# Lawrence Expressway Grade Separation Concept Study

## FINAL REPORT
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Prepared for

Prepared by

Kimley»Horn

apex STRATEGIES

# Project Working Group

***County of Santa Clara Roads and Airports Department***
Michael Murdter, Director
Dan Collen, Deputy Director, Infrastructure Development, *Study Oversight*
Dawn Cameron, County Transportation Planner, *Study Project Manager*
Masoud Akbarzadeh, County Traffic Engineer
Ananth Prasad, Senior Civil Engineer, Traffic Engineering & Operations
Bill Yeung, Senior Civil Engineer, Signal & Electrical Design
Craig Peterson, Associate Civil Engineer, Highway Design
Janice Spuller, Transportation Planner
Ivana Yeung, Transportation Planner

***City of Santa Clara***
Dennis Ng, City Traffic Engineer
Steve Lynch, City Planner

***City of Sunnyvale***
Jack Witthaus, Transportation & Traffic Manager
Andrew Miner, Principal Planner

***Santa Clara Valley Transportation Authority***
Rob Swierk, Senior Transportation Planner

***Consultant Team***
Adam Dankberg, Kimley-Horn and Associates, Inc., *Consultant Project Manager*
Zach Miller, Kimley-Horn and Associates, Inc.
Prasanna Muthireddy, Kimley-Horn and Associates, Inc.
Eileen Goodwin, Apex Strategies
Greg Kenning, Biggs Cardosa Associates, Inc.

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## Executive Summary

Lawrence Expressway is part of the County Expressway System, a regional network of key thoroughfares operated and maintained by the County of Santa Clara. The expressways serve numerous functions, including regional connectivity, local access, and multi-modal circulation. The primary mission of the expressway system is to relieve local streets of through traffic and supplement the freeway system.

Lawrence Expressway is a vital regional artery that directly supports the expressway system's mission. It has 8 through lanes north of I-280, including high-occupancy vehicle (HOV) lanes between Stevens Creek Boulevard and US 101. It provides connectivity between three east-west freeways and access for the cities of Cupertino, San Jose, Santa Clara, Saratoga, and Sunnyvale. It serves over 80,000 vehicles per day between Reed Avenue/Monroe Street and US 101. The volume of traffic carried by this segment results in congestion and long delays, and creates a physical and visual barrier between the businesses and communities on either side of the expressway.

Past expressway planning efforts identified the section of Lawrence Expressway north of El Camino Real and south of US 101 as the busiest portion of Lawrence Expressway, and even the busiest portion of any expressway countywide. The 2003 Comprehensive County Expressway Planning Study identified the at-grade signalized intersections of Lawrence Expressway with Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street as the most congested along Lawrence Expressway and in need of major capacity improvements. These findings were supported again in the 2008 Update to the Expressway Study.

*Lawrence Expressway serves over 80,000 vehicles per day between US 101 and Reed Avenue/Monroe Street, resulting in congestion, long delays, and a physical and visual barrier within the community.*

Grade separations have been historically implemented at various locations throughout the expressway network as a solution for congested intersections when all feasible at-grade solutions are not sufficient. Lawrence Expressway itself is grade separated at major crossings of both El Camino Real and Stevens Creek Boulevard. Grade separations have been long considered as potential improvements for the Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street intersections, with some rough concepts dating back decades. Over the years, a number of at-grade improvements have been implemented at these locations, with the addition of travel lanes, turn lanes, and extensive signal operations optimizations along the corridor. With the congestion along Lawrence Expressway between US 101 and Reed Avenue/Monroe Street continuing to increase, and rising to the top of the areas of greatest need countywide, the County and its partners, the City of Santa Clara and the City of Sunnyvale, elected to embark on a study to better understand the type of solutions needed to improve the most congested section of Lawrence Expressway. With the identification of community-supported improvements, the right-of-way needed to implement those improvements can be preserved and accumulated as the area redevelops.

### *Project Purpose*

The main purpose of the Lawrence Expressway Grade Separation Project is to identify potential improvements at the intersections of Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue that will address existing and forecast traffic congestion in the study area. Identifying these improvements through this study will be critical to serving the long-term congestion problem by allowing for:

- Preservation of right-of-way needed for long-term improvements as the area redevelops;
- Identification of project costs, supporting inclusion in traffic impact fee programs and in the ultimate preparation of a financing plan;
- Establishment of a basis for further preliminary engineering and environmental analysis, getting improvements closer to being shovel-ready to capitalize on financing opportunities as they arise; and
- Identification of a project and cost for inclusion in the Expressway Plan 2040 Study, the Valley Transportation Plan and the Regional Transportation Plan.

The study is focused on identifying improvements to the three intersections of Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue; however, it also examines the associated effects over a wider area to ensure that solutions at those locations will not result in

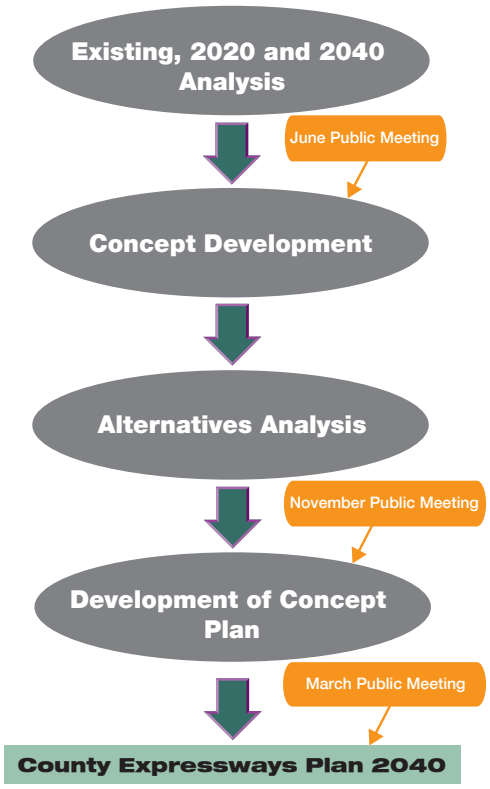
the problem shifting elsewhere. The study area consists of Lawrence Expressway and other major roadways included within the area bound by Oakmead Parkway to the north, Oakmead Parkway/Corvin Drive to the east, Commercial Street/Deguigne Drive to the west, and Cabrillo Avenue to the south. Central Expressway runs through the heart of the study area. Considerations were given to circulation to and from Central Expressway in the vicinity of Lawrence Expressway, although modifications to the existing square loops were not inherent to the study. The project study area is depicted on **Figure ES-2**.

The project process included the development of a range of potential solutions, testing and refinement of those solutions, extensive public and stakeholder input, and the identification of a proposed concept. The project was roughly divided into the following stages:

- Baseline analysis phase where the challenges within the corridor, such as right-of-way, traffic volumes, bicycle/pedestrian mobility impairments and others were identified through analysis and public input;
- Concept development where a range of potential solutions was developed and tested for their feasibility and effectiveness at addressing the project goals;
- Alternatives analysis where three solutions were analyzed in greater detail, and presented for public input, for their circulation benefits, design feasibility, and community context; and
- Proposed concept refinement where an identified solution was further refined and presented to the public and stakeholders.

The project process is summarized in **Figure ES-1** at right.

***Figure ES-1 - Project Flow Chart***



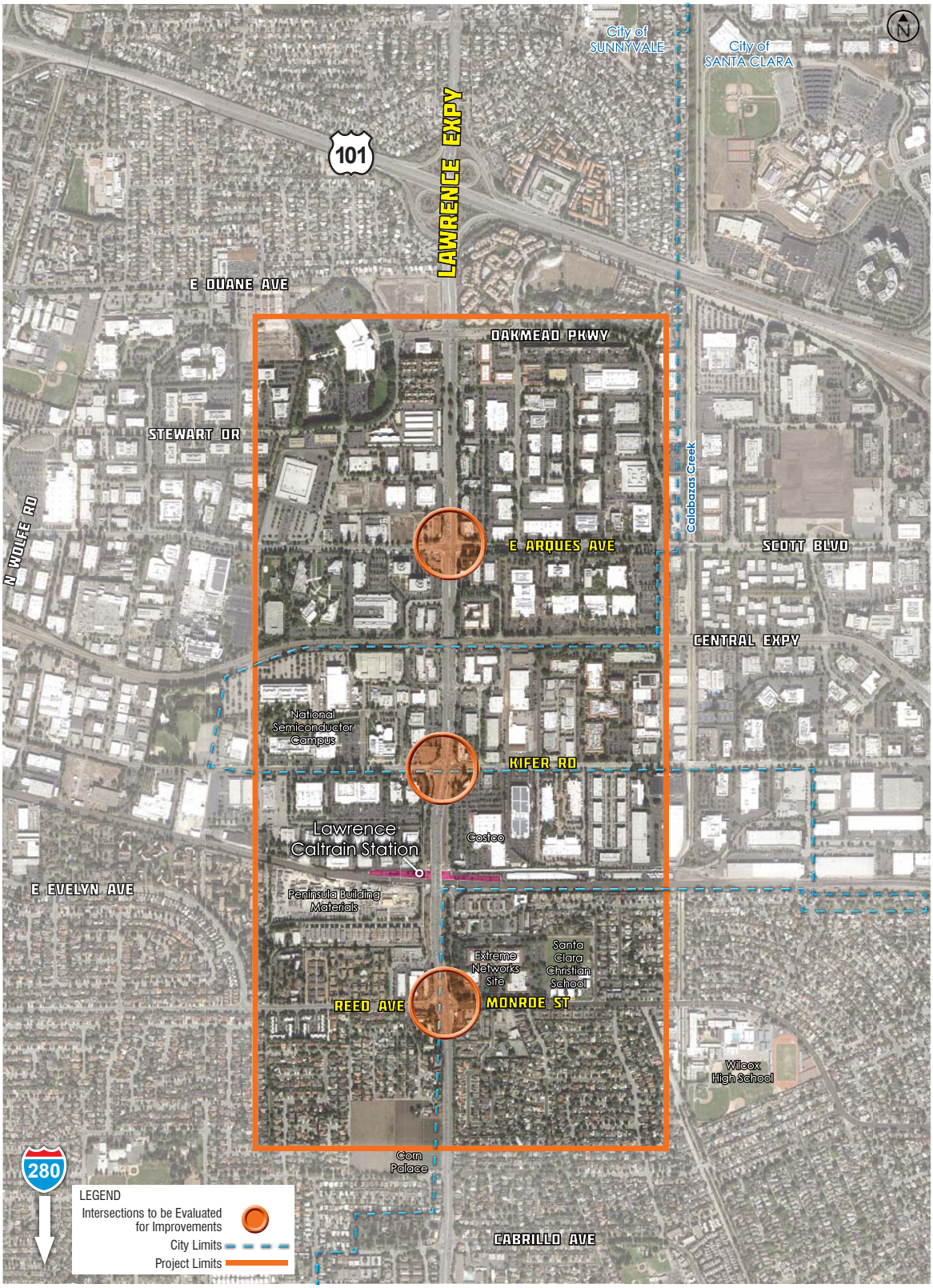

A key element of the project process was the inclusion of stakeholder and public involvement. Three sets of public meetings were held at key stages in the project process where public input was received and the project findings and recommendations were presented. The meetings were well attended, with an engaged mix of residents, commuters and business owners. Each meeting had interactive elements, both providing information about the project and eliciting input and feedback from the attendees. Additionally, the project was presented to key advisory and decision making bodies of the three cooperating agencies (County of Santa Clara, City of Sunnyvale, and City of Santa Clara), presented at various stakeholder meetings (Chambers of Commerce, Silicon Valley Leadership Group), and discussed with elected officials. Project information was distributed through community newsletters, newspapers and e-blasts. A project e-mail list was maintained and utilized to distribute information regarding project milestones and opportunities for public input. The County maintained a project website, phone number, and e-mail address, providing additional opportunities for public input.

## Baseline Conditions and Challenges

Based on input from the project stakeholders and the public, the following set of goals, and associated baseline challenges, were identified for improvements to Lawrence Expressway.

- Reduce congestion along Lawrence Expressway: Long delays occur at the traffic signals along Lawrence Expressway, while signal operations have already been optimized as much as possible.
- Enhance bicycle and pedestrian connectivity across Lawrence Expressway: Currently bicyclists and pedestrians encounter long

*Figure ES-2 - Study Area Map*



crossing distances and long waits to cross Lawrence Expressway.

- Maintain and enhance access to the Lawrence Caltrain Station: The current configuration of the local streets used to access the Lawrence Caltrain Station is difficult to navigate for automobiles and buses and difficult to access for bicyclists and pedestrians.
- Provide sufficient capacity along Lawrence Expressway so that commute traffic stays on Lawrence Expressway and off local streets: Traffic volumes have been increasing as the economy recovers and are forecast to continue to increase as the area redevelops, necessitating improvements that can increase capacity.
- Coordinate solutions with the ongoing Lawrence Station Area Plan (LSAP) efforts: Ensure that the Lawrence Expressway solution works harmoniously with the LSAP efforts in improving connectivity, providing for redevelopment and density, and enhancing the viability of the Lawrence Caltrain Station.
- Ensure that any solution fits the community context: Reduce or minimize the existing visual and perceived community barrier that is Lawrence Expressway and develop a solution that fits the varying character of adjacent land uses.
- Develop a cost effective solution with community support.

*The project included three sets of public meetings, presentations to several key advisory and decision making bodies, and meetings with stakeholders and elected officials. Project information was posted to the project website and distributed via e-mail blasts.*

The community meetings were well attended. Interactive elements helped solicit input from the engaged attendees.

A few additional guiding principles were identified through the stakeholder and public process that would be used to evaluate and prioritize the identified improvements:

- Minimize right-of-way needs: Minimize encroachment upon any adjacent parcels and properties.
- Avoid shifting the entire problem to another choke point: Consider the effects of potential solutions on nearby streets and downstream on Lawrence Expressway.
- Maintain local access: Maintain access to businesses and the community from Lawrence Expressway.
- Consistency with environmental goals and policies: Reduce greenhouse gas emissions and other pollutants associated with vehicle idling and delays, and support the use of alternative modes in the corridor.

The over-arching goal of the project was to identify a cost-effective, community-supported, and constructible long-term solution for Lawrence Expressway within the study corridor to alleviate congestion and improve traffic flow. Additionally, the project will support the movement of bicyclists, pedestrians, and transit on both Lawrence Expressway and the local street network.

*The project sought to identify a cost-effective, community-supported, and constructible long-term solution to alleviate congestion, improve traffic flow and support the movement of bicyclists, pedestrians, and transit within the study corridor.*

The baseline analysis identified that both Kifer Road and Reed Avenue/Monroe Street are operating deficiently in current, Year 2013, conditions. The three focus intersections of Lawrence Expressway with Arques Avenue, Kifer Road and Monroe Street/Reed Avenue are all forecast to be deficient by Year 2020. Average delays at Reed Avenue/Monroe Street are forecast to exceed three minutes during the AM peak hour, and average delays at all three intersections are forecast to exceed two minutes during the PM peak hour. By Year 2040, all

three intersections are forecast to be at a deficient level of service F (excessive delays) in both the AM and PM peak hours, with average delays at Reed Avenue/Monroe Street exceeding five minutes during the AM peak hour. The free-flow speed on Lawrence Expressway is 50 miles per hour; however, without any improvements, the average speed on the section of Lawrence Expressway within the study area is projected to drop to 13 miles per hour by Year 2040. That will result in increased congestion on parallel roadways such as San Tomas Expressway, Bowers Avenue or Wolfe Road, and increased vehicle miles traveled as Lawrence Expressway users detour off of the expressway to avoid the congestion. In addition, local residents and businesses will experience decreased access, affecting economic growth.

*Without improvements, the average speed on Lawrence Expressway is forecast to drop to 13 miles per hour by Year 2040, with average delays exceeding 5 minutes at Reed Avenue/ Monroe Street. This will shift congestion to parallel roadways and reduce mobility.*

The constraints along the corridors that create all of that congestion are the signalized intersections. At each signalized intersection, Lawrence Expressway traffic is stopped while cross-street traffic and pedestrians crossing Lawrence Expressway are served. Traffic signal coordination has been fine-tuned to the point where no further improvements are feasible strictly from timing modifications. There is just too much traffic on Lawrence Expressway to fit within the available green time. The baseline analysis demonstrated that some measure of significant capacity enhancement is needed in order to reduce congestion and improve circulation.

## Concept Evaluation

The project team investigated the applicability of a wide variety of intersection geometric design treatments that would address the needs of the Lawrence Expressway project corridor as defined by the baseline analysis. These treatments included:

- Indirect Left Turns
- Hook Ramps
- Tight Diamond Urban Interchanges
- Single Point Urban Interchanges
- Roundabouts
- Frontage Roads
- Elevated Left Turns
- Jughandles/Square Loops

These treatments were considered for their applicability at each of the improvement intersections. Nine distinct concepts were developed based on various combinations of these improvements. The concepts were considered for their ability to handle near-term and horizon year projected traffic needs, bicycle and pedestrian mobility, enhance access to/from the Lawrence Caltrain Station, and design feasibility given right-of-way and other constraints. It was determined that roundabouts were not a feasible solution due to the very high turning movement volumes at each of the three improvement locations. Indirect left-turns and other at-grade treatments also did not provide the capacity needed to handle projected traffic flows. Based on the quantitative and qualitative evaluation, certain concepts were deemed most feasible for meeting the project goals.

## Alternatives Analysis

Based on input from County of Santa Clara, City of Sunnyvale and City of Santa Clara staff, three corridor alternatives were chosen for further study. These alternatives were comprised of selected concepts from the concept evaluation phase of the project. Each alternative was developed at a conceptual level for analysis of traffic, multi-modal circulation, community context, cost and other design elements. The three alternatives are summarized below:

- Alternative 1 - Frontage Road Alternative: This alternative introduced one-directional frontage roads on either side of Lawrence

Expressway. The expressway itself would be depressed below Arques Avenue, Kifer Road, the Caltrain tracks, and Reed Avenue/Monroe Street. Traffic would travel between the frontage roads and the expressway at either end of the frontage roads and between Kifer Road and Reed Avenue/Monroe Street. Local traffic would utilize the frontage roads, while through traffic would stay on the expressway. Bicycle/pedestrian features would be primarily provided on the frontage roads, although commute cyclists could continue to travel along the shoulder of the expressway.

- Alternative 2 - Interchange Alternative: This alternative would depress Lawrence Expressway below Arques Avenue and elevate it above Kifer Road and Reed Avenue/Monroe Street. It introduced median-ramps at each of the three cross-streets to facilitate access between the expressway and those streets. Median ramps were proposed instead of traditional diamond ramps in order to avoid a conflict between high-speed vehicles and bicycles and pedestrians along the corridor and to improve the functionality of the HOV lanes. Ramps would be provided between bicycle and pedestrian facilities along Lawrence Expressway and the cross-streets to facilitate that connectivity.
- Alternative 3 - Grid Network Concept: This alternative would partially rely on the enhanced street network proposed by the Sunnyvale LSAP. The LSAP is proposing an enhanced grid network in the vicinity of the Lawrence Caltrain Station. This alternative would grade separate Lawrence Expressway and rely on existing and proposed roadways to facilitate connections between the expressway and the local community. These connections would function in a similar manner to the square loops that exist today at Central Expressway, using streets such as Titan Way, Kern Avenue, Ryder Street, and Enochs Street to provide for right-turn movements onto and off of the expressway. Lawrence Expressway would be depressed below Arques Avenue, elevated above Kifer Road, and would be elevated above Reed Avenue/Monroe Street. A median ramp interchange, similar to Alternative 2, would be implemented at Reed Avenue/Monroe Street since there is not the opportunity for a sufficient grid street network to provide connectivity as there would be at Kifer Road and Arques Avenue.

Conceptual engineering was prepared in the form of concept-level plan views, cross-sections, and profiles to-scale for the proposed concept. Kimley-Horn evaluated constructability, implementation, and phasing, including a structural feasibility review. Additionally, Kimley-Horn identified changes in circulation and traffic volumes associated with the proposed concept and developed micro-simulation models to analyze intersection delay, corridor travel time, and intersection queuing. The three alternatives were presented at public meetings and with key stakeholders for questions and comments. The key findings, based on our analysis and public feedback, for each of the three alternatives are shown in **Table ES-1**.

***Table ES-1 - Alternatives Analysis Summary***

| | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| *Vehicular Traffic* | *Best improvement in throughput on expressway. Not as efficient for cross-street traffic due to closely spaced intersections.* | *Works well for expressway and very well for cross-street traffic.* | *Works well for expressway and cross-streets, but may result in queuing and congestion for exiting/entering movements.* |
| *Multi-Modal Circulation* | *Pedestrians and cyclists on lower speed frontage road. Introduces high-speed conflict for commuter cyclists.* | *Greatly improves safety by eliminating conflict points at cross-streets. Bike/ped movements still along high-speed expressway.* | *Still retains a number of high-speed conflicts for bicyclists and pedestrians.* |
| *Community Factors* | *Lowering of expressway eliminates it as a barrier and frontage roads maintain strong local access.* | *Elevating expressway introduces a visual barrier.* | *Elevating expressway introduces a visual barrier and traffic volumes on connecting local streets would greatly increase.* |
| *Design Elements* | *Depressing expressway would be difficult to construct and costly, particularly at Caltrain.* | *Would require more right-of-way at interchange locations, but can partially utilize existing bridge over Caltrain.* | *Dependent on elements of LSAP to be implemented for grade separations to proceed.* |
| *Project Cost* | *Very high due to roadway depression.* | *Moderate with elevated roadway and some right-of-way requirements.* | *Lowest due to elevated roadway and assumption that LSAP implementation will provide needed right-of-way.* |

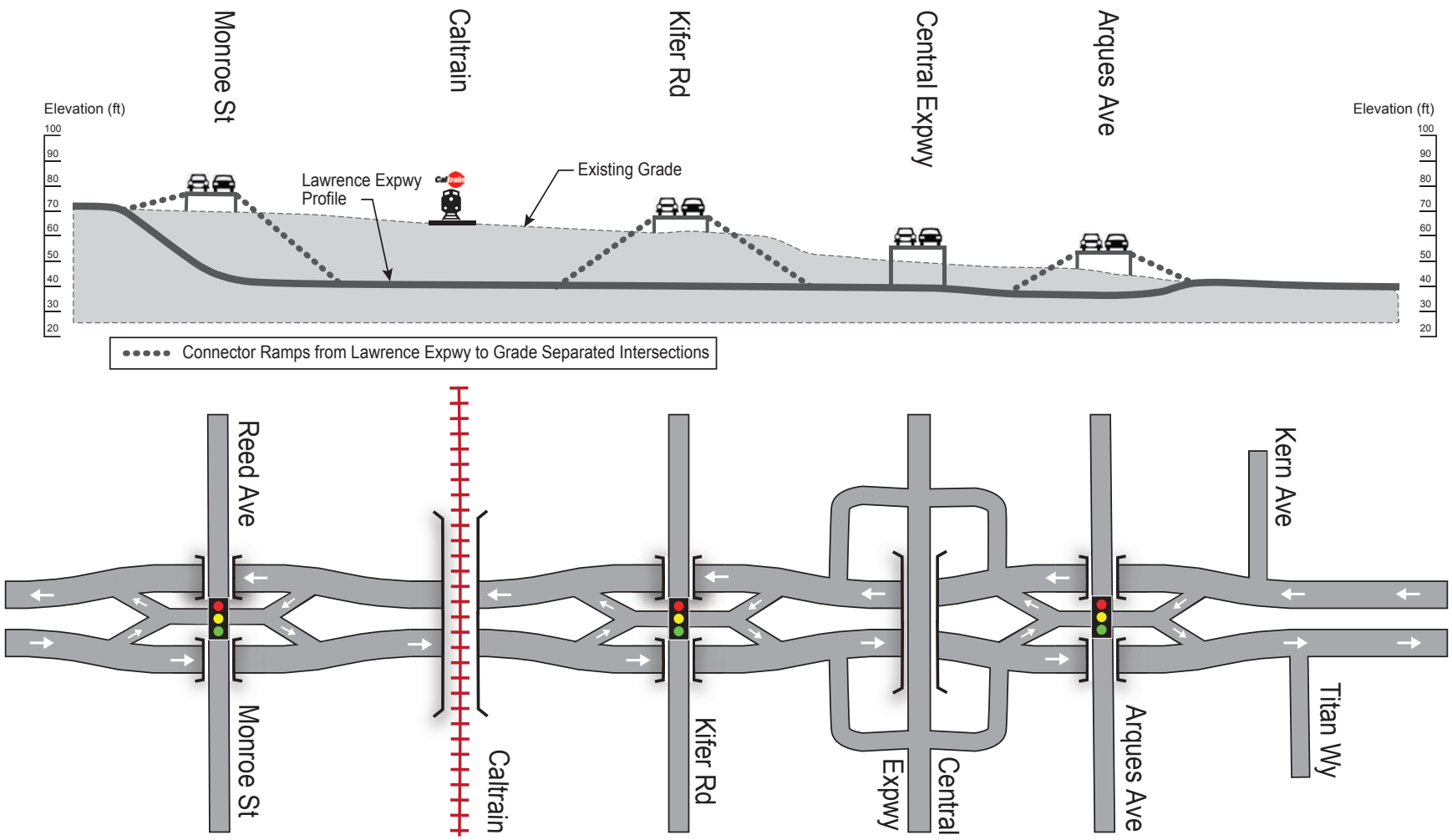
## Proposed Concept

Based on community and stakeholder input and technical analyses, staff representing the three cooperating agencies jointly selected a proposed concept for further study. Alternative 3 was deemed insufficient in meeting the project goals because it would increase traffic flow on community-serving streets, and it would introduce choke points at merge locations along the corridor. Alternative 1 was desired due to its depressing of Lawrence Expressway and its removal of the visual and connectivity barrier. However, Alternative 2 provided a desirable solution for commuting cyclists and presented fewer grade changes for pedestrians, while providing a more efficient connection between Lawrence Expressway and the cross-streets. Community input was strongly in favor of lowering the expressway. Lowering the expressway has a significant trade-off in cost, construction duration, and project complexity due to the required removal of the existing Caltrain bridge and construction of a new tunnel. However, avoiding a substantial, new visual barrier was a critical element to the local community. Therefore, the previous Alternative 2 was modified to include a lowered Lawrence Expressway instead of an elevated structure.

