51.2	D	31.3	C	68.1	E
			NBL	48.1	D	29.9	C	67.5	E
			NBTR	215.6	F	11.7	B	6.2	A
			SBL	56.0	E	35.5	D	0.0	A
			SBT	22.2	C	18.3	B	61.3	E
			SBR	4.6	A	4.3	A	3.2	A

Interim 2025 Intersection 95th Percentile Queues

Interim (2025) intersection 95th percentile queue results are summarized in **Table 11** below. Based on the results, queues of greater than 50 vehicles on SR 227 are estimated to occur in both the northbound and southbound directions (depending on peak hour) at Buckley Road and Los Ranchos Road. For two approaches at these two intersections, estimated queue lengths extend beyond available storage creating the potential for queue spill-back conditions at the adjacent upstream intersection (see shaded cells). Side street queues in the eastbound direction are most pronounced at Crestmont Drive and Los Ranchos Road where estimated queues extend 11-14 vehicles in length.

Table 11: Interim 2025 Intersection 95th Percentile Queues

#	Intersection	Control	Movements	Available Storage (ft)	95th Percentile Queues (ft)		
					AM	MD	PM
1	SR 227 & Airport Rd	TWSC	NBL	-	0	0	0
			EB	-	0	25	25
2	SR 227 & Farmhouse Ln	TWSC	WB	-	33	33	63
			SBL	190	25	25	25
3	SR 227 & Kendall Rd	TWSC	WB	-	25	25	55
			SBL	100	25	25	25
4	SR 227 & Buckley Rd	Signalized	EBLT	-	45	74	72
			EBR	135	36	45	65
			WBLTR	-	0	0	0
			NBL	345	205	95	86
			NBTR	430	**#1,431**	319	325
			SBL	465	8	19	8
			SBT	2,370	392	455	**#1,308**
			SBR	465	25	18	10
5	SR 227 & Crestmont Dr	TWSC	NBL	124	25	25	25
			EB	-	298	63	160
			WB	-	25	0	25
			SBL	-	0	0	0
6	SR 227 & Los Ranchos Rd	Signalized	EBLT	-	345	166	228
			EBR	330	23	14	29
			WBLTR	-	24	0	32
			NBL	225	98	56	76
			NBTR	> 2,500	**#1,771**	283	255
			SBL	110	18	19	0
			SBT	1,380	347	414	**#1,898**
			SBR	250	22	16	43

Bold and shaded cells indicate that queues exceed available storage

# indicates greater queue lengths can be experienced

Based on Synchro 8 operational models

Interim 2025 SR 227 Segment Level of Service

Interim (2025) corridor segment traffic operations are summarized in **Table 12**. All the study segments fail to operate at LOS C or better during the AM and PM peak hours with the exception of southbound traffic south of Los Ranchos Road during AM peak hour and northbound traffic south of Los Ranchos Road in the PM peak hour.

Table 12: Interim 2025 Corridor Segment Operations

Corridor Segment	Direction	AM Peak			PM Peak		
		LOS	% Free Flow[1]	% Time[2]	LOS	% Free Flow[1]	% Time[2]
SR 227 North of Buckley Road	Northbound	**E**	**61.7**	**93.9**	**D**	**64.0**	**76.3**
	Southbound	**D**	**62.4**	**71.2**	**E**	**60.8**	**92.3**
SR 227 North of Crestmont Drive	Northbound	**E**	**63.2**	**96.5**	**D**	**63.5**	**79.3**
	Southbound	**D**	**61.6**	**75.9**	**E**	**58.1**	**97.0**
SR 227 South of Crestmont Drive	Northbound	**E**	**64.2**	**95.6**	**D**	**64.8**	**75.9**
	Southbound	**D**	**62.5**	**76.5**	**E**	**58.9**	**96.7**
SR 227 South of Los Ranchos Road	Northbound	**E**	**69.4**	**93.7**	C	68.4	68.3
	Southbound	C	70.7	62.6	**E**	**62.3**	**94.6**

1 Percent of free flow speed; indicates how much traffic is slowed by peak congestion.
2 Percent of time following other vehicles; indicates the proportion of time speed is inhibited by other traffic.

2035 Intersection Level of Service

Future (2035) intersection traffic operations are summarized in **Table 13** below. All the study intersections fail to operate at acceptable conditions (LOS C or better) during the AM and PM peak hours.

Table 13: Future 2035 Intersection Traffic Operations

#	Intersection	Control	Movement	AM		MD		PM	
				Delay	LOS	Delay	LOS	Delay	LOS
1	SR 227 & Airport Rd	TWSC	Worst	**31.3**	**D**	20.1	C	**32.2**	**D**
2	SR 227 & Farmhouse Ln	TWSC	Worst	**51.7**	**F**	64.5	**F**	**173.2**	**F**
3	SR 227 & Kendall Rd	TWSC	Worst	**34.0**	**D**	17.3	C	**33.9**	**D**
4	SR 227 & Buckley Rd	Signalized	Average	**64.2**	**E**	17.2	B	**101.4**	**F**
			EBLT	42.7	D	36.2	D	40.9	D
			EBR	20.0	B	25.0	C	31.7	C
			WBLTR	42.7	D	40.1	D	43.0	D
			NBL	25.8	C	32.2	C	38.5	D
			NBTR	86.5	F	7.3	A	6.8	A
			SBL	43.9	D	59.8	E	44.4	D
			SBT	22.2	C	20.6	C	151.8	F
			SBR	13.4	B	8.7	A	6.6	A
5	SR 227 & Crestmont Dr	TWSC	Worst	**>300**	**F**	**120.7**	**F**	**>300**	**F**
6	SR 227 & Los Ranchos Rd	Signalized	Average	**203.5**	**F**	18.3	B	**76.6**	**E**
			EBLT	32.4	C	29.1	C	72.3	E
			EBR	24.3	C	25.0	C	54.3	D
			WBLTR	54.1	D	39.2	D	69.6	E
			NBL	48.4	D	38.3	D	68.8	E
			NBTR	278.0	F	12.0	B	7.1	A
			SBL	59.7	E	47.2	D	0.0	A
			SBT	27.6	C	22.5	C	115.5	F
			SBR	4.9	A	3.6	A	3.4	A

2035 Intersection 95th Percentile Queues

Estimated 2035 intersection 95th percentile queue results are summarized in **Table 14** below. All results are presented in feet. Based on the results, queues of greater than 60 vehicles on SR 227 are estimated to occur in both the northbound and southbound directions (depending on peak hour) at Buckley Road and Los Ranchos Road. For two approaches at these two intersections, estimated queue lengths extend beyond available storage creating the potential for queue spill-back conditions at the adjacent upstream intersection (see shaded cells). Side street queues in the eastbound direction are most pronounced at Crestmont Drive and Los Ranchos Road where estimated queues extend 12-15 vehicles in length.

Table 14: 2035 Intersection 95th Percentile Queues

#	Intersection	Control	Movements	Available Storage (ft)	95th Percentile Queues (ft)		
					AM	MD	PM
1	SR 227 & Airport Rd	TWSC	NBL	-	0	0	0
			EB	-	0	25	25
2	SR 227 & Farmhouse Ln	TWSC	WB	-	70	188	295
			SBL	190	25	25	25
3	SR 227 & Kendall Rd	TWSC	WB	-	25	25	73
			SBL	100	25	25	25
4	SR 227 & Buckley Rd	Signalized	EBLT	-	47	59	75
			EBR	135	38	35	66
			WBLTR	-	0	0	0
			NBL	345	217	80	90
			NBTR	430	#1,561	262	393
			SBL	465	9	16	8
			SBT	2,370	432	302	#1,516
			SBR	465	26	19	10
5	SR 227 & Crestmont Dr	TWSC	NBL	124	25	25	25
			EB	-	310	88	188
			WB	-	25	0	25
			SBL	-	0	0	0
6	SR 227 & Los Ranchos Rd	Signalized	EBLT	-	365	118	263
			EBR	330	24	8	39
			WBLTR	-	25	0	33
			NBL	225	101	44	84
			NBTR	> 2,500	#1,929	211	316
			SBL	110	18	15	0
			SBT	1,380	395	255	#2,293
			SBR	250	22	16	52

Bold and shaded cells indicate that queues exceed available storage

# indicates greater queue lengths can be experienced

Based on Synchro 8 operational models

2035 SR 227 Segment Level of Service

Future (2035) corridor segment traffic operations are summarized in **Table 15**. All the study segments fail to operate at LOS C or better during the AM and PM peak hours with the exception of southbound traffic south of Los Ranchos Road during AM peak hour.

Table 15: Future 2035 Corridor Segment Operations

Corridor Segment	Direction	AM Peak			PM Peak		
		LOS	% Free Flow[1]	% Time[2]	LOS	% Free Flow[1]	% Time[2]
SR 227 North of Buckley Road	Northbound	**E**	**58.1**	**97.0**	**D**	**59.6**	**81.7**
	Southbound	**D**	**58.2**	**76.3**	**E**	**52.7**	**98.3**
SR 227 North of Crestmont Drive	Northbound	**E**	**59.9**	**98.3**	**F**	**58.1**	**83.6**
	Southbound	**D**	**57.5**	**80.2**	**F**	**52.4**	**99.9**
SR 227 South of Crestmont Drive	Northbound	**E**	**61.0**	**96.9**	**F**	**59.3**	**80.5**
	Southbound	**D**	**58.6**	**81.0**	**F**	**53.9**	**100.0**
SR 227 South of Los Ranchos Road	Northbound	**E**	**68.5**	**93.0**	**D**	**64.0**	**73.7**
	Southbound	C	68.1	66.2	**E**	**57.7**	**98.0**

1 Percent of free flow speed; indicates how much traffic is slowed by peak congestion.
2 Percent of time following other vehicles; indicates the proportion of time speed is inhibited by other traffic.

Signal Warrants

The four non-signalized intersections in the study area were evaluated for their ability to meet Caltrans peak hour volume and safety warrants for the installation of traffic signals. Results indicate that no intersections meet safety warrants. Peak hour warrants were met during the AM peak hour at Crestmont Drive and during the PM peak hour at Kendall Road. All intersections except at Airport Road meet at least one peak hour warrant under 2025 and 2035 conditions. Results of the warrant analysis are shown in Table 16 and Table 17 (worksheets are provided in **Appendix D**). Note that per the CA-MUTCD *"The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal."* This traffic analysis is a "planning level" analysis of a selected subset of warrants should not be considered to take the place of a full engineering signal warrant analysis. Hence, the application of these two warrants should be considered as indicators for the potential need for a more detailed "full" warrant analysis.

Table 16. Peak Hour Volume Traffic Signal Warrants

Intersection	Control	Peak Hour Volume or Delay Warrant Met?								
		Existing			Interim 2025			Future 2035		
		AM	PM	MD	AM	PM	MD	AM	PM	MD
SR 227 and Airport Road	TWSC	No	No	No	No	No	No	No	No	No
SR 227 and Farmhouse Lane	TWSC	No	No	No	No	Yes	Yes	Yes	Yes	Yes
SR 227 and Kendall Road	TWSC	No	Yes	No	No	Yes	No	No	Yes	No
SR 227 and Crestmont Drive	TWSC	Yes	No	No	Yes	No	No	Yes	No	No

Table 17. Safety Traffic Signal Warrants

Intersection	Control	> 5 Crashes in the last 12 Months
SR 227 and Airport Road	TWSC	No
SR 227 and Farmhouse Lane	TWSC	No
SR 227 and Kendall Road	TWSC	No
SR 227 and Crestmont Drive	TWSC	No

Travel Time and Reliability Observations

Travel Speeds / Travel Time

Existing corridor travel speeds and times were measured using Bluetooth signal detection as described in the Data Collection section. Measured travel speeds and travel times are corridor-based and therefore reflect delays experienced at intersections. Average weekday AM/PM peak hour travel time and speed summaries are shown in **Table 18**. Off-peak evening travel time and speeds are provided as a surrogate for free flow conditions.

Table 18. Mean Corridor Travel Time and Speed

Segment	Northbound			Southbound		
	AM Pk. Hr.	PM Pk. Hr.	Night	AM Pk. Hr.	PM Pk. Hr.	Night
Travel Time (mm:ss)						
Corbett Canyon Road to Biddle Ranch Road	2:23	2:08	1:52	2:08	2:32	1:47
Biddle Ranch Road to Buckley Road	2:14	1:59	1:34	2:01	2:23	1:41
Buckley Road to Tank Farm Road	2:03	3:15	1:49	2:38	3:44	2:05
Speed (mph)						
Corbett Canyon Road to Biddle Ranch Road	40.1	44.9	51.0	44.8	37.9	53.6
Biddle Ranch Road to Buckley Road	37.3	41.8	53.0	40.4	34.1	48.2
Buckley Road to Tank Farm Road	41.8	26.4	47.2	32.7	23.0	41.2

As shown in **Figure 9**, AM/PM peak hour travel speeds between Biddle Ranch Road and Buckley Road are reduced roughly 10-17 mph in the northbound direction and 8-14 mph in the southbound direction relative to off-peak conditions. Between Buckley Road and Tank Farm Road, peak hour travel speeds decline approximately 5-21 mph in the northbound direction and 8-18 mph in the southbound direction relative to off-peak conditions (**Figure 10**) with the greatest reduction in free flow speeds occurring in the PM peak hour. Travel times through these segments increase during both the AM and PM peak periods relative to free flow conditions. Congestion is particularly acute between Buckley Road and Tank Farm Road. The Biddle Ranch to Buckley Road section had directional congestion northbound in the AM peak and southbound during the PM peak. South of the study corridor, the section from Corbett Canyon Road to Biddle Ranch Road experiences much less peak hour congestion and slowing.

Figure 9. Travel Speeds Biddle Ranch to Buckley Road

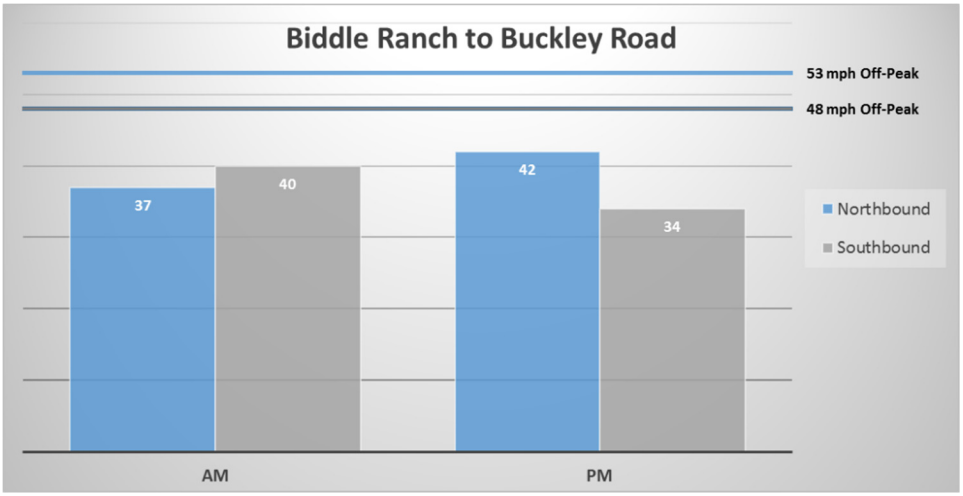
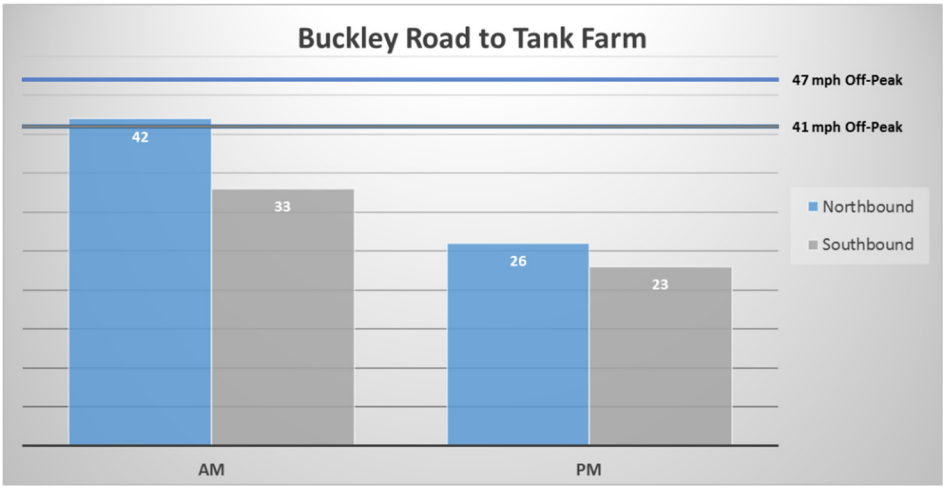


Figure 10. Travel Speeds Buckley Road to Tank Farm



Travel Time Reliability

Travel time reliability is defined as the variation in travel time for the same trip from day to day ("same trip" implies a trip made with the same purpose, from the same origin, to the same destination, at the same time of the day, using the same mode, and by the same route). If variability is large, the travel time is considered to be unreliable. If there is little or no variation in the travel time for the same trip, the travel time is considered to be reliable.

The basic causes of unreliable travel times are an imbalance between demand and capacity and the congestion that can result. Once congestion occurs, travel times become more variable (less reliable and thus less predictable). Moreover, congested facilities lack the resilience to accommodate unexpected travel interruptions, which leads to flow breakdowns and serious degradation of reliability. Travel times vary from one day to the next because conditions influencing traffic differ each day. The seven sources of congestion that influence travel time reliability are fluctuations in normal travel, physical bottlenecks, special events, traffic incidents, weather, traffic-control devices, and work zones.[2]

This section summarizes the travel time reliability findings within the study corridor. Although the primary focus of this study is on average weekday AM/PM peak hour commuter conditions, this data is reported for all days of the week between January 24, 2016 and April 1, 2016.

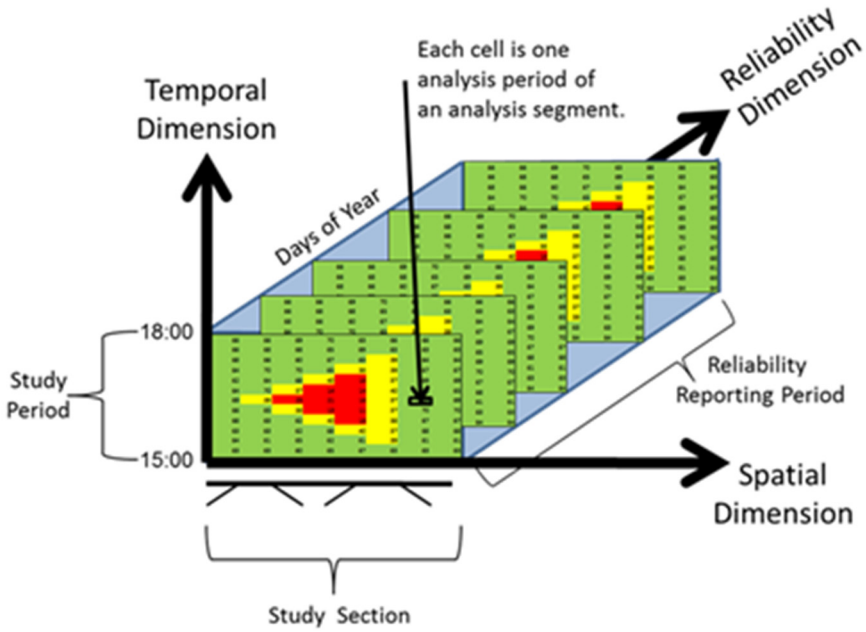
Buffer Time and Buffer Time Index

There are several measures of travel time reliability. They generally quantify the variability in travel time on a particular roadway at a particular time of the day or over the course of a study period as characterized in **Figure 11**.

For purposes of this analysis, Buffer Time and the Buffer Time Index (BTI) are used to measure reliability. Buffer Time is the amount of extra time a person needs to account for, above the average travel time, to ensure being on time 95% of the time (approximately one day late per month). If a commute trip usually takes 30 minutes, but there are periodic issues with weather or traffic incidents that can cause the commute to take 45 minutes, the buffer time would be 15 minutes, causing the commuter to be 15 minutes early on an average day, and late only rarely. The BTI normalizes that buffer time against the average travel time controlling for distance and typical daily congestion. The BTI is simply the ratio of Buffer Time against the average travel time and is expressed as a percentage. For the example above, 15 minutes of buffer time relative to a mean commute time of 30 minutes equates to a BTI of 0.50. The percentage shows the amount of buffer time relative to average travel time. Typically, a BTI over 0.50 indicates unreliable travel conditions. The relationship between travel time reliability indices is shown in **Figure 12**.

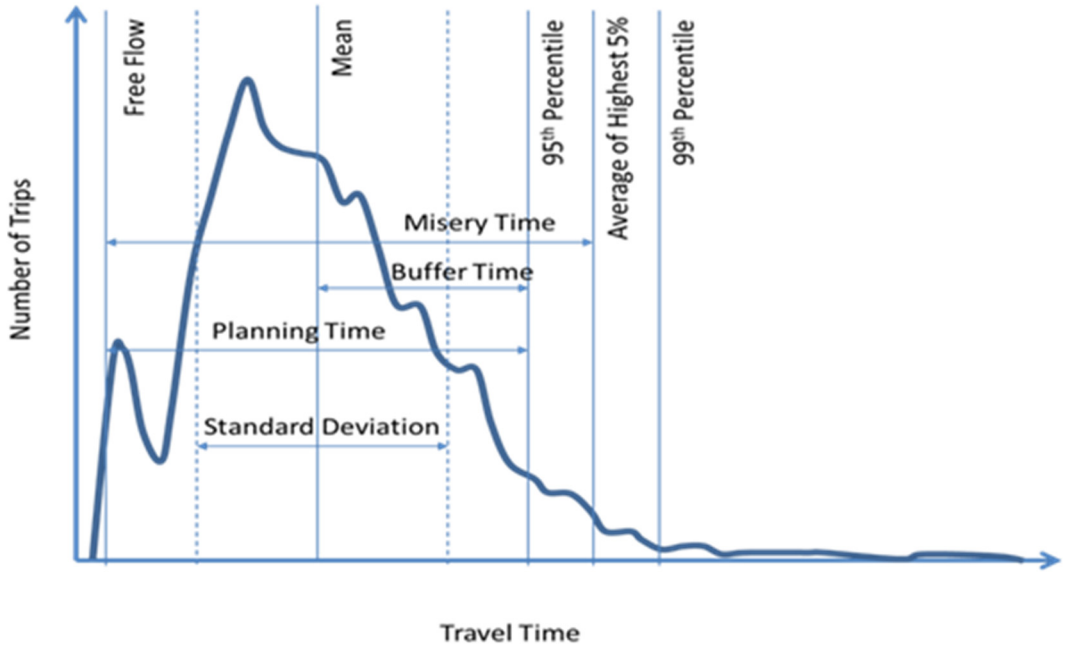
[2] National Academies, (2103). Evaluating Alternative Operations Strategies to Improve Travel Time Reliability. Library of Congress Control Number: 2013946101.

Figure 11. Travel Time Reliability Variables



Source: Chapter 36, Highway Capacity Manual 2010, Transportation Research Board, Washington DC, 2013

Figure 12. Travel Time Reliability Indices



Source: Chapter 36, Highway Capacity Manual 2010, Transportation Research Board, Washington DC, 2013

A key factor to remember when reviewing travel time reliability results is that they are not the same as congestion or delay. A trip that is on a route that is typically congested will likely have a very good reliability rating because it is predictable. A trip that is usually easy, but is prone to severe issues due to collisions or poor weather will likely have the worst reliability because travelers need to plan for extra time just in case something happens. Buffer Time and Buffer Time Index for SR 227 are shown in **Table 19** and **Table 20** respectively.

Table 19. Corridor Buffer Time (mm:ss)

Corbett Canyon Road to Biddle Ranch Road								
		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
North	AM	00:12	00:25	00:35	00:27	00:34	00:30	00:15
	PM	00:06	00:20	00:15	00:13	00:15	00:21	00:17
South	AM	00:14	00:17	00:20	00:32	00:32	00:23	00:09
	PM	00:09	00:20	00:12	00:16	00:20	00:14	00:11
Biddle Ranch Road to Buckley Road								
North	AM	00:14	00:18	00:49	00:36	00:33	00:29	00:13
	PM	00:12	00:15	00:13	00:17	00:18	00:16	00:13
South	AM	00:13	00:17	00:24	00:30	00:24	00:25	00:10
	PM	00:17	00:27	00:25	00:28	00:24	00:26	00:11
Buckley Road to Tank Farm Road								
North	AM	00:09	00:14	00:16	00:17	00:16	00:17	00:10
	PM	00:10	00:12	00:15	00:17	00:15	00:17	00:13
South	AM	00:20	00:25	00:41	00:31	00:40	00:32	00:13
	PM	00:23	01:50	02:43	01:56	02:12	02:16	00:20

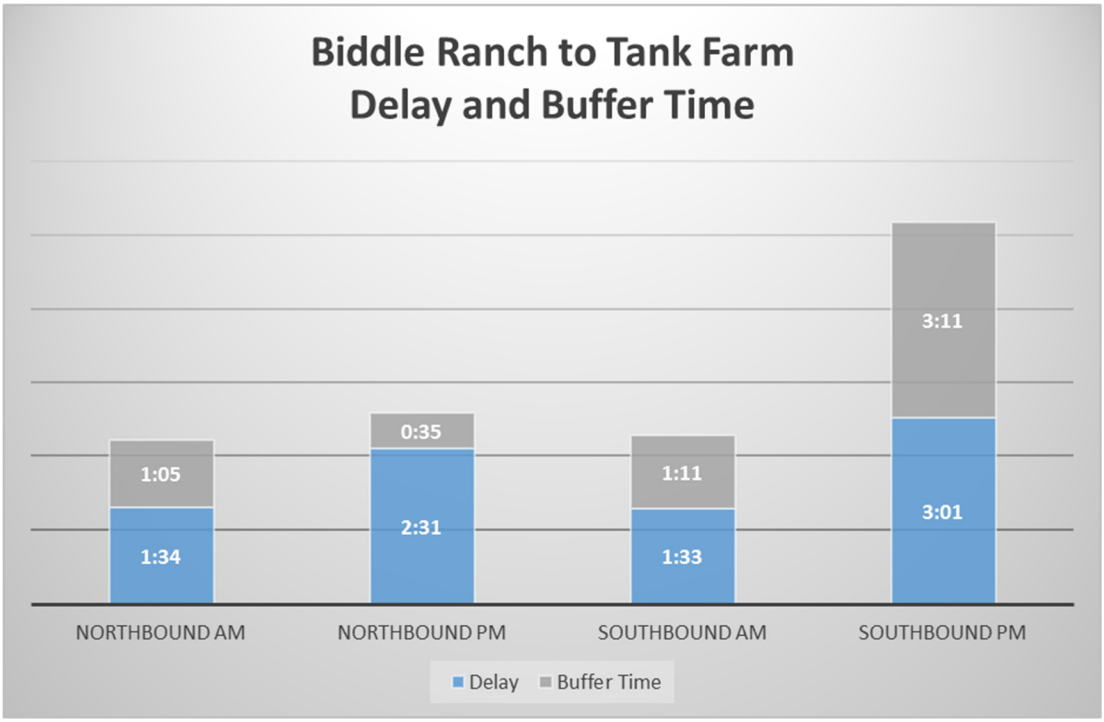
Table 20. Corridor Buffer Time Index

Corbett Canyon Road to Biddle Ranch Road								
		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
North	AM	11.5%	18.2%	23.7%	19.1%	24.5%	22.0%	13.3%
	PM	5.1%	16.8%	12.4%	11.2%	12.3%	18.5%	14.4%
South	AM	14.1%	14.3%	15.1%	24.8%	24.9%	18.4%	8.6%
	PM	8.4%	16.9%	10.1%	13.7%	17.4%	11.6%	9.9%
Biddle Ranch Road to Buckley Road								
North	AM	15.7%	16.1%	34.5%	27.3%	25.7%	23.6%	13.2%
	PM	11.8%	14.5%	12.8%	15.8%	16.9%	15.3%	13.0%
South	AM	13.5%	14.5%	19.2%	25.3%	19.7%	20.9%	9.6%
	PM	15.8%	19.6%	17.2%	19.7%	16.5%	18.4%	10.2%
Buckley Road to Tank Farm Road								
North	AM	8.7%	11.8%	13.2%	13.4%	12.7%	14.2%	9.1%
	PM	9.8%	9.5%	11.7%	14.4%	12.3%	13.6%	11.7%
South	AM	15.2%	16.4%	25.9%	19.8%	24.8%	19.1%	9.3%
	PM	17.8%	56.2%	67.7%	54.3%	59.9%	62.1%	15.3%

Results indicate that reliability is the poorest in the southbound direction between Tank Farm Road and Buckley Road during the PM peak period. Northbound reliability on the two southern segments is also worse than average during the AM peak periods. These segments during are the most difficult to anticipate travel time for.

As shown in **Figure 13**, buffer time – the amount of time a motorist must leave earlier than normal to ensure that they can accommodate an unpredictable travel experience on SR 227 and still ensure they arrive at their destination 95 percent of the time – was measured to be roughly equal to the amount of delay motorist experience while driving through the corridor. This equates to a BTI of approximately 1.00. Typically, a BTI over 0.50 indicates unreliable travel conditions.

Figure 13. Travel Time Delay Plus Buffer Time



Travel Patterns

Given SR 227's growing importance as a regional throughway as well as an important alternative parallel route to US 101, Bluetooth origin-destination data was examined to better understand the travel patterns both through and within the study corridor. Answers to the following questions were sought:

- Which is the preferred route for traveling between the City of San Luis Obispo and the Five Cities area: SR 227 or Price Canyon Road?
- What percentage of traffic on SR 227 within the study corridor is local traffic and how much is regional traffic? In this context, regional trips are those trips that are identified as both entering the corridor and exiting (north of Tank Farm Road or south of Biddle Ranch Road) while local trips are those that are identified at one end but not the other or not at either end (i.e., trips that either begin or end within the study corridor).

This section summarizes the traffic pattern findings within the study corridor. The findings are based on the weekday data (i.e., Tuesday, Wednesday, and Thursday commute periods) collected by BlueMac devices between January 24, 2016 and April 1, 2016.

Table 21 shows the proportion of traffic for each combination of first (row) and last observation (column). This allows directionality to be inferred. For instance, 10.3% of trips first identified at Tank Farm Road were not identified passing any other BlueMac locations (same first and last location). This indicates that these trip destinations did not reach Buckley Road or locations further south (i.e., indicating an intra-corridor or local trip). An additional 26.6% of trips first identified at Tank Farm Road were identified passing Buckley Road but not Biddle Ranch Road (i.e., also indicating an intra-corridor or local trip). Another 16.7% and 25.1% of trips first identified at Tank Farm Road were identified traveling south of Corbett Canyon Road and Price Canyon Road respectively (i.e., regional trips). Conversely, 40.9% of trips first detected at Price Canyon Road traveled as far as Tank Farm Road and beyond (i.e., regional trips).

The observed travel patterns in the study corridor indicate that more study area motorists prefer to take Price Canyon Road to travel between the City of San Luis Obispo and the Five Cities area than continues along SR 227.

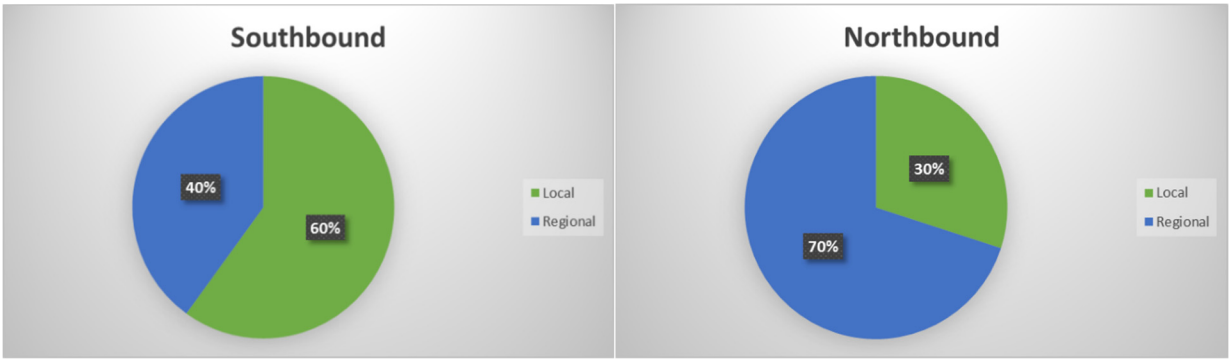
Table 21. Corridor Travel Patterns

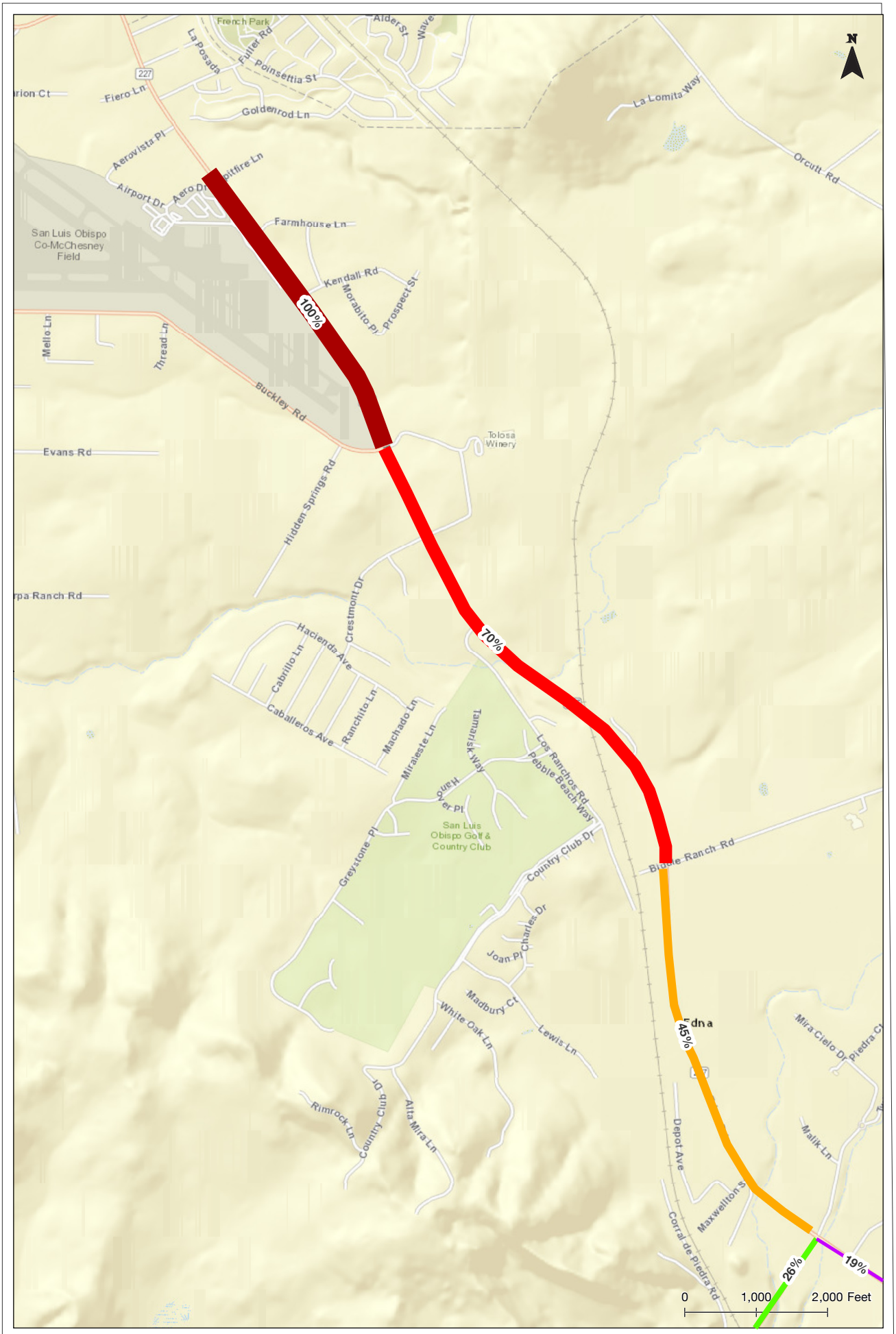
	Tank Farm Road	Buckley Road	Biddle Ranch Road	Corbett Canyon Road	Price Canyon Road
Tank Farm Road	10.3%	26.6%	21.3%	16.7%	25.1%
Buckley Road	28.6%	17.9%	21.7%	14.0%	17.7%
Biddle Ranch Road	29.8%	24.4%	18.6%	9.0%	18.2%
Corbett Canyon Road	41.6%	23.9%	12.8%	16.7%	4.9%
Price Canyon Road	40.9%	28.2%	15.7%	4.7%	10.6%

Observed travel patterns in the study corridor also indicate that the 52% of motorists that use SR 227 either begin or end their trip within the study corridor (i.e., considered local trips) – while 48% neither begin nor end their trip in the study corridor (i.e., considered regional trips). Of the 89,000 trips observed entering the study area from Buckley Road or further north, 62% were local and did not continue through the southern limit of the study area. Of the 40,800 trips observed entering the study area from the south, 30% were local and did not continue north as far as Buckley Road. This pattern indicates that if local residents along the corridor are provided an alternate route or mode into the City of San Luis Obispo it could impact well over half of the users of SR 227 along the northern section of the study area. This indicates a high potential for congestion relief if an alternative route and/or mode can be established.

These results are graphically shown in **Figure 14.** The southbound distribution of trips is also shown in **Figure 15.**

Figure 14. SR 227 Local vs. Regional Split – Southbound and Northbound Directions





Service Layer Credits: Sources: Esri, HERE, DeLorme , USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Southbound Traffic from Buckley Road
San Luis Obispo, California

Figure
15

Kimley»Horn

Safety Conditions

The three (3) most recent years of crash records for the SR 227 study corridor were acquired from Traffic Accident Surveillance and Analysis System (TASAS) database and the Statewide Integrated Traffic Records System (SWITRS), respectively.

The available most recent TASAS data (2011-2013) were requested from Caltrans District 5 for SR 227 roadway and intersections between post mile 6.20 (Tolosa Place intersection) and post mile 10.264 (south of Kendall Road) at the end of Caltrans' right-of-way.

The three most recent available SWITRS data within the study area were downloaded from the SWITRS website. The consecutive three (3) year period between 2011 and 2013 was available for analysis. Collisions within a 500-foot influence area of an intersection were excluded from this SWITRS crash analysis. Intersection collisions (within 500-foot influence area of an intersection) were analyzed as part of the safety evaluation for the Intersection Control Evaluation (ICE) analysis.

To calculate crash rates for local roadway segments within the project vicinity, the average daily traffic data collected for the project was used.

SWITRS Segments Crash Analysis

Table 22 presents roadway segment volume, total collisions, and overall crash rates for each roadway segment within the study area.

For collisions on roadway segments, the segment between Biddle Ranch Road and Los Ranchos Road (located outside the study corridor) recorded the highest crash rate (0.41 collisions per million vehicle-miles traveled). The second highest crash rate was recorded within the study corridor between Crestmont Drive and Los Ranchos Road (0.35 collisions per million vehicle-miles traveled). No fatalities were recorded along segments with two segments having no injuries reported as well.

Table 23 presents roadway segment crashes by collision type. Key factors from the roadway segment crash history by collision type include:

- Rear end collisions are the most common collision type for the study corridor accounting for 9 (or 69%) of the 13 segment crashes.
- No other collision type had more than one crash.

Given the limited number of collisions occurring outside the influence area of intersections along the corridor, the SWITRS data available does not indicate any clear crash history patterns beyond the prevalence of rear end collisions. A high propensity of rear-end collisions is indicative of unstable flow conditions (i.e., congestion) on SR 227. These crashes may also be associated with vehicles accessing minor roadways or developments along the SR 227 study corridor. The rear-end crashes are spread along the corridor. However, possible mitigations to address these types of crashes include:

- providing left and right turn pockets with deceleration lanes to allow turning vehicles to safely slow and access their destination; or
- providing wide shoulders at minor intersections and/or development entrances to allow turning vehicles a larger turning area to avoid hard decelerations.