*The proposed concept represents a blend of alternatives, developed from community and stakeholder input and selected by members of the Project Working Group representing the three cooperating agencies*

The proposed concept is illustrated in **Figure ES-3** on the next page. Lawrence Expressway would be depressed under the three major study intersections as well as Central Expressway and the Caltrain tracks. The depression of Lawrence Expressway for the entirety of the project corridor would remove it as a visual and contextual barrier which was one of the primary goals of the project. Additionally, the proposed concept would include the construction of grade separated interchanges at each of the three major study intersections of Lawrence Expressway: Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue. The interchanges would include median ramps from the expressway up to the cross-street and a signalized intersection. In order to reduce project costs, the cross-streets would be slightly

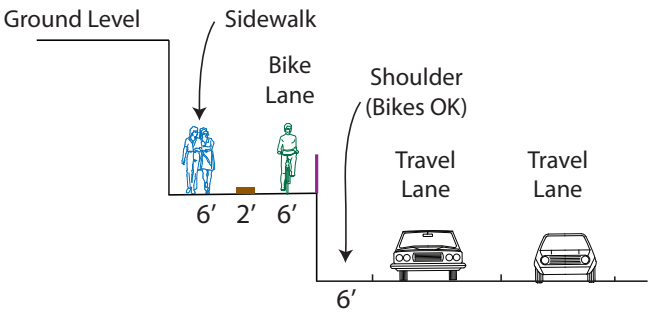
*Figure ES-3 - Proposed Concept Plan and Profile*



raised above the existing grade to reduce the depth of the depressed Lawrence Expressway. The raising of the cross-street elevations as they pass over Lawrence Expressway would be done in such a way as to minimize impacts to existing driveways located near the expressway on the cross-streets.

Bicycle and pedestrian movements would be provided in a corridor running adjacent to and slightly elevated above the vehicular roadway bed. The corridor would include both a bicycle path and a pedestrian path, separated by a small buffer, as shown in the cross-section depicted in **Figure ES-4**. The elevation of the bicycle/pedestrian corridor, on the order of 5 feet to 6 feet above the roadway bed, would improve safety by introducing a barrier from vehicles, reduces cost by minimizing excavation, and would reduce the vertical distance between the bicycle/pedestrian corridor along the expressway and the cross-streets. Bicycle and pedestrian movements between the corridor and cross-streets would occur via two-directional shared ramps on either side of each cross-street. Commuter cyclists also will still have the option to travel within the shoulder of Lawrence Expressway at the elevation of the roadway bed if desired.

***Figure ES-4 - Cross-Section of Bicycle/Pedestrian Corridor***




Conceptual renderings of the proposed concept were prepared and are provided as **Figure ES-5** and **Figure ES-6**.

Transit stops would be located on the median ramps at the signalized intersections. This would provide easy access to and from adjacent land uses and the stops, while minimizing bus delay. The HOV lane functionality would be significantly improved by eliminating a number of the existing right-turn movements that require vehicles to enter and exit the HOV lanes prior to intersections. With the proposed concept, weaving movements across the HOV lane would be eliminated, except at the Central Expressway ramps.

***Figure ES-5 - Conceptual Rendering of View from Lawrence Expressway***

An optional feature of the proposed concept is the provision of bus pullouts along the expressway, directly beneath the Lawrence Caltrain Station. Such pullouts, combined with vertical circulation elements such as stairs and elevators, would provide direct access between the station and bus service along the expressway. These pullouts will be further evaluated for inclusion at a later stage of the project.

The proposed concept would reduce the projected Year 2040 average travel time between Oakmead Parkway/Duane Avenue and Cabrillo Avenue for the peak-hour travel direction along Lawrence Expressway by 40 percent or greater. Travel time across Lawrence Expressway along the crossing streets is projected to be reduced by 40 percent to as much as 90 percent, depending on the cross-street and time period. These reductions in travel time and associated reductions in vehicle idling time would dramatically reduce fuel consumption and greenhouse gas emissions.

By grade separating the turn movements from all the approaches at the three study intersections, north/south through traffic along

the expressway would be able to flow freely, thus accomplishing one of the primary goals of the project of alleviating congestion along Lawrence Expressway and increasing the throughput of the expressway. The existing four through lanes in each direction on Lawrence Expressway were found to be sufficient to handle projected Year 2040 volumes with the removal of the at-grade intersections. The grade separations would serve to keep traffic on Lawrence Expressway. Bicycle circulation would be improved through the inclusion of a grade-separated, dedicated bike lane to provide both comfort for the recreational cyclist and speed for commuter cyclist. By dramatically reducing the width of existing cross-street intersections to the narrower ramps only, pedestrian and bicycle crossing distances would be significantly shorter compared to existing conditions. This increases pedestrian and bicycle comfort and safety, and reduces travel time. Additionally, vehicle conflicts with pedestrian and bicycle movements would be reduced by eliminating a number of right turn movements that currently exist at the cross-streets, improving pedestrian and bicycle safety.

***Figure ES-6 - Conceptual Rendering of Birds-Eye View of Interchange***

*The proposed concept is projected to reduce average vehicle delay in the study area by over 60 percent and total fuel consumption by roughly 30 percent in both peak hours in Year 2040, providing both significant circulation and environmental benefits.*

The proposed concept would require complex construction phasing to maintain access along Lawrence Expressway while the improvements are constructed. Closing the roadway would greatly shorten the project duration, but is likely to be infeasible given the limited number of alternative routes. Construction staging would likely require closing the road in phases, balancing the number of lanes maintained with the desire for a short construction schedule. Given the strong directionality to traffic movements, reversible lanes during the construction period may be beneficial. It is likely that periods of full closures of Lawrence Expressway and the cross-streets may be needed. The construction duration is currently estimated to be three to five years. Additional design development and consideration to traffic handling during construction will be required in order to refine the duration period.

*The proposed concept includes a grade-separated bicycle and pedestrian corridor with connections to cross-streets and transit, which serves to improve safety and remove significant barriers to mobility.*

A high-level opinion of probable cost, with a 40 percent contingency amount, was prepared for the proposed concept. The proposed concept is estimated to cost $434 Million, which includes approximately $321 Million in construction cost, $46 Million in right-of-way acquisition, and $66 Million for design, environmental studies, project administration, and construction support.

The proposed project has only been designed at a very rough, conceptual level. Further design will be needed in order to increase the confidence in the project cost estimate, the construction schedule and the right-of-way needs. The next step in the design process would be to expand the design work to further explore the drainage/water table issues, better define the bridge, tunnel and retaining wall requirements, and further consider stage construction requirements. A more detailed plan line would serve to better identify required right-of-way and easement boundaries. An environmental analysis will be required, and alternatives evaluated, prior to completion of preliminary engineering. It is anticipated that the most significant risk factors in the project cost, schedule and viability may include

the challenges of removing an existing bridge over and constructing a new tunnel under an active freight and passenger railway, the high water table, potential contamination of the soil that would be excavated, relocation of existing utilities, construction staging areas, and traffic handling requirements during construction.

*Next steps in the project include further design and refinement of the cost estimate, an environmental analysis and identification of funding sources.*

The proposed project was presented at a public meeting, stakeholder meetings, and to several advisory and decision-making bodies of the County of Santa Clara, City of Sunnyvale, and City of Santa Clara. Upon receiving support of the proposed project by the decision-making entities of each of the project partners, the proposed project will be incorporated into the Expressway Plan 2040 Study.

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# 1. Introduction

Lawrence Expressway is part of the County Expressway System, a regional network of key thoroughfares operated and maintained by the County of Santa Clara. The expressways serve numerous functions, including regional connectivity, local access, and multi-modal circulation. The primary mission of the expressway system is to relieve local streets of through traffic and supplement the freeway system.

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Grade separations have been historically implemented at various locations throughout the expressway network as a solution for congested intersections when all feasible at-grade solutions are not sufficient. Lawrence Expressway itself is grade separated at major crossings of both El Camino Real and Stevens Creek Boulevard. Grade separations have been long considered as potential improvements for the Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street intersections, with some rough concepts dating back decades. Over the years, a number of at-grade improvements have been implemented at these locations, with the addition of travel lanes, turn lanes, and extensive signal operations optimizations along the corridor. With the congestion along Lawrence Expressway between US 101 and Reed Avenue/Monroe Street continuing to increase, and rising to the top of the areas of greatest need countywide, the County and its partners, the City of Santa Clara and the City of Sunnyvale, elected to embark on a study to better understand the type of solutions needed to improve the most congested section of Lawrence Expressway. The section of Lawrence Expressway examined in this study is shown in **Figure 1-1**.

The Lawrence Expressway Grade Separation Concept Study used technical analysis, design feasibility evaluation, and public and stakeholder input to develop a proposed concept that would address near-term and long-term circulation needs within the congested portion of Lawrence Expressway between Arques Avenue and Reed Avenue/Monroe Street.

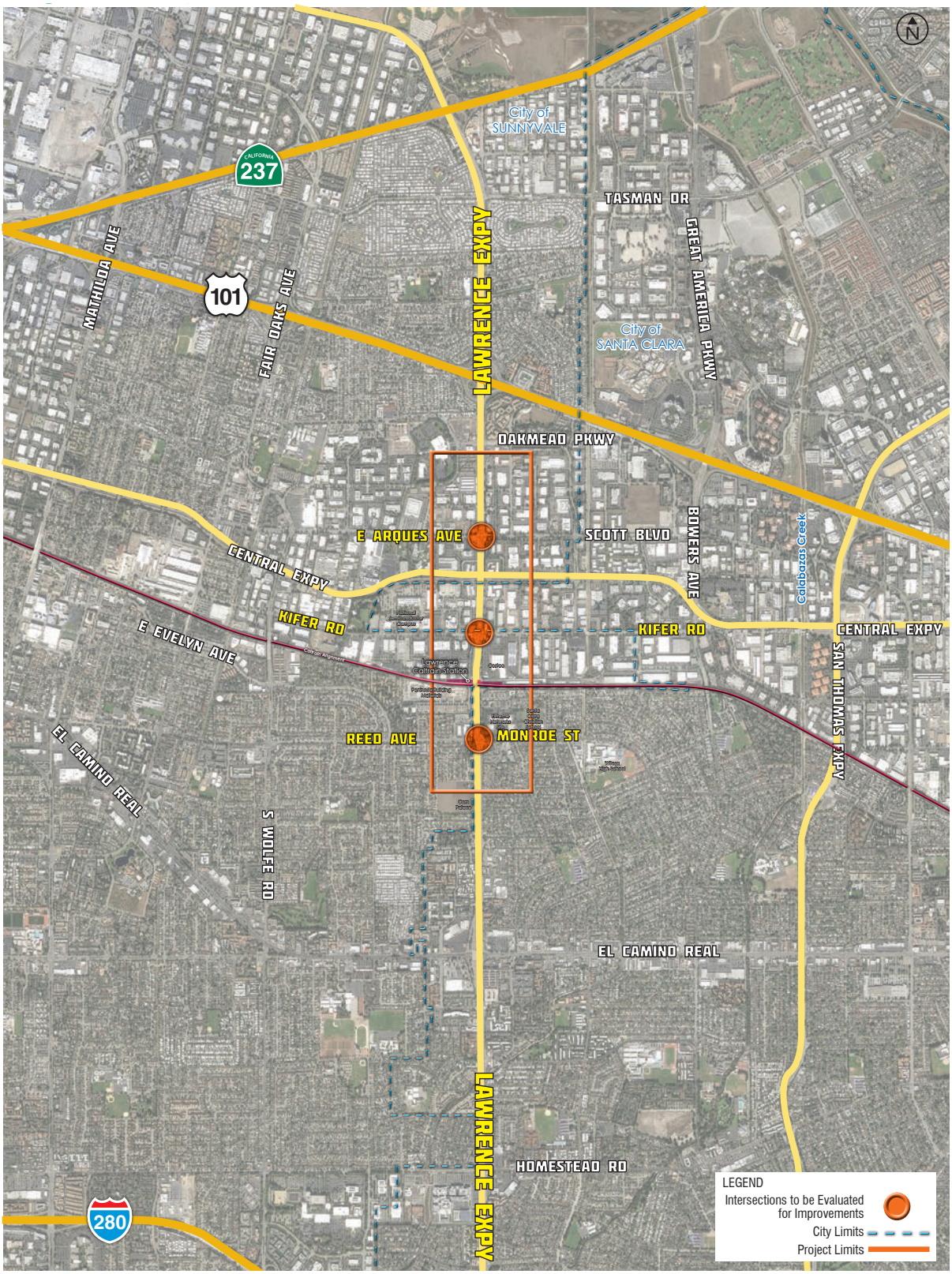
## *1.1. County Expressway Planning*

In 2003, the County of Santa Clara completed a Comprehensive County Expressway Planning Study, which developed a long-term plan and program for the improvement and maintenance of the County expressway system. The study used an extensive public process to identify the local vision and desired function for each expressway. This effort resulted in agreement upon the following vision for Lawrence Expressway:

> *Southern end more arterial-like; mid-section more high-end expressway with freeway like segments; and northern end more high-end express arterial.*

The portion of Lawrence Expressway under consideration in this study is the mid-section. The 2003 Expressway Study identified the intersections along Lawrence Expressway at Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue as operating at level of service (LOS) F conditions in 2001 and recommended that interchanges be constructed at these three intersections to reduce congestion along Lawrence Expressway. Level of service is a traffic engineering term used to grade vehicle flows and operations on traffic facilities, and identify those in need of improvement. LOS F is the lowest grade possible and is associated with significant delays and excessive

*Figure 1-1 - Regional Project Map*



queuing. The mid-section of Lawrence Expressway was identified as one of the most critical needs in the expressway system. However, beyond identifying the need for grade separation at these locations, no detailed evaluation of solutions or associated costs was performed.

In 2008, an update to the 2003 Comprehensive County Expressway Planning Study was completed. The 2008 Update was undertaken to reflect new conditions along the County expressways and to address other key issues that were not fully addressed in the 2003 Study. As part of the 2008 Update, the three intersections along Lawrence Expressway were analyzed again and it was determined that the LOS conditions had improved since the original Expressway Study due to signal timing technical advances, improvements on parallel facilities, and reduced traffic demand resulting from high unemployment rates. However, the grade separation projects at these three intersections remained as priorities in the 2008 Update in recognition of anticipated growth and worsening LOS associated with the recovering economy and new development in the cities of Sunnyvale and Santa Clara.

The Lawrence Expressway Grade Separation Concept Study was born out of the needs identified in the 2003 and 2008 Expressway Planning Studies in an effort to define the improvements needed, and develop a reasonable cost estimate. This study was initiated in 2013 with the intent to identify a technically feasible, community-supported solution for inclusion in the subsequent update to the 2008 Expressway Planning Study (called "Expressway Plan 2040"), which began in 2013.

The Expressway Plan 2040 is currently underway and will be the successor to the 2003 Comprehensive County Expressway Planning Study and the subsequent 2008 Study Update. The purpose of the Expressway Plan 2040 is to analyze the County expressways and assess the infrastructure needs based on existing and projected traffic volumes, bicycle and pedestrian circulation, and community input. The Expressway Plan 2040 will identify policy, solutions and implementation strategies that will guide infrastructure investments in the County expressway system going forward.

## *1.2. Project Need*

Previous County expressway planning efforts identified Lawrence Expressway south of US 101 and north of El Camino Real as one of the most capacity-constrained, congested segments within the expressway system. The corridor currently serves over 80,000 vehicles per day; a traffic volume level often comparable to grade-separated multi-lane freeways. These traffic volumes, and the corresponding roadway width needed to serve them, results in an expressway with a wide footprint. The high volumes and wide footprint result in a corridor that divides the adjacent communities, makes it challenging to access adjacent land uses, and results in an undesirable bicycling and pedestrian environment.

Opportunities for alleviating current congestion through signal timing, striping and other low-cost means have been exhausted; compounding the need, volumes and congestion are forecast to continue to grow as the Silicon Valley economy booms, and land use is intensified in areas around transit stations, such as the Lawrence Caltrain Station. The Lawrence Expressway Grade Separation Project seeks to identify potential improvements at the intersections of Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue that will address existing and forecast traffic congestion in the study area and promote community goals of enhanced connectivity. Identifying these improvements through this study will be critical to addressing the long-term congestion problem by allowing for:

- Preservation of right-of-way (ROW) needed for long-term improvements as the area redevelops;
- Identification of project costs, supporting inclusion in traffic impact fee programs and in the ultimate preparation of a financing plan;
- Establishment of a basis for further preliminary engineering and environmental analysis, getting improvements closer to being shovel-ready to capitalize on financing opportunities as they arise; and
- Identification of a project and cost for inclusion in the Expressway Plan 2040 Study, the Valley Transportation Plan, and the Regional Transportation Plan.

The study is focused on identifying improvements to the three intersections of Reed Avenue/Monroe Street, Kifer Road, and Arques

Avenue; however, it also examines the associated effects over a wider area to ensure that solutions at those locations won't just shift the problem elsewhere.

Based on input from the project stakeholders and the public, the following set of goals, and associated baseline challenges, were identified for improvements to Lawrence Expressway:

- Reduce congestion along Lawrence Expressway: Long delays occur at the traffic signals along Lawrence Expressway and traffic volumes along this corridor are projected to continue increasing.
- Enhance bicycle and pedestrian connectivity across Lawrence Expressway: Currently bicyclist and pedestrians encounter long crossing distances and long waits to cross Lawrence Expressway.
- Maintain and enhance access to the Lawrence Caltrain Station: The current configuration of the local streets used to access the Lawrence Caltrain Station is difficult to navigate for automobiles, buses, bicyclists, and pedestrians.
- Coordinate solutions with the ongoing Lawrence Station Area Plan (LSAP) efforts: Ensure that the Lawrence Expressway solution works harmoniously with the LSAP efforts in improving connectivity, providing for redevelopment and density, and enhancing the viability of the Lawrence Caltrain Station.
- Ensure that any solution fits the community context: Reduce or minimize the existing visual and perceived community barrier that is Lawrence Expressway and develop a solution that fits the varying character of adjacent land uses.
- Develop a cost effective solution with community support.

A few additional guiding principles were identified through the stakeholder and public process that would be used to evaluate and prioritize the identified improvements:

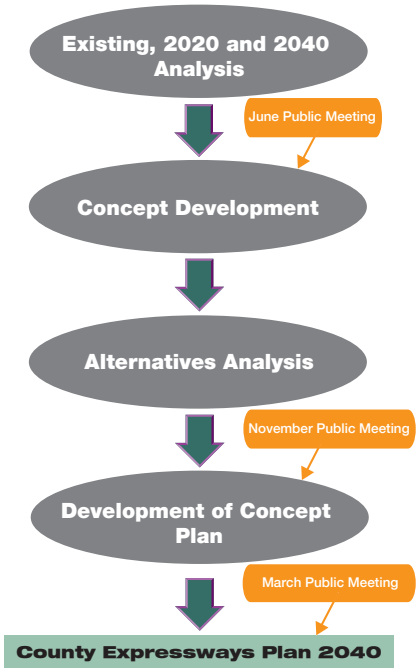
- Minimize ROW needs: Minimize encroachment upon any adjacent parcels and properties.
- Avoid shifting the entire problem to another choke point: Consider the effects of potential solutions on nearby streets and downstream on Lawrence Expressway.
- Maintain local access: Maintain access to businesses and the community from Lawrence Expressway.
- Consistency with environmental goals and policies: Reduce greenhouse gas emissions and other pollutants associated with vehicle idling and delays, and support the use of alternative modes in the corridor.

# 2. Project Methodology

## 2.1. Project Process

The project was completed following the general process shown in **Figure 2-1**. The project was guided by a Project Working Group (PWG). The PWG was comprised of transportation planning, traffic operations, and highway design staff from the County of Santa Clara, transportation engineers and planners from the City of Sunnyvale, transportation engineers and planners from the City of Santa Clara, and transportation planners from the Santa Clara Valley Transportation Authority (VTA). The PWG met at key decision points in the project to review project materials, identify and assist with stakeholder coordination, provide input on public meeting format and content, and provide project guidance. A Small Working Group (SWG), comprised of key County of Santa Clara, City of Sunnyvale, and City of Santa Clara staff, was also utilized to provide direction at key decision points.

*Figure 2-1 - Project Flow Chart*




### 2.1.1. Baseline Analysis

The baseline analysis included developing an understanding of existing and future traffic conditions, design constraints, and other circulation needs. The baseline analysis relied upon existing traffic, bicycle and pedestrian counts; travel demand forecast models; available utility information; available topography; and field observations of the corridor. The project utilized analysis years of 2020 and 2040. Year 2020 was used as the near-term scenario since it represents the earlier timeframe for which improvements could be realistically implemented, and a traffic forecast scenario that can be predicted with reasonable confidence. Year 2040 was selected as the horizon year to be consistent with other regional planning efforts and to capture potential future traffic growth in the area.

A community workshop was held to present some of the findings of the baseline analysis, understand how the community interacts with the corridor, and obtain community input on the goals of the project, existing challenges, and areas of greatest need. This information was utilized to refine the project objectives and to guide the concept development phase of the project. The project was also presented at stakeholder and community meetings, including with elected officials, bicycle and pedestrian advisory committees and the County of Santa Clara Roads Commission.

### 2.1.2. Concept Development

The consultant, Kimley-Horn and Associates (Kimley-Horn), developed a list of potential capacity-enhancing solutions for the study intersections along Lawrence Expressway. The list included a variety of solutions that would be feasible in a developed, constrained urban area. Kimley-Horn consulted recent research, recent projects in the region, and past experience in developing the potential concept list. Kimley-Horn evaluated the list of potential concepts based on their applicability to the unique environment and constraints in the project area and identified those concepts that would be most appropriate and consistent with the project goals. Simple sketches of each of the concepts were prepared and presented to the PWG. Based on direction from the PWG, a total of nine corridor concepts were selected for further study. The nine concepts included distinct solutions at each of the study area intersections, with some solutions appearing in multiple concepts. The concepts were to be evaluated on a corridor-basis to understand the effectiveness of a set of solutions at achieving the project goals.

Each concept resulted in some sort of capacity enhancement at each of the study intersections. This was achieved through grade separation or removal of phases at signalized intersections. The solutions for local access and connectivity varied amongst the grade separation concepts. The changes in circulation patterns and traffic volumes specific to each concept were identified and baseline volumes were modified to represent with concept near-term and horizon year volumes. Kimley-Horn analyzed traffic conditions with the implementation of each of the concepts for the near-term and horizon year time frames. The analysis was performed consistent with

Highway Capacity Manual guidelines, the industry standard, using the Synchro software package. Synchro allows for the calculation of delay and level of service at individual intersection locations. Subsequent to the traffic analysis, the concepts were refined to provide additional capacity where needed. Access patterns and the number of lanes at signalized intersections and on ramp facilities required with each of the concepts were refined based on the traffic analysis.

This information was utilized to prepare a rough conceptual design for each of the concepts. They were sketched out in plan view with an aerial background. Profiles were created to examine the feasibility of grade separations on Lawrence Expressway. The concepts were shared with the structural subconsultant, Biggs Cardosa Associates (BCA), for their evaluation of the structural feasibility of the concepts. ROW needs, costs, and implementation feasibility were qualitatively evaluated for each concept.

Based on the analysis performed, Kimley-Horn prepared a qualitative matrix identifying how each of the nine concepts address traffic flow, local traffic circulation, bike/pedestrian circulation, local access, and community context. A qualitative evaluation of cost magnitude was prepared for each concept along with a limited assessment of the constructability and potential major utility conflicts associated with each of the nine concepts.

### *2.1.3. Alternatives Analysis*

The SWG reviewed the concept evaluation and identified three corridor alternatives for further study. These alternatives represented a combination of the most feasible and effective of the individual solutions proposed as part of the concept development stage of the project. Illustrative circulation graphics were prepared for each alternative to obtain consensus on the characteristics of the alternatives. Traffic volumes within the study area with implementation of each of the three alternatives were developed. Some of the alternatives resulted in changes in traffic patterns off of the expressway, and those were considered and examined. The traffic volumes, potential geometric layouts and signal operations strategies were programmed into a micro-simulation model, for a detailed analysis of each of the alternatives.

The micro-simulation model, developed using the VISSIM software package, allows for modeling of individual vehicle movements as they travel through the roadway network. By using a micro-simulation model, the operations of the entire study area network can be considered in an integrated fashion, allowing for the detailed evaluation of upstream and downstream effects of a set of solutions. A critical component of the alternatives analysis was understanding how proposed treatments at the individual intersections would interact and affect upstream and downstream locations. VISSIM provides the opportunity to model complex multi-modal traffic interactions, including merge, weave, pedestrian and bicycle movements and represents a more sophisticated and detailed analysis tool than was used in the concept development stage of the project. The VISSIM analysis was used to calculate metrics such as intersection delay, queuing, and corridor travel time for each alternative. Based on the VISSIM analysis, some modifications were made to the geometry and operations of the alternatives to make them more effective. Videos were prepared of the micro-simulation models and used in the alternatives evaluation to visually convey the resulting traffic operations with each alternative.

Based on the refinements made through the transportation modeling process, conceptual designs were prepared for each alternative in the form of plan views, cross-sections, and profiles. Bicycle and pedestrian facilities were considered and incorporated into the conceptual designs. ROW and access impacts on parcels were identified for each alternative. Constructability and implementation was reviewed, including a structural feasibility review by BCA. Opinions of probable cost were prepared, with a 40 percent contingency, for each alternative.

Findings from the traffic analysis, multi-modal circulation review, cost assessment, and feasibility review were combined into an evaluation matrix for the three alternatives.

During the alternatives analysis process, a set of community workshops were held to inform the public on the alternatives under consideration. At the workshops, the project team presented the alternatives and obtained feedback on how well they aligned with community needs and vision. The alternatives were also presented to a number of key stakeholders and area employers, including Chambers of Commerce, and at several committees and advisory bodies, including bicycle and pedestrian advisory committees.

### 2.1.4. Development of the Proposed Concept

The SWG reviewed the alternatives evaluation and collectively identified one corridor alternative as the proposed concept. The proposed concept represented a combination of certain features of the different design alternatives. The proposed concept resulted in some modifications to the circulation patterns proposed as part of the alternatives, thus new traffic analysis was conducted. The micro-simulation models were revised and the concept was refined based on the findings.

From the refined geometrics, conceptual engineering was prepared in the form of concept-level plan views, cross-sections, and profiles. Alternatives for bicycle and pedestrian connectivity and circulation were evaluated. Based on input from bicycle and pedestrian advisory bodies, a preferred bicycle and pedestrian solution was identified and incorporated into the proposed concept. The proposed concept was evaluated for constructability, implementation, and phasing, including a structural feasibility review by BCA. The level of review was more extensive than what was conducted in previous project phases. This resulted in a revised opinion of probable cost that incorporated cost elements and risk factors not previously incorporated.

The third and final community workshop was held during this stage of the process to present the proposed concept, get feedback from the community and answer any questions they may have. The proposed concept was additionally presented to decision-making and advisory bodies such as the County of Santa Clara Roads Commission, planning commissions, bicycle and pedestrian advisory committees and VTA committees, as well as to key stakeholders. The general consensus of the outreach was support for the proposed concept to be incorporated into Expressway Plan 2040.

## 2.2. Study Area

The proposed improvement concepts were developed for the Lawrence Expressway corridor between and including Titan Way and Reed Avenue/Monroe Street. Improvements were focused on the study intersections of Lawrence Expressway with Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street. A larger area was evaluated to quantify the effects of the proposed improvement concepts, including Lawrence Expressway and other major roadways within the area bound by Oakmead Parkway to the north, Oakmead Parkway/Corvin Drive to the east, Commercial Street/Deguigne Drive to the west, and Cabrillo Avenue to the south. This larger traffic analysis area includes portions of both the City of Sunnyvale and the City of Santa Clara. Lawrence Expressway and the signals along the expressway are owned and maintained by the County of Santa Clara. The intersections of Lawrence Expressway and Oakmead Parkway to the north and Cabrillo Avenue to the south were included in the traffic analysis area in order to analyze the effects of the proposed improvements on adjacent intersections and to ensure the traffic issues were not moved upstream and/or downstream from the focused study area where improvements would occur. The extents of the analysis area and the more focused study area for improvements are shown in **Figure 2-2**.

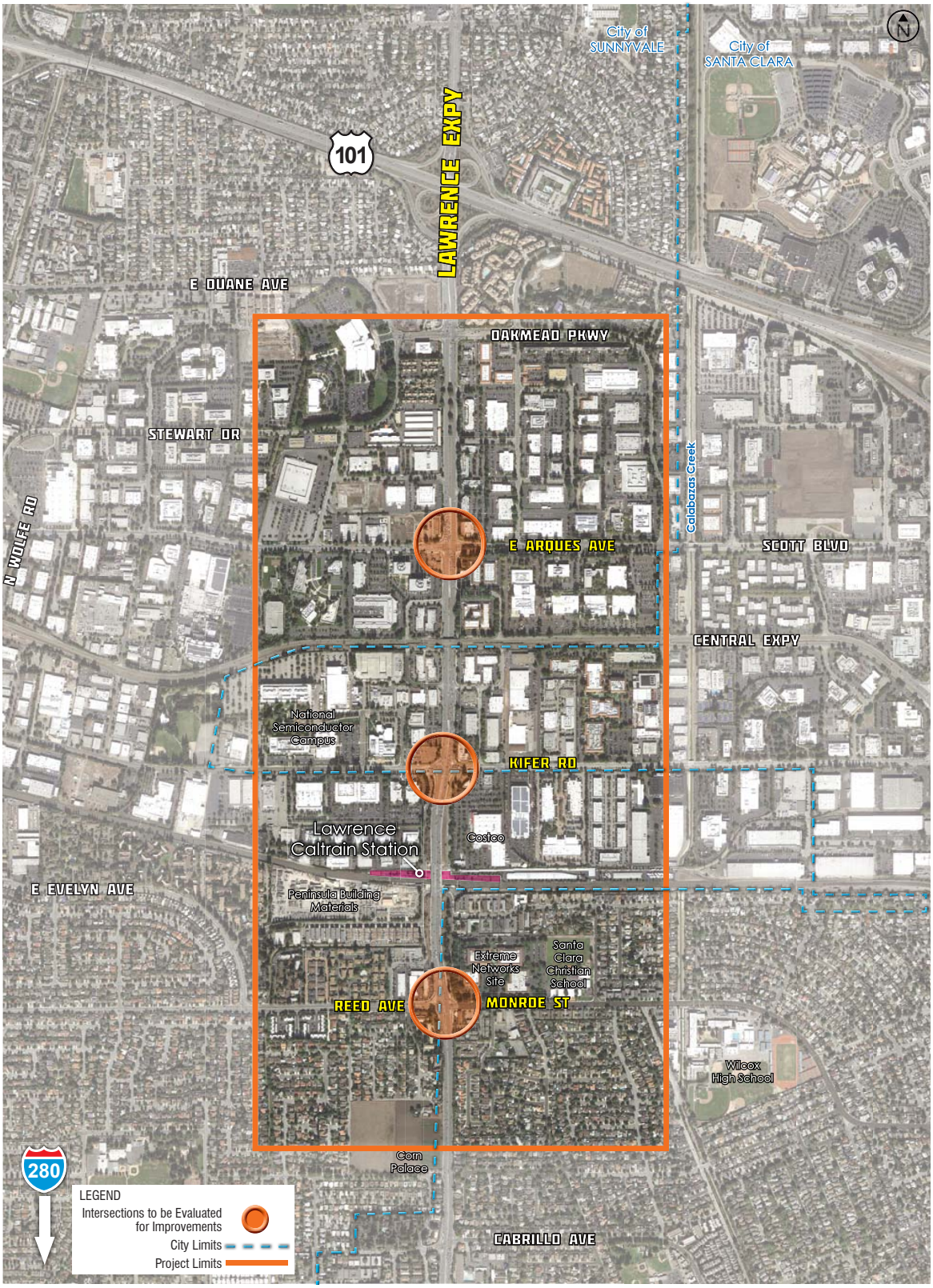
## 2.3. Data Collection

Kimley-Horn obtained available traffic count data for intersections and roadways within the study area. Counts were obtained from other recent studies (2012 and 2013 data), camera detection at the intersections along Lawrence Expressway (2012 and 2013 data), and new counts conducted for this and other ongoing County studies (May and June 2013). Bicycle and pedestrian counts were collected by County staff in April and May 2013. The County of Santa Clara and the cities of Santa Clara and Sunnyvale provided Kimley-Horn current traffic signal timing sheets. VTA modeling staff provided AM and PM model peak hour forecast plots of the study area for the baseline near-term (2020) and horizon year (2040) scenarios. The models were reviewed and refined to reflect reasonably expected roadway geometrics in the vicinity of the study area. The model plots are provided in **Appendix A**.

Kimley-Horn performed site visits to observe corridor conditions in the morning and evening peak hours, document existing intersection and roadway geometrics, and conducted a utility field review of the area noting observable above ground utility features.

A list of utility purveyors was obtained through a request to Underground Service Alert (USA) and Kimley-Horn sent utility letters requesting facility maps and as-builts from utility purveyors. Information was received from Air Products, AT&T, the City of Sunnyvale, Level 3 Network, Pacific Gas & Electric, and XO Communications regarding facilities within the corridor. Portions of the corridor have above-ground electrical poles. No potholing of the facilities was performed. The County of Santa Clara provided as-builts from the

*Figure 2-2 - Study Area Map*



widening (1995) and retrofit (1981) of the Caltrain Bridge, the improvement of Central Expressway (1989), and the widening of Lawrence Expressway (1965). The County also provided an aerial and GIS-based parcel data to Kimley-Horn for this project. Topographic contours were obtained from the Santa Clara Valley Water District website.

## 2.4. Design Techniques

The Caltrans Highway Design Manual (HDM) was used as the primary design standard for the design alternatives and the proposed concept. Lawrence Expressway is a high speed facility with many characteristics that are similar to a highway and Caltrans design standards are generally accepted where local geometric design standards are not present. Some modifications were made, where noted, to HDM standards to limit impacts or provide community-oriented facilities. The Americans with Disabilities Act (ADA) guidelines were also used for pedestrian facilities. Due to the preliminary level of design for this study, additional constraints will need to be analyzed during the final design phase.

Cost estimates were prepared to help in comparing each design alternative throughout the process and to aid the PWG in their selection of the features that would ultimately form the proposed concept. The construction quantities were determined for each alternative and the unit costs were assumed based on past bid results and Caltrans contract cost data. Several items were assumed as percentages of the estimated construction costs since the design is in the conceptual stage, and not all of the construction constraints or existing infrastructure is known. An overall contingency of 40 percent was used for this conceptual level of design as there are many factors that are unknown that will increase the project construction cost.

# 3. Baseline Conditions

## 3.1. Traffic Conditions

Lawrence Expressway is a heavily utilized, access constrained 8.7-mile, north-south running expressway. The expressway varies from 6 to 8 lanes including HOV lanes and has a speed limit of 50 miles per hour. The outside lanes of the expressway are designated as HOV lanes, with the HOV requirement in effect from 6:00 to 9:00 AM and 3:00 to 7:00 PM. Lawrence Expressway provides freeway connections to I 280, US 101, and SR 237 and runs directly through the Lawrence Caltrain Station area. The expressway is primarily used as a north-south connection between the freeways and connecting communities within the cities of Sunnyvale, Santa Clara and Cupertino with each other and the freeway network.

Lawrence Expressway also serves a role in providing community circulation and access, with a number of residences, businesses and commercial centers along side streets that connect to the expressway. It is one of the few north-south streets in the project vicinity that traverse the Caltrain tracks. The nearest north-south streets to Lawrence Expressway that cross the Caltrain tracks are Bowers Avenue just over one mile to the east and Wolfe Road approximately one mile to the west. Similarly, only Wolfe Road and Oakmead Parkway/ Corvin Drive provide through access across Central Expressway in the vicinity of the project area. Therefore, Lawrence Expressway plays a critical role in local circulation and access within the study area. Over half of the PM peak-hour southbound traffic and roughly half of the AM peak-hour northbound traffic on Lawrence Expressway is associated with local traffic that accesses or egresses the expressway at one of the studied cross-streets.

Major backups and delays occur in the southbound direction in the evening, primarily emanating from the Kifer Road and Reed Avenue/ Monroe Street intersections. Major backups and delay also occur in the northbound direction in the morning, primarily emanating from Reed Avenue/Monroe Street. The regional travel demand model is forecasting an increase in traffic volumes in the study area. Traffic volumes on Lawrence Expressway are forecast to increase by approximately 30 percent by Year 2040. Both increases in local land use (see Lawrence Station Area Plan section below) and regional commute traffic are expected to contribute to this increase. Central Expressway is planned to be widened from its currently four-lane configuration to a six-lane configuration, which will increase the number of vehicles traveling between Lawrence Expressway and Central Expressway.

The cross-streets of Arques Avenue and Kifer Road provide local access to a number of employers and commercial areas in the cities of Sunnyvale and Santa Clara. Costco is located immediately east of Lawrence Expressway and is accessed from Lawrence Station Road and Kifer Road. Reed Avenue and Monroe Street serve primarily residential neighborhoods in the vicinity of the study area, and also connect between downtown Sunnyvale and central Santa Clara. Central Expressway extends between Mountain View and San Jose, providing a key east-west circulation route and functions as a traffic reliever to a congested US 101.

The existing Lawrence Caltrain Station is served by a set of local streets with limited connections. The streets used to access the station are San Zeno Way and Lawrence Station Road, both of which are accessed from Kifer Road via right-in/right-out movements only. Vehicles traveling south on Lawrence Expressway have to access the station by turning left on Kifer and right on Lawrence Station Road. It is difficult to depart from the station and head north on Lawrence Expressway or west on Kifer Road.

Kimley-Horn analyzed the existing, near-term, and horizon year baseline traffic conditions at the three study intersections identified for improvement using collected count data. The existing, near-term and horizon year turning movement volumes are shown in **Figure 3-1**, **Figure 3-2** and **Figure 3-3**, respectively.

As shown in **Table 3-1**, the three study intersections identified for improvement will all operate at deficient levels of service by Year 2020, and two of the three locations currently operate deficiently. The amount of intersection delay is expected to grow significantly by Year 2040.

*Figure 3-1 - Existing Peak-Hour Traffic Volumes*

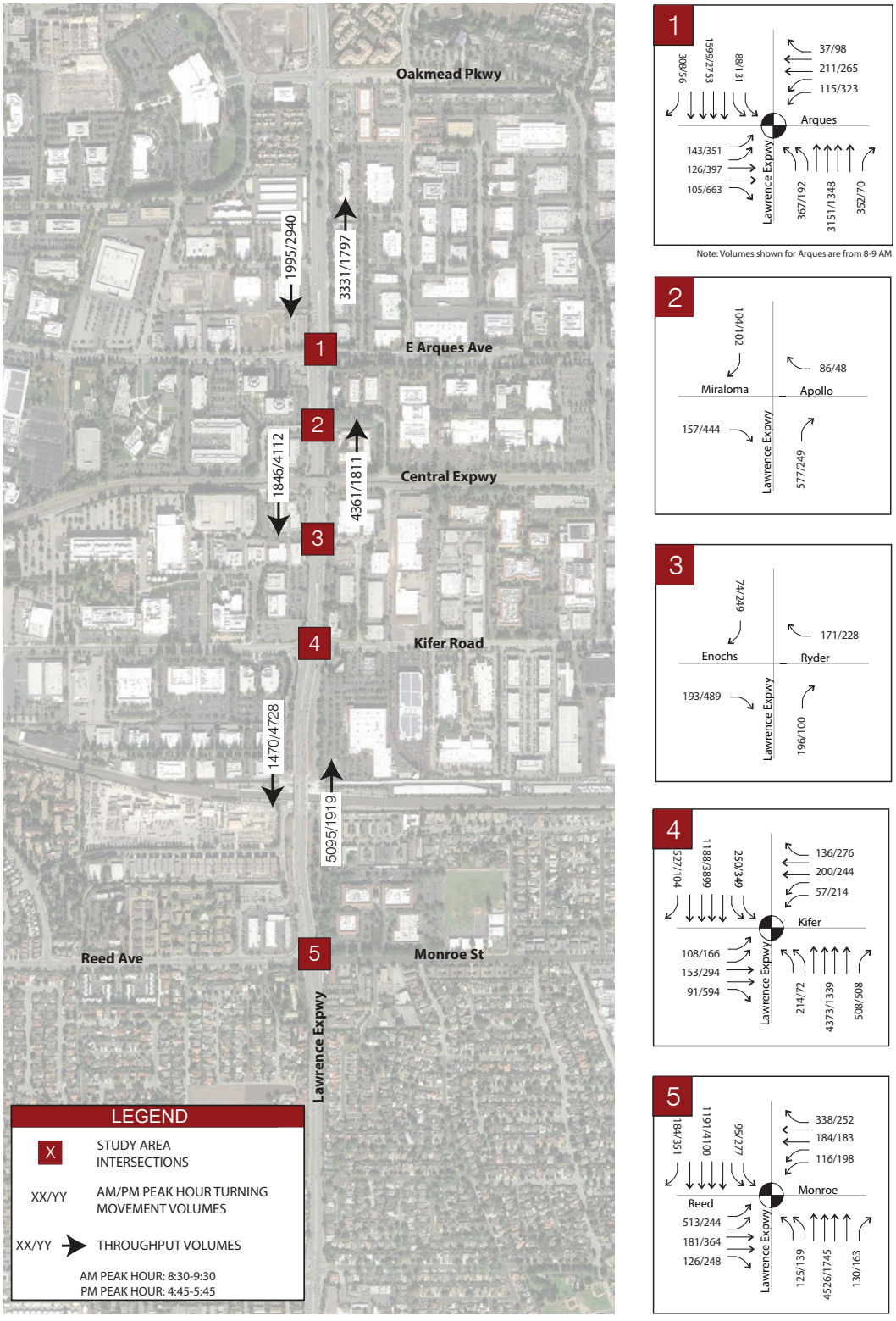


*Figure 3-2 - 2020 Peak-Hour Volumes*

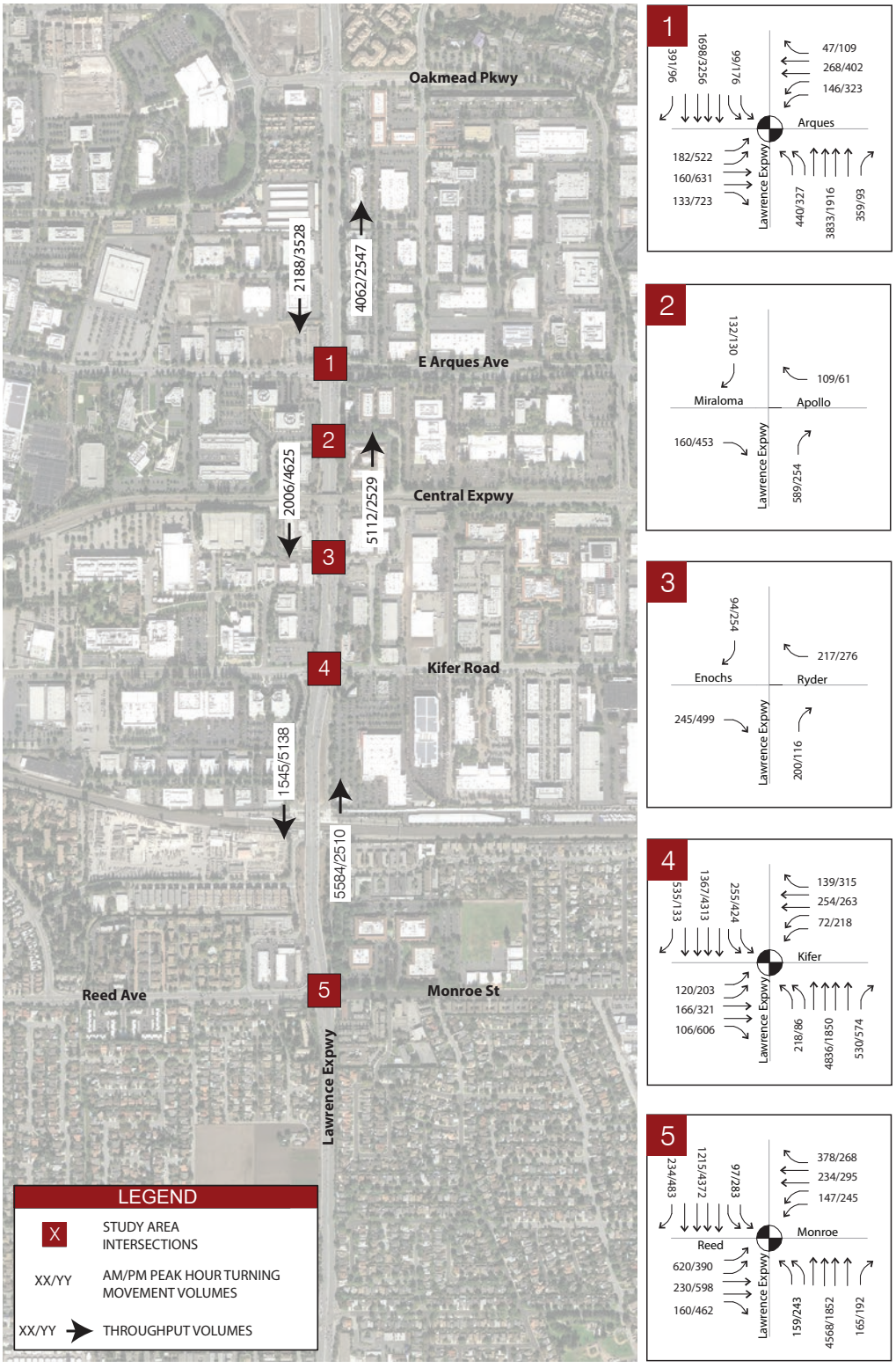


*Figure 3-3 - 2040 Peak Hour Volumes*

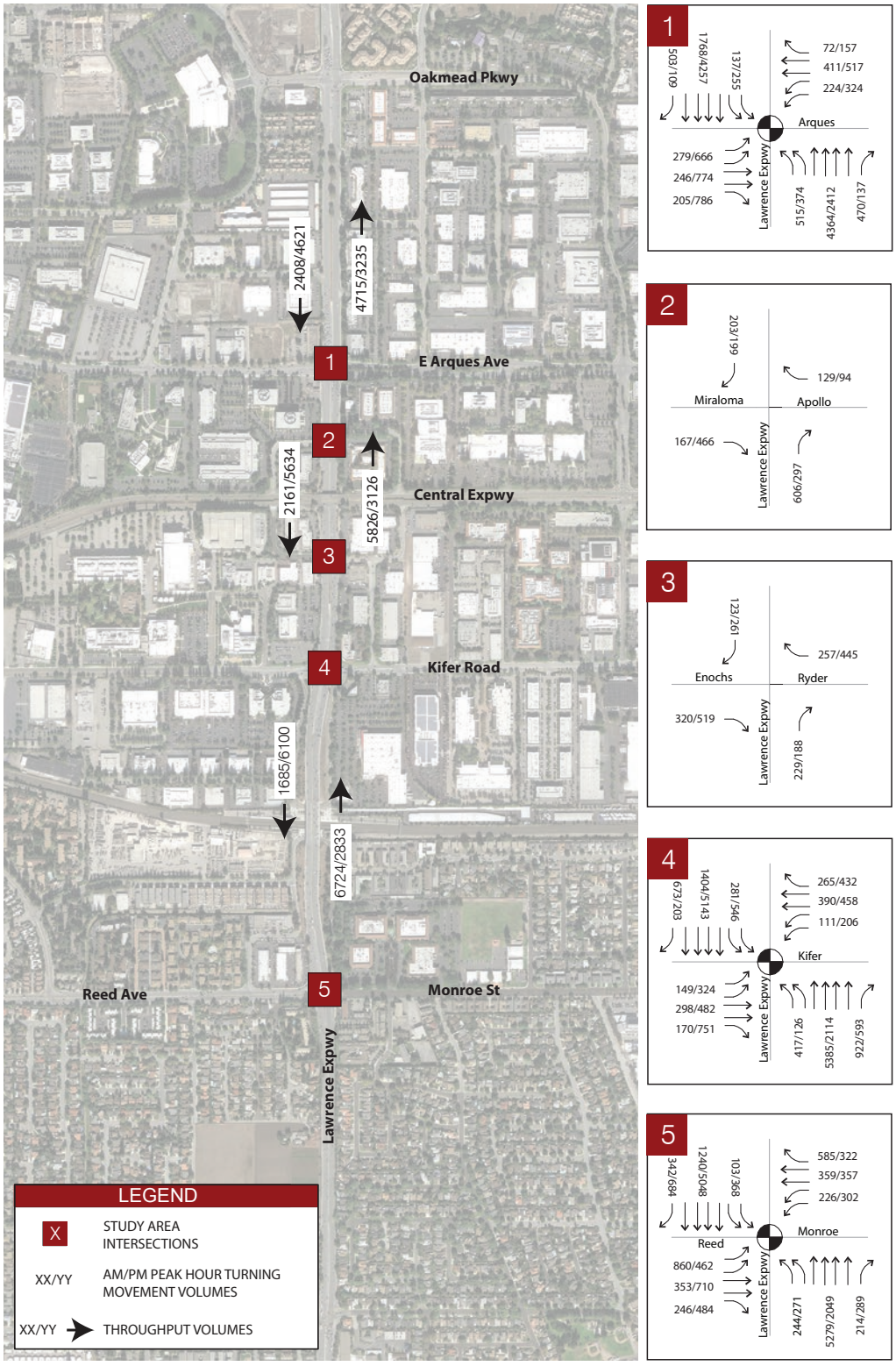


*Table 3-1 - Summary of Peak-Hour Intersection Level of Service Analysis*

| | INTERSECTION | PEAK HOUR | EXISTING | | 2020 BASELINE | | 2040 BASELINE | |
|---|---|---|---|---|---|---|---|---|
| | | | DELAY (a) | LOS (b) | DELAY (a) | LOS (b) | DELAY (a) | LOS (b) |
| 1 | Lawrence Expy / Arques Ave | AM | 27.6 | C | 35.8 | D | 92.5 | **F** |
| | | PM | 47.1 | D | 153.1 | **F** | 245.7 | **F** |
| 2 | Lawrence Expy / Kifer Rd | AM | 74.3 | **E** | 118.5 | **F** | 179.1 | **F** |
| | | PM | 109.4 | **F** | 129.2 | **F** | 236.3 | **F** |
| 3 | Lawrence Expy / Monroe St/Reed Ave | AM | 157.7 | **F** | 196.6 | **F** | 322.2 | **F** |
| | | PM | 72.0 | **E** | 155.3 | **F** | 174.6 | **F** |

(a) Delay refers to the average control delay for the entire intersection, measured in seconds per vehicle.

(b) LOS calculations are based on the methodology outlined in the 2000 Highway Capacity Manual and performed using Synchro 7.0

## 3.2. Multi-Modal Circulation

Sidewalks are provided along both sides of Lawrence Expressway north of Reed Avenue/Monroe Street. A sidewalk is not provided on the east side of Lawrence Expressway between Monroe Street and Cabrillo Avenue and the sidewalk on the west side of the same segment is very narrow and does not meet Americans with Disabilities Act (ADA) requirements. Pedestrian activity along Lawrence Expressway is somewhat limited, although more frequent pedestrian activity is present on the cross-streets. Pedestrian activity within the study area is focused at Arques Avenue, which is utilized by pedestrians predominately at lunch-time to access restaurants in the vicinity. Pedestrian activity also was noted at Reed Avenue/Monroe Street, possibly associated with nearby educational institutions.

Bicycles are allowed to use the shoulder along Lawrence Expressway, which is designed to bike lane standards but is not designated as a bike lane. Due to the high volumes and high speeds along Lawrence Expressway, cyclists using the shoulders are generally highly experienced commute cyclists. Bike lanes are provided along Arques Avenue, Kifer Road west of Lawrence Expressway, and Reed Avenue. Cyclists are also allowed in the shoulder of Central Expressway. Other streets in the vicinity with bike lanes include Oakmead Parkway/Duane Avenue, Cabrillo Avenue, Evelyn Avenue, Calabazas Boulevard, Commercial Street and Lakeside Drive. A map of bicycle facilities is provided in **Figure 3-4**. Bicycle volumes were highest for movements crossing the expressway, and during the PM commute period. The Lawrence Caltrain Station is, or has the potential to be, a major pedestrian and bicycle trip generator; however, local connectivity to the station is somewhat limited.

Existing bicycle and pedestrian volumes are shown in **Figure 3-5**.

Transit service along Lawrence Expressway is currently limited. VTA Route 328 is a limited stop bus route that operates between Sunnyvale and San Jose. It only has two directional trips in each peak period, on weekdays only. The route previously had 4 trips in each peak period, but declining ridership resulted in the service decrease. Bus stops are located on the expressway just north of Kifer Road, at Arques Avenue, and at Oakmead Parkway/Duane Avenue. An Altamont Commuter Express (ACE) shuttle route to the Great America Station operates on Arques Avenue and Kifer Road, with one shuttle meeting each of the four AM and PM peak period trains. Limited stop VTA Route 304 operates between Sunnyvale and San Jose along Arques Avenue with four trips in each of the AM and PM peak periods, on weekdays only. VTA Community Route 32 operates between Los Altos and Santa Clara via Reed Avenue/Monroe Street at roughly 30-minute frequencies during the AM and PM peak periods, with lower frequency mid-day service. Existing transit service is depicted on **Figure 3-6**.

The project team met with VTA as part of this project to discuss VTA's transit vision for this corridor. VTA indicated that Lawrence Expressway was not an ideal transit corridor due to land use and geometric constraints over the full extents of the corridor. Major cross-streets are not constructed in a way to facilitate the placement of bus stops and there are limited locations along the corridor where there are high ridership areas. Long-term, VTA does not see Lawrence Expressway as a strong transit corridor. It will alternatively focus service on parallel routes such as Wolfe Road or Bowers Avenue. If ridership were to increase, VTA would consider restoring peak period trips to Route 328.

VTA does not currently provide service to the Lawrence Caltrain Station. Service had been previously provided, but was replaced over time by private shuttles. Bus access to the Caltrain Station is poor and shuttle service is focused on nearby Caltrain stations such as Sunnyvale and Santa Clara. VTA noted that even if the study segment of Lawrence Expressway were to become more transit friendly, service would still be undesirable due to geometric and other constraints elsewhere on the corridor.

VTA did note that Route 32 could possibly be modified to better serve the area, including the Lawrence Caltrain Station. However, the route already extends between Caltrain stations, so serving another station along the route may not provide substantial benefit to outweigh the travel time cost.