Table 22. Roadway Segment Volume and Crash Rate (2012-2014)

Street Name	From	To	Average Annual Daily Traffic[1]	Segment Length (miles)	Number of Crashes	Severity		Crash Rate Per Million Vehicle-Miles
						Fatalities	Injuries	
State Route 227	Price Canyon Road	Biddle Ranch Road	15,800	1.12	3	0	0	0.15
State Route 227	Biddle Ranch Road	Los Ranchos Road	15,800	0.84	6	0	2	0.41
State Route 227	Los Ranchos Road	Crestmont Drive	18,600	0.28	2	0	2	0.35
State Route 227	Crestmont Drive	Buckley Road	19,400	0.25	0	0	0	0.00
State Route 227	Buckley Road	Airport Drive	17,400	0.72	2	0	2	0.15

[1] Source: Caltrans Published 2014 State Highway Volumes

Table 23. Roadway Segment Crashes by Type (2012-2014)

Street Name	From	To	Crash Type				
			Sideswipe	Rear End	Fixed Object	Overturned	Other
State Route 227	Price Canyon Road	Biddle Ranch Road	1	2	0	0	0
State Route 227	Biddle Ranch Road	Los Ranchos Road	0	3	1	1	1
State Route 227	Los Ranchos Road	Crestmont Drive	0	2	0	0	0
State Route 227	Crestmont Drive	Buckley Road	0	0	0	0	0
State Route 227	Buckley Road	Airport Drive	0	2	0	0	0
Total			1	9	1	1	1

TASAS Crash Analysis

The most recent available TASAS data (2011-2013) was provided by Caltrans District 5 for SR 227 for roadway and intersections between post mile 6.20 (Tolosa Place intersection) and post mile 10.264 (south of Kendall Road) at the end of Caltrans' right-of-way. As shown in **Table 24**, there have been no fatal crashes along the study corridor with the analysis period (the most recent fatality was recorded in 2009 at Los Ranchos Road intersection[3]). Most segments and intersections along the study corridor have lower crash rates than the average statewide rates for similar facilities. However, the segment of SR 227 from Tolosa Place to north of Maxwellton Street had a higher total crash rate (1.62) than the average total crash rate for similar facilities (1.20). For intersections along the study corridor, only two intersections had higher crash rates than the average crash rates for similar facilities. SR 227 at Corbett Canyon Road has a higher fatal and injury crash rate (0.15) than the average for a similar facility (0.07). SR 227 and Crestmont Road has a higher fatal and injury crash rate (0.11) and higher total crash rate (0.17) compared to the average rates for similar facilities (0.07 and 0.16, respectively).

[3] A fatality did occur near Biddle Ranch Road involving a vehicle striking a cyclist during the development of this study.

Table 24. State Route Segment and Intersection Crash Rates (2011-2013)

Route	Start Mile Post	ADT of Main Street	Total MVM (in millions)	Fatal Rate	Fatal + Injury Rate	Total Rate	Average Fatal Rate	Average Fatal + Injury Rate	Average Total Rate
SR- 227 Segment and Intersection Combined	6.20	10.5	46.62	0.00	0.32	0.84	0.022	0.46	1.04
SR-227, Tolosa Place to north of Maxwellton St	6.20	6.1	8.64	0.00	0.46	**1.62**	0.026	0.56	1.20
SR-227, north of Maxwellton St to south of Buckley Road	7.493	12.2	28.24	0.00	0.28	0.60	0.020	0.36	0.85
SR-227, south of Buckley Road to south of Kendall Road	9.605	13.7	9.89	0.00	0.30	0.81	0.016	0.56	1.32
Intersections:									
State Route 227 & Corbett Canyon Road	6.700	4.2	6.58	0.00	**0.15**	0.15	0.003	0.07	0.16
State Route 227 & Greengate Road	7.028	4.7	5.22	0.00	0.00	0.00	0.002	0.06	0.12
State Route 227 & Price Canyon Road	7.120	7.7	13.68	0.00	0.07	0.51	0.004	0.19	0.50
State Route 227 & Biddle Ranch Road	8.249	11.1	13.61	0.00	0.00	0.15	0.005	0.10	0.23
State Route 227 & Los Ranchos Road	9.089	13.3	18.02	0.00	0.06	0.22	0.004	0.19	0.50
State Route 227 & Crestmont Road	9.367	14.5	17.41	0.00	**0.11**	**0.17**	0.003	0.07	0.16
State Route 227 & Buckley Road	9.818	14.1	17.82	0.00	0.00	0.11	0.002	0.17	0.43

Note: Cells shaded in grey are higher than statewide average for like facilities.

Table 25 shows the segment and intersection crash history by severity and type. Key factors from this analysis include:

- There were no fatalities and a total of 19 people injured along the corridor.
- 10 of the 19 people injured were injured on the segment between north of Maxwellton Street and south of Buckley Road
- Nearly 72% of total corridor crashes were multi-vehicle collisions
- One-third of all corridor crashes occurred under dark conditions.
- The intersection of SR 227 at Price Canyon Road had the most intersection crashes (7) followed by SR 227 at Los Ranchos Road (4).
- Focusing on the SR 227 segment that overlaps most with the study corridor (between Biddle Ranch and Kendall Road), a total of 25 collisions were recorded between 2011-13). Of those 25 collisions, 11 were injury collisions involving 14 persons injured; 21 were multi-vehicle collisions; 7 occurred at night; and. 3 under wet conditions)

Table 25. State Route Segment and Intersections Crashes by Severity and Type (2011-2013)

Route	Start Mile Post	End Mile Post	Total	Fatal	Injury	Fatal + Injury	Multi Vehicle	Wet	Dark	Persons Killed	Persons Injured
SR- 227 Segment and Intersection Combined	6.20	10.264	39	0	15	15	28	4	13	0	19
SR-227, Tolosa Place to north of Maxwellton St	6.20	7.492	14	0	4	4	7	1	6	0	5
SR-227, north of Maxwellton St to south of Buckley Road	7.493	9.604	17	0	8	8	13	3	5	0	10
SR-227, south of Buckley Road to south of Kendall Road	9.605	10.263	8	0	3	3	8	0	2	0	4
Intersections											
State Route 227 & Corbett Canyon Road	6.700	--	1	0	1	1	0	1	1	0	1
State Route 227 & Greengate Road	7.028	--	0	0	0	0	0	0	0	0	0
State Route 227 & Price Canyon Road	7.120	--	7	0	1	1	5	0	2	0	1
State Route 227 & Biddle Ranch Road	8.249	--	2	0	0	0	2	0	0	0	0
State Route 227 & Los Ranchos Road	9.089	--	4	0	1	1	2	1	2	0	1
State Route 227 & Crestmont Road	9.367	--	3	0	2	2	3	0	0	0	4
State Route 227 & Buckley Road	9.818	--	2	0	0	0	2	0	0	0	0

The TASAS safety analysis indicates that the corridor is performing better than the average crash rates for similar facilities for all corridor segment locations (which include intersection crashes) except the segment from Tolosa Place to north of Maxwellton Street. Collisions along these segments indicate that they were predominately multi-vehicle (50%) and occurred under dark conditions (43%). Given that the TASAS corridor data does not separate intersection and segment crash data, segment-specific recommendations cannot be made. However, to more broadly address multi-vehicle and dark conditions crashes along the Tolosa Place to north of Maxwellton Street segment, the potential safety improvements could include:

- providing or improving illumination along the segment and/or at intersections;
- providing left and right turn pockets with deceleration lanes to allow turning vehicles to safely slow and to turn off SR-227 to prevent rear end and turning related multi vehicle crashes; or
- providing wide shoulders at minor intersections and/or development entrances to allow turning vehicles a larger turning area to avoid hard decelerations to prevent rear end crashes or turning-related crashes; and,
- installing centerline rumble strips to address crossover crashes.

Multimodal Analysis

The Multimodal Corridor Assessment evaluates several aspects of multimodal activity along the corridor. Intersection operations are evaluated for bicycles, pedestrians, and transit vehicles using the 2010 Highway Capacity Manual (HCM) Multimodal Level of Service (MMLOS) methodology. The Anza Trail alignment and neighborhood pedestrian access are also reviewed including a focus on school pedestrian access and connectivity. Future transit service and the potential for park and ride lots were also reviewed. Based on these assessments, multimodal improvements are recommended along the corridor.

The multimodal level of service assessment of State Route 227 evaluated existing conditions at the six study intersections along the corridor. The study intersections analyzed include:

- State Route 227 & Airport Drive;
- State Route 227 & Farmhouse Lane;
- State Route 227 & Kendall Road;
- State Route 227 & Buckley Road;
- State Route 227 & Crestmont Drive; and,
- State Route 227 & Los Ranchos Road.

MMLOS Analysis

The bicycle and pedestrian mode MMLOS thresholds for each letter grade are shown in **Table 26** per the HCM[4] . As shown, higher scores mean a worse LOS grade. Additionally, it is important to note that LOS scores can be less than zero which corresponds to LOS A. Negative values represent an especially beneficial condition such as buffered bike lanes. The rest of this section details the results of each of the six study intersections.

Table 26. Bicycle and Pedestrian LOS Criteria

LOS Score	LOS
≤ 2.00	A
> 2.00-2.75	B
> 2.75-3.50	C
> 3.50-4.25	D
> 4.25-5.00	E
> 5.00	F

Source: 2010 *Highway Capacity Manual*

[4] *Highway Capacity Manual*. Transportation Research Board, Washington, D.C. 2010.

The MMLOS methodology does not analyze intersection LOS for the whole intersection but rather for the individual legs. For example, if a pedestrian or bicyclists is heading westbound on a street they will be crossing the northern leg of the intersection. Therefore, the multimodal methodology analyzes the LOS for this leg in particular. Pedestrian and bicyclist LOS were evaluated as part of this intersection MMLOS assessment. The analysis of the six study intersections looked at all legs of the intersections to determine the experience crossing each leg. The results for bicycle and pedestrian intersection LOS for these six study intersections are discussed in the following sections.

Bicycle LOS

The bicycle intersection LOS results for the six study intersections are shown in **Table 27** for the AM, mid-day, and PM peak hours. As shown in the table, the signalized intersection bicycle LOS scores can vary widely between the different legs and intersections. These variations result from the diversity in the primary inputs for bicycle LOS at signalized intersections which include:

- intersection crossing distance;
- width of the travel lane, bike lane, and shoulder; and,
- number of vehicles per lane.

For signalized intersections, all three of these inputs can account for why each leg can have a widely varying LOS result within the same peak hour. The number of vehicles per lane accounts for why there are changes between the AM and PM peak hour.

Pedestrian LOS

The results for pedestrian LOS by intersection leg are shown in **Table 28**. The primary inputs for pedestrian intersection LOS include:

- number of lanes being crossed;
- right-turn-on-red vehicles;
- vehicle volumes and speed; and,
- delay at the intersection.

The two signalized study intersections analyzed generally had longer cycle lengths, more lanes to cross, and higher vehicle volumes. Longer cycles lead to more pedestrian delay at the signal while more vehicles and additional lanes make for less comfortable crossing conditions for pedestrians. This leads to these intersections having LOS results in the LOS C range in the PM peak hour where volumes are highest and LOS results in the LOS A or B range in the mid-day peak hour due to lower vehicle volumes and shorter cycle lengths.

All four non-signalized study intersections experience poor LOS results for pedestrians. This is primarily due to crossing the crossing distances at the north and south legs of the intersections and the expectation that motorists will not yield due to the lack of crossing treatments and high vehicle speeds. Combined with the high vehicle volumes on SR 227 the LOS methodology indicates that pedestrians will not find an acceptable gap to cross the roadway at a typical walking speed.

In summary, pedestrian crossing at non-signalized intersection locations along the study corridor are expected to experience extreme difficulty crossing the roadway at LOS F. All crossings at the two signalized study intersections remained at LOS C or above. Bicycle LOS generally remained at LOS C or higher with the exception of the non-signalized intersections where high vehicle volumes increase delay for bicyclists operating from the side streets.

MMLOS worksheets for bicyclists and pedestrians are presented in **Appendix F**.

Table 27. Study Intersection Bicycle LOS by Peak Hour and Approach Leg

AM Peak Hour					
Intersection	Control	North Leg	South Leg	East Leg	West Leg
State Route 227 & Airport Drive	TWSC	20.3 (C)			
State Route 227 & Farmhouse Lane	TWSC	15.1 (C)			
State Route 227 & Kendall Road	TWSC	21.9 (C)			
State Route 227 & Buckley Road	Signal	2.75 (C)	1.40 (A)	3.87 (D)	2.85 (C)
State Route 227 & Crestmont Drive	TWSC	>45.0 (F)			
State Route 227 & Los Ranchos Road	Signal	2.99 (C)	3.19 (C)	3.24 (C)	2.11 (B)
Mid-Day Peak Hour					
Intersection	Control	North Leg	South Leg	East Leg	West Leg
State Route 227 & Airport Drive	TWSC	14.0 (B)			
State Route 227 & Farmhouse Lane	TWSC	14.1 (B)			
State Route 227 & Kendall Road	TWSC	14.1 (B)			
State Route 227 & Buckley Road	Signal	2.76 (C)	1.43 (A)	2.08 (B)	2.87 (C)
State Route 227 & Crestmont Drive	TWSC	32.5 (D)			
State Route 227 & Los Ranchos Road	Signal	2.98 (C)	2.80 (C)	1.71 (A)	1.98 (A)
PM Peak Hour					
Intersection	Control	North Leg	South Leg	East Leg	West Leg
State Route 227 & Airport Drive	TWSC	26.2 (D)			
State Route 227 & Farmhouse Lane	TWSC	27.2 (D)			
State Route 227 & Kendall Road	TWSC	28.5 (D)			
State Route 227 & Buckley Road	Signal	2.76 (C)	1.76 (A)	2.16 (B)	3.96 (D)
State Route 227 & Crestmont Drive	TWSC	>45.0 (F)			
State Route 227 & Los Ranchos Road	Signal	3.00 (C)	2.78 (C)	1.75 (A)	3.27 (C)

Table 28. Study Intersection Pedestrian LOS by Peak Hour and Approach Leg

AM Peak Hour					
Intersection	**Control**	**North Leg**	**South Leg**	**East Leg**	**West Leg**
State Route 227 & Airport Drive	TWSC	>45.0 (F)		N/A	0.00 (A)
State Route 227 & Farmhouse Lane	TWSC	>45.0 (F)		0.00 (A)	N/A
State Route 227 & Kendall Road	TWSC	>45.0 (F)		0.00 (A)	N/A
State Route 227 & Buckley Road	Signal	N/A	3.36 (C)	2.34 (B)	2.44 (B)
State Route 227 & Crestmont Drive	TWSC	>45.0 (F)		0.00 (A)	0.00 (A)
State Route 227 & Los Ranchos Road	Signal	N/A	3.19 (C)	3.24 (C)	2.11 (B)
Mid-Day Peak Hour					
Intersection	**Control**	**North Leg**	**South Leg**	**East Leg**	**West Leg**
State Route 227 & Airport Drive	TWSC	>45.0 (F)		N/A	0.00 (A)
State Route 227 & Farmhouse Lane	TWSC	>45.0 (F)		0.00 (A)	N/A
State Route 227 & Kendall Road	TWSC	>45.0 (F)		0.00 (A)	N/A
State Route 227 & Buckley Road	Signal	N/A	2.70 (B)	2.34 (B)	2.41 (B)
State Route 227 & Crestmont Drive	TWSC	>45.0 (F)		0.00 (A)	0.00 (A)
State Route 227 & Los Ranchos Road	Signal	N/A	2.80 (C)	1.71 (A)	1.98 (A)
PM Peak Hour					
Intersection	**Control**	**North Leg**	**South Leg**	**East Leg**	**West Leg**
State Route 227 & Airport Drive	TWSC	>45.0 (F)		N/A	0.00 (A)
State Route 227 & Farmhouse Lane	TWSC	>45.0 (F)		0.00 (A)	N/A
State Route 227 & Kendall Road	TWSC	>45.0 (F)		0.00 (A)	N/A
State Route 227 & Buckley Road	Signal	N/A	3.28 (C)	2.35 (B)	2.75 (C)
State Route 227 & Crestmont Drive	TWSC	>45.0 (F)		0.00 (A)	0.00 (A)
State Route 227 & Los Ranchos Road	Signal	N/A	2.78 (C)	1.75 (A)	3.27 (C)

Edna/Price Canyon Trail Alignment

The adoption of the Edna-Price Canyon Trail Feasibility Study represents a significant milestone in planning for an active transportation connection between the City of San Luis Obispo and the Five Cities area. Most of the alternative alignments for the trail at some point use the SR 227 study corridor as part of the route. It is important that the recommendations in this study account for and accommodate future construction of the trail. **Figure 16** shows the alignments as recommended by the Edna-Price Canyon Trail Feasibility Study.

The preferred alignment joins the study corridor at Los Ranchos Road and runs along the west side of the roadway. There is sufficient clearance from the existing roadway to accommodate the trail without encroaching too closely to the roadway or the airfield. The plan for this trail largely precludes any expansion of SR 227 to the west that would reduce the available space for the Edna-Price Canyon Trail.

Recommendations for corridor improvements such as driveway consolidation and improved community access would be of benefit to both projects.

Neighborhood and School Pedestrian Access and Connectivity

There is limited street connectivity for the residential neighborhoods along SR 227 between Buckley Road and Los Ranchos Road. Crestmont Drive and Los Ranchos Road are the only access routes for their respective communities. Neighborhoods just east of SR 227 near Tank Farm (e.g. Spanish Oaks) have good internal trail connectivity but face challenges connecting to destinations to the south (e.g. Los Ranchos Elementary School). This lack of interconnectivity and alternative access makes SR 227 an important corridor for all transportation modes into and out of these communities. SR 227 is not equipped with formal bicycle and pedestrian facilities, but an informal trail does exist along the west side of the road between Crestmont Drive and Los Ranchos Road that pedestrians and cyclists can use to travel between neighborhoods and to access Los Ranchos Elementary School.

An alternative route for students in the Crestmont Drive neighborhood exists via Hacienda Avenue which has a trail connection to the neighborhood and ends on Los Ranchos Road. Hacienda Avenue is a very narrow roadway with no sidewalks, but carries much less traffic at much lower speeds than SR 227 does. Existing bicycle and pedestrian connections are shown on **Figure 17**.

The residential neighborhood surrounding the San Luis Obispo Country Club is well connected internally by sidewalks. There are no sidewalks in the Crestmont Drive neighborhood or in the community south of Country Club Drive. Construction of the preferred alignment of the Edna / Price Canyon Trail would help connect the communities together.

There are currently no dedicated bicycle facilities in these neighborhoods.

Future Transit Service Assessment

Since September 2015, the San Luis Obispo Regional Transit Authority (RTA) has provided two roundtrips along SR 227 via the Route 10X express service. The RTA Route 10X provides inter-county commuter oriented express service between the the unincorporated community of Orcutt and the City of Santa Maria (in northern Santa Barbara County), the City of San Luis Obispo, and Cal Poly. Route 10X adds transit connectivity with the San Luis Obispo County Airport and connects with the Santa Barbara County subscription regional commuter express service, the Clean Air Express, at the Hagerman Park-and-Ride transfer point in Orcutt (near the Santa Maria Airport). Per the RTA 2016 SRTP, RTA is open to expanding future new/additional express runs that utilize SR 227 or Price Canyon Road. Conversely, the RTA 2016 Short Range Transit Plan (SRTP) does not support diverting the trunk line Route 10 buses to SR 227, as it would incur an additional 20 minutes of running time while continuing to serve the high-demand South Higuera corridor in San Luis Obispo.

The City of San Luis Obispo's 2016 SLO Transit SRTP recommends altering SLO Transit Route 3 to serve the employment area near the San Luis Obispo County Airport. This extension of service would not directly reach the

residential communities in the study corridor, but would provide a new southern terminus for transit services and could be the site of a collection point for those wishing to avoid driving and parking downtown.

Transit infrastructure on SR 227 is limited to one bus stop in each direction at Airport Drive. The stops have a pole with the bus stop sign and Transit Tracker sign. No additional passenger amenities are currently provided at this bus stop pair, with the exception of a Transit Tracker ID number that lets waiting passengers determine the arrival time of the next bus using SMS texting.

Both services would provide options for corridor residents to travel downtown via transit, and in the case of the RTA service, additional access to the Five-Cities Area and northern Santa Barbara County. The travel patterns observed for corridor residents (Table 12) show that despite the heavy weighting of commute traffic to downtown San Luis Obispo, a significant proportion of regional trips are to the south and therefore indicate potential ridership opportunities for corridor transit service in both directions.

Future Park and Ride Assessment

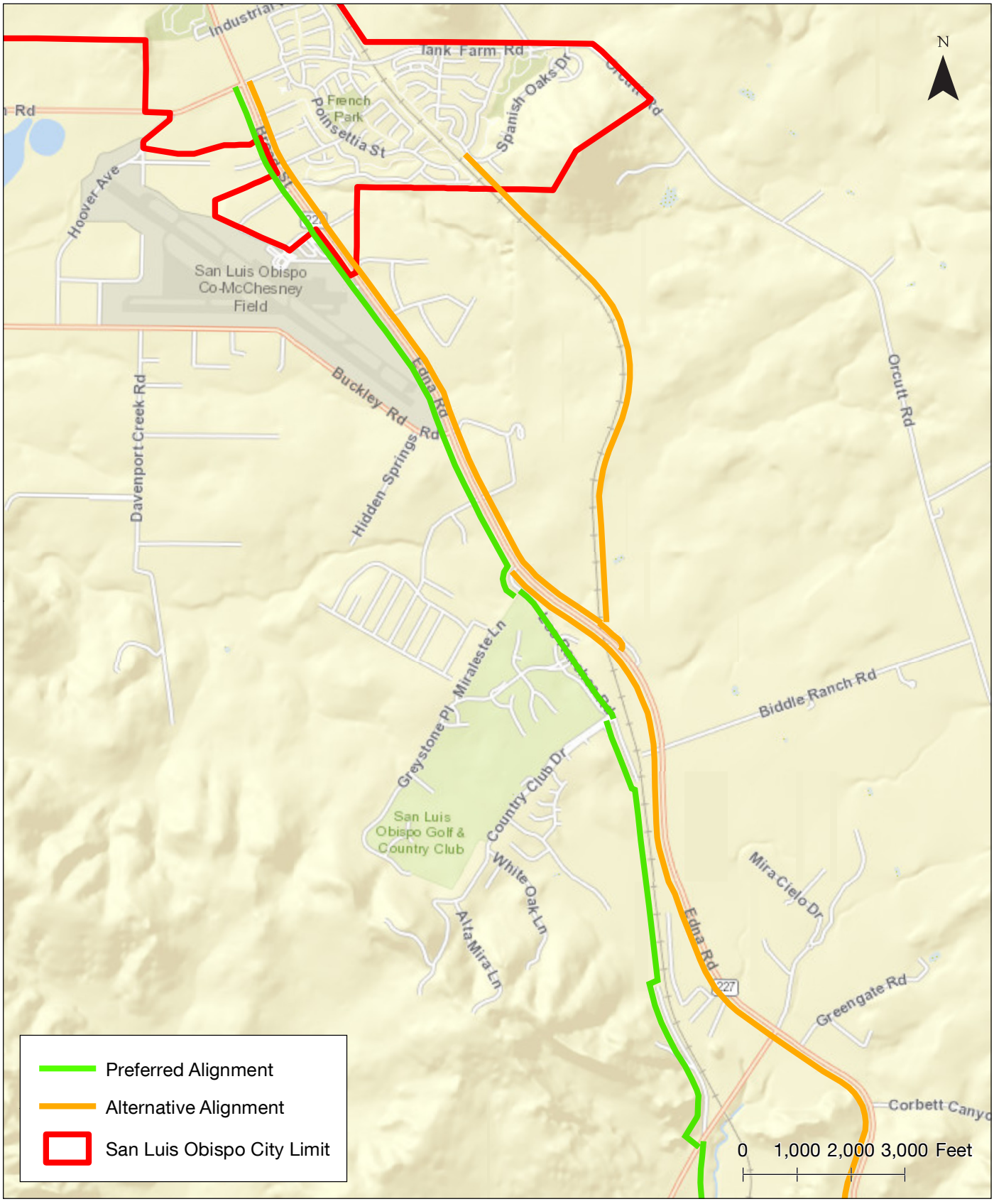
There is no park and ride facility along the study corridor, nor are any identified as potential future locations in the 2013 Park & Ride Lot Study prepared by SLOCOG.

Of those living in the study corridor and commuting to work, most are commuting less than 10 miles to the north, and mostly into the City of San Luis Obispo with the largest concentration of people employed either downtown or at Cal Poly San Luis Obispo. According to the US Census' Longitudinal Employment and Housing Dynamic, there are approximately 422 people commuting from the study corridor with only 10 working locally. 180 or 42.7% of those people are commuting to the City of San Luis Obispo, and 40 or 9.5% commuting to Santa Maria. The fact that study area residents are employed in such concentrated areas enhances the feasibility of carpool and transit commutes.

Based on this demand profile, a remote park-and-ride lot that intercepts commuters close to their trip origin and at relatively distant locations from their destinations does not appear viable. Conversely, a peripheral or fringe park-and-ride lot that intercepts commuters closer to their destinations does appear to hold the most promise. Whereas remote park-and-ride lots are intended to reduce vehicle miles traveled (VMT) and improve air quality, fringe lots are primarily intended to ease parking demands in the downtown area and ease congestion - in this case downtown San Luis Obispo. Typically, fringe lots include a free shuttle bus service linking the downtown with the lot. For a fringe lot to attract users along SR 227, transit service provided by SLO Transit or RTA would be needed. Given that downtown parking in the City of San Luis Obispo is not prohibitively expensive or in short supply and that SR 227 itself experiences significant congestion during peak hours - even with linked transit service it will be a challenge for a fringe park-and-ride lot located in the corridor north of Crestmont Drive to attract carpoolers or provide an additional mode choice option for corridor residents. However, with buildout of the Edna-Price Canyon Trail as well as other bicycle infrastructure connecting to downtown San Luis Obispo, a peripheral lot may hold some appeal as a "park-and-bike" location.

Secondary Access for Rolling Hills

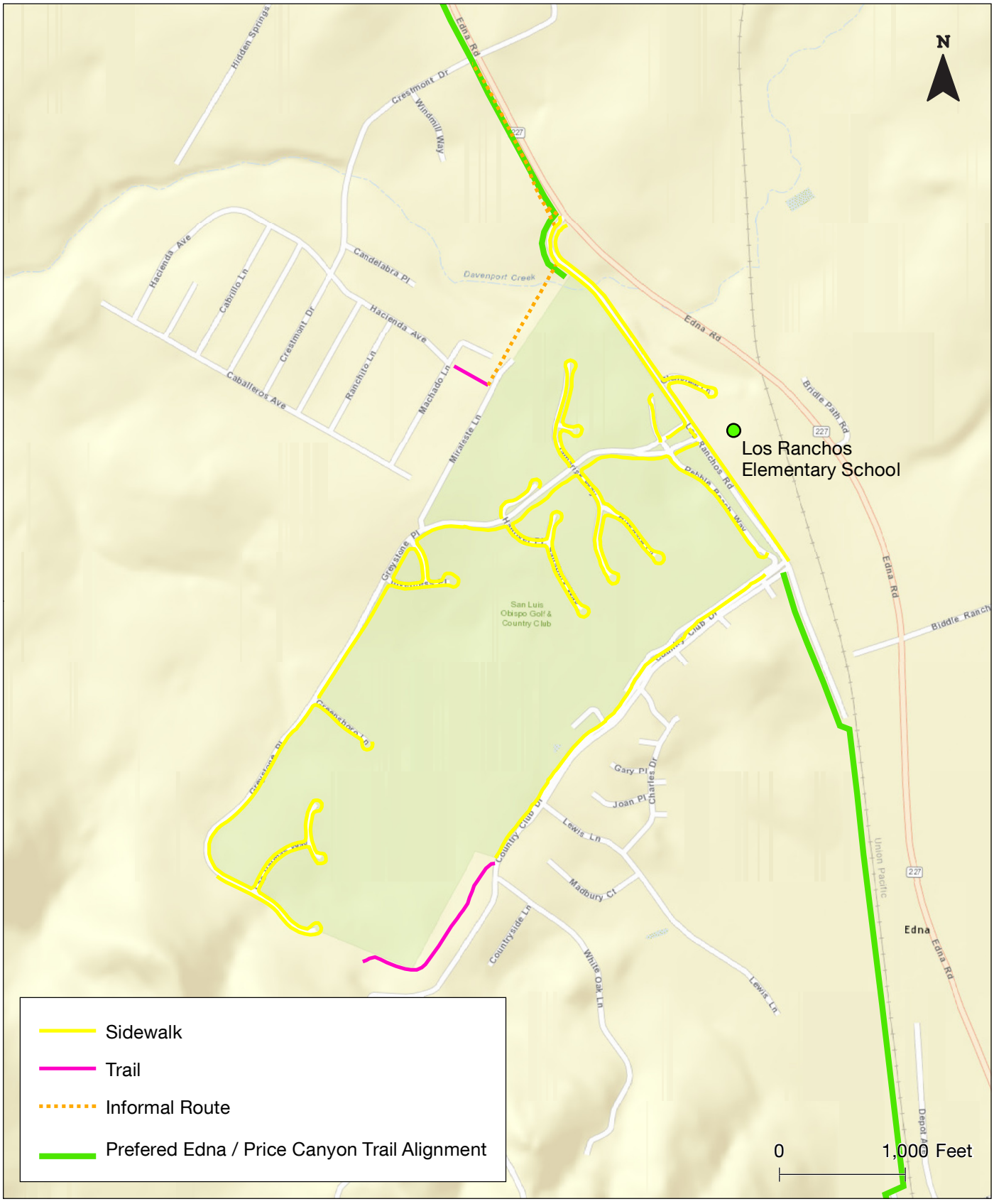
Establishing a secondary access to the Rolling Hills community via a connection with Buckley Road to the north is recommended. The County of San Luis Obispo has examined various alignments for a secondary access route over the years. One potential alignment documented in the *Buckley Road Area Circulation Study* is shown in **Figure 18**. The connection would be functionally classified as a "Local" street and include traffic calming treatments to ensure that design speeds do not encourage cut-through traffic. The cost of establishing a secondary access has been estimated at $2.3 Million (Source: County of San Luis Obispo Public Works). A secondary access would provide Rolling Hills residents the choice to avoid the left turn egress onto SR 227 if desired – potentially improving safety, travel time reliability and emergency response times for Rolling Hills residents. Based on traffic counts, a secondary access could remove up to 150 peak hour trips on SR 227. However, despite this potential peak hour trip reduction, establishing a secondary access would not obviate the need for increased capacity on SR 227 nor alter the need for other operational and safety improvements on SR 227.



Edna - Price Canyon Trail
Preferred and Alternate Alignments
San Luis Obispo County, California

Figure
16

Kimley»Horn



Neighborhood Bicycle and Pedestrian Network
San Luis Obispo County, California

Figure
17

Kimley»Horn

Rolling Hills Secondary Access Alignment
Example Alternative: *Buckley Road Area Circulation Study*

Figure
18

Kimley»Horn

INTERSECTION CONTROL EVALUATIONS

Given that the form of intersection control can dramatically influence and define a corridor's operational efficiency as well as the convenience and safety of pedestrians and bicycles, an intersection control evaluation consistent with Caltrans Traffic Operation Policy Directive (TOPD) #13-02 was performed for four of the six study area intersections. This task includes the objective evaluation of intersection control per intersection control alternatives (stop control, signal or roundabout) specific to California conditions based on system performance measures focusing on safety, operations, emissions and life-cycle costs.

Key features evaluated for each intersection include:

- Identification of deviations from design standards
- Alignment of approaches and departures
- Number of approach, departure, turn, and circulatory lanes
- Channelization
- Size and location relative to right-of-way and geometric constraints
- Design speed, design vehicle, and sight line considerations
- Local access / access control considerations
- Pedestrian and bicycle facilities

Signal and roundabout intersection control alternatives were evaluated against system performance measures focusing on safety, operations, and life-cycle costs. Specifically, the following evaluations were applied to each intersection:

- Safety performance and collision cost estimation, where quantifiable
- Capacity and operational considerations
- Service life analysis
- Conceptual initial / phased estimated construction costs (order of magnitude)
- Cost of performance impacts / Cost savings of performance benefits (controlling peak hour cost of delay)
- Operation and maintenance life-cycle costs
- Pollutant emission considerations

Traffic operations at the study intersections were evaluated based on the established design year traffic scenarios. Traffic operations were evaluated for stop (existing condition), signal, and roundabout intersection control. Stop and signal control options were performed with the SYNCHRO software package using 2010 HCM methodologies. Roundabout control evaluations were performed using the Sidra software package based on the 2010 HCM capacity model with California calibration factors.

An Intersection Control Evaluation (ICE) was performed to objectively evaluate and screen intersection control alternatives at the following four study area intersections:

Study Intersection	Intersection ID#
Farmhouse Lane at SR 227	2
Buckley Road at SR 227	4
Crestmont Drive at SR 227	5
Los Ranchos Road at SR 227	6

This screening summary provides an overview of performance measures used to calculate the return on investment for study intersections. Results of the analysis and preferred traffic control type are presented in graphical form for

quick reference. The table below lists the symbols of intersection control types evaluated (refer to the intersection summary for the list of alternatives evaluated at each intersection).

Control Type	Legend
Stop Sign	
Traffic Signal	
Roundabout	

Summary of Key Performance Measures

Five performance metrics were evaluated at each study intersection to calculate the B/C ratio. The performance measures used to calculate the benefits of a roundabout compared to a stop or traffic signal are:

- **Safety Benefit** (of a roundabout);
- **Delay Reduction Benefit** (of a roundabout); and,
- **Emission Reduction Benefit** (of a roundabout).

Performance measures used to calculate the costs of a roundabout compared to a stop or traffic signal are:

- **Operations and Maintenance Cost** (added costs of a roundabout); and,
- **Initial Capital Cost** (added costs of a roundabout).

The above performance measures were used to calculate the benefit, or cost savings, of a roundabout compared to stop or signal control. For each performance measure, roundabout control provides a benefit if the calculated life-cycle cost of the roundabout is less than the life-cycle cost of stop or signal control. The magnitude of the benefit is the difference between the life-cycle cost of the stop or signal less the life-cycle cost of the roundabout.

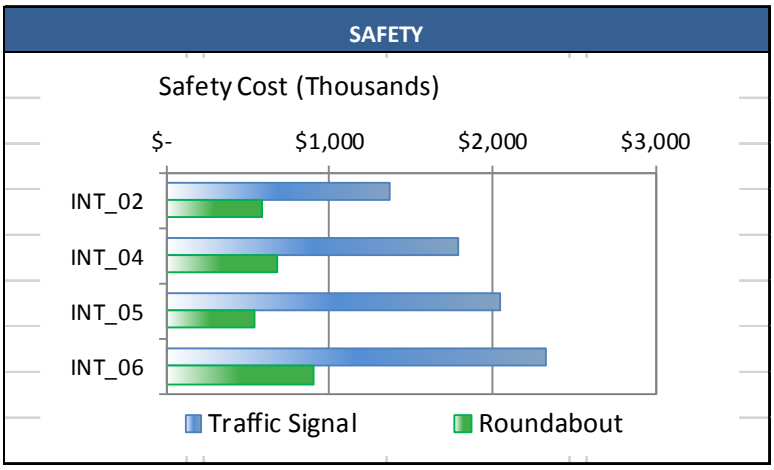
A brief overview of each performance measure and the assumptions used to calculate the performance measure costs are provided. A bar chart illustrating the calculated cost of each performance measure by intersection control type is provided for each intersection. Following the performance measure overview is a table summarizing the preferred form of intersection control based solely on the results of individual performance measure.

Safety Cost

Safety measures the societal cost associated with the predicted number and severity of collisions that may occur for each proposed intersection control type. The number of predicted collisions was calculated using Highway Safety Manual predictive methods and crash modification factors. The societal cost of property damage only (PDO) collisions is consistent with the Caltrans Life-Cycle Benefit-Cost Analysis Economic Parameters 2012. The societal cost of fatal/injury collisions are a weighted average based on the 2011-2013 SWITRS proportion of fatal/injury collisions. Safety costs are the summation of PDO and fatal/injury collisions.

Figure 19 provides an intersection comparison of the estimated societal costs associated with predicted collisions (2015-2035) between a signal versus roundabout control type.

Figure 19. Intersection Safety Cost: Signal vs. Roundabout Control



As shown in **Figure 20**, based solely on the lowest predicted life-cycle cost for safety, the preferred intersection control type for each study intersection is roundabout control.

Figure 20. Preferred Intersection Control Type Based on Safety Cost

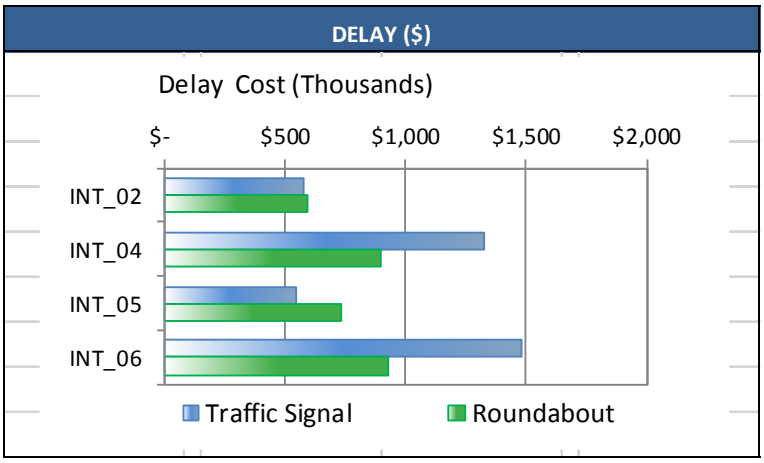
Safety Study Intersection	Int ID #	Preferred Control
Farmhouse Lane at SR 227	2	
For Buckley Road at SR 227	4	
Crestmont Drive at SR 227	5	
Los Ranchos Road at SR 227	6	

Delay Cost

Delay measures the societal cost associated with the number of person-hours of delay at the intersection during the study period. Consistent with the Caltrans Life-Cycle Benefit-Cost Analysis Economic Parameters 2012, vehicle occupancy of 1.15 is used to convert delay to person-hours of delay at a value of $17.35 per vehicle-hour of delay.

Figure 21 provides an intersection comparison of the estimated delay costs between a signal versus roundabout control type.

Figure 21. Intersection Delay Cost: Signal vs. Roundabout Control



As shown in **Figure 22**, based solely on lowest expected person hours of delay, the preferred intersection control type for the SR 227 intersections at Buckley Road and Los Ranchos Road in roundabout control. For the two non-signalized intersections the preferred intersection control type is signal control.

Figure 22. Preferred Control Type Based on Safety Cost

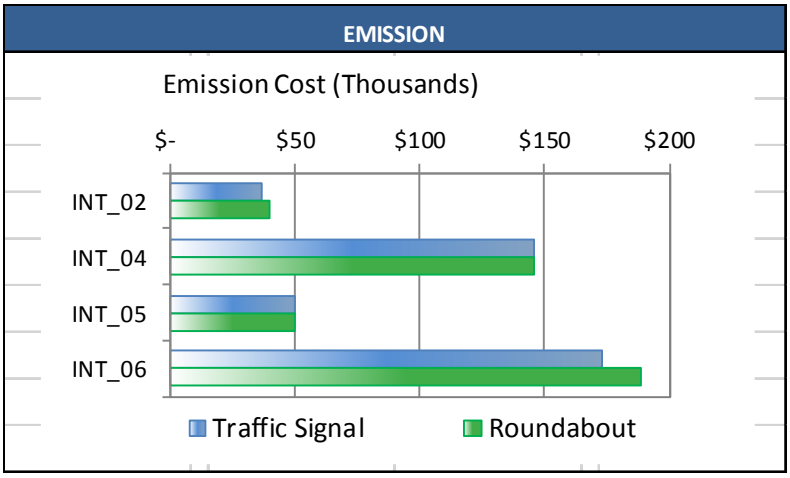
Delay Study Intersection	Int ID #	Preferred Control
Farmhouse Lane at SR 227	2	
Buckley Road at SR 227	4	
Crestmont Drive at SR 227	5	
Los Ranchos Road at SR 227	6	

Emissions Cost

The emissions performance measure calculates the societal cost associated with exposure to health based pollutants emitted by motor vehicles. Pollutant emissions are running emissions based on the average speed of vehicles traveling through the intersection during the study period. Given that average vehicular speed is the key on-road activity input for estimating emissions, the effects of delay (vehicle idling) are not explicitly captured by this analysis. Pollutant emissions evaluated include reactive organic gasses (ROG), nitrogen oxides (NOx), and particulate matter (PM10). The societal cost of emissions is calculated using emission data from the California Air Resource Board (CARB) Methods to Find the Cost-Effectiveness of Funding Air Quality Projects, Table 4 Emission Factors by Speed (April 2013) and cost per ton data from Caltrans Life-Cycle Benefit-Cost Analysis Economic Parameters 2012 for emissions (Note: VOC is assumed to be synonymous with ROG).