*Figure 3-4 - Existing Bicycle Facilities*

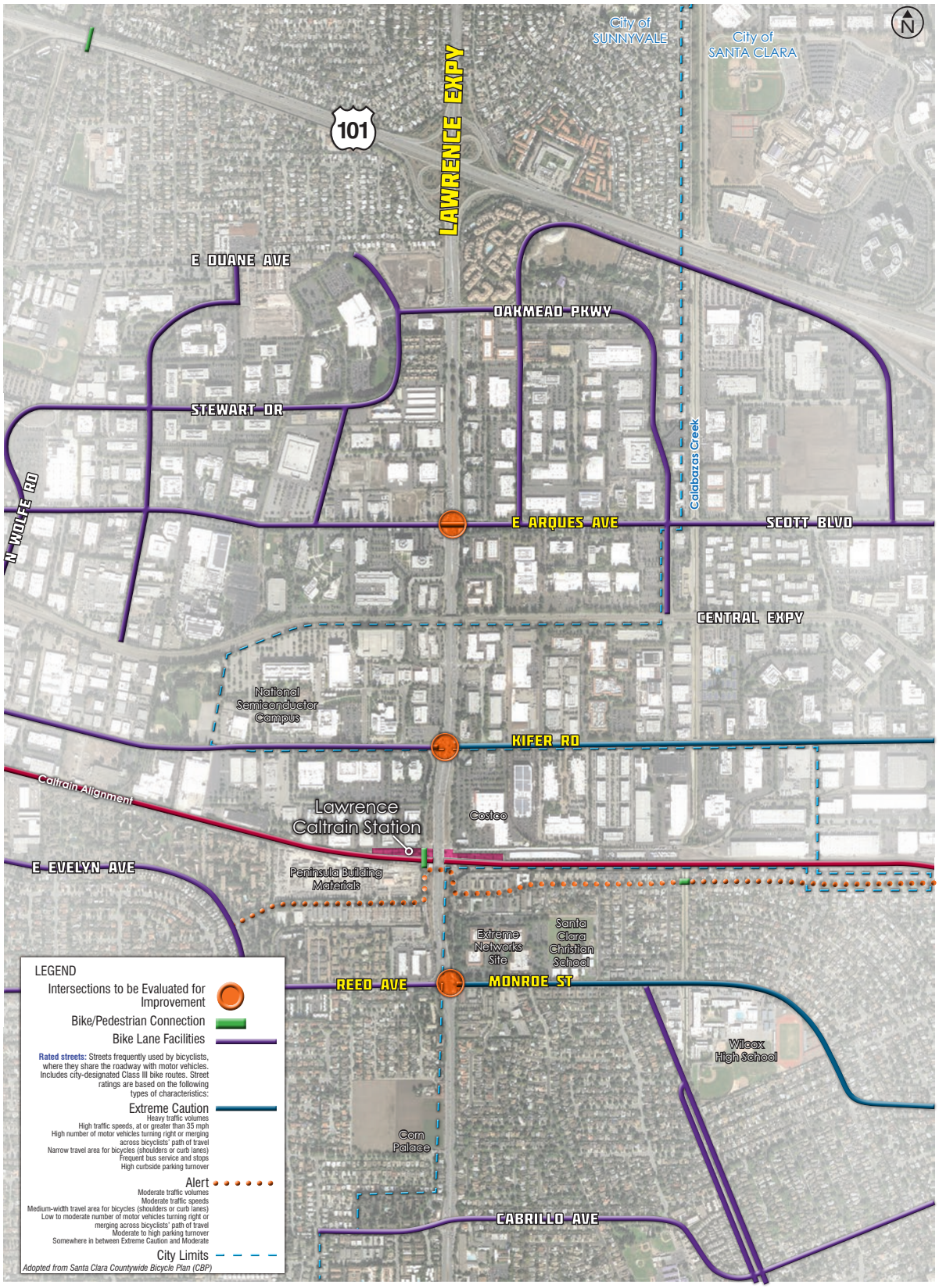
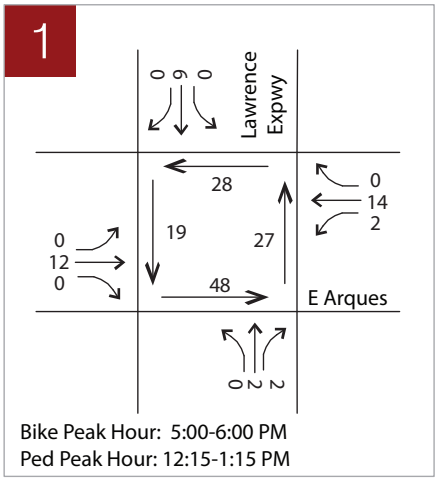
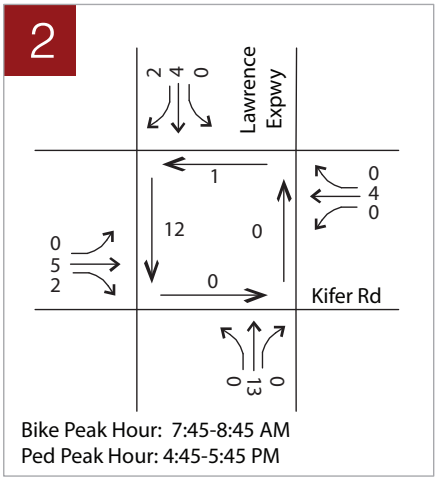


*Figure 3-5 - Existing Pedestrian and Bicycle Volumes*

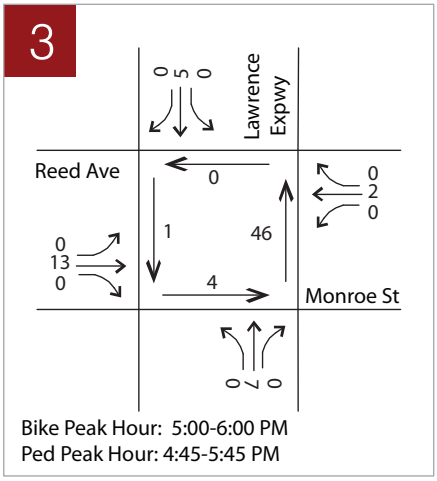
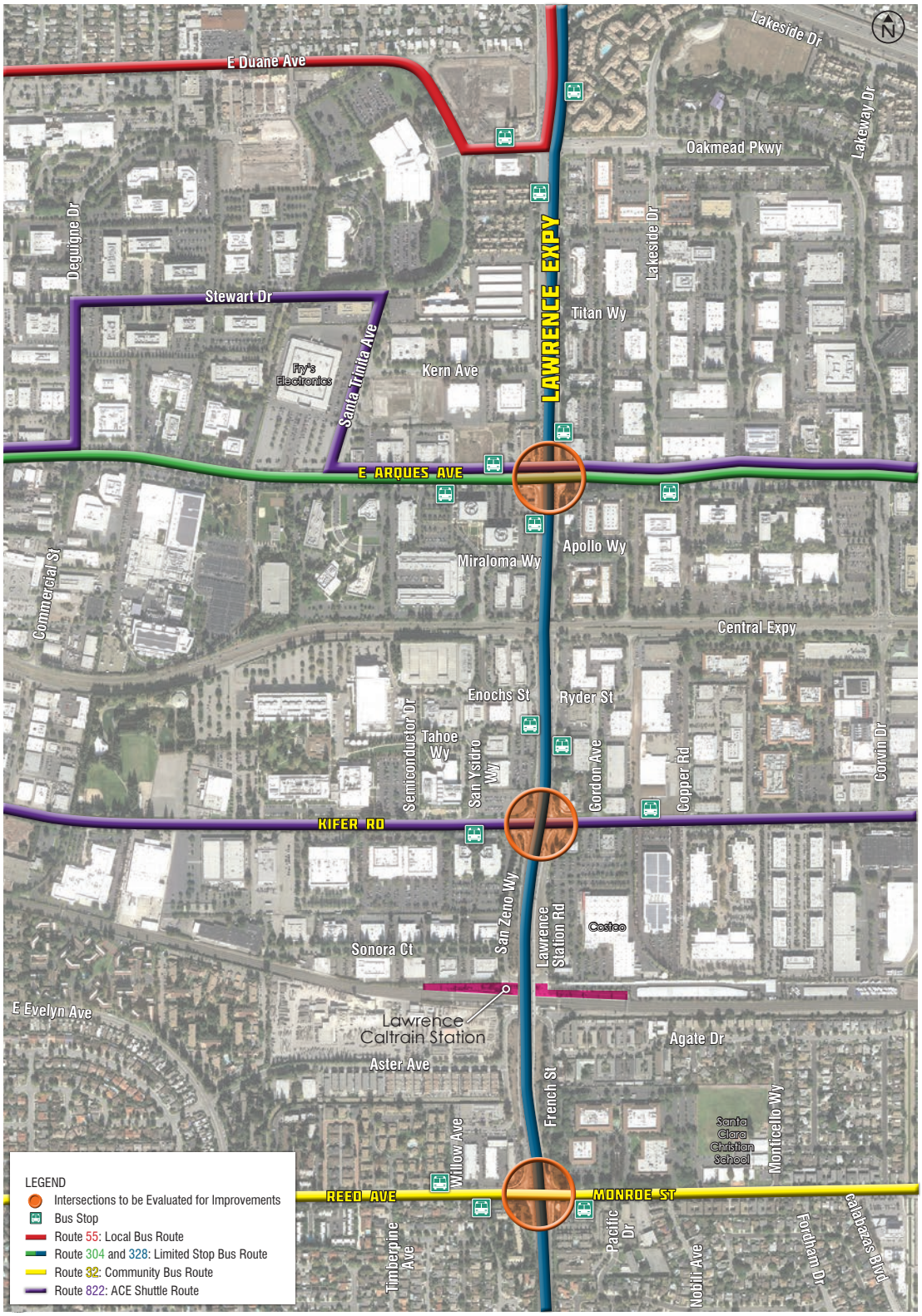



*Figure 3-6 - Existing Transit Service*



## 3.3. Land Use and Lawrence Station Area Plan

In general, there are two distinct land use patterns that occur within the study area. South of the Caltrain tracks, uses are primarily medium-density and low-density residential, with some educational facilities and limited commercial. The northern portion of the project area is more oriented toward larger scale office campuses and business parks, industrial uses, and some retail and commercial uses. Most of these uses are located on larger parcels and include large surface parking lots. Major businesses include Costco, Fry's Electronics, and Texas Instruments.

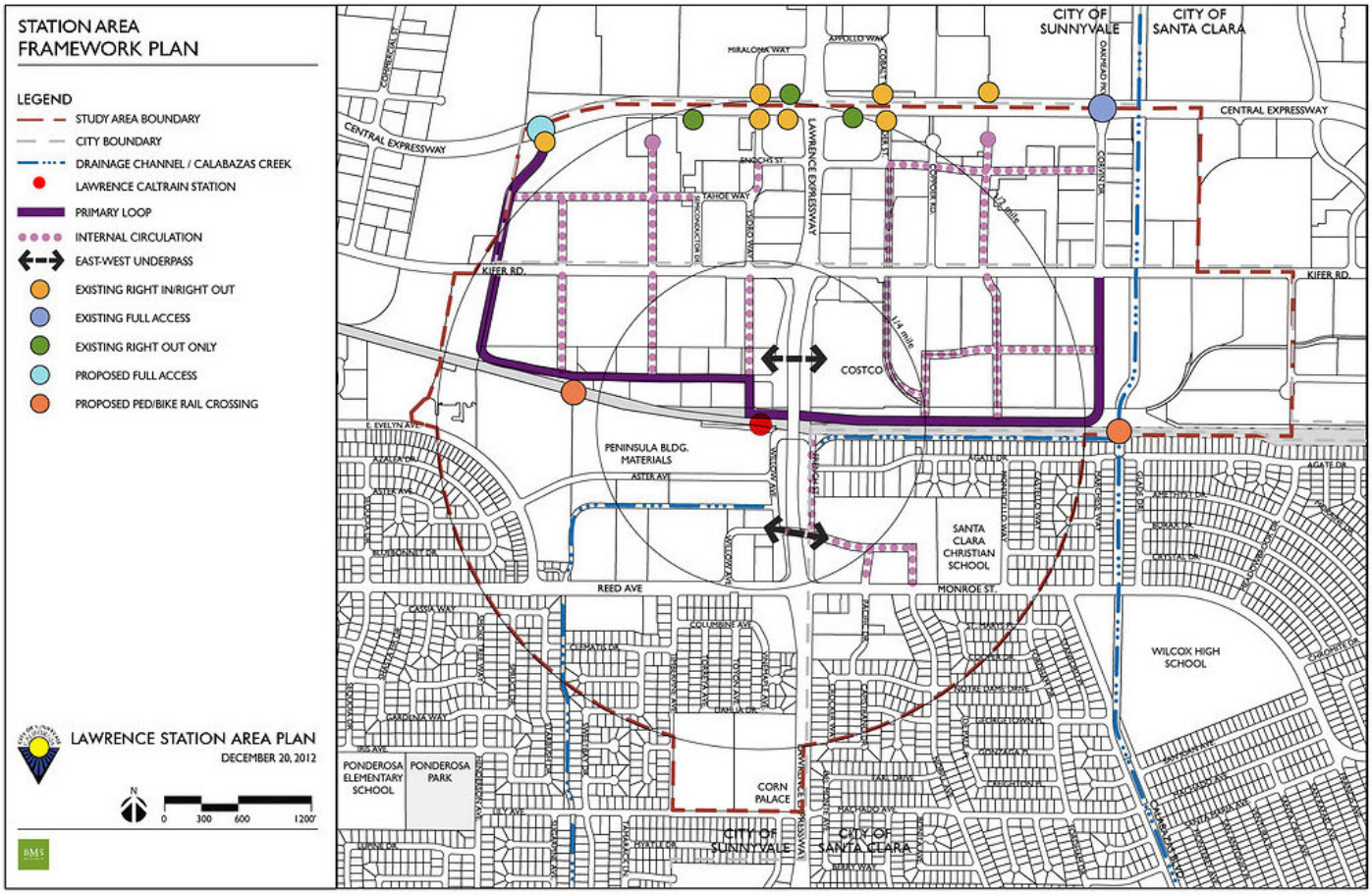
Within the study area, a few redevelopment projects are currently proposed. A mixed-use project has been proposed for the 16-acre Extreme Networks site, located in the northeast quadrant of Monroe Street and Lawrence Expressway in the City of Santa Clara. The proposed project includes development of 825 residential units, including apartments, live/work lofts, townhouses and single-family detached homes, at an approximate gross site density of over 50 dwelling units per acre. Included in the proposed project is also up to 50,000 square feet of ground floor retail. The developer, Irvine Company, has been working with the City of Santa Clara and the County of Santa Clara to ensure that the redevelopment footprint is set back sufficiently to provide for the desired improvements at Lawrence Expressway and Reed Avenue/Monroe Street. The redevelopment is considering closing auto access to French Street from Monroe Street and forming a cul-de-sac, accessible from Willow Avenue. With this concept, bicycle and pedestrian access would be maintained between French Street and Monroe Street. The redevelopment footprint was provided by Irvine Company to the County and the project team for consideration in this study.

The City of Sunnyvale's first phase of the Lawrence Station Area Plan (LSAP) was kicked off in December 2010. The goal is to increase utilization of the Lawrence Caltrain Station through redevelopment and improved circulation. The LSAP is designed to transform the station area, broaden and strengthen the range of viable transportation choices, and encourage efficient use of available land and infrastructure. The recommendations contained in the LSAP will guide future development in the area and bolster other planning efforts including the Land Use and Transportation Element (LUTE) update and future General Plan updates.

At the time of the preparation of this study, the LSAP was entering its second phase, including the preparation of an environmental document and detailed traffic analysis. The LSAP proposed a new street network and the creation several new street connections which would provide direct access to the Lawrence Caltrain Station. The LSAP study area and proposed transportation network are shown in **Figure 3-7**. The enhanced local access would reduce traffic impacts on the expressway and arterial network. In addition, the balance of new neighborhood streets would create more opportunities for walking and bicycling through shortened travel paths to the station from nearby land uses.

The LSAP study area overlaps with the project area being studied for this project. The solutions of this study were developed in coordination with the solutions of the LSAP. The proposed LSAP roadway network will benefit Lawrence Expressway by providing alternatives for local streets and will further improve local circulation and access, notably to and from the Caltrain Station. The City of Santa Clara will be undertaking a similar study of its jurisdictional area in the vicinity of the Lawrence Caltrain Station in the near future.

*Figure 3-7 - Lawrence Station Area Plan Proposed Circulation Network*



# 4. Concept Development

The concept development stage of the project included the identification of a range of concepts, evaluation of the applicability of those concepts in meeting the goals and objectives of this project, and then analysis of a set of concepts for their ability to address the particular challenges within the study area.

## 4.1. Development of Initial Range of Concepts

Kimley-Horn investigated a variety of intersection geometric design treatments that would address the needs of the Lawrence Expressway project corridor as defined by the baseline analysis. Industry research and reference documents such as the FHWA-produced *Alternative Intersections/Interchanges: Informational Report* (April 2010) and the Caltrans-produced *Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians* (2010) were consulted. Based on background research that included a number of innovative solutions that would address the goals of the project, a set of treatments was identified for further consideration as possible solutions for Lawrence Expressway. Simple sketches of each of the treatments were prepared in order to illustrate the concepts to the PWG. The eight treatments consisted of the following intersection improvement solutions:

- Indirect Left Turns
- Hook Ramps
- Tight Diamond
- Single Point Urban Interchanges
- Roundabouts
- Frontage Roads
- Elevated Left Turns
- Jughandles

These solutions are discussed and graphically presented in the sub-sections below.

### 4.1.1. Indirect Left Turns

An indirect left turn solution shifts left-turn movements out of the major intersection. Drivers desiring to turn left from the major road instead travel straight through the intersection. Drivers then make the U-turn at a designated mid-block point downstream. In most cases, signal control is added at the location of the U-turn movement to provide a gap in oncoming traffic. The drivers would then turn to the far right lane in the opposite direction, travel back to the major intersection and make a right turn at the signal. It results in the removal of left-turn phases at the major intersection and the addition of half-signals in each direction downstream of the major intersection. The three signalized intersections would all be coordinated to provide efficiency.

Indirect left turns provide a variety of benefits including the following:

- Improves safety by reducing conflict points at the major intersection
- Improves intersection efficiency by removing turning phases that conflict with the primary through movements
- May not require significantly more ROW, as U-turn movements and storage can occur in the area currently occupied by left-turn lanes
- Lower cost as it does not include grade-separation

**Figure 4-1** shows how the principle of indirect left turns could be implemented within the project area. Note that not all current movements could be maintained at Kifer Road and Reed Avenue/Monroe Street with the indirect left-turn concept due to insufficient median width to provide for storage for the U-turn movements.

*Figure 4-1 - Indirect Left Concepts*

### 4.1.2. Hook Ramps

Hook ramps are J-shaped ramps that connect to a parallel or diagonal street or frontage road. Hook ramps are feasible along the study corridor at the intersections of Lawrence Expressway at Kifer Road and Reed Avenue/Monroe Street. The current geometry and land use in the vicinity of Lawrence Expressway and Arques Avenue precludes hook ramps from being implemented at this intersection. Hook ramps would be implemented in conjunction with full grade separation and would provide local connectivity to the expressway. Hook ramps in some cases require a larger amount of ROW to provide sufficient acceleration and deceleration lengths and minimum turning radii. **Figure 4-2** shows how the hook ramps could be implemented within the project area.

### 4.1.3. Tight Diamond Interchanges, Single Point Urban Interchanges, and Roundabouts

The implementation of grade-separated interchanges would eliminate conflicts at the intersections by vertically separating the main roadway from the intersecting side streets. Implementing such an interchange at a location where an existing signalized intersection exists would reduce delay and reduce safety hazards at the location. Grade-separated interchanges with high speed entrance/exit ramps can be implemented with a variety of treatments at the ramp intersection with the cross-street. Options considered as part of this study include tight diamond interchanges, single point interchanges, and roundabouts. These solutions all serve to greatly increase capacity on the major roadway by eliminating conflict points. Local access is achieved through merge, weave, and/or diverge movements. These solutions introduce a high-speed entrance/exit point on the expressway that may be in conflict with pedestrian and bicycle movements. They are typically implemented at freeway interchanges where there are no pedestrian or bicycle facilities. **Figure 4-3** shows how the geometric designs detailed above could be implemented within the project area.

#### *Tight Diamond*

The tight diamond interchange is typically used in urban areas where there are substantial constraints on the property immediately adjacent to the intersection. This geometric design reduces the distance between the ramp intersections and typically requires that retaining walls be constructed between the ramps and the expressway. This interchange configuration provides medium-to-high traffic capacity, has a high construction cost, and requires comparatively less land to construct. It typically includes the installation of two closely-spaced traffic signals that operate under one controller or are closely coordinated. The two signals are generally located proximate to each other such that there is limited or no vehicle queuing between them. It can result in a somewhat less efficient intersection operation, depending on the vehicle volumes and flow patterns.

#### *Single Point Urban Interchange*

The Single Point Urban Interchange (SPUI) is an interchange design with a single signal to control all interchange traffic. The ramp movements are brought together via a large structure above or below the main grade-separated roadway. A SPUI has a single signalized intersection with three phases that allows for left-turn from the ramps and right-turn movements to the ramps, left-turn movements to the ramps and right-turn movements from the ramps, and minor street through movements. The limited number of phases result in a SPUI intersection generally being very efficient in handling vehicle movements.

SPUIs do present some limitations and downsides. Through movements from ramp to ramp are precluded. Additionally, pedestrian and bicycle movements across the minor street are precluded. Pedestrian movements along the minor street require a number of distinct crossing movements, potentially requiring four signal cycles to cross all of the ramps. Furthermore, the SPUI intersections are inherently quite large, resulting in long all-red time and challenges for bicycles. Some of these elements are partially, but not fully, alleviated through the use of Compact SPUIs, a form of the SPUI with the minor street limit lines brought closer together.

#### *Roundabouts*

The traditional use of roundabouts for interchanges was to have a single large roundabout, in a manner similar to the SPUI, typically with the major road crossing over the roundabout. This traditional roundabout requires a very large footprint and extensive bridging along the freeway.

*Figure 4-2 - Hook Ramp Concepts*

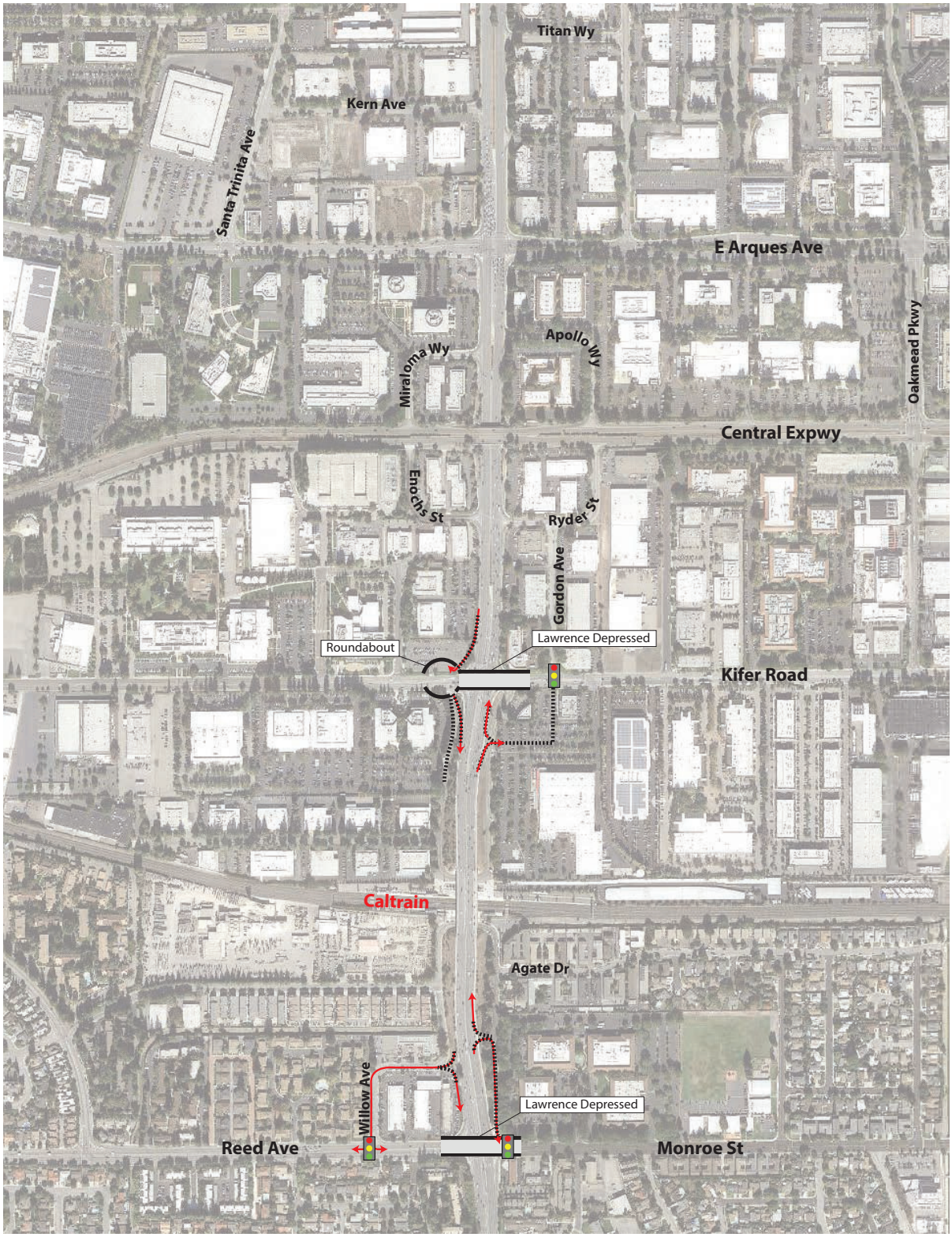


*Figure 4-3 - Tight Diamond Concepts*

A more recent roundabout design that has become more common is a pair of smaller roundabouts (dual roundabouts) at each point where the ramp intersects the minor street. This allows the minor street crossing of the major street to occur on a single bridge. Additionally, the bridge crossing of the major roadway is typically narrower than for a traditional diamond interchange because the roundabout does not include left turn lanes.

Roundabouts have been found to be safer than traditional forms of intersection control by greatly reducing the number of conflict points. They may also reduce delay by eliminating loss time (yellow and all-red time) that occurs at signalized intersections. The application of roundabouts as interchange control has been somewhat limited due to the significant ROW required for roundabouts and limitations in the number of vehicles that they can efficiently serve. Roundabouts can also present challenges for bicycle movements by increasing the number of yield conflict points.

### *4.1.4. Frontage Roads*

A strategy for addressing congestion and delay on urban expressways is to utilize a system of parallel frontage roads that separate out the local traffic from the through traffic on the expressway. The parallel frontage roads are located on either side of the expressway and connect to the expressway via slip ramps. The frontage roads are generally at a different elevation than the expressway to facilitate circulation to and from fronting land uses and cross-streets. The expressway would be grade separated at the cross-street. Frontage road intersections with cross-streets would function in a similar manner to tight-diamond intersections, with closely spaced traffic signals.