Figure 23 provides an intersection comparison of the estimated emission costs between a signal versus roundabout control type. As shown, comparable results exist between signal and roundabout control.

Figure 23. Intersection Societal Cost of Pollution: Signal vs. Roundabout Control



As shown in **Figure 24**, based solely on fewer tons per year of mobile source pollutant emissions (i.e., higher average speeds through the intersection) and the societal cost associated with exposure to these health based pollutant emissions, the preferred intersection control type for the SR 227 intersections at Farmhouse Lane and Los Ranchos Road is signal control. For the SR 227 intersections at Buckley Road and Crestmont Drive, both control types yield similar emission reductions.

Figure 24. Preferred Control Type Based on Societal Cost of Pollution

Emissions Study Intersection		Int ID #	Preferred Control
Farmhouse Lane at SR 227		2	
Buckley Road at SR 227		4	EQUAL
Crestmont Drive at SR 227		5	EQUAL
Los Ranchos Road at SR 227		6	

Cost Performance Measures

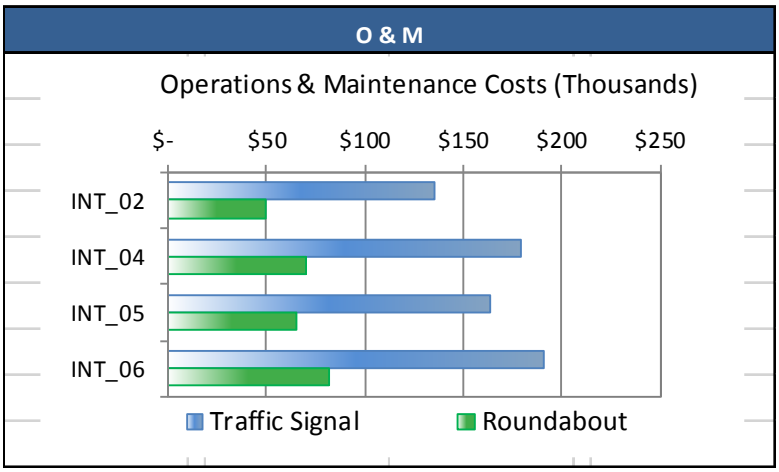
The following performance measures are used to calculate the added cost of a roundabout compared to stop or signal control. For each performance measure, the roundabout adds to the cost of the intersection if the calculated life-cycle cost of the roundabout is greater than the life-cycle cost of stop or signal control. The magnitude of the cost is the difference between the life-cycle cost of the roundabout less the life-cycle cost of the stop or signal.

Operations and Maintenance Cost

The operations and maintenance performance measure incorporates common annualized costs associated with operating and maintaining the proposed type of intersection control. Common costs include signal timing and maintenance, power consumption for signal operations and intersection illumination, landscape maintenance, and pavement rehabilitation. Average annualized costs were used if intersection specific costs were not provided.

Figure 25 provides an intersection comparison of the estimated operations and maintenance cost between a signal versus roundabout control type.

Figure 25. Intersection Operations and Maintenance Costs: Signal vs. Roundabout Control



As shown in **Figure 26**, based solely on lowest expected annual operations and maintenance costs, the preferred intersection control type for each study intersection is roundabout control.

Figure 26. Preferred Control Type Based on Operations and Maintenance Costs

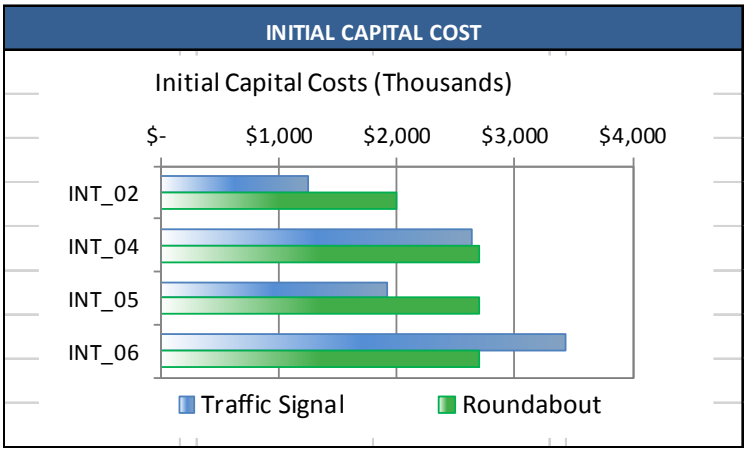
Operations and Maintenance Costs Study Intersection	Int ID #	Preferred Control
Farmhouse Lane at SR 227	2	
Buckley Road at SR 227	4	
Crestmont Drive at SR 227	5	
Los Ranchos Road at SR 227	6	

Initial Capital Costs

The initial capital costs performance measure estimates the capital costs needed to plan, design, and construct the proposed intersection improvement. The capital costs include construction, capital support, and right of way.

Figure 27 provides an intersection comparison of the estimated initial capital cost between a signal versus roundabout control type.

Figure 27. Intersection Initial Capital Costs: Signal vs. Roundabout Control



As shown in **Figure 28**, based solely on lowest estimated initial capital cost, the preferred intersection control type for all SR 227 study area intersections is signal control with the exception of Los Ranchos Road. This result is not surprising given the greater coverage of pavement (i.e., footprint) required for roundabouts.

Figure 28. Preferred Control Type Based on Initial Capital Costs

Initial Capital Costs Study Intersection	Int ID #	Preferred Control
Farmhouse Lane at SR 227	2	
Buckley Road at SR 227	4	
Crestmont Drive at SR 227	5	
Los Ranchos Road at SR 227	6	

Benefit Cost Ratio Results

Based on the information developed for the five performance measures, a holistic benefit cost (B/C) ratio was calculated for each intersection. The holistic B/C score is based on the net present value (i.e., life cycle duration using a discount rate of 4%). The B/C ratio measures the expected return on investment when either a stop control or a signal controlled intersection is compared relative to a roundabout controlled intersection.

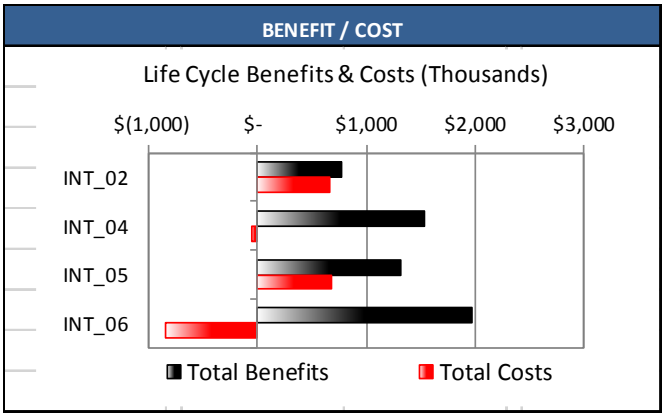
B/C = 1.00: A B/C ratio of 1.00 is a neutral rating. This indicates that the return on investment for either stop or signal control improvement is equal to a roundabout.
B/C < 1.00: A B/C ratio less than 1.00 indicates that a stop/signal will provide a better return on investment when compared to a roundabout.
B/C > 1.00: A B/C ratio greater than 1.00 indicates that a roundabout provides a better return on investment when compared to either stop or signal control.
B/C = NA-R: When the cost of a roundabout is less than the cost of a stop/signal and the roundabout provides benefits over the stop/signal, a B/C ratio cannot be computed. This special case is denoted by "NA-R" and indicates that a roundabout provides a better return on investment when compared to a stop/signal.

As shown in **Figure 29**, based on the holistic B/C ratios for each intersection, the preferred intersection control type based on return on investment for the four study intersections is roundabout control. The summation of the performance measure benefits and performance measure costs for roundabouts are illustrated for each intersection in **Figure 30**.

Figure 29. Preferred Control Type Per Benefit-Cost (All Metrics Combined)

Study Intersection	Int ID #	B/C Ratio	Preferred Control
Farmhouse Lane at SR 227	2	**1.15**	
Buckley Road at SR 227	4	**NA-R**	
Crestmont Drive at SR 227	5	**1.93**	
Los Ranchos Road at SR 227	6	**NA-R**	

Figure 30. Roundabout Control Type: Benefit and Costs



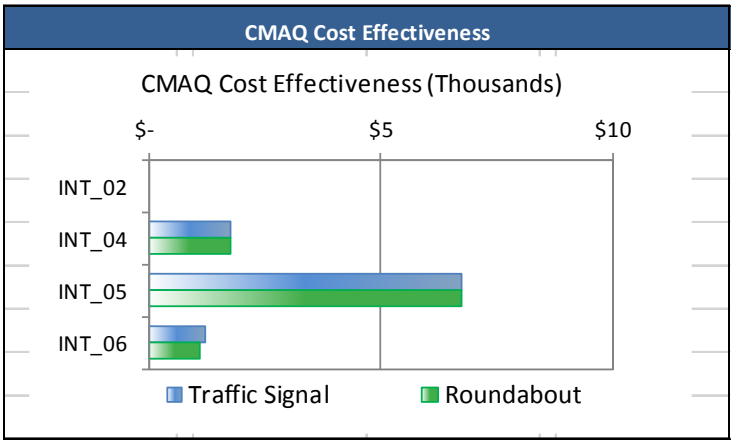
Cost Effectiveness to Reduce Emissions (CMAQ)

The cost effectiveness to reduce pollutant emissions measures based on the California Air Resources Board (CARB) Congestion Mitigation and Air Quality (CMAQ) Program. The emission factors used in the calculations are based on the year 2013 Table 4 Emission Factors by Speed for Project Life 6-10 years. The assumed funding amount is $400,000 with an effectiveness period equaling the life cycle analysis period. Per CMAQ guidelines, the discount rate for emissions is 3% and the capital recovery factor (CRF) is 0.12.

Pollutant emissions evaluated include reactive organic gasses (ROG), nitrogen oxides (NOx), and particulate matter ten microns in diameter or less (PM10). These health-based pollutants are applicable to San Luis Obispo County and are specific to CMAQ programming eligibility in the county.

Figure 31 provides an intersection comparison of the estimated initial capital cost between a signal versus roundabout control type. Based solely on the lowest cost per ton in reducing pollutant emissions (i.e., return on investment of CMAQ funding), both control types (signalization or roundabout) would be competitive for CMAQ funding at all intersections except Farmhouse Lane where emissions reduction are projected to be negligible for either control type. In priority order (i.e., from greatest return on investment to least) the top candidates for use of CMAQ funding for SR 227 intersection improvements are at: 1) Los Ranchos Road; 2) Buckley Road; and, 3) Crestmont Drive. Use of CMAQ funds for intersection improvements at Crestmont Drive is questionable given that its cost effectiveness is three to four times less for like improvements at Los Ranchos Road or Buckley Road.

Figure 31. Intersection Initial Capital Costs: Signal vs. Roundabout Control



SUMMARY OF OPERATIONAL FINDINGS

Based on the technical analyses performed as part of this study, the effectiveness of the corridor to accommodate existing and future vehicular demand was determined to be currently constrained by the inefficiency of the existing intersection control types. Under existing conditions, the SR 227 intersections at Crestmont Drive (non-signalized control) and Los Ranchos Road (signalized control) both fail during peak hours. The intersections at Farmhouse Road (non-signalized control) and Buckley Road (signalized control) are projected to fail under interim and future year conditions (2025-2035). Heavy SR 227 through movements, versus conflicting left or right turn movements, present the greatest challenge for all study corridor intersections to accommodate existing and future vehicular demand and achieve favorable operations. SR 227 queues are estimated to be most pronounced at the Buckley Road and Los Ranchos Road intersections – with worst-case 95th percentile queues estimated to reach over 50 vehicles under existing peak hour conditions and over 60 vehicles under future peak hour conditions. Side-street queues are most pronounced at Crestmont Drive with observed queues of up to 10 vehicles and worst-case 95th percentile queues estimated to reach up 15 vehicles in the future.

Whereas queues on SR 227 contribute to delays and motorist frustration, they can also create a higher likelihood of rear-end collisions. A high propensity of rear-end collisions is indicative of unstable flow conditions (i.e., congestion). Not surprisingly, over 70% of all SR 227 collisions recorded over the three most recent years of available accident data (2011-2014) were rear-end collisions. The highest segment-based collision rate occurs between Crestmont Drive and Los Ranchos Road. Side-street queue conditions at non-signalized intersections also create delays that can create motorist frustration with potentially more serious consequences. Motorists can be tempted to take ill-advised risks entering the traffic stream when adequate gaps are not as prevalent which can lead to high-speed T-bone collisions that are more likely to result in injury or fatalities. Currently, the crash rate for the intersection of SR 227 at Crestmont Drive exceeds the statewide average for like facilities. Of the 25 collisions recorded on SR 227 from Biddle Ranch to Kendall Road between 2011-2014, 11 resulted in injury to 14 persons, 21 were multi-vehicle collisions, seven occurred at night and three occurred under wet conditions. No fatal crashes occurred during the analysis period for this study[5].

Analysis of bicycle and pedestrian quality of service at study area intersections indicates poor bicyclist quality of service at Crestmont Drive and poor pedestrian quality of service at all non-signalized intersections (Airport Drive, Farmhouse Lane, Kendall Road and Crestmont Drive). Factors contributing to the difficult biking conditions at Crestmont Drive include: crossing distances, proximity of the outside travel lane, high traffic volumes and speed, presence of trucks, and lack of a bike lane or shoulder. The primary factors contributing to the difficult pedestrian/walking conditions at the non-signalized intersections include: crossing distances, lack of crossing treatments, high vehicle speeds, presence of right-turning vehicles, and motorist delays on the minor leg. Given the protected phasing for pedestrian/bicycle crossings, the signalized intersections at Buckley Road and Los Ranchos Road provide the best bicycle and pedestrian quality of service. Although not formally analyzed, pedestrian and bicycle quality of service along SR 227 segments is significantly affected by the lack of physically separated bicycle and pedestrian infrastructure.

The intersections of Farmhouse Lane, Kendall Road, and Crestmont Drive are projected to collectively meet peak hour warrants (Warrant #3) by 2025. Although meeting a traffic signal warrant or warrants does not in itself require the installation of a traffic control signal, this finding suggests that a full warrant analysis is justified and that signalization may be warranted at these intersections in the near-future as travel demand continues to grow.

For segments, SR 227 operational determinations were based on several metrics including: percent of time spent following; percent of free flow speed; travel speed; travel time; and, travel time reliability. All SR 227 segments were determined to fail in either one or both AM/PM peak hours. Based on over four months of continuous data collection, results indicate that average travel speeds drop approximately 16 mph relative to typical free flow speeds during AM peak hour and as much as 21 mph in the PM peak hour. Speed reduction is most prominent in the northbound

[5] A fatality did occur near Biddle Ranch Road involving a vehicle striking a cyclist during the development of this study.

direction and occurs in both the AM and PM peak hours. However, the lowest average speeds (23 mph) were observed in the southbound direction during the PM peak hour. Under future conditions (2035), travel time through the corridor is projected to degrade from just over four minutes under existing conditions to over five minutes in AM peak hour and from five-six minutes to seven-eight minutes in the PM peak hour. Measurements of travel speed variability on SR 227 is greatest during the PM peak hour in the southbound direction and is most pronounced at the northern end of the corridor. Buffer time – the amount of time a motorist must leave earlier than normal to ensure that they can accommodate an unpredictable travel experience on SR 227 and still ensure they arrive at their destination on time 95 percent of the time – was measured to be roughly equal to the amount of delay experienced while driving through the corridor. Assuming this relationship holds, under future year peak hour conditions buffer time and delay combined is projected to be 12 to 16 minutes per motorist if no improvements on SR 227 are implemented.

Given that the form of intersection control can dramatically influence and define a corridor's operational efficiency as well as the convenience and safety of pedestrians and bicycles, an Intersection Control Evaluation (ICE) consistent with Caltrans TOPD #13-02 was performed for the SR 227 intersections at Farmhouse Lane, Buckley Road, Crestmont Drive, and Los Ranchos Road. The ICE revealed that a significant degree of "residual" or "potential" capacity exists at the intersections on SR 227. Increasing capacity at the intersection "nodes" would improve operational efficiency to a point where travel through the corridor would no longer be as constrained by the intersections themselves. Results indicate that the most cost-effective intersection control type for the four SR 227 intersections was roundabout control.

Other Findings

To inform development of alternative corridor concepts, the following assessments were also examined.

SR 227 Travel Patterns

Based on the observed travel patterns in the study corridor more study area motorists prefer Price Canyon Road for travel between the City of San Luis Obispo and the Five Cities area than continuing on SR 227. Of trips entering the study corridor from the north, 62% are typically local trips (i.e., they did not continue through the southern limit of the study area). Of the trips observed entering the study area from the south, 30% are typically local and do not continue north as far as Buckley Road. This pattern suggests that providing local residents with an alternate route into the City of San Luis Obispo could impact well over half of the users along the northern section of the study area, and could likely result in some of them using an alternate route if available.

Secondary Access to Rolling Hills Community

Based on traffic counts, providing a secondary access to the Rolling Hills (i.e., Crestmont) community via Buckley Road could remove up to approximately 150 peak hour trips off of SR 227. Although providing a secondary access would improve safety, travel time reliability and emergency response times for Rolling Hills residents – it would not dramatically relieve congestion on SR 227.

Pedestrian-Bicycle Connectivity

There is limited street connectivity for the residential neighborhoods along SR 227 between Buckley Road and Los Ranchos Road. Crestmont Drive and Los Ranchos Road are the only access routes for their respective communities. The lack of interconnectivity and alternative access emphasizes the importance of the SR 227 corridor for all transportation modes into and out of Rolling Hills and Country Club communities. Construction of the preferred alignment of the Edna-Price Canyon Trail will serve to better connect the communities together.

Transit and Park and Ride Lot Potential

Based on the area's origin-destination commuter profile, most commuters living along SR 227 are not long-distance commuters. Hence, constructing a remote park-and-ride lot on SR 227 does not appear viable. Conversely, a peripheral or fringe park-and-ride lot located north of Crestmont Drive which would target commuters with jobs in the City of San Luis Obispo appears viable. However, a fringe lot would primarily serve/benefit downtown San Luis

Obispo and would not relieve congestion on SR 227 itself. Given that downtown parking in the City of San Luis Obispo is not prohibitively expensive or in short supply, even with linked transit service, it will be a challenge for a fringe park-and-ride lot to attract enough commuters or provide a viable mode choice option for corridor residents.

ALTERNATIVE CORRIDOR CONCEPTS

Based on the operational analysis results, two corridor concepts were screened for purposes of this analysis: 1) SR 227 Widening with Coordinated Signal Control; and, 2) SR 227 Roundabout Corridor.