Frontage roads provide enhanced access to adjacent property and, by eliminating local traffic, provides uninterrupted travel for through traffic along the expressway. Frontage roads do require additional ROW by providing a new roadway adjacent to the expressway and require retaining walls or extensive bridge structures. A variation on this concept is the median-running "frontage road" which accomplishes many of the same objectives and benefits of the parallel frontage roads, but has one bidirectional frontage road running grade separated from and down the middle of the expressway. The benefit of this concept is that it reduces the ROW footprint needed and only requires one, much more efficient, signalized intersection with the cross-street. It however, does not provide fronting land use access between cross-streets.

**Figure 4-4** and **Figure 4-5** show how the geometric designs detailed above could be implemented within the project area.

### *4.1.5. Elevated Lefts*

The elevated left-turn interchange separates left-turn movements at an intersection from through movements by relocating them to an elevated structure accessed via ramps within the median. The major and minor through and right-turn traffic continue to use the same signalized intersection to make their movements. This configuration allows for a simple, very efficient two-phase signal on both the elevated and at-grade intersections. After completing the left-turn movement on the elevated structure, traffic would merge back onto the receiving street. Elevated left-turns are very efficient in traffic operations, but do require a large elevated concrete structure. They also do not remove the major street/minor street through movement conflict, and maintenance of two traffic signals is required.

**Figure 4-6** shows how the geometric designs detailed above could be implemented within the project area.

A modification of this concept is to move cross-street through traffic to the elevated left intersection as well, eliminating the need for a signal on the major roadway.

### *4.1.6. Jughandles*

The jughandle is an intersection concept that redirects left-turn movements from the major street by constructing a ramp or roadway that allows for right-turn movements to connect to the minor street. Drivers wanting to turn left would exit the major roadway to the ramp via a diverge movement on the right side of the roadway and then turn at the minor street depending on which direction they desire to travel. A combination of jughandle treatments in each quadrant of the intersection/interchange is known as a square loop configuration and occurs at the Central Expressway and Lawrence Expressway interchange. Jughandles do not require grade separation. Without grade separation, through movements would still be signalized at the intersection of the major and minor street.

*Figure 4-4 - Side-Running Frontage Road Concepts*

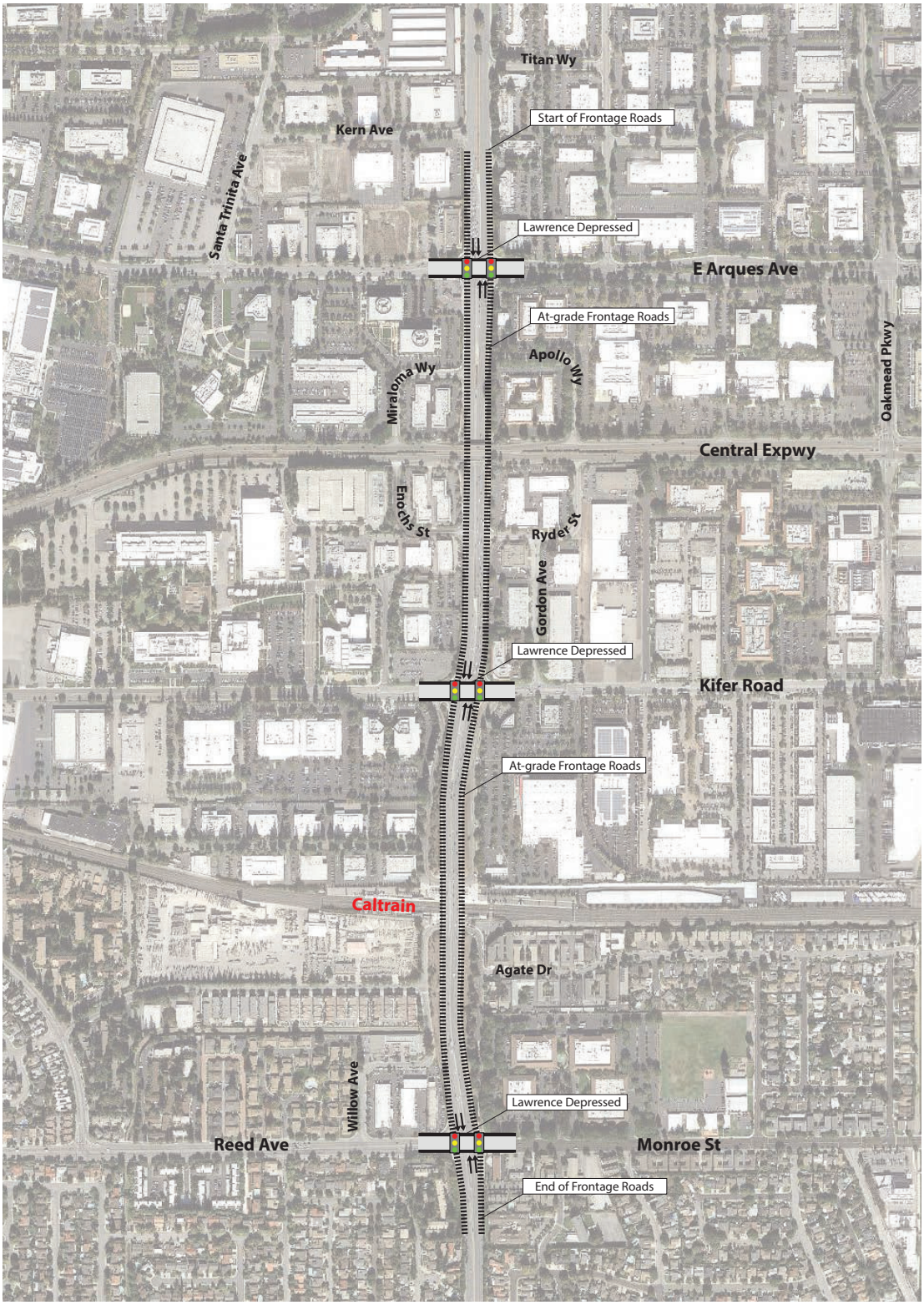


*Figure 4-5 - Median-Running Frontage Road Concept*

*Figure 4-6 - Elevated Left Concepts*

Jughandles often require signalization of the ramp with the minor street to allow movements from the major street to any direction of the minor street. The implementation of square loops eliminates the need for signalization along the minor street. Access to fronting land use can occur along the jughandle or square loop.

The jughandle concept improves traffic operations by redirecting the turns away from the main intersection, and allowing more green time to be allotted to the major street through traffic, or by facilitating access/egress movements from a grade-separated roadway. The primary downsides of the jughandle concept are an increased footprint to accommodate the ramps and a higher potential for conflicts between bicyclists and vehicles at the exit/entry point to the ramps. **Figure 4-7** shows how the geometric designs detailed above could be implemented within the project area.

The improvements were presented to the PWG as improvements that could be individually implemented at any of the three intersection improvement locations, and did not have to be universally implemented along the corridor.

## 4.2. Concept Development

The PWG reviewed and offered their comments, preferences, and recommendations based on the initial range of concepts detailed in the previous section. A total of nine concepts were identified for consideration for Lawrence Expressway. These nine concepts incorporated elements of the above solutions at each of the intersections of Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street. The concepts were identified for each location based on circulation patterns, the surrounding street network and geometric constraints. Each of the concepts were evaluated for:

- Vehicular Traffic Operations
- Multi-Modal Circulation
- Community Factors
- Design Elements
- Cost Magnitude

The concepts were iteratively refined based on a preliminary traffic evaluation and design considerations in order to maximize their effectiveness and viability. At the conclusion of the circulation analysis and conceptual design, the concepts were qualitatively evaluated for their effectiveness and consistency with project goals.

A conceptual plan-view drawing and profile of Lawrence Expressway was prepared for each concept and is included in **Appendix B**.

### 4.2.1. Concept 1

#### Concept Description

Concept 1 employs the strategy of parallel frontage roads along the project area corridor. **Figure 4-8** shows how the parallel frontage roads would be implemented along the project corridor.

The parallel frontage roads would run at-grade on either side of a depressed Lawrence Expressway. The eastern frontage road would handle northbound traffic and the western frontage road would handle southbound traffic. The expressway would pass underneath Arques Avenue, Kifer Road, the Caltrain alignment, and Reed Avenue/Monroe Street. The frontage roads would remain at-grade throughout the project corridor, save where they would be depressed in order to cross under Caltrain and elevated to cross over Central Expressway. At Central Expressway, there would be three levels of roadway, a partially depressed Lawrence Expressway, a partially elevated Central Expressway, and the fully elevated frontage roads. The existing bridge over the Caltrain tracks would be replaced by a new tunnel underneath the tracks. Lawrence Expressway would connect to and from the frontage roads mainly via the entrances at either end of the project corridor but also via slip ramps that enter and exit on the right side of the Lawrence Expressway in the vicinity of the Caltrain

*Figure 4-7 - Jughandle Concepts*

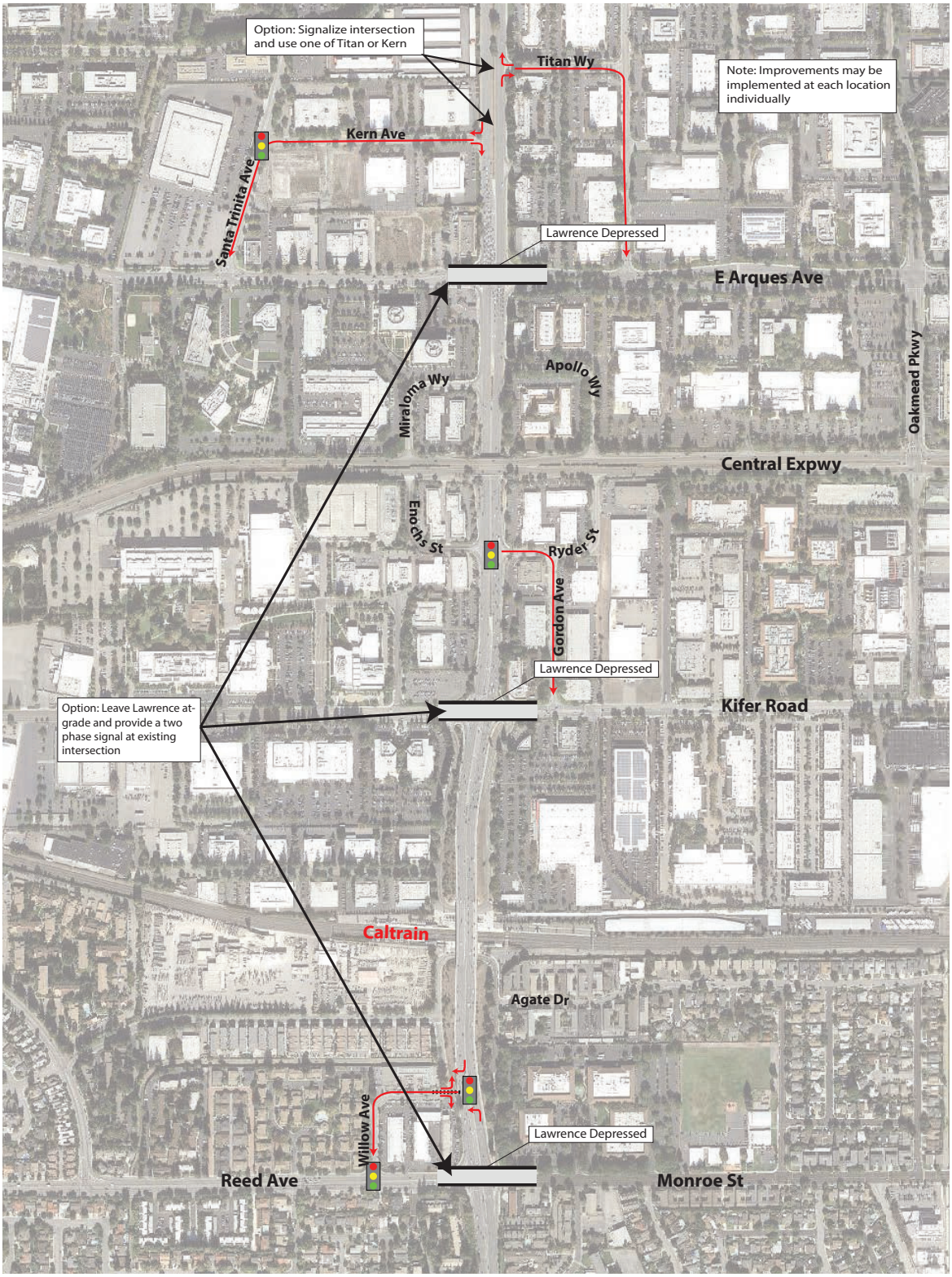
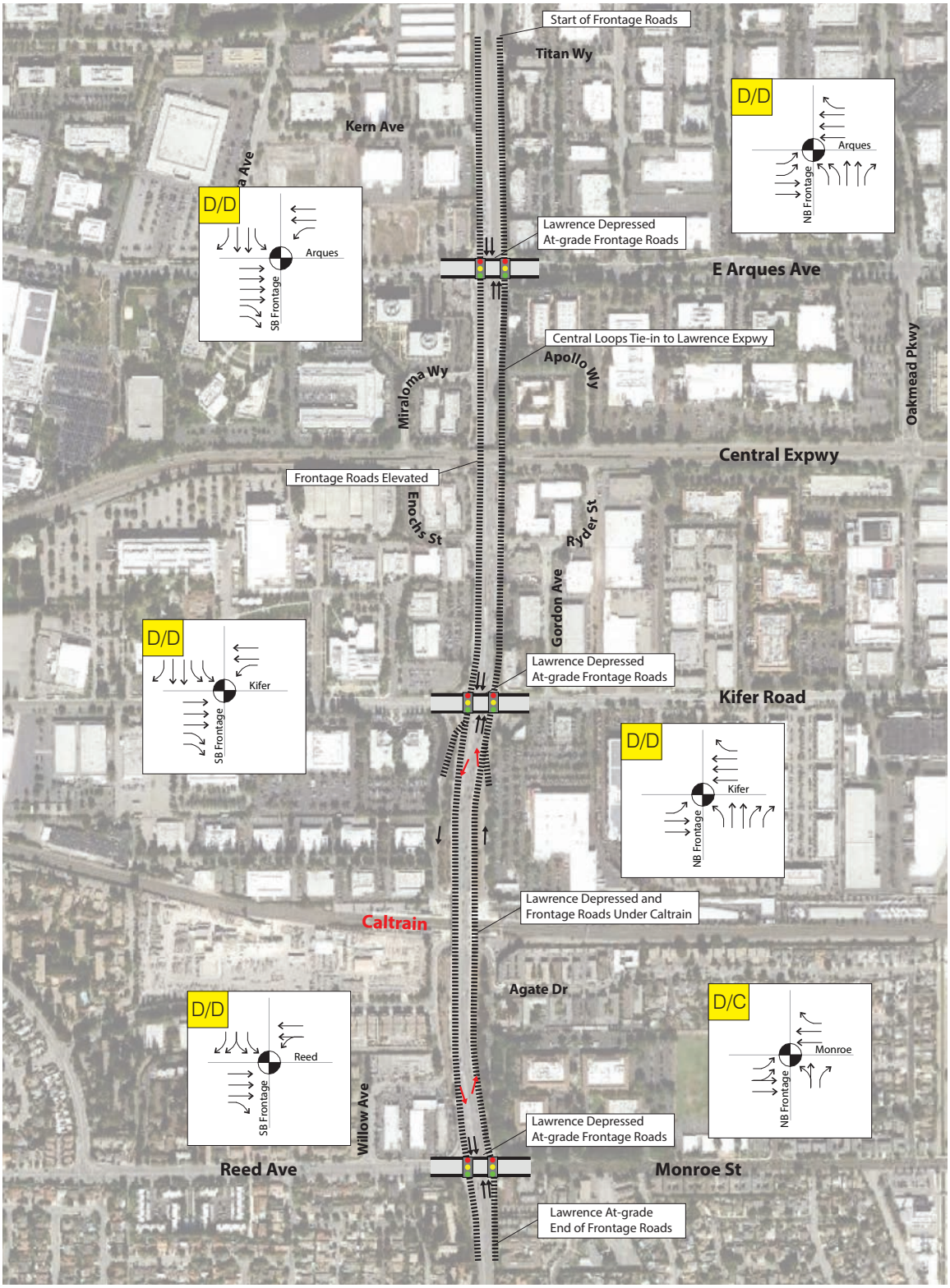


*Figure 4-8 - Concept 1 Geometrics and Year 2040 Level of Service*



tracks. The slip ramps would reduce traffic at the signalized intersections by allowing some local traffic to access the expressway mid-segment.

#### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and associated forecast Year 2040 AM and PM peak hour LOS is shown in **Figure 4-8**. Two signalized intersections would be required along each of the cross-streets, where they cross the northbound and southbound frontage roads. The signals would need to be coordinated or operated under one controller due to close spacing.

The parallel frontage roads allow uninterrupted travel for through traffic along Lawrence Expressway. Concept 1 would maintain all local access and movements, although modifications to the grades along the square loops ramps at Central Expressway could affect some local driveways. The frontage roads would generally each be two lanes, although they would need to flare out at the cross-streets to provide turning lanes. In order to achieve an acceptable LOS D at the frontage road intersections, a number of turning lanes would need to be provided. Lawrence Expressway would be reduced to three lanes in each direction. This reduction is possible due to the shifting of local traffic to the frontage roads and the elimination of conflict points. Three lanes would be sufficient on Lawrence Expressway to handle anticipated Year 2040 volumes.

Pedestrian and bicycle circulation along Lawrence Expressway would occur on the frontage roads. This would be desirable given the lower volumes and speeds along the frontage roads. Crossings of the expressway would be improved due to the shortened crossing distance at intersections and lower intersection cycle lengths. Bicycle and pedestrian facilities in Concept 1 are shown in **Appendix C**.

#### *Design*

The primary downsides to Concept 1 lie in the constructability, implementation, and cost associated with its proposed improvements. As shown in the plan view drawing included in **Appendix B**, slivers of ROW would be needed throughout the project corridor. Concept 1 requires numerous structures, cantilevered roadways, and a depressed roadway, all which would be very expensive to construct. The frontage road concept cannot be phased due to the nature of frontage roads in handling local traffic within the corridor. The flyover of Central Expressway would necessitate the construction of a high aerial structure that would be difficult to construct and would create visual impacts for the adjacent properties. The depression of Lawrence Expressway will require relocation of all utilities and may introduce significant drainage and water table concerns. Additionally, the tunnel underneath the Caltrain tracks may be challenging to construct while maintaining active operations along the rail corridor. All of these factors would contribute to Concept 1 being expensive to construct and difficult to implement.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-1**.

### *4.2.2. Concept 2*

#### *Concept Description*

Concept 2 includes a median-running frontage road and depresses Lawrence Expressway throughout the study area. **Figure 4-9** shows how the median frontage road would be implemented along the project corridor. The median-running frontage road would run down the middle of the expressway with Lawrence Expressway depressed beneath Arques Avenue, Kifer Road, the Caltrain alignment, and Reed Avenue/Monroe Street. The frontage road would remain at-grade throughout the project corridor except for where it would be elevated to in order to cross the Caltrain track alignment and Central Expressway. The frontage road would utilize the existing bridge over Caltrain to span the tracks. Lawrence Expressway would be located in a new tunnel underneath the tracks. Lawrence Expressway would connect to and from the frontage road via median ramps at either end of the project corridor. Concept 2 would also result in access from Lawrence Expressway to Kern Avenue (southbound), and to Titan Way and a driveway just south of Titan Way (northbound) being restricted.

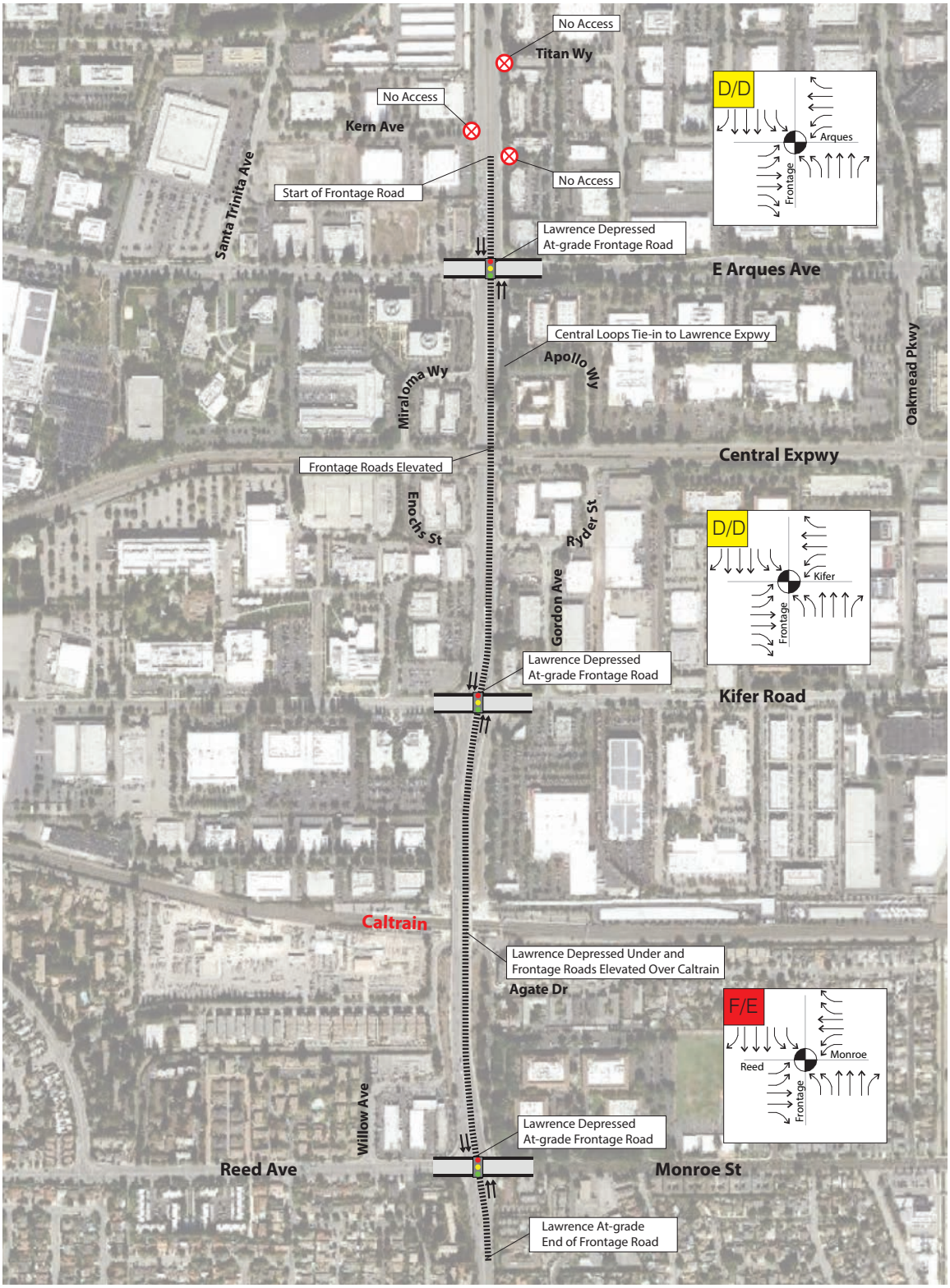
A variation of this concept would be to put Lawrence Expressway in a tunnel for the full extent of the study area and reclaim the existing expressway roadway width not used for the frontage road for a park area or other land use.

### *Table 4-1 - Concept 1 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ● | |
| - Corridor Throughput | ● | Conflicts points on the Expressway are removed. The number of weaving/merge points is reduced, further increasing corridor flow. |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ● | The Arques bridge would need to be 7-lanes wide to provide sufficient capacity. With that geometry, the Arques intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Kifer | ● | The Kifer bridge would need to be 6-lanes wide to provide sufficient capacity. With that geometry, the Kifer intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Reed/Monroe | ● | The Reed/Monroe bridge would need to be 5-lanes wide to provide sufficient capacity. With that geometry, the Reed/Monroe intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Local Circulation | ◑ | Access is maintained to/from all local movements. Lawrence drivers will need to know in advance to exit to frontage road to access both Arques and Kifer. Adjusting elevation of Central Ramps may affect some local driveways. Requires one-way circulation pattern on San Zeno and Lawrence Station Way. |
| **Multi-Modal Circulation** | ● | |
| - Pedestrian crossing | ● | Pedestrian crossing distances are shortened compared to existing conditions. Circulation is maintained for all existing uses. Pedestrians would have to cross two signalized intersections instead of one. |
| - Pedestrian along Expwy | ● | Pedestrian activity would occur on the frontage roads, which will be lower speed and lower volume. Pedestrian access would be the same or better than existing. Pedestrians would need to cross San Zeno and Lawrence Station Way. |
| - Transit Access to Lawrence Station | ◑ | This concept requires a one-way circulation pattern on San Zeno and Lawrence Station Way. It does provide full access from either direction of Lawrence or Kifer to the station. |
| - Transit Stops along Corridor | ● | Transit stops can be provided along the frontage road with easy access to the community. |
| - Bike crossing | ● | Bicycle crossing distances are shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Bike along Expwy | ● | Bicycle activity would be encouraged to occur on the frontage roads, which will be lower speed and lower volume. Shoulders will still be provided on Lawrence. Bicycle access would be the same or better than existing. |
| **Community Factors** | ● | *Note: Design could be modified to put frontage road underneath Central* |
| - Visual Impacts | ◑ | Lawrence would be depressed. However, as currently shown, the frontage road would fly-over Central. That would be the only vertical structure with this concept. |
| - Community Context | ● | With Lawrence depressed, community interface would be with the smaller, lower-speed frontage roads. Full access would be maintained and bike/ped circulation would be enhanced. |
| **Design Elements** | ○ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively widen Caltrain bridge).* |
| - Right-of-Way Needs | ◑ | Slivers of right-of-way would be needed throughout the corridor. However, no buildings appear to be impacted. |
| - Constructability | ○ | Concept requires numerous structures, cantilevered roadways, and a depressed roadway which raises geotechnical concerns. This would require signficant and complex construction phasing and would require significant lane reductions on the Expressway during construction. |
| - Allows Phased Implementation | ○ | There is limited opportunity for phasing the project given that it is centered around a local bypass concept. The portion south of Kifer could probably be phased separately. |
| **Cost** | ○ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively widen Caltrain bridge).* |
| - Structural Cost | ○ | There are numerous structures that would be required. Depressing Lawrence will require significant excavation. The concept also requires an aerial structure high over Central or complete reconstruction of the Central bridge. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-9 - Concept 2*



### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS is shown in **Figure 4-9**.