The following traffic improvements are proposed for the SR 227 Widening with Coordinated Signal Control Concept:

- Crestmont Drive/SR 227 – install operational improvements consistent with the Highway Design Manual (interim improvement prior to roundabout control) subject to Caltrans safety evaluation and determination, engineering discretion and approval to provide safe ingress and egress through this intersection.
- Widen SR 227 for two through lanes in each direction from Kendall to just south of Los Ranchos Road. Retain shared center left-turn lane. Note that widening can either occur to the west or to the east. If the SR 227 widening occurs to the west, the preferred alignment of the Edna-Price Canyon Trail may be compromised (an alternative alignment would be necessary). An east side widening of SR 227 could encroach into prime agricultural land. Given the railroad bridge structure, the southern terminus of the SR-227 five-lane widening would need to occur prior to or immediately just south of Los Ranchos Road.
- Construct a secondary access connecting the Rolling Hills community with Buckley Road north. Secondary access road will be designed to include traffic calming treatments to reduce speeds and cut-through traffic.
- Crestmont Drive/SR 227 – channelize and signalize with illumination and striping for pedestrian/bicycle crossings. Left turn radii will accommodate U-Turns of STAA-sized vehicles (48-52 feet kingpin to rear axle). Note: striping for east side SR 227 pedestrian/bicycle crossings is not recommended (per design flexibility allowed by DIB-82, Sec. 4.2) but may be required by Caltrans.
- Buckley Road/SR 227 – channelize and add striping for pedestrian/bicycle crossings. Left turn radii will accommodate U-Turns of STAA-sized vehicles (48-52 ft kingpin to rear axle).
- Los Ranchos Road/ SR 227 – channelize and striping for pedestrian/bicycle crossings. Left turn radii will accommodate U-Turns of STAA-sized vehicles (48-52 ft kingpin to rear axle).
- Airport Drive: close off access to SR 227 and realign west leg of Airport Drive with Farmhouse Lane and convert SR 227 at Farmhouse Lane to a four-legged intersection. This realignment would not reduce access to the airport.
- SR 227/Farmhouse Lane – channelize and signalize with illumination, and striping for pedestrian/bicycle crossings. Left turn radii will accommodate U-Turns of STAA-sized vehicles (48-52 ft kingpin to rear axle).
- Replace the bus stop currently on Aero Drive with a new bus stop and amenities (i.e., lighting, shelter etc.) near the new four-legged intersection at Farmhouse Lane. Consideration for placing the new stop on either Kendall Road or Farmhouse Lane would require concurrence from the business park owners who own and maintain both roads.
- Synchronize and coordinate the four signals at Farmhouse Lane, Buckley Road, Crestmont Drive and Los Ranchos Road.
- Install rumble strip along the SR 227 outside travel lanes between Airport Drive and Price Canyon Road with breaks/gaps provided near bus stops and pull-outs.
- Identify and construct alternative alignment of the Edna-Price Canyon Trail from the west side of SR 227 to the east side. Construct Edna-Price Canyon Trail from Los Ranchos Road to Tank Farm Road.
- Restrict turn movements from Kendall Road to right-in/right-out and left-in, and provide median channelization to restrict the left-out movement.
  Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This could entail creating small parallel driveways west of the Edna Trail alignment. Restrict turn movements from consolidated driveways to right-in/right-out and left-in, and provide median channelization to restrict the left-out movements.

The following traffic improvements are proposed for the Roundabout Corridor Concept:

- Los Ranchos Road/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings).
- Crestmont Drive/SR 227 – install operational improvements consistent with the Highway Design Manual (considered an interim improvement prior to roundabout control) subject to Caltrans safety evaluation and determination, engineering discretion and approval to provide safe ingress and egress through this intersection.
- Buckley Road/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings). This roundabout would include City of San Luis Obispo Gateway signage and treatments.
- Crestmont Drive/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings). Note: striping for east side SR 227 pedestrian/bicycle crossings is not recommended (per design flexibility allowed by DIB-82, Sec. 4.2) but may be required by Caltrans. Striping will be included for the Edna-Price Canyon Trail crossings.
- Restripe northbound SR 227 for two through lanes between Farmhouse Lane to just south of Kendall Road (widening would not entail any additional ROW).
- Widen southbound SR 227 for two through lanes from Farmhouse Lane to just south of Kendall Road.
- Construct a secondary access connecting the Rolling Hills community with Buckley Road north. Secondary access road will be designed to include traffic calming treatments to reduce speeds and cut-through traffic.
- Rehabilitate pathway from Los Ranchos Road to Crestmont Drive to become part of the Edna-Price Canyon Trail. Install signage warning bicyclists of driveway/s south of Crestmont Drive.
- Construct Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road based on the Preferred Alignment adopted by SLOCOG.
- Airport Drive: close off access to SR 227 and realign west leg of Airport Drive with Farmhouse Lane to provide new access to SR 227 at Farmhouse Lane. This realignment would not reduce access to the airport.
- Convert intersection of SR 227 at Farmhouse Lane to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings).
- Replace the bus stop currently on Aero Drive with a new bus stop and amenities (i.e., lighting, shelter etc.) near the new four-legged intersection at Farmhouse Lane. Consideration for placing the new stop on either Kendall Road or Farmhouse Lane would require concurrence from the business park owners who own and maintain both roads.
- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This could entail creating small parallel driveways west of the Edna Trail alignment. Restrict turn movements from consolidated driveways to right-in/right-out and left-in, and provide median channelization to restrict the left-out movements.
- Install rumble strip along the SR 227 outside travel lanes between Airport Drive and Price Canyon Road with breaks/gaps provided near bus stops and pull-outs.
- Restrict turn movements from Kendall Road to right-in/right-out and left-in, and provide median channelization to restrict the left-out movement.

Both corridor concepts include the recommendation that the County of San Luis Obispo establish a secondary access for the Rolling Hills community via a connection to Buckley Road to the north. Given that establishing such as access is included in both corridor concepts and would not alter the ultimate facility sizing recommendations of either alternative corridor concept, this access improvement is not reflected or incorporated into the technical comparative analysis of the alternative corridor concepts. Similarly, both corridor concepts include the construction of the Edna/Price Canyon multi-purpose trail (3.3. mile Phase 1). However, each concept would result in a different alignment of the trail.

Corridor Concept Planning Level Cost Estimates

To yield corridor concept cost opinions each individual project/treatment of the SR 227 Widening with Coordinated Signal Control alternative was analyzed based on industry-accepted standards and practices. The basis of the planning level estimate format is the Caltrans 11-page cost estimate template and supporting documentation outlined in the Caltrans Project Development Procedures Manual (PDPM), Chapter 20. Project costs were developed using a format based on Caltrans preparation guidelines for project planning cost estimates which groups related work items in a standardized format that captures primary cost items common in transportation roadway projects. A one-page worksheet was developed to identify and calculate estimated construction, capital support, and right of way costs including unit prices and percentage based cost calculations.

A combination of current unit costs for known, calculable quantities as well as percentages for minor and common items was used to determine opinions of planning level total project costs for: Roadway Excavation; Structures; HMA & Aggregate Base; Minor Concrete; and, a Storm Water Collection System. These items are quantified and estimated based on conceptual layouts of the SR 227 Widening with Coordinated Signal Control alternative and were the basis for estimating supplemental work items including: Erosion Control; Traffic Control; and, Water Pollution Control. While the supplemental work items are considered as percentages of the primary construction cost contributors these percentages were carefully considered and adjusted based on the level of demand anticipated from the considered alternative.

Capital support costs were estimated as percentages of the combined roadway and structure construction costs and could include costs for the following phases: Project Initiation Document (PID), Project Engineering (PA/ED and PS&E), Construction Support / Construction Management, & Right of Way Support. Potential right-of-way impact areas were estimated based on record information for Commercial, Residential, or Undeveloped areas. The cost of the right-of-way impacts were based on similar nearby projects or estimated based on publicly available real estate cost information.

The one-page worksheet consists of the following parts (with section references to Caltrans Project Development Procedures Manual (PDPM), Chapter 20):

Roadway Items

- Earthwork (Section 1): Planning level quantity estimate of excavation and fill based on current unit prices. An earthwork contingency percentage is included for varying project conditions and engineering judgment.
- Pavement Structural Section (Section 2): Potential pavement structural sections for three types of roadways were developed. The cost of the structural sections was developed using current unit costs for asphalt and base material. The cost for each roadway type is calculated as a Lane Mile (LM) unit based on an equivalent 12 ft. lane. Also included in this section is a sidewalk, curb and gutter assembly measured in 1 ft. linear units consisting of concrete for a 2 ft. curb and gutter with an 8 ft. sidewalk.
- Drainage (Section 3): This is a lump sum estimate based on site conditions and engineering judgment.
- Specialty Items (Section 4): Specialty items include water pollution control, minor concrete, and wet utility adjustments and relocations. Water pollution control is a percentage based calculation that can be adjusted based on project site conditions. A wet utility adjustment is a lump sum estimate based on site conditions and engineering judgment. Retaining walls are captured in Structure Items.
- Traffic Items (Section 5): Traffic Items is a percentage based calculation that can be modified to capture complex traffic control and/or construction staging strategies. The section also includes a per intersection unit cost for constructing a basic traffic signal system.
- Planting and Irrigation (Section 6): This is a lump sum estimate based on site conditions and engineering judgment.
- Roadside Management and Safety Section (Section 7): Erosion control is a percentage based calculation that can be adjusted based on project site conditions. Pavement items are included in Section 2 calculations for each particular roadway type.

- Minor Items (Section 8): Minor items is a percentage calculation based on calculated unit cost items in Sections 1-7. This calculation captures minor work elements that are typically calculated with detailed estimates but are not suitable to calculate, or are not known at the planning level. The percentages used were developed by the team through coordination with Caltrans.
- Roadway Mobilization and Roadway Additions (Sections 9-10): These items are percentage based calculations for construction items described in Sections 1-8. Contractor mobilization costs are included in Section 9. Contingencies for supplemental work that is uncertain at this time as well as a contingency for unforeseen items are captured in Section 10. The percentages used were coordinated with Caltrans.

Structure Items

- Structure Items include bridges and retaining walls and are calculated based on engineering judgment for a likely structure type and estimated unit cost per square foot. A contingency factor is included.

Capital Support Costs

Capital support costs are a percentage based calculation to budget professional services and agency support through project initiation, engineering, construction, and right of way support. The costs are based on a percentage of the total estimated construction costs for roadway and structure items. The percentages used were developed by the team through coordination with Caltrans.

Right of Way Costs

The potential for right of way acquisition was based on the likely project footprint for each project alternative. Parcels were broken into three primary land use types: 1) Commercial; 2) Residential; and, 3) Undeveloped. Parcels with conflicting structures, significant impact to access and circulation, and/or parcel take resulting in a remnant were calculated as a full parcel take.

Signalization Alternative Approach

Conceptual widening layouts for each of the five (5) intersection layouts along SR 227 were prepared in CAD format and were based on publicly available aerial and GIS data in the project vicinity. Additionally, a 5-lane widening of SR 227 was configured based on the existing roadway geometry. This CAD information was utilized as the basis for quantity take-offs for pavement widening, sidewalks, roadway excavation, and right-of-way impact areas, if any. This information was then compiled in the 1-page estimate format detailed above and was used to develop an overall planning level cost for each of the five intersection locations within the project study area. The complete planning level cost analysis and cost worksheets are provided **Appendix G**.

Roundabout Alternative Approach

Given that the estimation of construction, capital support, and right of way costs required conceptual roundabout layouts which were not available, roundabout alternative costs were empirically assigned based on similar roundabout sizes and configurations. The roundabout configurations considered included a variety of completed roundabouts, roundabouts currently under design, and other conceptual roundabout configurations. Costs considered included right-of-way, capital support, and construction. This comprehensive review resulted in the ability to ascribe an overall conceptual cost to convert the four (4) intersection locations along SR 227 to roundabout control. This resulted in an initial capital cost of $2 million at Farmhouse Lane and $2.7 million at Buckley, Crestmont Drive and Los Ranchos respectively. Costs for non-roundabout related improvements also included in SR 227 Widening with Coordinated Adaptive Signal Control Concept were extracted as appropriate.

The planning level capital cost estimates for each corridor concept alternative is provided below and reflects an order of magnitude capital cost that covers the spectrum of potential improvements associated with each corridor concept. These costs do not the cost of providing a secondary access to Rolling Hills or the construction of the Edna-Price Canyon multi-purpose trail.

- SR 227 Widening with Coordinated Signal Control Initial Capital Cost: $11.3 Million
- SR 227 Roundabout Corridor Initial Capital Cost: $10.8 Million

With signalization, the SR 227 Widening with Coordinated Signal Control Corridor Concept will entail greater life-cycle Operations and Maintenance (O&M) costs (20-year) relative to the Roundabout Corridor Concept (e.g., power, signage, signal heads, cabinet etc.). Estimated 20-year intersection O&M costs for intersection control only are shown below.

- SR 227 Widening with Coordinated Signal Control Intersection O&M Cost: $650,000
- SR 227 Roundabout Corridor Intersection O&M Cost: $250,000

Given the greater coverage of pavement (i.e., five-lane vs. three-lane footprint), roadway O&M for the SR 227 Widening with Coordinated Signal Control Corridor Concept will entail greater life-cycle O&M costs (20-year) relative to the Roundabout Corridor Concept. Life-cycle (20-year) pavement O&M cost estimates are provided below.

- SR 227 Widening with Coordinated Signal Control Segment O&M Cost: $4.0 Million
- SR 227 Roundabout Corridor Segment O&M Cost: $2.4 Million

Total estimated planning level capital and O&M life-cycle costs for each corridor concept alternative is as follows:

- SR 227 Widening with Coordinated Signal Control Initial Capital + O&M Cost: $15.95 Million
- SR 227 Roundabout Corridor Initial Capital Cost + O&M Cost: $13.45 Million

Given that they are part of both corridor concept alternatives, the cost of constructing a secondary access for the Rolling Hills community or, the Edna-Price Canyon Trail is not reflected above. The cost of constructing a secondary access route connecting the Rolling Hills neighborhood north to Buckley Road is estimated at approximately $2.3 million (Source: San Luis Obispo County Public Works). This cost estimate would be the same for either corridor concept alternative.

Environmental Screening

An Environmental Constraints Analysis was developed to identify those aspects of the preliminary design concepts of recommended roadway improvements for both corridor concepts under consideration along SR 227, including roadway widening, that may have a potential significant effect on the environment based on information known to date. The Environmental Constraints Analysis provides a qualitative description of potential environmental resources and issues that could affect selection of the recommended improvements and will identify environmental issues and constraints that may be associated with projects; however, the constraints analysis would not provide environmental clearance documentation. Although the Environmental Constraints Analysis identified several constraints, these were considered minor and could be resolved during the final design development stage. Assuming no prime farmland or agricultural land of statewide importance, flood hazard areas, or cultural resources are identified within the improvement project limits, and that feasible mitigation would be available for any identified noise impacts, the appropriate level of environmental analysis under CEQA would be an Initial Study-Mitigated Negative Declaration. The complete Environmental Screening analysis is provided **Appendix H**.

Based on the environmental screening assessment, the cost of constructing the Edna-Price Canyon multi-purpose trail would likely be greater for SR 227 Widening with Coordinated Signal Control Corridor Concept given that it would entail widening SR 227 from three to five lanes and necessitate an east-side versus west-side trail alignment. The latter would potentially have greater Right-of-Way and environmental mitigation costs relative to the preferred west-side alignment. This would create a greater cost differential than what is reflected above planning level capital expenditure comparison.

ANALYSIS OF CORRIDOR CONCEPTS

Future (2035) intersection LOS results for both corridor concepts are summarized in **Table 28** and **Table 29** below. All study intersections (less Airport Drive) are shown to operate at acceptable conditions (LOS C or better) during weekday AM and PM peak hours under both corridor concept alternatives.

Table 28: 2035 Intersection Traffic Operations: SR 227 Widening with Coordinated Signal Control

#	Intersection	Control	AM		PM	
			Delay	LOS	Delay	LOS
2	SR 227 & Farmhouse Ln	Signalized	7.6	A	14.2	B
3	SR 227 & Kendall Rd	TWSC	16.6	C	11.8	B
4	SR 227 & Buckley Rd	Signalized	11.5	B	19	B
5	SR 227 & Crestmont Dr	Signalized	4.3	A	4.7	A
6	SR 227 & Los Ranchos Rd	Signalized	22.5	C	13.1	B

Table 29: 2035 Intersection Traffic Operations: SR 227 Roundabout Corridor

#	Intersection	Control	AM		PM	
			Delay	LOS	Delay	LOS
2	SR 227 & Farmhouse Ln	Roundabout	8.3	A	8.9	A
3	SR 227 & Kendall Rd	TWSC	11.2	B	5.5	A
4	SR 227 & Buckley Rd	Roundabout	9.4	A	17.0	C
5	SR 227 & Crestmont Dr	Roundabout	9.4	A	8.8	A
6	SR 227 & Los Ranchos Rd	Roundabout	13.1	B	10.7	B

Future (2035) intersection 95th percentile queue results for both corridor concepts are summarized in **Table 30** and **Table 31**. All results are presented in feet. Based on the results, queue lengths are less for all study intersections under the Roundabout Corridor Concept. Given that roundabouts do not require turn bays for specific movements (e.g., left turn pockets), exceedance of storage lengths was based on the distance of the nearest upstream intersection. Given that the longest queue projected is nine vehicles (218 feet) at Buckley Road during the PM peak hour, the potential for queue spillback conditions is not evident. Conversely, queues are comparatively greater under the SR 227 Widening with Coordinated Signal Control Concept. For all but one intersection, projections of 95th percentile queues extend beyond available storage for at least one movement. Increasing storage capacity commensurate to these estimated queue lengths would be a design consideration for this corridor concept. Intersection LOS and 95th percentile queue worksheets for the two alternative corridor concepts under 2035 conditions are provided in **Appendix I**.

To better reflect the combined operational characteristics of both intersections and mid-block segments, corridor level operations were based on the network/corridor LOS method (per the HCM 2010 and SIDRA 6.0) in lieu of applying the segment-based two-lane rural and multi-lane highway HCM LOS methodologies. Network/corridor LOS is based on the Speed Efficiency Ratio (i.e., ratio of average corridor travel speed to average corridor free flow speed) and Travel Time Index (i.e., ratio of average corridor travel time to average corridor free flow travel time). Results are provided in **Table 32**. These corridor-based diagnostic results indicate that under current and future no project conditions, corridor performance fails (LOS F). Implementation of either improvement concept is projected to result in vastly improved corridor performance (LOS B) under future year conditions.

Based on total corridor-wide travel time (vehicle hours per hour), the Roundabout Corridor Concept is projected to provide slightly better operations (4% less delay) over the Widening with Coordinated Signal Control Concept. Based

on the relative change (delta) in the computed average corridor-wide travel speeds and travel times results, travel time through the corridor under future year conditions is projected to degrade by approximately 8% and 37% in the AM and PM peak hours respectively. If the one-to-one relationship of buffer time (travel time reliability) to delay holds in the future, buffer time and delay combined is projected to be 12 to 16 minutes per motorist. By implementing the Widening with Coordinated Signal Control Concept or the Roundabout Corridor Concept, average peak hour travel speeds are projected to improve through the corridor by approximately 22 mph and 24 mph on average respectively.

Network LOS summary worksheets are provided in **Appendix I**.

Relative to the SR 227 Widening with Coordinated Signal Control Concept under future year conditions, the Roundabout Corridor Concept will result in 20% less delay and between 2% and 7% lower travel times in the AM and PM peak hours respectively. The Roundabout Corridor Concept will result in 64% less safety related costs, and 60% less operations and maintenance costs.

While both concepts would result in significant air quality improvement, given the slightly higher average intersection speed profiles of the Roundabout Corridor Concept (i.e., all vehicle are traveling slower through the roundabout but no vehicles are stopped or queuing to offset the higher through speeds a signalized intersections), vehicle emission reductions are projected to be slightly less than the SR 227 Widening with Coordinated Signal Control Concept. Both concepts would result in significant air quality improvement, however, given that it does not entail widening SR 227 from three to five lanes, the Roundabout Corridor Concept provides greater eligibility for federal Congestion Mitigation and Air Quality (CMAQ) funding. The top candidates based on CMAQ cost competitiveness being the recommended roundabouts at: 1) Los Ranchos Road; 2) Buckley Road; and, 3) Crestmont Drive.

Given the larger footprint of the roundabout intersections, initial intersection specific capital costs would be approximately 9% greater for the Roundabout Corridor. However, as documented previously, due to the widening of SR 227 the total capital cost of the SR 227 Widening with Coordinated Signal Control Concept would exceed the total cost of the Roundabout Corridor Concept.

Figure 32 shows the ICE performance metric comparisons that reiterate the relative differences in benefits and costs associated with the SR 227 Widening with Coordinated Signal Control Concept and the Roundabout Corridor Concept. These comparisons again demonstrate that the Roundabout Corridor Concept provides greater relative benefits than the widening/signalization alternative concept.

Given the margin-of-error potential associated with developing planning level cost estimates, a sensitivity analysis using a 10% +/- initial capital cost variance was performed to test the stability of the preferred control type results. **Figures 33 – 36** demonstrate that the preferred SR 227 roundabout control type recommendations at Buckley Road, Crestmont Drive and Los Ranchos Road intersections would still hold despite a 10% error margin in initial capital costs.

The recommended control type for the intersection at Farmhouse Lane is less certain. Also shown is the length of time needed to render a return on investment. Based on this analysis, the two most cost-effective locations for converting to roundabout control are the signalized intersections at Buckley Road and Los Ranchos Road which pay for themselves is 10 years or less after opening day. Cost sensitivity and return of investment worksheets are provided in **Appendix J**.

Table 30: 2035 Intersection 95th Percentile Queues SR 227 Widening with Coordinated Signal Control

#	Intersection	Control	Movements	Available Storage (ft)	95th Percentile Queues (ft)	
					AM	PM
2	SR 227 & Farmhouse Ln	Signalized	EBL	50	25	25
			EBTR	-	0	0
			WBL	50	25	**123**
			NBL	75	25	25
			NBTR	325	25	68
			SBL	190	#149	145
			SBTR	-	113	302
3	SR 227 & Kendall Rd	TWSC	WB	-	25	25
			SBL	100	28	25
4	SR 227 & Buckley Rd	Signalized	EBLT	-	42	61
			EBR	135	25	**#189**
			WBLTR	-	0	0
			NBL	346	192	#113
			NBTR	-	123	136
			SBL	466	25	25
			SBTR	466	138	**#558**
5	SR 227 & Crestmont Dr	Signalized	EBLTR	-	43	0
			WBLTR	-	0	0
			NBL	124	25	32
			NBTR	100	75	**113**
			SBL	50	0	0
			SBTR	-	41	35
6	SR 227 & Los Ranchos Rd	Signalized	EBTL	150	**#343**	**155**
			EBR	330	0	0
			WBLTR	-	25	25
			NBL	225	61	55
			NBTR	-	#460	102
			SBL	110	25	0
			SBT	-	119	477
			SBR	250	98	37

Notes:
Bold and shaded cells indicate that queues exceed available storage
# indicates greater queue lengths can be experienced
Based on Synchro 8 operational models

Table 31: 2035 Intersection 95th Percentile Queues SR 227 Roundabout Corridor

#	Intersection	Control	Movements	Available Storage (ft)	95th Percentile Queues (ft)	
					AM	PM
2	SR 227 & Farmhouse Ln	Roundabout	EBLTR	n/a	25	25
			WBLTR	n/a	21	49
			NBLT	n/a	110	46
			NBTR	n/a	110	46
			SBLT	n/a	45	129
			SBTR	n/a	45	131
3	SR 227 & Kendall Rd	TWSC	WBR	n/a	25	25
			SBL	n/a	30	25
4	SR 227 & Buckley Rd	Roundabout	EBLT	n/a	25	218
			EBR	n/a	25	25
			WBLTR	n/a	25	25
			NBLT	n/a	182	44
			NBTR	n/a	182	44
			SBLT	n/a	40	128
			SBTR	n/a	40	128
5	SR 227 & Crestmont Dr	Roundabout	EBLTR	n/a	25	25
			WBLTR	n/a	25	25
			NBLT	n/a	174	38
			NBTR	n/a	174	38
			SBLT	n/a	38	173
			SBTR	n/a	38	172
6	SR 227 & Los Ranchos Rd	Roundabout	EBLTR	n/a	60	59
			WBLTR	n/a	25	25
			NBLT	n/a	203	33
			NBTR	n/a	203	33
			SBLT	n/a	39	169
			SBTR	n/a	41	169

Notes:
Bold and shaded cells indicate that queues exceed available storage
# indicates greater queue lengths can be experienced
Based on SIDRA operational models

Table 32: Network LOS: SR 227 Corridor Concepts (SIDRA Network LOS)

Scenario	Corridor Concept	AM				PM			
		Travel Time[1]	Speed Efficiency[2]	TTI[3]	LOS	Travel Time[1]	Speed Efficiency[2]	TTI[3]	LOS
2015 Existing Corridor	Signalization/TWSC	471.4	0.14	.40	**F**	393.5	.19	.97	**F**
2035 Existing Corridor	Signalization/TWSC	508.5	0.14	.40	**F**	537.7	.15	.61	**F**
2035 With Project	Widening + Signalization	141.2	0.68	6.43	B	141.9	.71	6.79	B
2035 With Project	Roundabout	132.3	0.74	7.15	B	138.9	.74	7.16	B

Sidra 6.0 Network Summary:

[1]. veh-hrs/hrs (intersection delays+mid-block cruise times); [2] travel speed as a percentage of free flow speed; [3] travel time / free flow travel time

Figure 32. Intersection Control Evaluation Result Summaries.

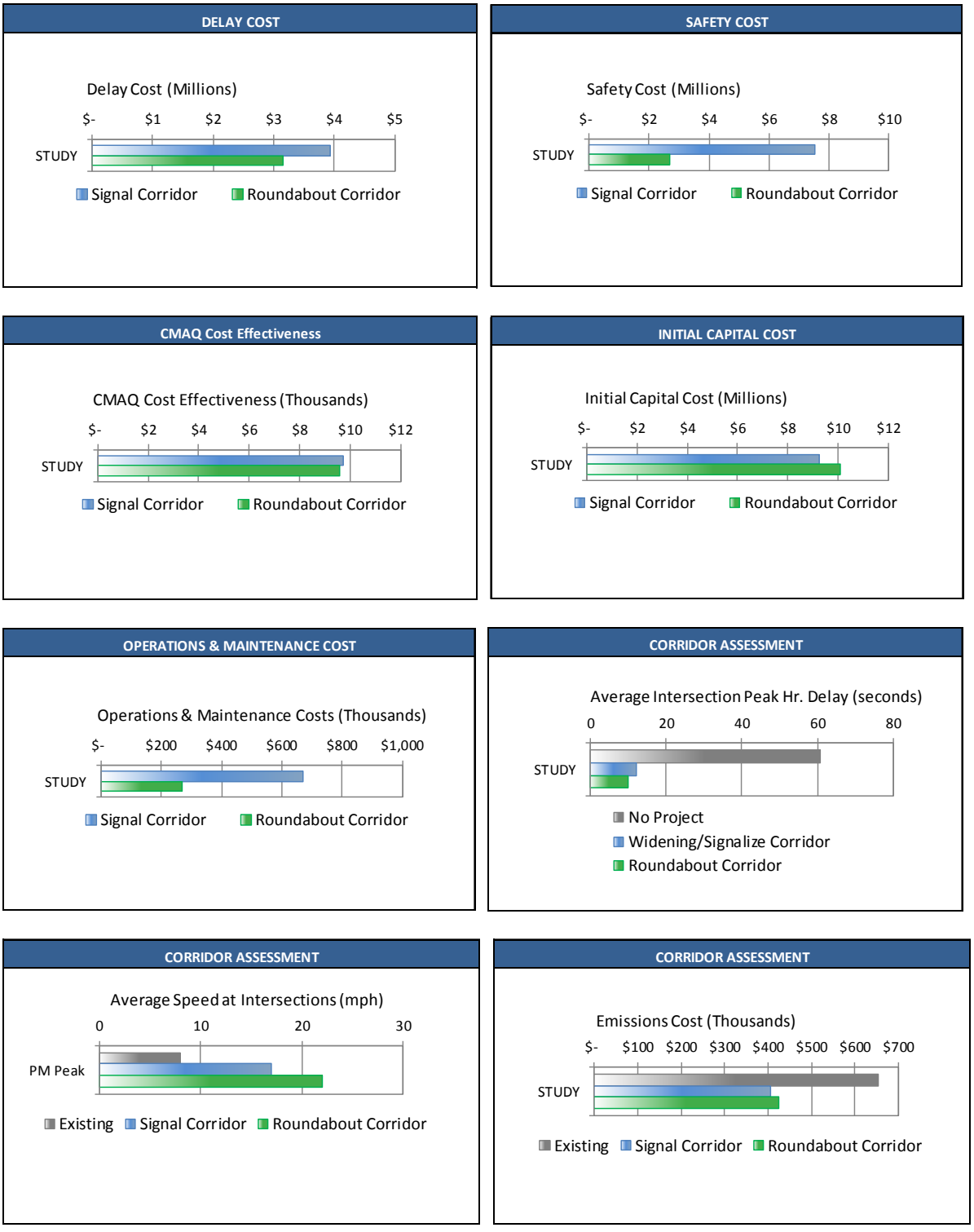
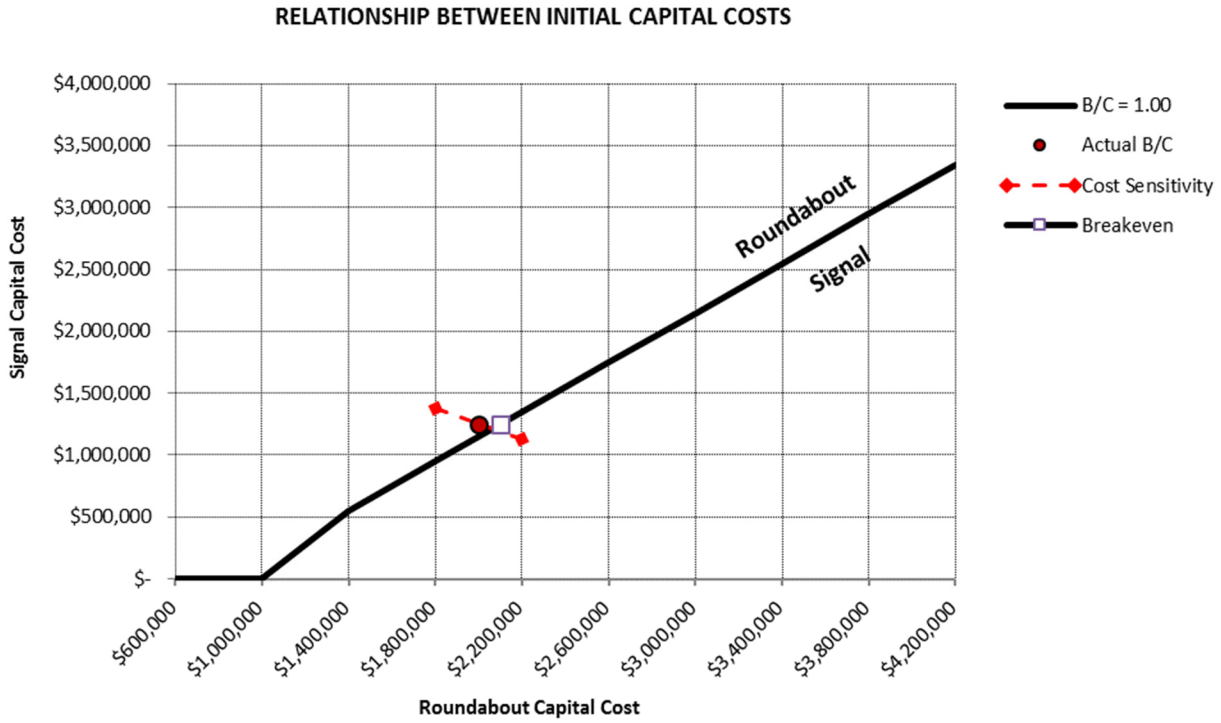


Figure 33. SR 227/Farmhouse Lane: Cost Sensitivity and Return on Investment



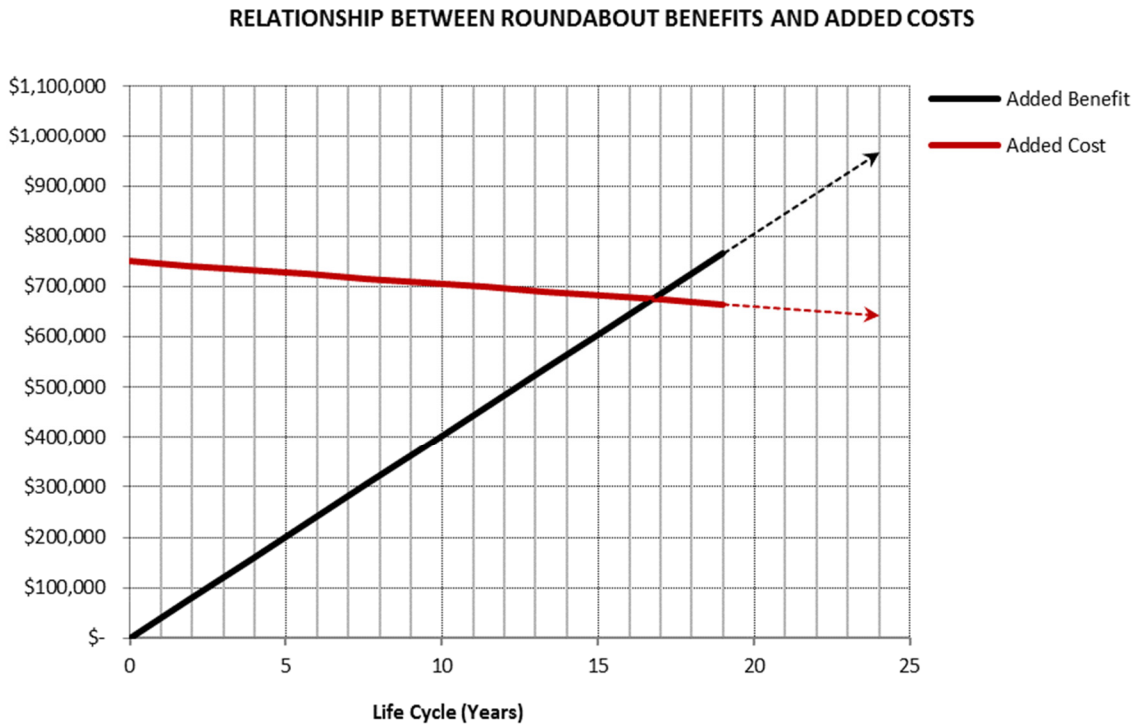


Figure 34. SR 227/Buckley Road: Cost Sensitivity and Return on Investment

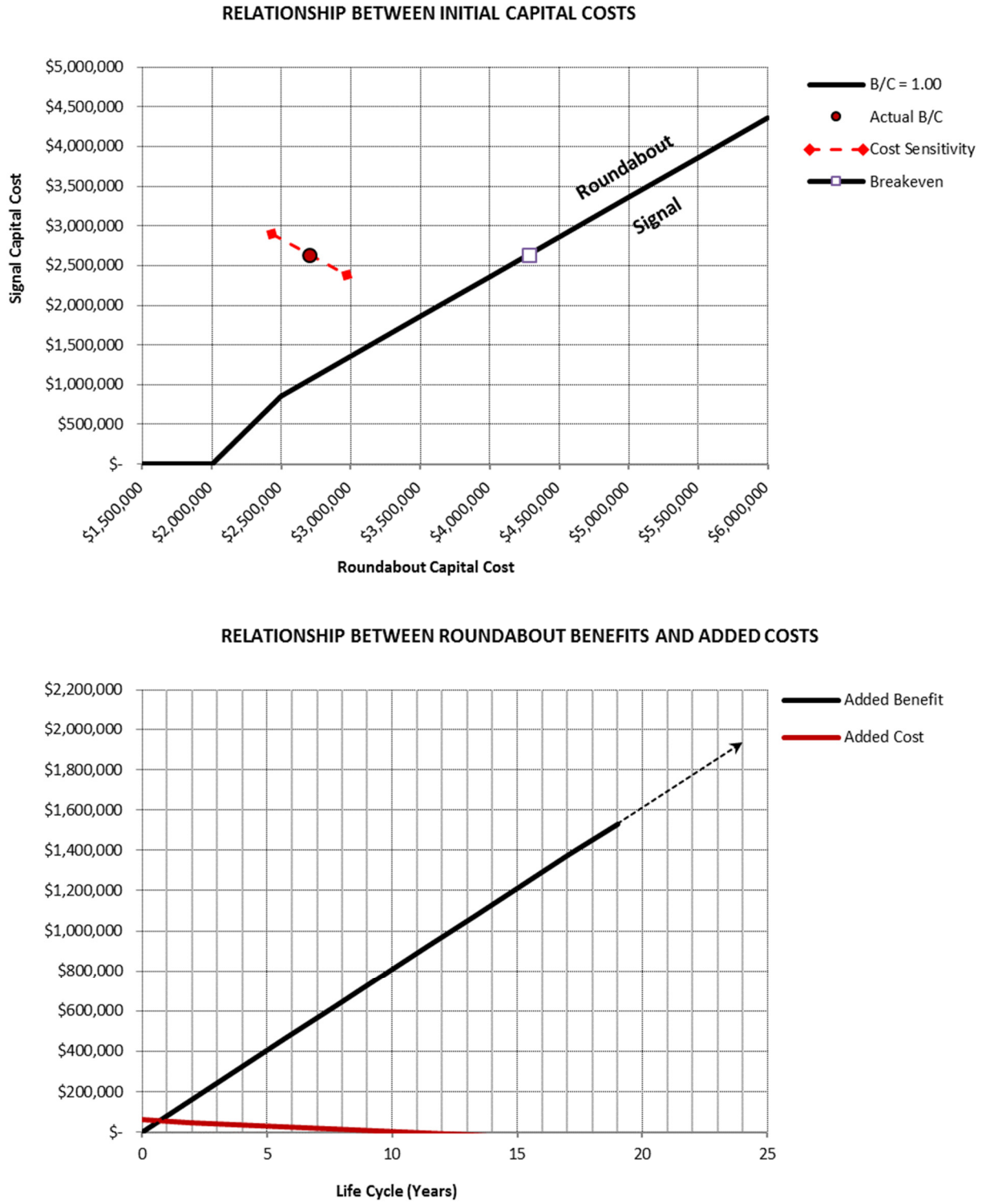
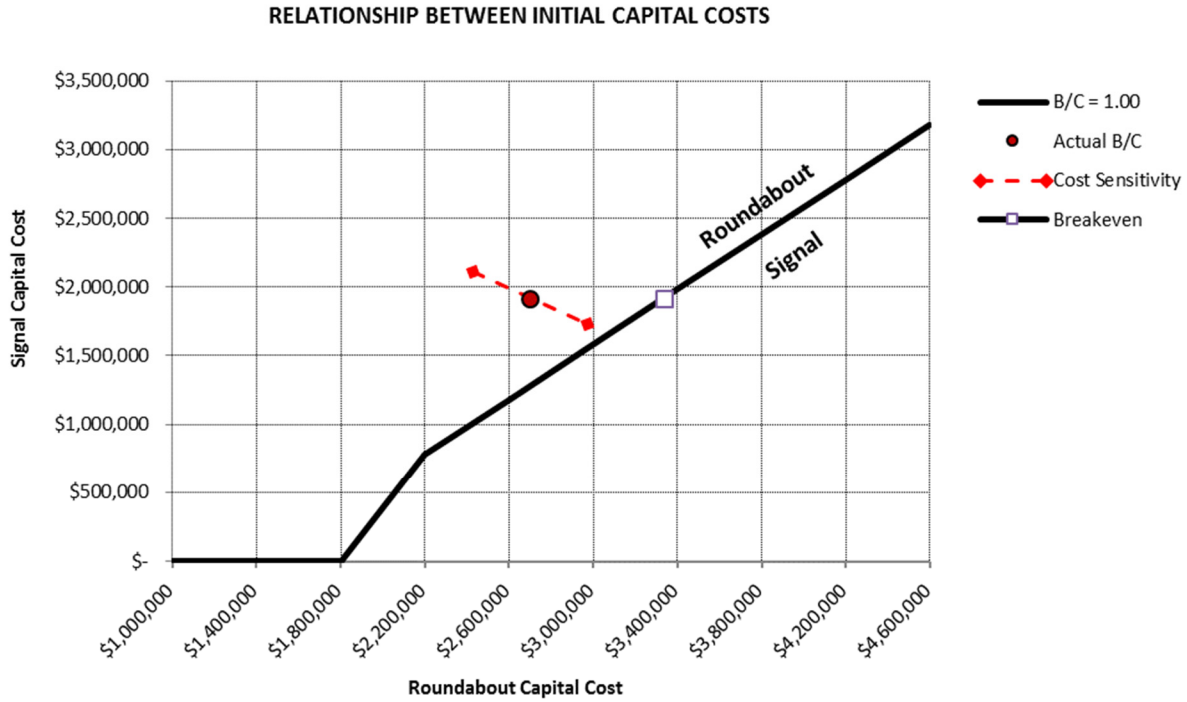