Concept 2 shares some of the same benefits as Concept 1. These similarities include removing conflict points for through traffic along Lawrence Expressway. It would further reduce the number of weaving/merge points and thus increase corridor flow. The frontage road allows uninterrupted travel for through traffic along Lawrence Expressway. Except where noted north of Arques Avenue, Concept 2 would maintain all local access and movements, although modifications to the grades along the square loops ramps at Central Expressway could affect some local driveways. However, by not providing the slip ramps between Lawrence Expressway and the frontage road between Kifer Road and Reed Avenue/Monroe Street, as in Concept 1, the volumes on the frontage road are much higher. This results in a deficient level of service in both peak periods at the Reed Avenue/Monroe Street intersection with the frontage road, even with a six-lane frontage road. Widening the frontage road any further would run counter to one of the goals of this project to reduce the perceived barrier of the expressway.

As a result, Concept 2 does not rate as high as Concept 1 in several specific traffic and circulation categories. The frontage road intersections at Kifer Road and at Reed Avenue/Monroe Street would require many lanes and thus very large bridges to accommodate the projected traffic flows at these intersections. These factors result in Concept 2 ranking lower than Concept 1.

Pedestrian and bicycle facilities would be along the at-grade frontage road, a lower speed roadway. These facilities are depicted in the bicycle and pedestrian facility graphic in **Appendix C**.

### *Design*

As shown in the plan and profile drawing for this concept in **Appendix B**, Lawrence Expressway would be depressed for the span of the project corridor between Reed Avenue/Monroe Street and Arques Avenue. From a community context perspective, Concept 2 would end up with only a moderate narrowing and lower volume/speed than the current expressway.

Additional downsides to Concept 2 are similar to those of Concept 1. Concept 2 requires numerous structures, column-supported and depressed roadways, which raise cost and constructability concerns as noted in Concept 1.

The matrix showing the comparison of findings of the qualitative concept evaluation can be seen in **Table 4-2**.

## *4.2.3. Concept 3*

### *Concept Description*

Concept 3 is similar to Concept 2, but with Lawrence Expressway primarily elevated above grade. This maintains the existing bridge over Caltrain. Lawrence Expressway would be depressed under Arques Avenue. In order to preserve the existing Caltrain bridge and maintain pedestrian and bicycle facilities along the frontage road, the frontage road would split to either side of Lawrence Expressway south of Kifer Road on a widened structure over the railroad tracks. The median local access road would intersect with Arques Avenue and Reed Avenue/Monroe Street at-grade, and with Kifer Road elevated. Lawrence Expressway would be depressed and pass underneath Arques Avenue. **Figure 4-10** depicts this frontage road concept.

Lawrence Expressway would connect to and from the frontage road via median ramps at the northern end of the project corridor and via side ramps at the southern end, south of the Reed Avenue/Monroe Street intersection. The Central Expressway square loops would tie into Lawrence Expressway, not the frontage road.

### *Traffic and Circulation*

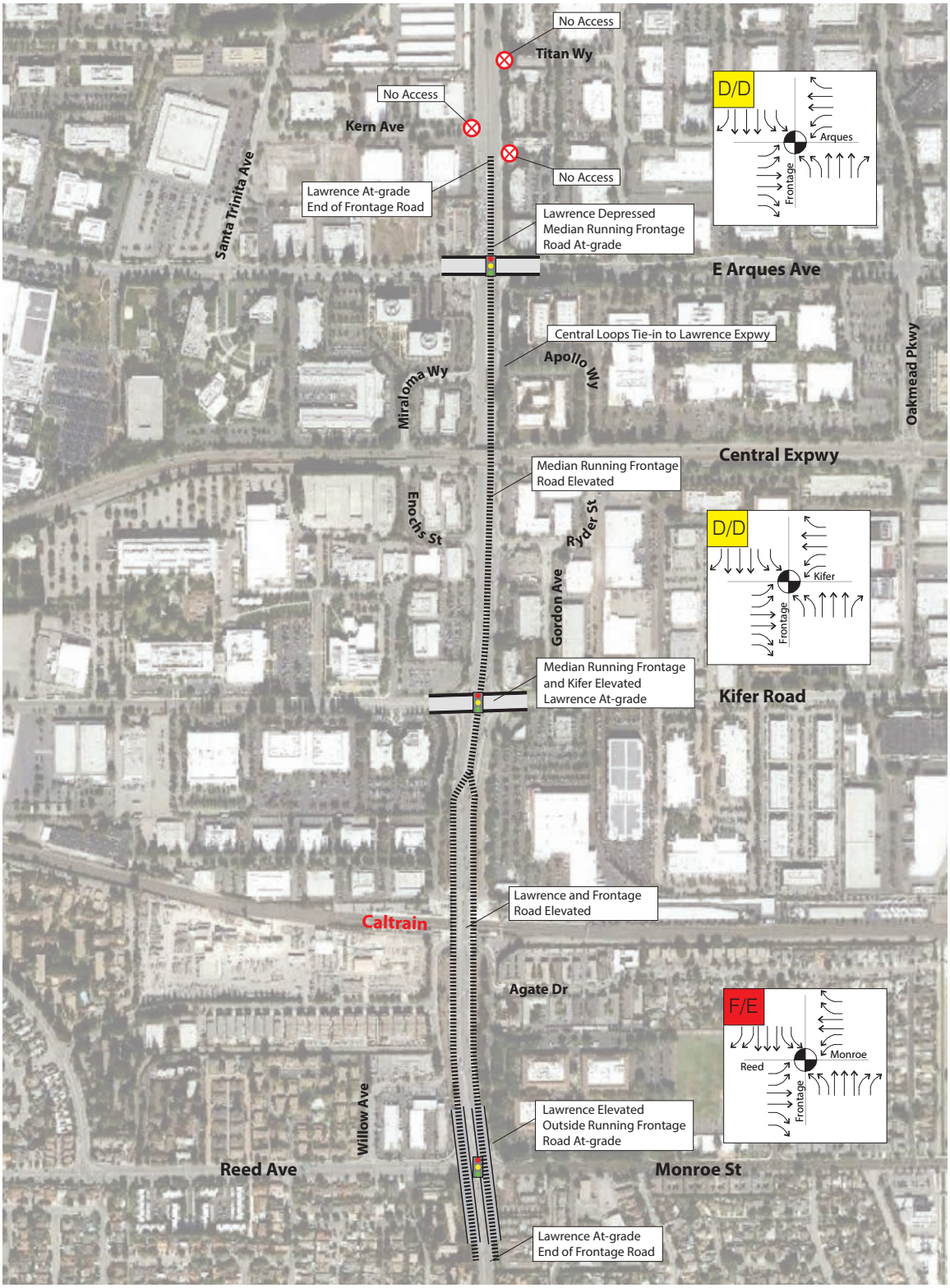
Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS are also shown in **Figure 4-10**.

### *Table 4-2 - Concept 2 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ○ | |
| - Corridor Throughput | ● | Conflicts points on the Expressway are removed. The number of weaving/merge points is greatly reduced, further increasing corridor flow. |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ● | The number of turning movements at Arques requires a very large bridge and a number of turn lanes. Sufficient capacity is shown to achieve LOS D. |
| - Kifer | ◑ | The number of turning movements at Kifer requires a very large bridge and a number of turn lanes. Cycle lengths are still fairly long and the intersection would operate at LOS D. |
| - Reed/Monroe | ○ | Even with a full slate of dual left-turn lanes, the intersection would be at or above capacity. The frontage road would need to be four lanes to function adequately, which is not considered feasible or desirable. |
| - Local Circulation | ◑ | Access is maintained to/from all local movements. Lawrence drivers will need to know in advance to exit to frontage road to access any of the local streets. Local street access to/from Central would have to occur on parallel/alternate routes. Adjusting elevation of Central Ramps may affect some local driveways. |
| **Multi-Modal Circulation** | ◑ | |
| - Pedestrian crossing | ◑ | Pedestrian crossing distances are moderately shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Pedestrian along Expwy | ● | Pedestrian activity would occur on the frontage roads, which will be lower speed and somewhat lower volume. Pedestrian access would be the same or better than existing. |
| - Transit Access to Lawrence Station | ○ | This concept does not improve access to the Caltrain Station. San Zeno and Lawrence Station Way would still have to be right-in/right-out roadways. |
| - Transit Stops along Corridor | ◑ | Transit stops would need to be along the frontage road aerial structure. They could still provide convenient access to the community at the signalized intersections but would carry significant cost for a bus pull-out. |
| - Bike crossing | ◑ | Bicycle crossing distances are moderately shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Bike along Expwy | ● | Bicycle activity would be encouraged to occur on the frontage roads, which will be lower speed and somewhat lower volume. Shoulders will still be provided on Lawrence. Bicycle access would be the same or better than existing. |
| **Community Factors** | ◑ | *Note: The Expressway could be placed in a tunnel (would require ventilation and greater cost), improving aesthetics and freeing up additional right-of-way.* |
| - Visual Impacts | ◑ | Lawrence would be depressed. However, as currently shown, the frontage road would fly-over Central. That would be the only new vertical structure with this concept. |
| - Community Context | ◑ | The frontage road would need to be only moderately narrower and lower volume/speed than the current Expressway. Therefore, the benefit to the community would be narrow. |
| **Design Elements** | ○ | |
| - Right-of-Way Needs | ◑ | Between Reed/Monroe and Arques, minimal right-of-way would be needed throughout the corridor due to stacking of facilities. North of Arques and south of Reed/Monroe some buildings may be impacted. |
| - Constructability | ○ | Concept requires numerous structures, column-supported and depressed roadways, which raises geotechnical concerns. This would require signficant and complex construction phasing and would require significant lane reductions on the Expressway during construction. Structural configuration at Caltrain would be very complex and may require significant re-construction and/or complex staging. |
| - Allows Phased Implementation | ○ | There is limited opportunity for phasing the project given that it is centered around a local bypass concept. The portion south of Kifer could probably be phased separately. |
| **Cost** | ○ | |
| - Structural Cost | ○ | There are numerous structures that would be required. A tunnel under Caltrain while maintaining a bridge would be structurally difficult. Depressing Lawrence will require significant excavation. The concept also requires an aerial structure high over Central or complete reconstruction of the Central bridge. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-10 - Concept 3*



Concept 3 is similar from a traffic circulation standpoint to Concept 2. The intersections of the frontage road with Kifer Road and with Reed Avenue/Monroe Street would require a six-lane frontage road and many turn lanes, resulting in large bridges and wide intersections to accommodate the traffic projected traffic flows. These factors result in Concept 3 also rating lower than the Concept 1 in traffic and circulation categories. Similar to Concept 2, the frontage road intersection with Reed Avenue/Monroe Street would operate deficiently even with a six-lane frontage road. The only solution would be a wider frontage road, which runs counter to the goals and objectives of this project.

Pedestrian and bicycle facilities would be along the frontage road, as depicted in the bicycle and pedestrian facilities graphic in **Appendix C**.

#### *Design*

As shown in the plan and profile drawing of this concept in **Appendix B**, Lawrence Expressway would be depressed at the northern end of the corridor and then elevated at the southern end of the corridor. The community context category is where the primary difference between Concept 3 and the other two frontage road concepts (Concept 1 and Concept 2) occurs. The visual impacts to the community would be more significant due to Lawrence Expressway being elevated over Reed Avenue/Monroe Street, adjacent to the residential uses in this portion of this corridor. This structure would create a visual barrier, further separating the neighborhoods on either side of Lawrence Expressway.

The numerous structures associated with the median frontage road and grade separating Lawrence Expressway introduce cost and constructability issues. One benefit of this concept is that it does not include construction of a tunnel below the Caltrain tracks, although it does require significant modification to the existing Caltrain bridge. Limiting the depression of Lawrence Expressway to just the portion north of Central Expressway also reduces the cost associated with earthwork and drainage.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-3**.

### *4.2.4. Concept 4*

#### *Concept Description*

Concept 4 has Lawrence Expressway depressed under Arques Avenue and Reed Avenue/Monroe Street and elevated over Kifer Road. This concept includes tight diamond interchanges at all three of the grade-separated intersections. **Figure 4-11** schematically depicts Concept 4. The tight diamond interchanges provide high-speed ramps between Lawrence Expressway and the cross-streets.

San Zeno Way and Lawrence Station Road would be modified to be one-directional in order to improve access to and from the Lawrence Caltrain Station. San Zeno Way would be accessed from the southbound on-ramp to Lawrence Expressway and Lawrence Station Road would merge with the northbound off-ramp from Lawrence Expressway. This would provide access to or from any direction and the Lawrence Caltrain Station. The Central Expressway square loop ramps would not be modified.

#### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS are also shown on **Figure 4-11**. As shown in the figure, the tight diamond signalized intersections would all function with an acceptable level of service. The paired tight diamond intersections would need to operate under one controller in order to minimize queuing and delay. This results in a somewhat inefficient operation and a number of turn lanes at each location. At Reed Avenue/Monroe Street the northbound on-ramp would need to consist of two lanes. A similar two-lane ramp would need to be provided for the southbound on-ramp at Kifer Road.

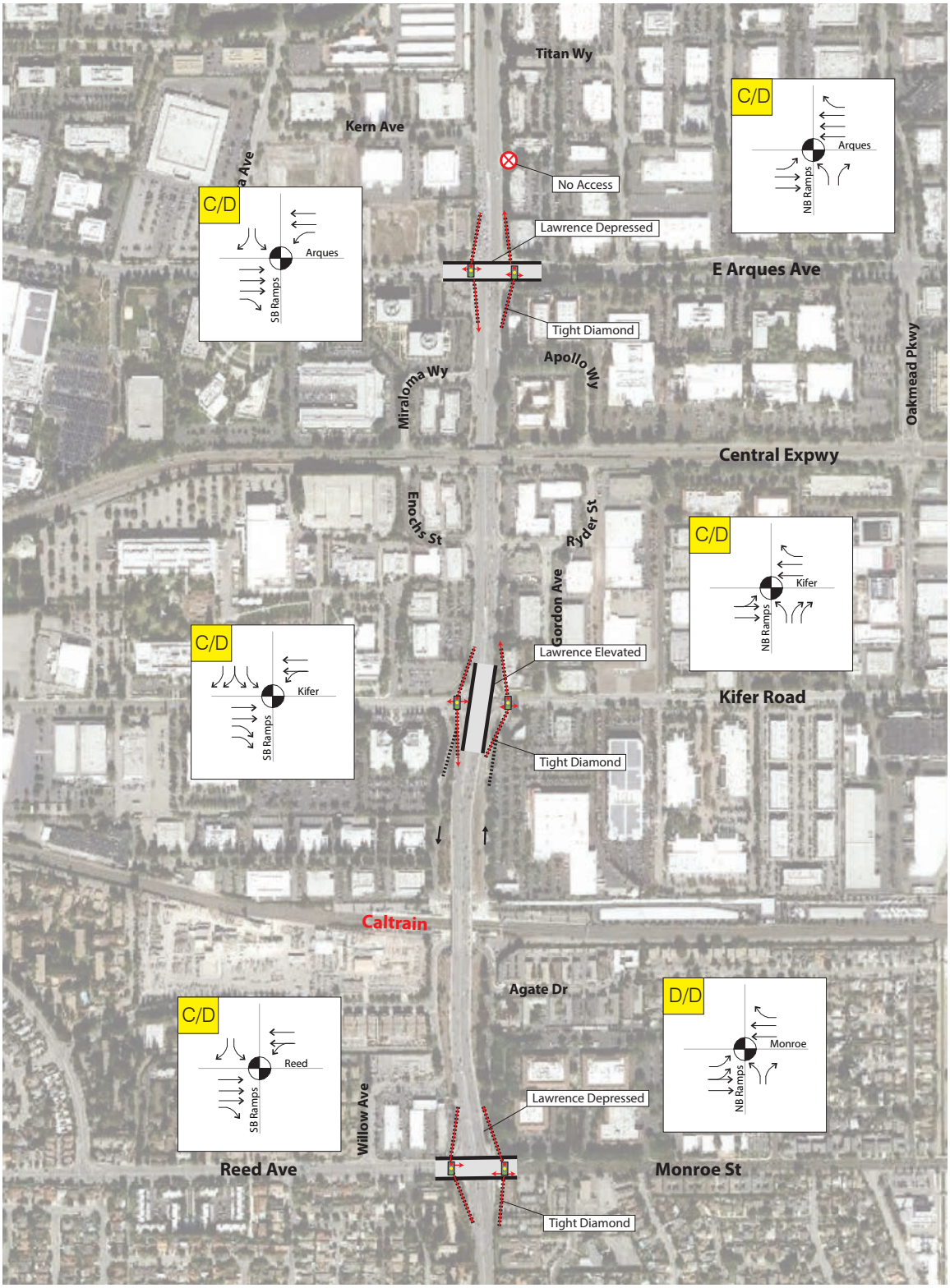
For this concept, and all other concepts where Lawrence Expressway conflict points are removed via new interchanges, the grade separation provides Lawrence Expressway with sufficient capacity that an 8-lane roadway is sufficient to handle projected Year 2040 volumes.

### *Table 4-3 - Concept 3 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | *Note: Design could potentially be modified to allow for a merge/weave on the Caltrain bridge. That would greatly reduce lane requirements at each signalized intersection.* |
| - Corridor Throughput | ● | Conflicts points on the Expressway are removed. The number of weaving/merge points is greatly reduced, further increasing corridor flow. |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ● | The number of turning movements at Arques requires a very large bridge and a number of turn lanes. Sufficient capacity is shown to achieve LOS D. |
| - Kifer | ◑ | The number of turning movements at Kifer requires a very large bridge and a number of turn lanes. Cycle lengths are still fairly long and the intersection would operate at LOS D. |
| - Reed/Monroe | ○ | Even with a full slate of dual left-turn lanes, the intersection would be at or above capacity. The frontage road would need to be four lanes to function adequately, which is not considered feasible or desirable. |
| - Local Circulation | ◑ | Access is maintained to/from all local movements. Lawrence drivers will need to know in advance to exit to frontage road to access any of the local streets. Local street access to/from Central would have to occur on parallel/alternate routes. Raising Kifer to meet Frontage Road may affect existing driveways. Adjusting elevation of Central Ramps may affect some local driveways. |
| **Multi-Modal Circulation** | ◑ | |
| - Pedestrian crossing | ◑ | Pedestrian crossing distances are moderately shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Pedestrian along Expwy | ● | Pedestrian activity would occur on the frontage roads, which will be lower speed and somewhat lower volume. Pedestrian access would be the same or better than existing. |
| - Transit Access to Lawrence Station | ○ | This concept does not improve access to the Caltrain Station. San Zeno and Lawrence Station Way would still have to be right-in/right-out roadways. |
| - Transit Stops along Corridor | ◑ | Transit stops would need to be along the frontage road aerial structure. They could still provide convenient access to the community at the signalized intersections but would carry significant cost for a bus pull-out. |
| - Bike crossing | ◑ | Bicycle crossing distances are moderately shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Bike along Expwy | ● | Bicycle activity would be encouraged to occur on the frontage roads, which will be lower speed and somewhat lower volume. Shoulders will still be provided on Lawrence. Bicycle access would be the same or better than existing. |
| **Community Factors** | ○ | *Note: Design could be modified to bring Lawrence under Reed/Monroe, reducing aerial structures.* |
| - Visual Impacts | ○ | Lawrence would be aerial over Reed/Monroe. Frontage road would fly-over Central. The Caltrain bridge would remain and be widened. |
| - Community Context | ○ | The frontage road would need to be only moderately narrower and lower volume/speed than the current Expressway. Therefore, the benefit to the community would be narrow. There would vertical structures adjacent to residential uses. |
| **Design Elements** | ○ | |
| - Right-of-Way Needs | ◑ | Minimal right-of-way would be needed throughout the corridor due to stacking of facilities. North of Arques and south of Reed/Monroe some buildings may be impacted. |
| - Constructability | ○ | Concept requires numerous structures, column-supported and depressed roadways, which raises geotechnical concerns. This would require signficant and complex construction phasing and would require significant lane reductions on the Expressway during construction. |
| - Allows Phased Implementation | ○ | There is limited opportunity for phasing the project given that it is centered around a local bypass concept. The portion south of Kifer could probably be phased separately. |
| **Cost** | ○ | |
| - Structural Cost | ○ | There are numerous structures that would be required. Depressing Lawrence below Arques will require significant excavation and an aerial structure is required over Kifer. The concept also requires an aerial structure high over Central or complete reconstruction of the Central bridge. |
| - Civil Cost | ◑ | Lawrence would only be depressed at Arques and the existing Caltrain bridge would be maintained. Therefore, it would have relatively less impact to existing utilities and drainage. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-11 - Concept 4*



The interchange concept does not require significant modification to the Caltrain bridge or the Central Expressway underpass or square loop ramps. However, the interchange ramps would introduce a number of merge and diverge points in the right lane of Lawrence Expressway. Coupled with the existing merge/diverge activity for the Central Expressway square loop ramps, this could result in congestion due to the close spacing of the merge/diverge points.

In order to avoid crossing the high-speed ramps, pedestrians would need to travel along the ramps and cross the cross-streets at the signalized ramp intersections. This represents an improvement from existing conditions due to the somewhat smaller size of the ramp intersections and the shorter cycle lengths compared to the existing Lawrence Expressway intersections. Bicycles will either need to take a similar path, or have to cross high speed ramps. For pedestrian and bicycle traffic crossing the expressway, crossing distances will be shorter compared to existing conditions, but two signalized intersections will have to be traversed instead of one. See **Appendix C** for the location of pedestrian and bicycle facilities with this concept.

#### *Design*

A plan view and profile layout of this concept is provided in **Appendix B**.

In comparison to the frontage road concepts, Concept 4 would not require as many structural elements. But with the depression of Lawrence Expressway at Reed Avenue/Monroe Street and Arques Avenue, many of the costs associated with excavation and drainage would still be incurred. Avoiding a new tunnel under Caltrain provides numerous cost savings. However, in order to pass underneath Reed Avenue/Monroe Street, the slope on the southern half of the Caltrain bridge will need to be increased, requiring reconstruction of the bridge. The required slope is higher than existing but would still meet ADA requirements. The corridor may feel like a roller coaster given the numerous slopes along this segment with this concept. Additionally, the elevated structure near Kifer Road would create a visual barrier for the community. Concept 4 would require less ROW along Lawrence Expressway between cross-streets, but would still require ROW acquisition at the interchanges in order to accommodate the ramps.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-4**.

### *4.2.5. Concept 5*

#### *Concept Description*

As shown in **Figure 4-12**, Concept 5 would consist of Lawrence Expressway being depressed for the entirety of the project corridor. The local street network would be accessed via SPUIs at Arques Avenue and Reed Avenue/Monroe Street and a single roundabout at Kifer Road. Kifer Road was identified as a possible location for a roundabout given the wider existing ROW in the vicinity of Kifer Road and the opportunity to improve Caltrain access. Much greater ROW acquisition would be required to place a roundabout at Arques Avenue or Reed Avenue/Monroe Street. Additionally, the relatively lower side street volumes at Kifer Road made this location most likely to be feasible for the implementation of a roundabout.

#### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS are also shown in **Figure 4-12**.

The primary concern with the vehicular traffic for Concept 5 is associated with the roundabout proposed for the Kifer Road bridge over Lawrence Expressway. A roundabout does not provide sufficient capacity to accommodate the traffic volumes projected to flow through this intersection. The roundabout would operate at a very poor LOS F due to the volume of turning movements. As noted above, Arques Avenue and Reed Avenue/Monroe Street would be even less conducive to a roundabout. Roundabouts, therefore, are not feasible options for the ramp intersections along Lawrence Expressway.

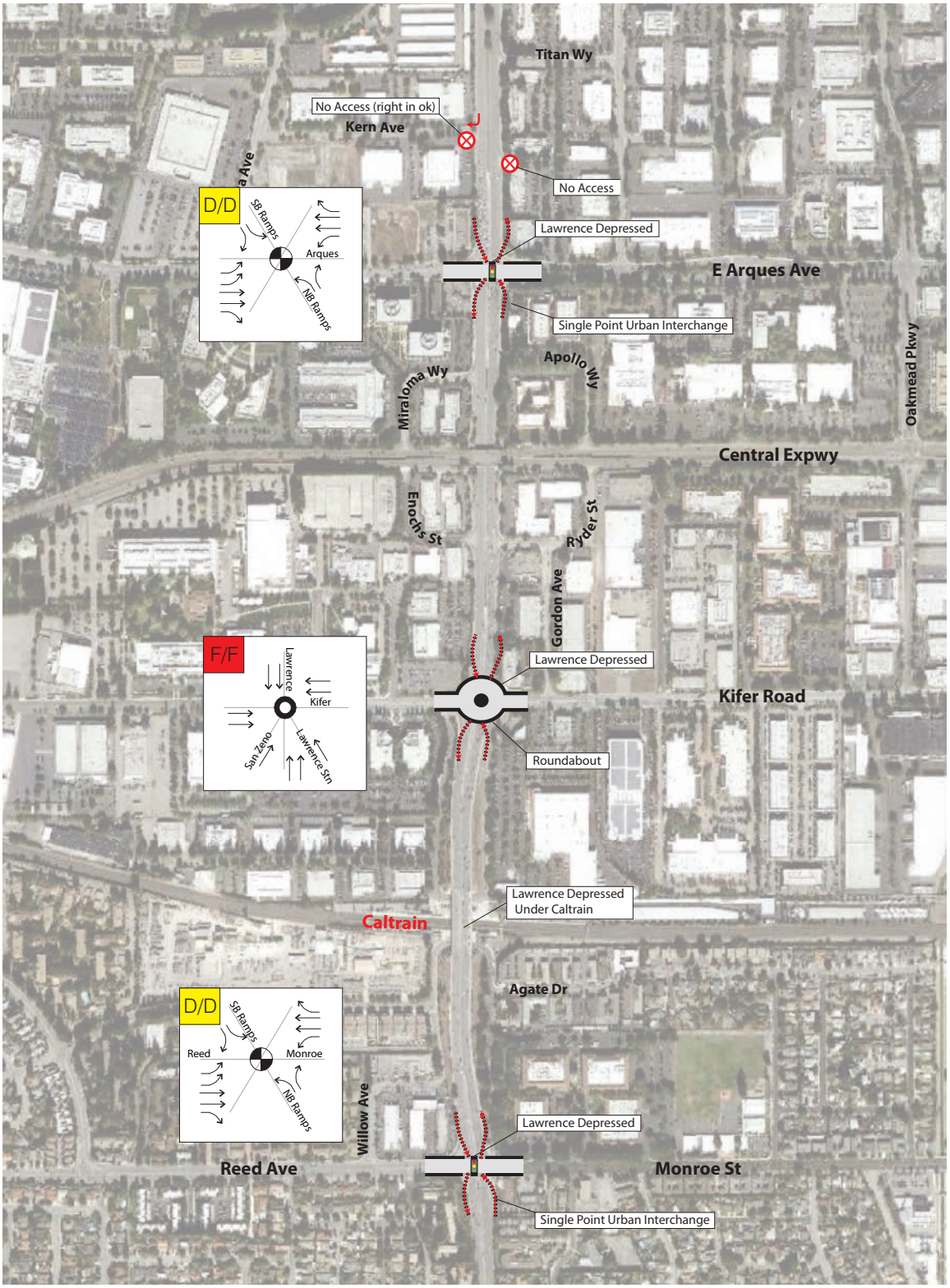
The two SPUIs would both function at an acceptable LOS D with the depicted geometrics.

### *Table 4-4 - Concept 4 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Corridor Throughput | ◑ | Conflicts points on the Expressway are removed. There would still be a number of weave/merge points along the corridor (4 within 1.2 mi) |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ● | The Arques bridge would need to be 6-lanes wide to provide sufficient capacity. With that geometry, the Arques intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Kifer | ● | The Kifer bridge would need to be 4-lanes wide to provide sufficient capacity. With that geometry, the Kifer intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Reed/Monroe | ● | The Reed/Monroe bridge would need to be 5-lanes wide to provide sufficient capacity. With that geometry, the Reed/Monroe intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Local Circulation | ◑ | Access is maintained to/from all local movements. Travel across Lawrence Expwy will be improved through reduced cycle lengths and reduced delay. Requires one-way circulation pattern on San Zeno and Lawrence Station Way. Access to Central requires travel through tight diamond at Kifer/Arques. |
| **Multi-Modal Circulation** | ◑ | |
| - Pedestrian crossing | ● | Pedestrian crossing distances are shortened compared to existing conditions. Circulation is maintained for all existing uses. Pedestrians would have to cross at two signalized intersections instead of one. |
| - Pedestrian along Expwy | ◑ | Pedestrians would be bought up to the intersecting roads to avoid high-speed ramps. This will result in some additional grades, but no new conflict points. |
| - Transit Access to Lawrence Station | ◑ | This concept requires a one-way circulation pattern on San Zeno and Lawrence Station Way. It does provide full access from either direction of Lawrence or Kifer to the station. |
| - Transit Stops along Corridor | ◑ | Transit stops could be located on either the interchange ramps or along the mainline. Stops on interchange ramps would require transit to wait at the signal. Stops on the mainline would require very long walking distance to the cross-streets. |
| - Bike crossing | ◑ | Bicycle crossing distances are moderately shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Bike along Expwy | ○ | Bicycle activity would be presumed to remain on the Expressway (although could be taken up to the intersections similar to peds). Maintaining bikes on the mainline would require two crossings of high-speed ramps at each interchange. |
| **Community Factors** | ◑ | *Note: Design could be modified to bring Lawrence under Reed/Monroe, reducing aerial structures.* |
| - Visual Impacts | ◑ | Lawrence would be aerial over Kifer, otherwise depressed. This would maintain the existing Caltrain structure. |
| - Community Context | ● | Lawrence would be out-of-sight and not a visible or safety barrier for the community at Reed/Monroe and at Arques. It would be easier to cross at Kifer but would constitute a visual barrier. |
| **Design Elements** | ◑ | |
| - Right-of-Way Needs | ○ | The interchange ramps would require ROW at each interchange, likely impacting buildings. SB Kifer ramp requires more significant ROW due to close proximity of Central square loop ramp. |
| - Constructability | ◑ | Concept would require significant work at each location to grade-separate Lawrence and construct ramps. There could be significant construction stage impacts to adjacent businesses. |
| - Allows Phased Implementation | ● | Each interchange is independent and the project could be built in phases. |
| **Cost** | ◑ | |
| - Structural Cost | ◑ | A relatively limited number of structures would be required, consisting primarily of bridges at cross-streets, ramps and retaining walls. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-12 - Concept 5*



This concept may benefit bicycles and pedestrians crossing Lawrence Expressway by greatly shortening crossing distances compared to existing conditions. However, there is no desirable option for bicycles and pedestrians to travel along Lawrence Expressway with this concept. As noted above, no pedestrian or bicycle movements are allowed across the minor street with a SPUI. Therefore, bicycles and pedestrians would have to cross the high-speed ramps exiting/entering the expressway or travel up to the cross-street and use a nearby intersection to get across the cross-street. As an alternative, joint bicycle and pedestrian ramps are proposed that would pass underneath the exiting/entering ramps. See the pedestrian and bicycle facilities figure in **Appendix C** for a depiction of these facilities. The cost of these facilities, due to required structures and ROW, would be significant, and they may still result in significant out of way travel for bicyclists and pedestrians wishing to turn left between Lawrence Expressway and the cross-street.

#### *Design*

The plan and profile view of Concept 5 is provided in **Appendix B**. Concept 5 does provide community benefits by depressing Lawrence Expressway for the span of the project corridor. However, the depressing of the corridor does raise excavation, drainage and constructability concerns. This concept will also require removal of the existing Caltrain bridge and construction of a new tunnel will be challenging and costly to implement. Concept 5 would require some ROW acquisition at each of the interchanges in order to accommodate the SPUIs and a very large bridge structure to support the SPUIs and roundabout over the depressed Lawrence Expressway.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-5**.

### *4.2.6. Concept 6*

#### *Concept Description*

Concept 6 uses a variety of intersection geometry and treatment options, determined by the land use constraints and roadway network opportunities in the vicinity of each cross-street. In this concept, Lawrence Expressway is depressed under Arques Avenue, Kifer Road, and the Caltrain alignment, but is elevated over Reed Avenue/Monroe Street. The concept is depicted in **Figure 4-13**.

The existing alignment of Kern Avenue and Santa Trinita Avenue would be utilized as a square loop ramp that connects Lawrence Expressway to Arques Avenue and accommodates all turning movements to or from southbound Lawrence Expressway that currently occur at the intersection of Lawrence Expressway and Arques Avenue. Similarly, Titan Way and Lakeside Drive would be utilized as a square loop ramp to accommodate all turning movements to or from northbound Lawrence Expressway currently served at the intersection of Lawrence Expressway and Arques Avenue. No ramps would be provided at the location of the existing Lawrence Expressway and Arques Avenue intersection. In order to facilitate the use of those existing streets as square loops, additional signals and roadway capacity would need to be provided.

A roundabout would be provided to handle ramp movements for southbound Lawrence Expressway at Kifer Road. Hook ramps would facilitate movements to/from northbound Lawrence Expressway. The hook ramps would provide connections from Lawrence Expressway to Lawrence Station Road, which would then provide access to Kifer Road. The intersections of Lawrence Station Road with both the hook ramps and with Kifer Road would be signalized.

A new connection, similar to a jughandle, would be utilized to connect southbound Lawrence Expressway to Reed Avenue/Monroe Street via Willow Avenue. The intersection of Willow Avenue with Reed Avenue would be signalized. Connectivity to/from northbound Lawrence Expressway would be provided by hook ramps that connect French Street to Lawrence Expressway just north of Reed Avenue/Monroe Street. French Street would become two-way and would be signalized at Lawrence Expressway.

#### *Traffic and Circulation*

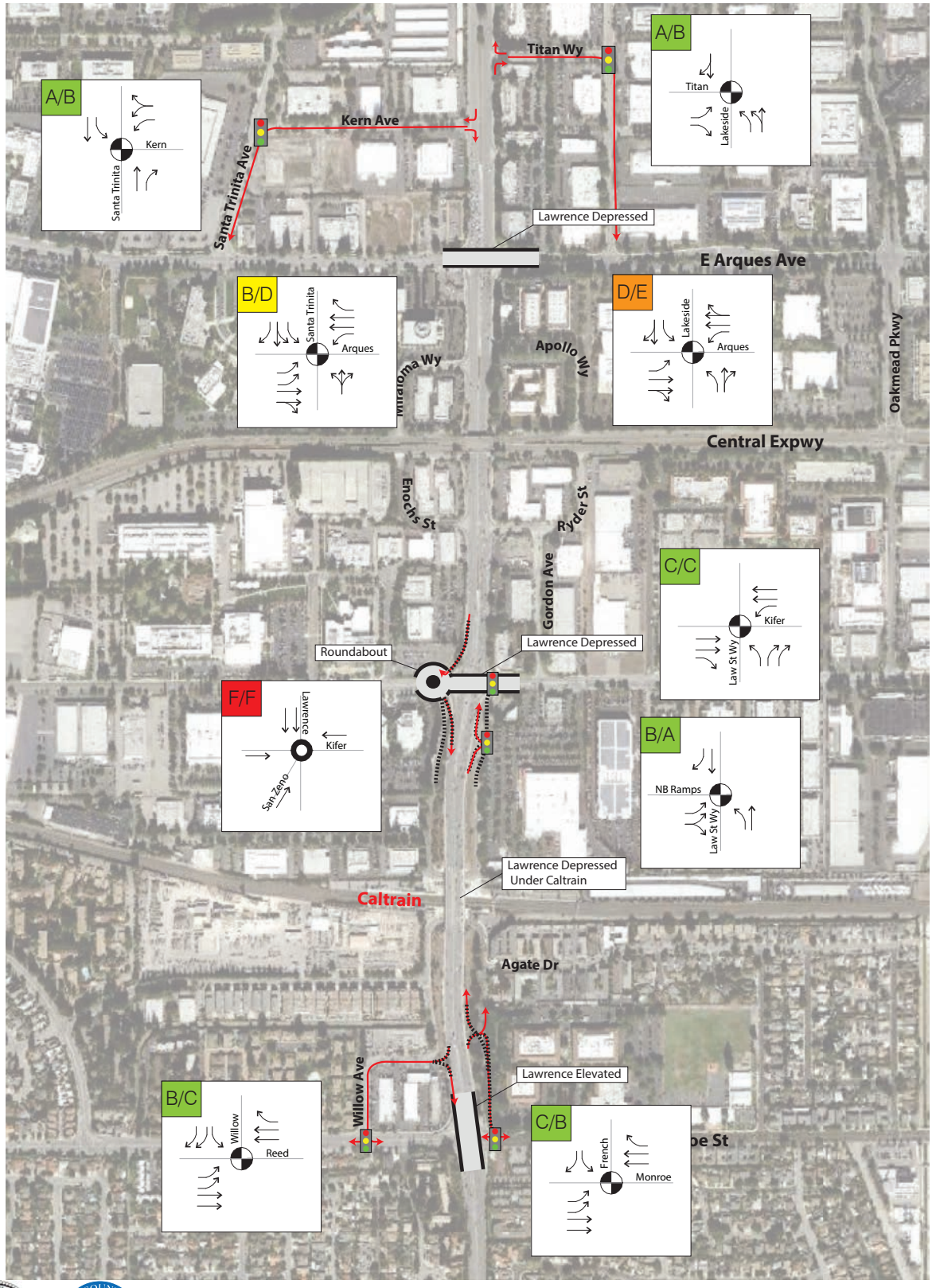
Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and associated Year 2040 LOS are also shown in **Figure 4-13**.

### *Table 4-5 - Concept 5 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Corridor Throughput | ◑ | Conflicts points on the Expressway are removed. There would still be a number of weave/merge points along the corridor (6 within 1.2 mi) |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ◑ | Right-turn volumes are high, resulting in some queuing and delay. Free-right turns (with add lanes) would significantly improve intersection to a very good LOS. Otherwise operates at LOS D. |
| - Kifer | ○ | Even a two-lane roundabout is insufficient given the volumes forecast for this location. |
| - Reed/Monroe | ◑ | Right-turn volumes are high, resulting in some queuing and delay. Free-right turns (with add lanes) would significantly improve intersection to a very good LOS. Otherwise operates at LOS D. |
| - Local Circulation | ● | Access is maintained to/from all local movements. Travel across Lawrence Expwy will be improved through reduced cycle lengths and reduced delay. Kern access to Expressway will be restricted due to proximity to Arques SPUI. |
| **Multi-Modal Circulation** | ◑ | *Note: Since roundabout is not a feasible alternative due to capacity limitations, comments below are focused on SPUI locations.* |
| - Pedestrian crossing | ◑ | Pedestrian crossing distances are greatly shortened compared to existing conditions. Circulation is maintained for all existing uses. However, pedestrians would have to cross ramps over numerous signal cycles. Free right-turns would need to be signalized against pedestrian activated phase to avoid conflict. |
| - Pedestrian along Expwy | ○ | Bicycle activity would remain on the Expressway. Joint bike/ped ramps and underpasses could be provided to maintain connectivity. Allows for safe travel, but potentially longer travel distances. Requires structures and ROW. |
| - Transit Access to Lawrence Station | ● | Roundabout allows for full access to station from both of San Zeno and Lawrence Station Way. |
| - Transit Stops along Corridor | ◑ | Transit stops would most likely be located directly below the SPUIs, with vertical circulation up to the intersection (that circulation needs to be provided for general ped circulation anyways). |
| - Bike crossing | ● | Bicycles would cross ramps with autos and would have shortened crossing distances (with a compact SPUI). Conversion to free right-turns would introduce new conflict for bikes. |
| - Bike along Expwy | ○ | Bicycle activity would remain on the Expressway. Joint bike/ped ramps and underpasses could be provided to maintain connectivity. Allows for safe travel, but potentially longer travel distances. Requires structures and ROW. |
| **Community Factors** | ● | |
| - Visual Impacts | ● | Lawrence would be fully depressed and no visual impacts would occur. |
| - Community Context | ● | Lawrence would be out-of-sight and not a visible or safety barrier for the community at each interchange. A roundabout could be considered an aesthetic feature. |
| **Design Elements** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Right-of-Way Needs | ○ | The SPUIs can mostly fit within existing ROW, although slivers would be needed at each corner. This could significantly affect the gas station at the SE corner at Reed/Monroe. Maintaining access to/from the Central ramps may impact existing buildings at Arques. |
| - Constructability | ◑ | Concept would require significant work at each location to grade-separate Lawrence and construct ramps. There could be significant construction stage impacts to adjacent businesses. The roundabout would require a large aerial structure. |
| - Allows Phased Implementation | ● | Each interchange is independent and the project could be built in phases. |
| **Cost** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Structural Cost | ◑ | The SPUIs will require an elevated intersection above Lawrence Expwy. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-13 - Concept 6*



The solutions at each of the three intersections are generally independent and can be evaluated separately in their effectiveness. The square loop ramps at Arques Avenue are generally effective, but will result in a deficient LOS E in the PM peak hour at the existing signalized intersection of Lakeside Drive with Arques Avenue. The roundabout for the southbound movements at Lawrence Expressway and Kifer Road does not have sufficient capacity to handle projected volumes. A number of geometric variants were tested for the roundabout, including multi-lane roundabouts and slip lanes, but none were sufficient to meet the projected vehicle demand. The hook ramps functioned well, but provided limited queuing storage both in exiting the expressway and along Lawrence Station Road. The hook ramps and jughandle at Reed Avenue/Monroe Street functioned well, but also had limited acceleration/deceleration distance for movements onto and off of the expressway.

Pedestrian and bicycle facilities with this concept are include in a figure in **Appendix C**. A set of shared bicycle and pedestrian ramps would be provided on either side of Arques Avenue and Lawrence Expressway to provide direct connectivity between the streets and avoid requiring extensive out of direction travel for bicyclists and pedestrians along the square loop ramps. However, pedestrian and bicycle movements along the expressway would not be served well by the hook ramps, the jughandles and the high-speed ramps to the roundabout. With each scenario, through cyclists would have to cross a large volume of relatively high-speed right-turn movements. Pedestrians would have similar conflicts with the square loops and the roundabout ramps. For the hook ramps, pedestrians could be brought to the hook ramp signalized intersections to avoid the right-turn movement conflict, but that would introduce additional grade changes and out-of-direction travel.

Concept 6 also provides improved transit access to and from the Lawrence Caltrain Station through use of the roundabout and hook ramp at Kifer Road.

#### *Design*

A plan and profile view of this concept is provided in **Appendix B**. The hook ramps and roundabout would require significant ROW. The jughandles would require enhancing the capacity and throughput of smaller streets such as Kern Avenue, Titan Way, and Willow Avenue. The grades and turning radii for the hook ramps necessitate ROW acquisition that would impact the Costco parking lot as well as the Irvine Company development site at the corner of Monroe Street and French Street.

As noted with other concepts, depressing Lawrence Expressway at Arques Avenue and Kifer Road would be associated with excavation, drainage and stage construction challenges. This concept would require removal of the existing Caltrain bridge and a new tunnel under Caltrain, resulting in significant costs and implementation challenges. The square loops at Arques Avenue would be cheaper to construct given that it would rely on already existing roadways. Each interchange could be implemented independently, thus allowing the project to be built in phases.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-6**.

### *4.2.7. Concept 7*

#### *Concept Description*

Concept 7 implements a unique intersection improvement treatment at each of the three major intersections along Lawrence Expressway within the project area, as shown in **Figure 4-14**.

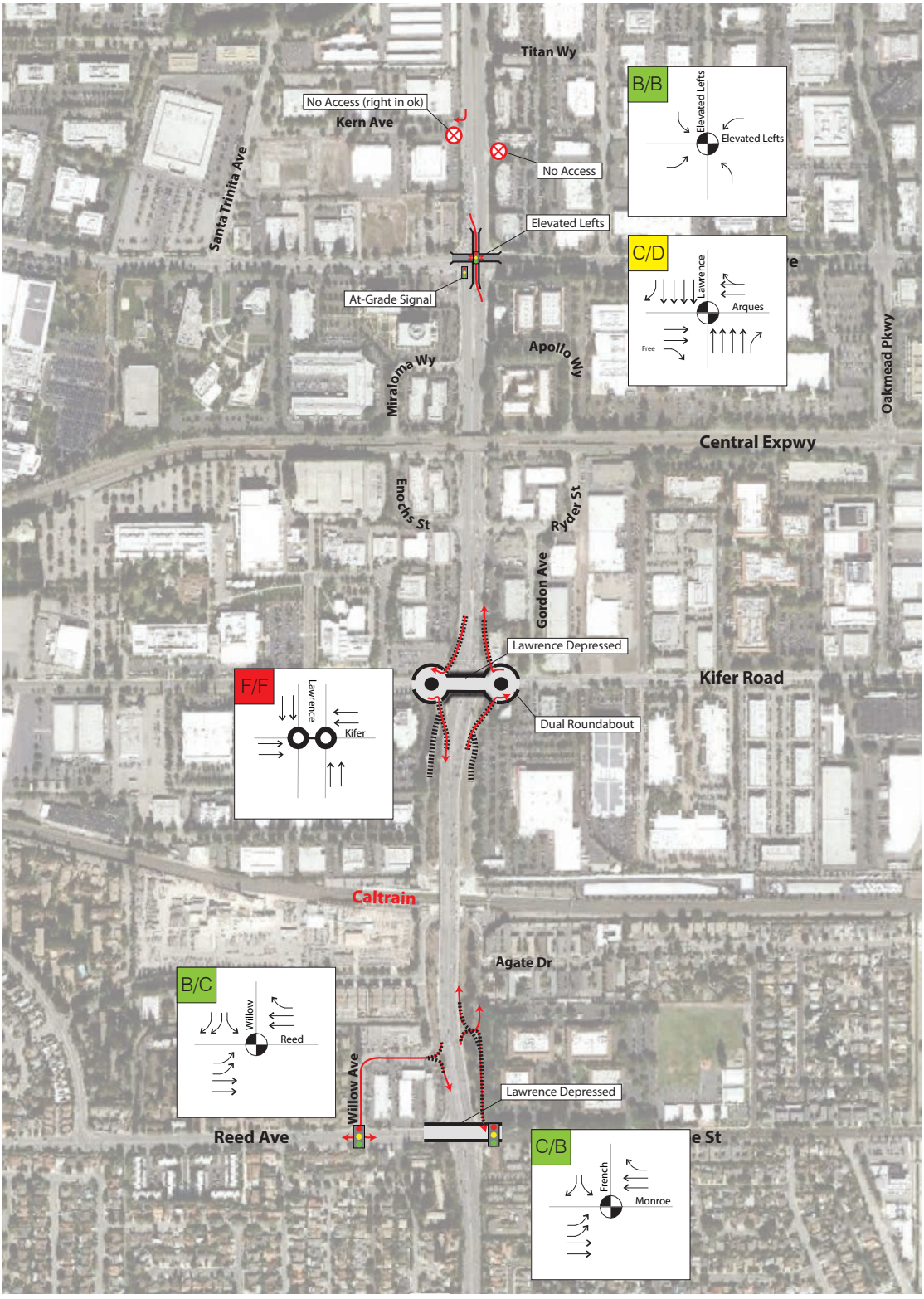
At the Arques Avenue intersection, Lawrence Expressway would remain at-grade, with left-turn movements to/from the expressway elevated above the existing at-grade intersection. There would be two signalized intersections, with the elevated left signal located directly above the through movement signal for Lawrence Expressway and Arques Avenue. By separating out left-turn movements from all the approaches and relocating them to an elevated structure using narrow ramps within the median, this allows for simple two-phase signals on both the elevated and at-grade intersections. Lawrence Expressway and Arques Avenue through and right-turn traffic would continue to use the same intersection as today to make their respective movements.

### *Table 4-6 - Concept 6 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Corridor Throughput | ◑ | Conflicts points on the Expressway are removed. There would still be a number of weave/merge points along the corridor (5 within 1.2 mi) |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ◑ | To avoid significant widening on Lakeside, Lakeside and Arques would operate at LOS E during the PM peak. The other locations along the jughandles would be signalized and would operate at LOS D or better. |
| - Kifer | ○ | While the NB hook ramp would operate well, the SB roundabout would be over-capacity. |
| - Reed/Monroe | ● | The hook ramps would all operate at LOS C or better, with minimal delay or queuing issues. |
| - Local Circulation | ◑ | Local circulation across the corridor would be greatly improved. However, access between Lawrence and the local streets would require some out-of-direction travel, particularly at Arques. Note that out-of-direction travel could be as much as 3/4 mile. |
| **Multi-Modal Circulation** | ◑ | *Note: Since roundabout is not a feasible alternative due to capacity limitations, comments below are focused on hook-ramp and jughandle locations.* |
| - Pedestrian crossing | ● | All pedestrian crossing locations of Lawrence would be removed. |
| - Pedestrian along Expwy | ◑ | Requires out-of-direction travel to avoid crossing high-speed ramps. Removal of all conflict points at Arques. |
| - Transit Access to Lawrence Station | ● | Roundabout and hook ramp allows for full access to station from both of San Zeno and Lawrence Station Way. |
| - Transit Stops along Corridor | ◑ | Transit stops would most likely be located on the mainline with vertical circulation up to the intersection provided at the ped ramps. |
| - Bike crossing | ● | All bike crossing locations of Lawrence would be removed. |
| - Bike along Expwy | ○ | Bicycle activity would remain on the Expressway, requiring crossings of high-speed ramps. |
| **Community Factors** | ◑ | *Note: Design could be modified to bring Lawrence under Reed/Monroe, eliminating aerial structures.* |
| - Visual Impacts | ◑ | Lawrence would be elevated over Reed/Monroe, requiring a vertical structure. No other vertical structures are proposed. |
| - Community Context | ◑ | Lawrence would be out-of-sight and not a visible or safety barrier for the community at each interchange. Hook ramps and jughandles would greatly increase traffic on existing minor streets. |
| **Design Elements** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Right-of-Way Needs | ◑ | The hook ramps and roundabout would require significant ROW. The jughandles would require minimal ROW (only at intersections for turn lanes). |
| - Constructability | ● | Concept would require significant work at each location to grade separate Lawrence. Jughandles would be easiest to construct with limited affect to mainline operations on Lawrence. |
| - Allows Phased Implementation | ● | Each interchange is independent and the project could be built in phases. |
| **Cost** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Structural Cost | ◑ | A relatively limited number of structures would be required at the interchanges, consisting primarily of bridges at cross-streets, ramps and retaining walls. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-14 - Concept 7*



South of Arques Avenue, Lawrence Expressway would be depressed under Kifer Road, Caltrain and Reed Avenue/Monroe Street. The intersection of the Lawrence Expressway ramps with Kifer Road is proposed to be constructed with dual roundabouts at-grade. The roundabouts would function in tandem due to their close spacing. Access to the local street network along Reed Avenue/Monroe Street is identical to that proposed in Concept 6, although in this concept Lawrence Expressway would be depressed below Reed Avenue/Monroe Street. Therefore, the ramps will extend upward from Lawrence Expressway to the existing grade level.

#### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS are also shown in **Figure 4-14**.

As with Concept 5, the roundabout at Kifer Road does not provide sufficient capacity to handle the projected turning movements at that location. It would operate at a deficient LOS F. The elevated left-turn intersection at Arques Avenue would operate well at LOS B. By removing the left-turn movements from the existing Arques Avenue and Lawrence Expressway intersection, operations of that intersection in Year 2040 would improve to an acceptable LOS D in the PM peak hour with the same number of through lanes as today. The provision of a signalized intersection on Lawrence Expressway at Arques Avenue will result in some metering, helping establish a platoon in the NB direction approaching Oakmead Parkway, benefiting the downstream intersection. Traffic operations in this scenario at the Reed Avenue/ Monroe Street are identical to Concept 6.

The elevated left-turn movements will be accessed or egressed via the median of Lawrence Expressway. With close spacing between the start of the ramp for the elevated left-turn and the Miraloma Way and Apollo Way square loop ramps, circulation between Central Expressway and westbound Arques Avenue will need to shift to other roadways such as Oakmead Parkway.

The elevated left-turn concept as shown in this concept does not provide significant benefits to bicyclists or pedestrians compared with existing conditions. There would be some benefit associated with a wide refuge being provided in the median of Lawrence Expressway at Arques Avenue beneath the elevated left-turn intersection. However, the overall crossing distance, number of conflicts and wait times would remain similar to today. Pedestrian and bicycle facilities for this concept are depicted in a figure in **Appendix C**.

#### *Design*

With Lawrence Expressway being depressed south of Central Expressway in this concept, many of the same challenges will occur with this concept as with other similar concepts with regards to excavation, drainage, the Caltrain tunnel and constructability. With Lawrence Expressway continuing to run at grade at Arques Avenue, that location would be somewhat less expensive and easier to construct. However, the elevated lefts intersection would be directly above the existing Arques Avenue intersection resulting in significant construction challenges to maintain traffic flow along Arques Avenue during the construction of the elevated structure.

The elevated lefts intersection will not require significant ROW. The dual roundabouts will reduce the required width of the structure over Lawrence Expressway when compared with Concept 5, but will require additional ROW along Kifer Road.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-7**.

### *4.2.8. Concept 8*

#### *Concept Description*

Concept 8 combines elements proposed as part of other concepts, such as the square loops at Arques Avenue and the tight diamond interchange at Reed Avenue/Monroe Street, with an elevated lefts concept at Kifer Road. Lawrence Expressway would be depressed for the span of the project corridor, including the three main cross streets of Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue and the Caltrain tracks. **Figure 4-15** schematically depicts the concept.