Figure 35. SR 227/Crestmont Drive: Cost Sensitivity and Return on Investment



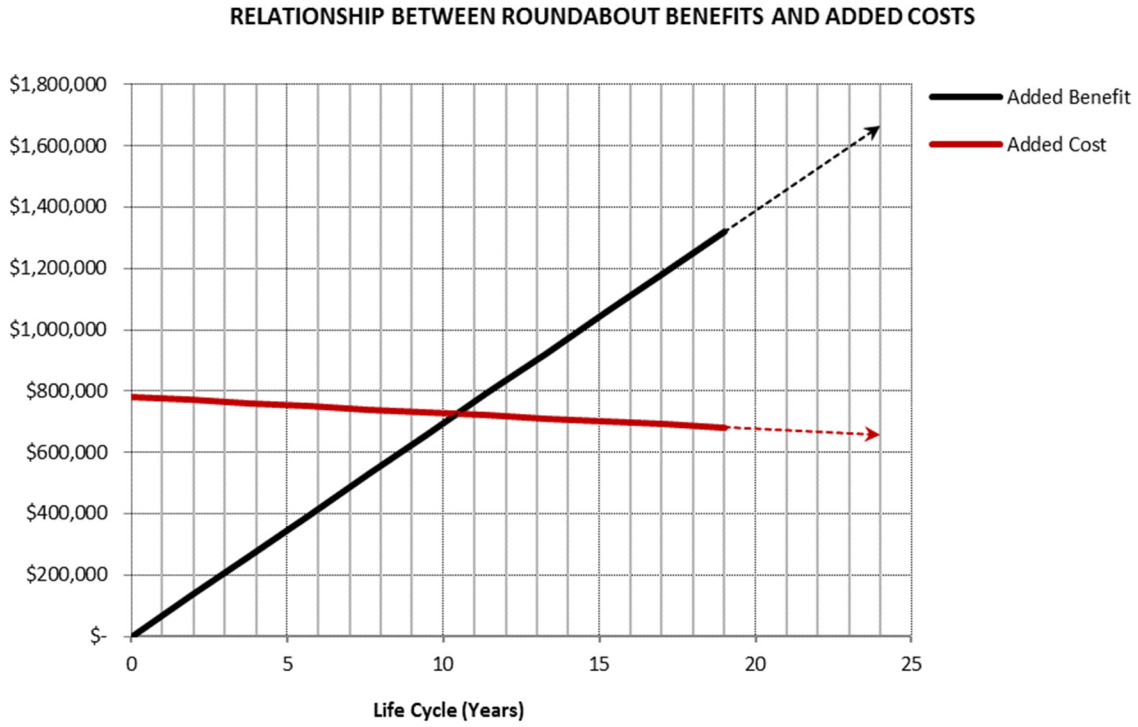
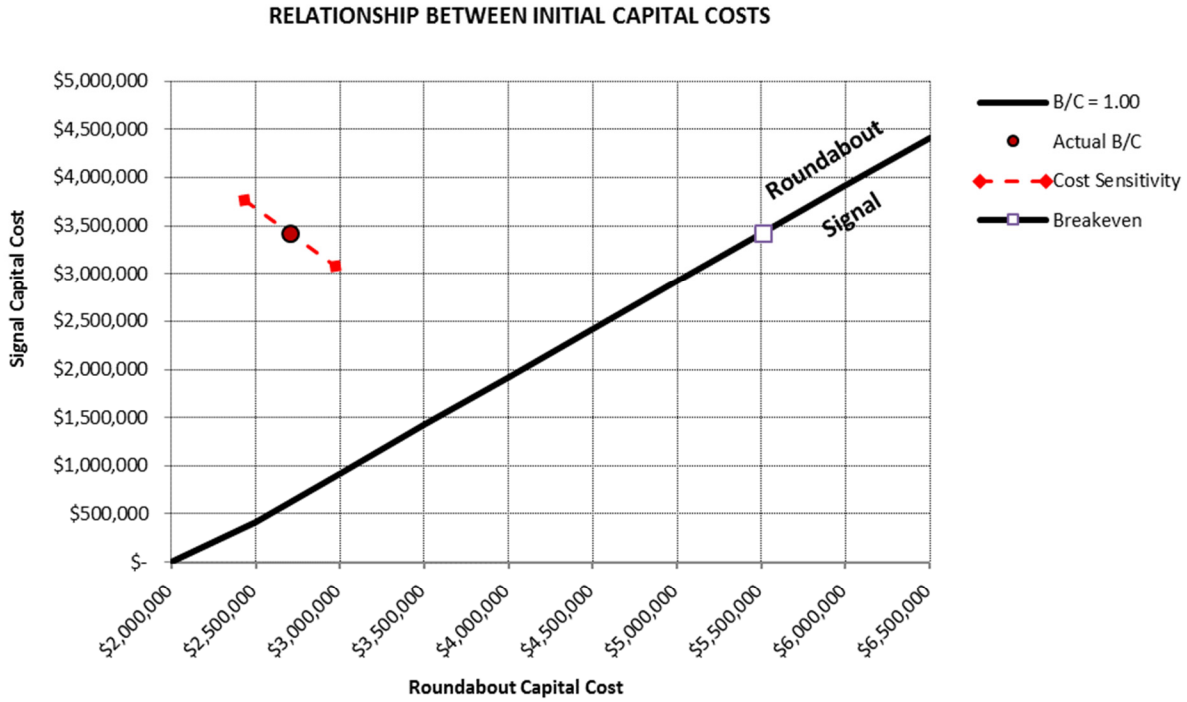
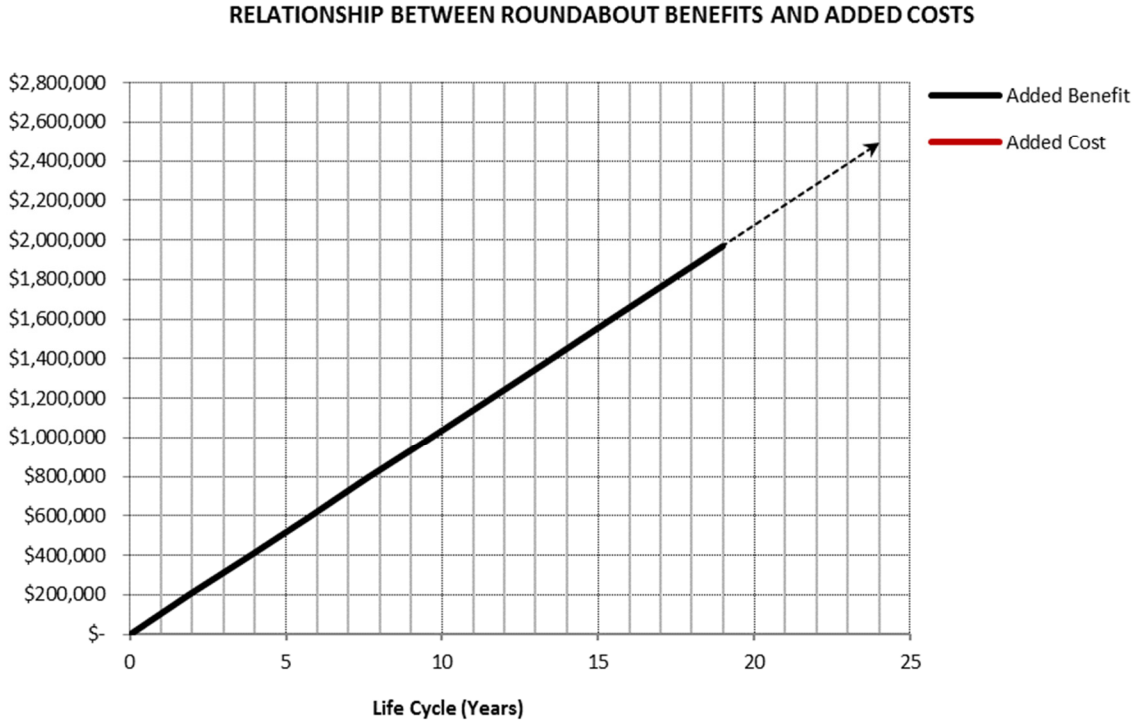


Figure 36. SR 227/Los Ranchos Road: Cost Sensitivity and Return on Investment





PREFERRED CORRIDOR CONCEPT

Per the Smart Mobility Framework process, the detailed Benefit-Cost (B/C) analysis of the operational, safety, emissions, and costing characteristics indicate that the Roundabout Corridor Concept yields the greatest estimated return on investment (highest B/C). Based on the Benefit-Cost results, roundabouts will provide the most efficient intersection control through the corridor that best balances operations and capacity in concert with resource preservation, safety, emissions, maintenance, and overall cost. Given that it will not entail a widening SR 227 to five lanes, the Roundabout Corridor Concept will not compromise the preferred alignment of the Edna-Price Canyon trail. Not requiring a full-widening also allows the implementation of the Roundabout Concept to be more scalable and amendable for construction phasing. In addition, it is recommended that the County of San Luis Obispo coordinate with SLOCOG to establish a secondary access for the Rolling Hills community via a connection to Buckley Road to the north. The connection would be functionally classified as a "Local" street and include traffic calming treatments to ensure that design speeds do not encourage cut-through traffic. Establishing such an access would not alter the ultimate facility sizing recommendations of the preferred corridor concept. However, it would have project phasing implications as described below.

While transit and park-and-ride lots were examined, based on the travel characteristics of the corridor, it was determined that short of enhancing the existing San Luis Obispo Regional Transit Authority (RTA) Route 10X commuter express service or establishing a new regional commuter express service between Santa Maria and San Luis Obispo - these components would provide marginal operational benefits in the corridor. A peripheral or fringe park-and-ride lot that intercepts commuters closer to their destinations holds the most promise. With buildout of the Edna-Price Canyon Trail as well as other bicycle infrastructure connecting to downtown San Luis Obispo, a peripheral lot may also serve as a "park-and-bike" location. Implementation of the Roundabout Corridor Concept would ensure safe pedestrian/bicycle access to existing/new transit stops and would not preclude transit enhancements or provision of park-and-ride lots. The study recommends that SLOCOG continue to work with RTA, the City and County of San Luis Obispo to identify opportunities for enhancing the role of transit along the SR 227 corridor.

Phasing of Improvements

Given the uncertainty of future funding availability and the identified funding shortfall associated with implementing the preferred corridor concept ($1.75 million available versus $10.8 million capital only), recommended phasing of the specific improvements that implement the Roundabout Corridor concept are prioritized into immediate- short-medium- and long-term phases. The key decision point for the preferred corridor concept is what order should the four proposed roundabouts be constructed to provide the greatest immediate and interim benefit.

Based on the Benefit-Cost (B/C) analysis, the two locations that provide the greatest over-all benefit by converting to roundabout control are the currently signalized intersections at Los Ranchos Road and Buckley Road. Los Ranchos is currently failing and Buckley is projected to fail by 2025 – both currently create significant queueing on SR 227. The monetized benefits of converting these two intersections to roundabout control covers the cost (i.e., pays for itself) in less than five years of operation. Establishing these two roundabouts first will provide immediate safety and operational benefits to the Rolling Hills community as motorists exiting Crestmont Drive will have the flexibility/option to avoid making the difficult permitted left-turn movement and instead make a right-turn onto SR 227 and execute a U-turn at either the Los Ranchos Road or Buckley Road roundabout depending on direction. At Crestmont Drive, installation of interim operational improvements consistent with the Highway Design Manual at Crestmont Drive and subject to Caltrans safety evaluation and determination, engineering discretion and approval for the purpose of safe ingress and egress through this intersection is a recommended interim improvement prior to conversion to a roundabout control. Given the high approach speeds, converting Crestmont Drive to a roundabout prior to converting Los Ranchos and Buckley to roundabouts is not recommended.

Peak hour signal warrants at both Farmhouse Lane and Crestmont Drive are not projected to be fully met until 2025. Staging these two intersections after improvements to Buckley Road and Los Ranchos Road will allow for further evaluation/deliberation of what control type is preferred at Farmhouse Lane and Crestmont Drive in a time frame more in line with when signal warrants are projected to be met. Additionally, provision of a secondary access to the Rolling Hills community via a connection with Buckley Road to the north could delay the need for "quantum" improvement at Crestmont Drive (i.e., converting to either a roundabout or signalized intersection). For instance, northbound motorists leaving Rolling Hills would be provided three choices – the secondary access route; right-turn followed by a U-turn at the Los Ranchos roundabout; or, a permitted left turn onto SR 227.

Although roundabouts at both Farmhouse Lane and Crestmont Drive are the most cost-effective control type and therefore recommended as part of the preferred corridor concept, staging improvements at these two intersections after the roundabouts at Los Ranchos Road and Buckley Road are implemented will more effectively reduce vehicle speeds through the Crestmont Drive intersection, increase safety, and provide maximum flexibility for the consideration of other alternatives with potential cost savings.

The recommended phasing of Roundabout Corridor improvements and associated capital costs are detailed below. To manage public expectations, the phasing of improvements is based on actual implementation (opening day) time frames. Also note that the short- and medium-term time horizons all begin at time "zero" indicating that the improvements listed should be implemented sooner if funding is available. Converting the deficient intersection at Los Ranchos to a multilane roundabout is considered the top priority followed by the Buckley Road roundabout, channelization improvements at Crestmont Drive and the provision of a secondary access to Rolling Hills.

Immediate-Term Actions (0-1 years) Cost Assumed as part of Capital Cost

- Coordinate with Caltrans to determine if the roundabout at SR 227 and Los Ranchos Road can be installed via an encroachment permit and permit engineering evaluation report (PEER). Subject to this determination, continue to coordinate with Caltrans to develop roundabout layout and preliminary engineering designs.
- Coordinate with Caltrans to develop roundabout layout and preliminary engineering designs for SR 227 at Buckley Road and a preferred project development process for expediting the SR 227 at Buckley Road roundabout.
- Coordinate with Caltrans and the County on the feasibility, layout and preliminary engineering designs for implementing any interim operational improvements consistent with the Highway Design Manual at Crestmont Drive/SR 227, subject to Caltrans safety evaluation and determination, engineering discretion and approval to provide safe ingress and egress through this intersection.
- Coordinate with Rolling Hills community on development of layout and preliminary engineering designs for creating a secondary access connecting the Rolling Hills community with Buckley Road north.
- Proceed with development of layout and preliminary engineering designs for Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road based on the Preferred Alignment adopted by SLOCOG.

Short-Term Improvements (0-5 years) Capital Cost: $5.8 Million

- Los Ranchos Road/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings).
- Crestmont Drive/SR 227 – per Caltrans review and approval, install striped or raised median channelization treatments and realign SR 227 to provide deflection (considered an interim improvement prior to roundabout control).
- Buckley Road/SR 227 - convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings). This roundabout would include City of San Luis Obispo Gateway signage and treatments.
- Rehabilitate pathway from Los Ranchos Road to Crestmont Drive to become part of the Edna-Price Canyon Trail. Install signage warning bicyclists of private driveway/s south of Crestmont Drive (cost not reflected)

- Construct Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road based on the Preferred Alignment adopted by SLOCOG (cost not reflected).
- Install rumble strip along the SR 227 outside travel lanes between Airport Drive and Price Canyon Road with breaks/gaps provided near bus stops and pull-outs.
- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This would entail creating a small parallel driveway west of the Edna Trail alignment. Restrict turn movements from consolidated driveway to right-in/right-out and left-in, and provide median channelization to restrict left-out movements (cost not reflected).
- Airport Drive: close off access to SR 227 and realign west leg of Airport Drive with Farmhouse Lane to provide new access to SR 227 at Farmhouse Lane.
- Convert SR 227/Farmhouse Lane to a four-legged intersection (convert to two-way stop control in interim).
- Replace the bus stop currently on Aero Drive with a new bus stop and amenities (i.e., lighting, shelter etc.) near the new four-legged intersection at Farmhouse Lane. Consideration for placing the new stop on either Kendall Road or Farmhouse Lane would require concurrence from the business park owners who own and maintain both roads.
- Restripe northbound SR 227 for two through lanes between Farmhouse Lane to just south of Kendall Road (widening would not entail any additional ROW).
- Restrict turn movements from Kendall Road to right-in/right-out and left-in, and provide median channelization to restrict the left-out movement.

Mid-Term Improvements (0-10 years) Capital Cost: N/A

- Construct a secondary access connecting the Rolling Hills community with Buckley Road north. Will include traffic calming treatments to reduce speeds and cut-through traffic. (cost not reflected)
- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This could entail creating small parallel driveways west of the Edna Trail alignment. Restrict turn movements from consolidated driveways to right-in/right-out and left-in, and provide median channelization to restrict left-out movements (cost not reflected).
- Construct Edna-Price Canyon Trail from Crestmont Drive to Tank Farm Road on the Preferred Alignment adopted by SLOCOG (cost not reflected).

Long-Term Improvements (10-20 years) Capital Cost: $5 Million

- Farmhouse Lane/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings).
- Crestmont Drive/SR 227 – convert to multilane roundabout (widening at 200 feet plus taper from up/down stream of intersection, including signage, illumination, and striping for pedestrian/bike crossings). Note: striping for east side SR 227 pedestrian/bicycle crossings is not recommended (allowed per DIB-82, Sec. 4.2) but may be required by Caltrans. Striping will be included for the Edna-Price Canyon Trail crossings.
- Widen southbound SR 227 for four through lanes from Farmhouse Lane to just south of Kendall Road
- Where feasible – encourage consolidation of private and commercial driveways south of Crestmont Drive. This could entail creating small parallel driveways west of the Edna Trail alignment. Restrict turn movements from consolidated driveways to right-in/right-out and left-in, and provide median channelization to restrict left-out movements (cost not reflected).

RELINQUISHMENT ASSESSMENT

A relinquishment cost assessment was developed as part of this study to help inform future planning level SR 227 relinquishment discussions between Caltrans and the County of San Luis Obispo. A preliminary planning-level review process is currently examining a potential relinquishment of SR 227 from the current northern limit with the City of San Luis Obispo to a yet to be defined southern limit. Scalable 20-year planning-level preventative maintenance cost information was developed based on per lane mile cost estimates for Fog Seal, Micro-surfacing and Grind and Overlay needs and inflated on a 2.5% basis per year for all future years beyond 2016. Given that Caltrans has recently completed rehabilitating the portion of SR 227 between Price Canyon Road (PM 7.1) to the San Luis Obispo City limits (PM 10.3), the planning-level cost preventative maintenance cost estimates assume that SR 227 is currently in a state of "good repair". Given the recent completion of this overlay project, 2016 has been assigned as the base-year for which the future cyclic preventive maintenance activities and costs are based.

The County of San Luis Obispo currently maintains a formal pavement management program (PMP) for documenting road conditions, forecasting pavement maintenance and scheduling maintenance funds for the County's road network. All County roads with a pavement condition index (PCI) score greater than 55 receive a classification of "Good" and are designated as Tier 1. Tier 1 roads include all roads that can be preserved merely with surface treatments, not full roadway rehabilitation. It is assumed as part of this analysis that if Caltrans and the County establish a SR 227 relinquishment agreement for the transfer of SR 227, the roadway will be incorporated into the County PMP as a Tier 1 road and will be maintained in the near-term through preventative surface treatments.

The 20-year preventative maintenance cost estimates were based on the following assumptions:

- Fog seal treatments at 2-year recurring intervals;
- Micro-surfacing occurs in year 6 and year 13; and,
- Grind and overlay occurs at year 20 (2035).

The cost per lane mile for micro-surfacing and fog seal include: traffic control (construction area signs, traffic control systems, and portable changeable message signs), treatment application, and 25% of the construction costs for project design, bidding, and construction management and administration. The cost per lane mile for grind and overlay is derived from the ongoing 2016 Caltrans SR 227 Overlay Project (excluding guardrail repairs) and includes 30% of the construction costs for project design, bidding, and construction management and administration.

The following two segments were delineated and 20-year preventative maintenance cost estimates developed:

- Segment Area No. 1: City Limits to Buckley Road Cost: $1,282,100
- Segment Area No. 2: Buckley Road to Los Ranchos Road Cost: $1,059,550

The relinquishment cost assessment of $2.34 million should not be construed to constitute or contribute to a full Relinquishment Assessment Report. Caltrans is under no statutory obligation to place a facility into a state of good repair, construct improvements or betterments, or incur a financial obligation of any kind to relinquish a state highway to a local agency. If the parties decide to initiate the relinquishment process, the steps outlined in the Caltrans Project Development Procedure Manual would be followed, and Caltrans would be responsible for facilitating the negotiation of the terms of a mutually beneficial relinquishment agreement with the County. The complete relinquishment cost assessment analysis is provided **Appendix K**.

Relinquishment of either segment will add to the total roadway centerline miles owned by the County of San Luis Obispo which will increase the County's annual gas tax revenue allocation (apportioned by formula). Based on the current $7,000 per year per mile tax formula, the County can anticipate $448,000 in additional gas tax revenue over the same 20-year horizon (assumes both Segment Area No. 1 and No. 2 combined) to offset the estimated $2.34 million relinquishment cost.

Jim Damkowitch
Jim.Damkowitch@kimley-horn.com

Kimley-Horn
555 Capitol Mall
Suite 300
Sacramento, CA 95814
916-858-5800