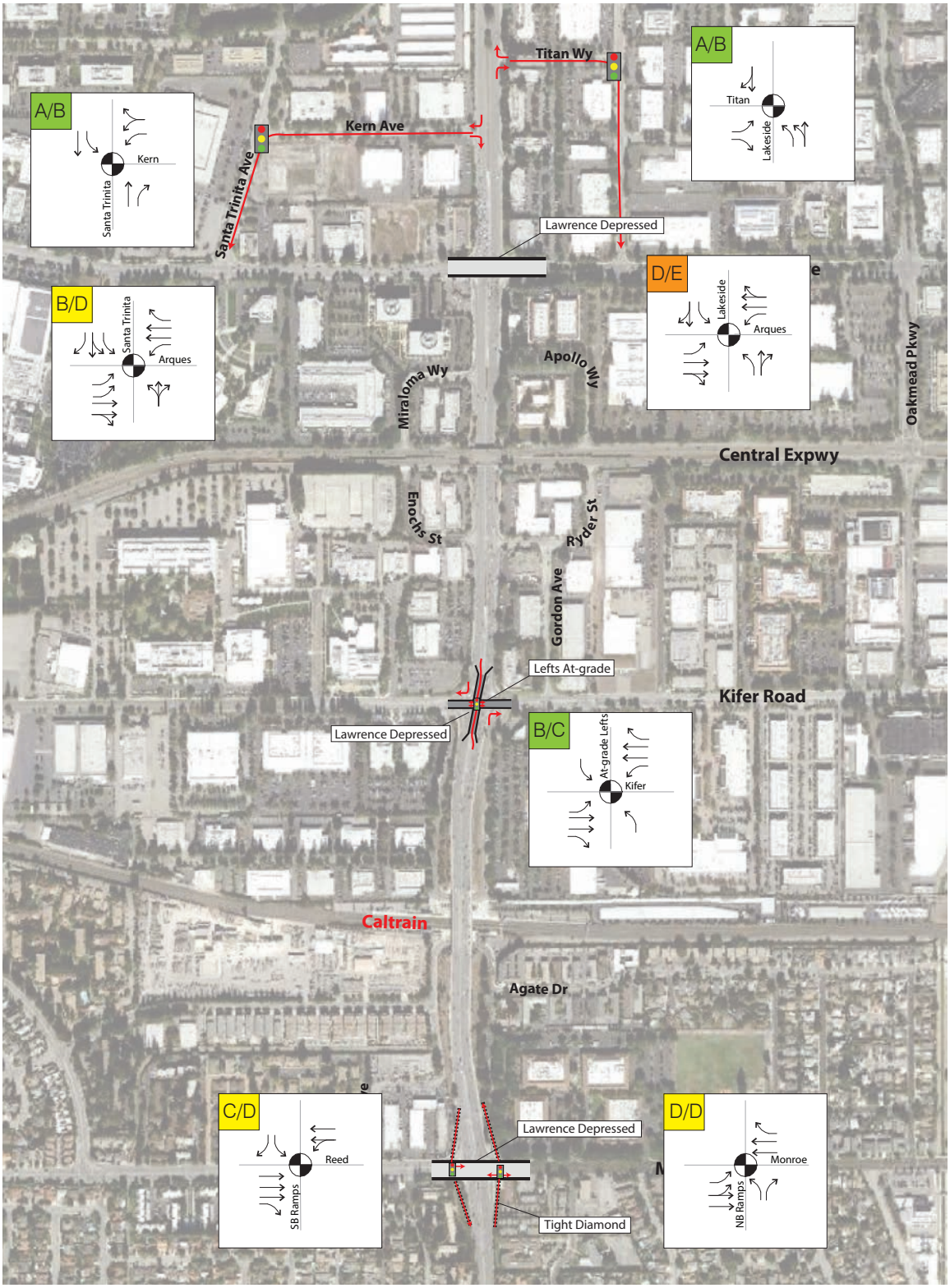
The elevated lefts concept proposed for Kifer Road is a little different than the elevated lefts concept proposed for Arques Avenue in Concept 7. In Concept 7, all through movements and right turns will still be served at the signalized intersection of Lawrence Expressway

### *Table 4-7 - Concept 7 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Corridor Throughput | ◑ | One two-phase signalized intersection would remain on Lawrence. It would operate at LOS D or better. There would still be a number of weave/merge points along the corridor (5 within 1.2 mi) |
| - Downstream Metering | ◑ | Some metering would occur at Lawrence & Arques, helping establish a platoon in the NB direction approaching Oakmead. |
| - Arques | ● | The elevated lefts would allow those movements with minimal delay. Arques and Lawrence would be greatly improved from baseline and would operate at LOS D or better. |
| - Kifer | ○ | Even a two-lane roundabout is insufficient given the volumes forecast for this location. |
| - Reed/Monroe | ● | The hook ramps would all operate at LOS C or better, with minimal delay or queuing issues. |
| - Local Circulation | ◑ | Local access across Lawrence will be improved through elimination of conflict points and reduction in cycle length. Local business access is not affected, although hook ramps require a very limited amount of out-of-direction travel. |
| **Multi-Modal Circulation** | ◑ | *Note: Since roundabout is not a feasible alternative due to capacity limitations, comments below are focused on hook-ramp and elevated left locations.* |
| - Pedestrian crossing | ◑ | Pedestrian crossing locations of Lawrence would be removed at Reed/Monroe. The at-grade pedestrain crossing of Lawrence at Arques would remain, but a large pedestrian refuge could be constructed in the median to shorten effective crossing distance. |
| - Pedestrian along Expwy | ◑ | Pedestrians ramps would need to constructed to provide access to/from Reed/Monroe, and pedestrians would have to cross high-speed ramps north of Reed/Monroe. The at-grade pedestrain crossing of Arques would remain, but a large pedestrian refuge could be constructed in the median to shorten effective crossing distance. |
| - Transit Access to Lawrence Station | ● | Roundabouts allow for full access to station from both of San Zeno and Lawrence Station Way. |
| - Transit Stops along Corridor | ◑ | Transit stops would most likely be located on the mainline with vertical circulation up to the intersection provided at the ped ramps at Reed/Monroe. Transit stops could be located similar to current at Arques. |
| - Bike crossing | ◑ | The bike crossing of Lawrence at Reed/Monroe would be removed. The bike crossing of Lawrence at Arques would remain, but the crossing distance would be reduced. |
| - Bike along Expwy | ○ | Bicycle activity would remain on the Expressway, requiring crossings of high-speed ramps at Reed/Monroe. Bike crossing would be similar to existing at Arques. |
| **Community Factors** | ● | |
| - Visual Impacts | ● | Lawrence would be fully depressed and no visual impacts would occur. |
| - Community Context | ● | Lawrence would be out-of-sight and not a visible or safety barrier for the community at each interchange. Hook ramps at Reed/Monroe would increase traffic for a short segment of existing minor streets. Roundabout could be considered an aesthetic feature. |
| **Design Elements** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Right-of-Way Needs | ◑ | The hook ramps and roundabout would require ROW. The elevated lefts would not require any ROW. |
| - Constructability | ◑ | Hook ramps would be easiest to construct with limited affect to mainline operations on Lawrence. The elevated lefts would likely result on some construction-stage impacts on the Expressway and at Arques. The roundabout would require a very large structure. |
| - Allows Phased Implementation | ● | Each interchange is independent and the project could be built in phases. |
| **Cost** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Structural Cost | ● | A relatively limited number of structures would be required at the interchanges, consisting primarily of bridges at cross-streets, ramps and retaining walls. This concept requires one less grade separation of Lawrence. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-15 - Concept 8*



with Arques Avenue underneath the left turn interchange. However, in this concept, Lawrence Expressway would be depressed underneath Kifer Road. Left-turn movements from Lawrence Expressway to Kifer Road would ramp up to grade level to intersect with Kifer Road. The intersection elevated above Lawrence Expressway, but at-grade relative to adjacent land use, would include all Kifer Road movements as well as the Lawrence Expressway left-turn movements. Right-turn movements from Lawrence Expressway to Kifer Road would occur via ramps on the outside of the expressway.

#### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS are shown on **Figure 4-15**.

Traffic operations for this concept at Arques Avenue would mirror that of Concept 6 and traffic operations for this concept at Reed Avenue/Monroe Street would mirror that of Concept 4. The elevated lefts intersection at Kifer Road would work with minimal delay and a short cycle length. The Lawrence Expressway left-turn movements, currently provided for by dual left-turn movements on Lawrence Expressway, can be handled in single left-turn lanes due to the shorter cycle length at the elevated intersection. Due to the close spacing between the Enochs Street and Ryder Street square loop ramps, movements between Kifer Road and eastbound Central Expressway would be precluded.

Bicycle and pedestrian facilities for this concept are shown in **Appendix C**. They would be identical to previous concepts for Arques Avenue and Reed Avenue/Monroe Street. Bicycle and pedestrian movements between Lawrence Expressway and Kifer Road would be provided alongside the right-turn movement ramps. In order to facilitate through bicycle and pedestrian movements along the expressway while avoiding the higher-speed right-turn ramps, a pedestrian and bicycle underpass would be required, crossing beneath the right-turn ramps. Crossing the expressway at Kifer Road would be much easier. Instead of the large crossing distance that exists today across the 8-lane expressway plus turning lanes, the crossing distance would simply consist of a two-lane ramp.

#### *Design*

A plan and profile view of this concept is included in **Appendix B**. In this concept, Lawrence Expressway would be fully depressed, resulting in the same challenges and complexities identified with similar earlier concepts. The design considerations at Arques Avenue and Reed Avenue/Monroe Street mirror previous concepts. At Kifer Road, significant ROW would be needed to facilitate access to Lawrence Expressway from the southwest quadrant of the Central Expressway square loop ramps (Enochs Street) due to the required length of the right-turn ramp from southbound Lawrence Expressway to westbound Kifer Road.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-8**.

### *4.2.9. Concept 9*

#### *Concept Description*

Concept 9 includes a unique set of options for each of the three major cross-streets, as depicted in **Figure 4-16**. Lawrence Expressway would continue to be at grade at Arques Avenue and follow its current grade at Central Expressway, but would be depressed under Kifer Road and Reed Avenue/Monroe Street.

Indirect left-turns would be utilized at Lawrence Expressways and Arques Avenue to shift left turns from Lawrence Expressway to downstream mid-block locations. To access Arques Avenue from Lawrence Expressway, drivers would travel through the intersection to a new half-signal where they would make a U-turn, return to Arques Avenue and make a right turn. The existing signal at Arques Avenue and Lawrence Expressway would continue to operate for through movements and right-turn movements. The turn lanes for the U-turn movements would occur in the median approximately in the area vacated by the existing left-turn pockets on Lawrence Expressway.

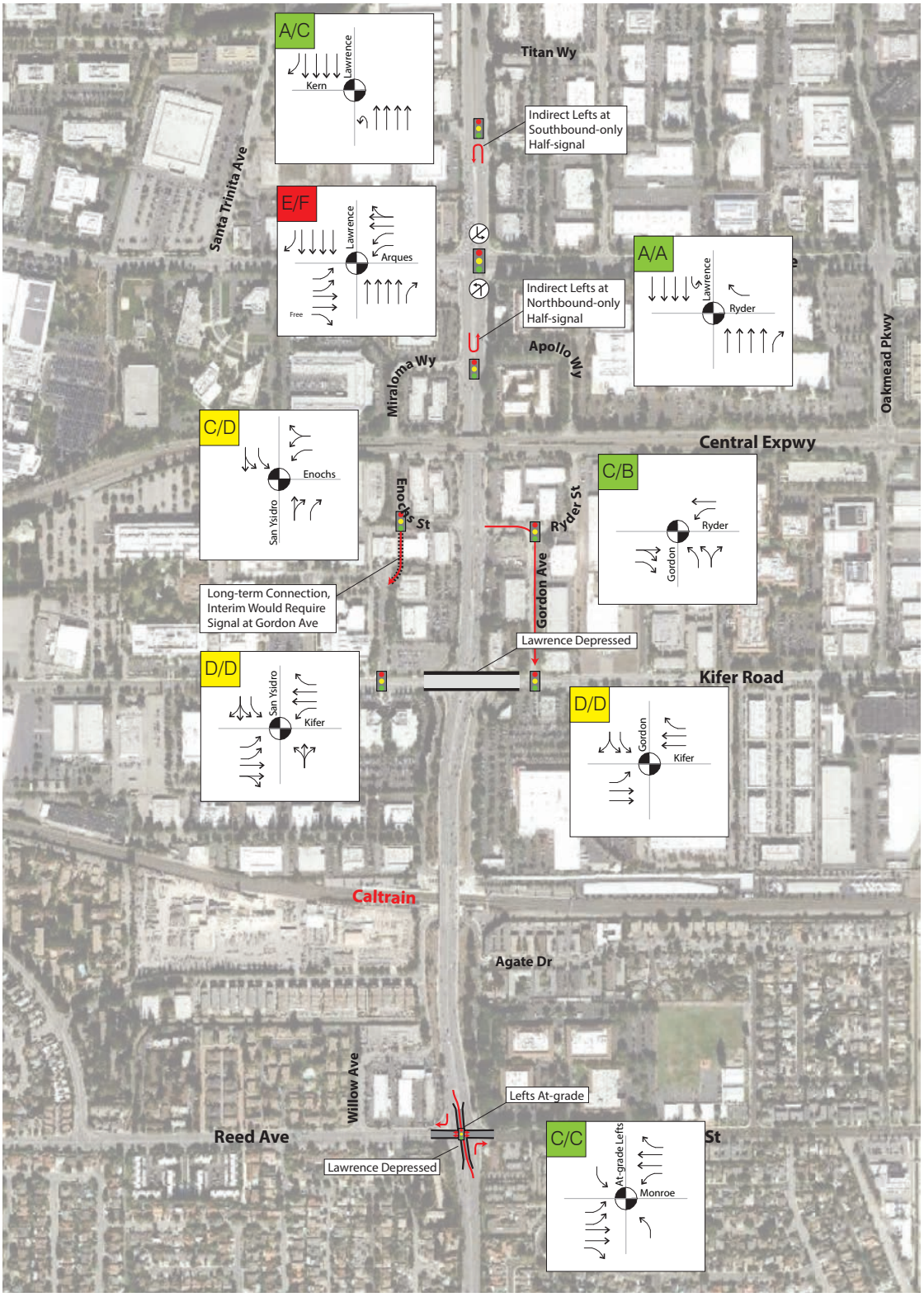
A jughandle/partial square loop configuration would be used at Kifer Road. Kifer Road would cross over the depressed Lawrence Expressway without any vehicle ramps. In order to travel between northbound Lawrence Expressway and Kifer Road, Ryder Street and Gordon Avenue would be utilized. In order to travel between southbound Lawrence Expressway and Kifer Road, Enochs Street and a new

### *Table 4-8 - Concept 8 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Corridor Throughput | ◑ | Conflicts points on the Expressway are removed. There would still be a number of weave/merge points along the corridor (6 within 1.2 mi) |
| - Downstream Metering | ○ | No metering would occur, resulting in downstream queuing |
| - Arques | ◑ | To avoid significant widening on Lakeside, Lakeside and Arques would operate at LOS E during the PM peak. The other locations along the jughandles would be signalized and would operate at LOS D or better. |
| - Kifer | ● | The elevated lefts intersection would work at LOS C or better. There would be some queuing for the EB left-turn. |
| - Reed/Monroe | ● | The Reed/Monroe bridge would need to be 5-lanes wide to provide sufficient capacity. With that geometry, the Reed/Monroe intersections will function at LOS D or better. Assumes standard tight diamond phasing (quad phasing). |
| - Local Circulation | ◑ | Local circulation across the corridor would be greatly improved. However, access between Lawrence and the local streets would require some out-of-direction travel at Arques. Note that out-of-direction travel could be as much as 3/4 mile. |
| **Multi-Modal Circulation** | ◑ | |
| - Pedestrian crossing | ● | Pedestrian crossing locations of Lawrence would be removed at Arques. Pedestrian crossing distances are significantly shortened at Kifer. Pedestrians would have to cross at two signalized intersections instead of one at Reed/Monroe, but the crossing distance would be less. |
| - Pedestrian along Expwy | ◑ | Pedestrians ramps would need to constructed to provide access to/from Arques. An underpass would be required to cross right-turns at Kifer. At Reed/Monroe, pedestrians would be bought up to the intersecting roads to avoid high-speed ramps. This will result in some additional grades, but no new conflict points. |
| - Transit Access to Lawrence Station | ○ | Concept would not improve (and may hinder) access to/from San Zeno and Lawrence Station Way. Would work best in conjunction with buildout of roadway network as proposed in LSAP. |
| - Transit Stops along Corridor | ◑ | Transit stops could be located on either the interchange ramps or along the mainline at Kifer and Reed/Monroe. Stops on interchange ramps would require transit to wait at the signal. Stops on the mainline would require very long walking distance to the cross-streets. Transit stops could be located below Arques, with pedestrian ramps up to the local streets. |
| - Bike crossing | ● | The bike crossing of Lawrence at Arques would be removed. Bicycle crossing distances are significantly shorted at Kifer and moderately shortened at Reed/Monroe. |
| - Bike along Expwy | ○ | Bicycle activity would be presumed to remain on the Expressway (although could be taken up to the intersections similar to peds) at Reed/Monroe. Maintaining bikes on the mainline would require two crossings of high-speed ramps. Bicycles would also cross high-speed ramps at Arques and would require underpass at Kifer. |
| **Community Factors** | ● | |
| - Visual Impacts | ● | Lawrence would be fully depressed and no visual impacts would occur. |
| - Community Context | ● | Lawrence would be out-of-sight and not a visible or safety barrier for the community at each interchange. Jughandles would greatly increase traffic on existing minor streets |
| **Design Elements** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Right-of-Way Needs | ◑ | ROW would be needed to facilitate the ramps south of Reed/Monroe and significant right-of-way would be needed to facilitate access to Lawrence from the SW quadrant Central ramp. This could be alleviated be removing the SB right-turn ramp to Kifer. |
| - Constructability | ◑ | Concept would require significant work at each location to grade separate Lawrence. Jughandles would be easiest to construct with limited affect to mainline operations on Lawrence. Elevated lefts and tight-diamond could result in some construction-stage impacts. |
| - Allows Phased Implementation | ● | Each interchange is independent and the project could be built in phases. |
| **Cost** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Structural Cost | ◑ | A relatively limited number of structures would be required at the interchanges, consisting primarily of bridges at cross-streets, ramps and retaining walls. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 4-16 - Concept 9*



connection between Enochs Street and San Ysidro Way would be utilized. Existing buildings currently preclude that proposed connection between Enochs Street and San Ysidro Way. The grade separation at Kifer Road may still be feasible prior to the construction of that connection if a half-signal is constructed at the intersection of Lawrence Expressway and Ryder Street to allow for southbound left-turn and westbound left-turn movements.

An at-grade left-turn interchange with the expressway depressed below would be implemented at the Lawrence Expressway and Reed Avenue/Monroe Street intersection. This is a similar treatment to the one proposed for Kifer Road in Concept 8. Right turn movements to Reed Avenue/Monroe Street would be provided via ramps on the outside of Lawrence Expressway.

### *Traffic and Circulation*

Based on the projected traffic volumes and associated traffic analysis conducted within the project area, the recommended roadway geometry and projected Year 2040 LOS resulting from this analysis are shown on **Figure 4-16**.

While both of the indirect left-turn movements downstream of the Arques Avenue intersection would function well, the intersection of Lawrence Expressway with Arques Avenue would still function at a deficient LOS in Year 2040 even with removal of the left-turn movements and close signal coordination with the indirect left-turn half-signals. Through movement and side-street left-turn volumes are too large on Lawrence Expressway and Arques Avenue for the intersection to handle, even with the reduction in conflicting phases. Widening the expressway to add one more lane is still not sufficient to get to LOS D at this location. It is projected that an extra through lane, dual NB/SB right-turns and triple eastbound left-turn improvements would be needed at this location in order to achieve acceptable operations. These improvements are not consistent with the goals of this project. Concepts 9 does however provide some metering at Lawrence Expressway and Arques Avenue, helping establish a platoon in the northbound direction approaching Oakmead Parkway.

In order to achieve acceptable operations for the partial square loop configuration at Kifer Road, Ryder Street and Enochs Street will need to be widened to each provide four lanes. Traffic on these streets will be required to merge to a single lane prior to merging onto Lawrence Expressway. New signals will be required at San Ysidro Way and Kifer Road, Enochs Street and San Ysidro Way, Gordon Avenue and Kifer Road, and Ryder Street and Gordon Avenue. The Gordon Avenue signal will be very closely spaced with the Costco access signal along Kifer Road. The elevated left-turn intersection at Reed Avenue/Monroe Street is projected to operate well with minimal delay.

Pedestrian and bicycle facilities with this concept are included in **Appendix C**. The pedestrian and bicycle environment for this concept would be similar to existing at Arques Avenue. The concept would increase the number of right-turn movements from the expressway to Arques Avenue, increasing conflicts with pedestrians crossing Arques Avenue along Lawrence Expressway. Shared bicycle and pedestrian ramps would be constructed between the expressway and Kifer Road, although these modes would have to cross a significantly increased number of free right-turn movements on and off of the expressway at Enochs Street and Ryder Street. At Reed Avenue/Monroe Street, cyclists would have to cross higher-speed right-turn movements. Pedestrian and bicycle movements along the cross-streets of Kifer Road and Reed Avenue/Monroe Street would be improved by reducing vehicle conflicts and crossing distances compared to existing conditions.

This concept does not significantly improve transit access to the Lawrence Caltrain Station, requiring out of direction travel for certain movements between the expressway and the station.

### *Design*

The plan and profile view of Concept 9 is provided in **Appendix B**. Concept 9 reduces some of the design challenges by leaving Lawrence Expressway at-grade at Arques Avenue and not modifying the Central Expressway square loop ramps. However, it does include removing the existing Caltrain bridge and constructing a new tunnel under the tracks, and bringing the expressway beneath Kifer Road and Reed Avenue/Monroe Street, introducing the cost, construction, and drainage challenges also faced by other concepts. The interchanges themselves are much simpler in this concept than others with Arques Avenue being at-grade, and Kifer Road relying on mostly existing streets. Thus, some of the construction impacts would be less with this concept than with others. The treatments

proposed for each of the intersections can function independently and thus could be implemented in phases and two of the intersection treatments (Arques Avenue and Kifer Road) could be implemented in the short-term.

A major downside of this concept is that ROW would be required for the ultimate connection between Enochs Street and San Ysidro Way, which would require nearly complete acquisition of an improved parcel. An interim solution is feasible at this location but would require an additional signalized intersection on the corridor at Ryder Street.

The matrix showing the findings of the qualitative concept evaluation can be seen in **Table 4-9**.

## *4.3. Concept Evaluation and Comparison*

Based on the analysis performed for each concept in the areas of traffic, multi-modal circulation, community context, design, and cost, Kimley-Horn developed concept evaluation matrices. Since the solutions at each of the three intersections could be implemented independently for most of the concepts, it was beneficial to compare the cost effectiveness of the solutions at each individual location. This evaluation is shown in **Table 4-10**. It was also beneficial to compare the concepts to each other to identify those that best met the goals of the project, which is shown in **Table 4-11**. As shown in the tables, each concept rated well in some categories but poorly in others. In most cases, the greater the investment, the greater the benefit. Concept 1 rated very well in vehicular traffic and multi-modal circulation, but was also the most complex and costly alternative. Concept 4 rated medium in many categories, but had some very significant deficiencies. Concepts 6 through 9 included effective treatments at certain locations along the corridor, but not at others. From this evaluation, the most desirable elements could be identified and combined to form the alternatives for further study. Additionally, concepts that scored well in many categories could be targeted for revision to improve effectiveness in other categories with poorer ratings.

### *Table 4-9 - Concept 9 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ○ | |
| - Corridor Throughput | ○ | A signalized intersection (and its two ancillary intersections) would still remain on the Expressway and would result in queuing and delay to through vehicles. However, only 3 other weave/merge points would occur on the corridor. |
| - Downstream Metering | ◑ | Some metering would occur at Lawrence & Arques, helping establish a platoon in the NB direction approaching Oakmead. |
| - Arques | ○ | The indirect left-turn intersections would work well, but 2040 volumes on Lawrence are too high for the existing four through-lanes. Widening to add one more lane is still not sufficient to get to LOS D. Would need the extra lane, dual NB/SB right-turns and a triple EB left-turn. |
| - Kifer | ◑ | Gordon, Ryder, Enochs and San Ysidro would all need to be expanded and signals installed, but with that widening, all intersections would operate at LOS D or better. There would still be some lengthy queuing on Enochs and Gordon. |
| - Reed/Monroe | ● | The elevated lefts intersection would work at LOS C or better. There would be some queuing for the EB left-turn. |
| - Local Circulation | ◑ | Local circulation across the corridor would be improved, especially at Reed/Monroe. However, access between Lawrence and the local streets would require some out-of-direction travel at Arques and at Kifer. Note that out-of-direction travel would be limited to less than 1/2 mile at Kifer and about 1/4 mile at Arques. |
| **Multi-Modal Circulation** | ○ | |
| - Pedestrian crossing | ◑ | Pedestrian crossing distances at Arques would be about the same, with likely the same wait time. Pedestrian crossing locations of Lawrence would be removed at Kifer (with a signalized crossing added at Gordon). Pedestrian crossing distances are significantly shortened at Reed/Monroe. |
| - Pedestrian along Expwy | ◑ | Pedestrian access across Arques would not be modified much from existing conditions. Pedestrians ramps would need to constructed to provide access to/from Kifer. Some out-of-direction travel would be required to cross Reed/Monroe since the crosswalks would be provided at the signalized intersection above the median of Lawrence. |
| - Transit Access to Lawrence Station | ○ | Concept would only slightly improve access to/from San Zeno and Lawrence Station Way. Would work best in conjunction with buildout of roadway network as proposed in LSAP. |
| - Transit Stops along Corridor | ○ | Transit conditions would be similar to existing at Arques. Transit stops would be provided below Kifer Road with pedestrian connections up to the roadway. Transit stops could be located on either the interchange ramps or along the mainline at Reed/Monroe. Stops on interchange ramps would require transit to wait at the signal. Stops on the mainline would require very long walking distance to the cross-streets. |
| - Bike crossing | ● | Bicycle crossing distances at Arques would be about the same, with likely the same wait time. Conflict points for the bicycle crossing of Lawrence would be removed at Kifer . Bicycle crossing distances are significantly shortened at Reed/Monroe. |
| - Bike along Expwy | ◑ | Bicycle facilities near Arques would not be modified much from existing conditions. Circulation would improve at Kifer by removing a conflict point. Bicycles would cross a high-speed ramp at Reed/Monroe. |
| **Community Factors** | ● | |
| - Visual Impacts | ● | Lawrence would be depressed or remain at-grade and no visual impacts would occur. |
| - Community Context | ◑ | Lawrence would be out-of-sight and not a visible or safety barrier for the community at Kifer and Reed/Monroe. Business access may require some out of direction travel at Kifer (could be limited with the addition of specific ramps). Not much change would result at Arques. |
| **Design Elements** | ● | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Right-of-Way Needs | ◑ | ROW would be required for the connection between Enochs St and San Ysidro Way, which would require nearly complete acquisition of an improved parcel. An interim solution is feasible but would require an additional signalized intersection on the corridor. Providing right-turn ramps at Reed/Monroe will require ROW and may impact buildings at the SE corner of Reed/Monroe. |
| - Constructability | ● | Concept would require some construction complexity and staging at Reed/Monroe to build elevated lefts. Other locations would have relatively fewer constructability challenges. |
| - Allows Phased Implementation | ● | Each interchange is independent and the project could be built in phases. Improvements (except Enochs to San Ysidro connection and Caltrain underpass) are releatively easier to implement in short-term. |
| **Cost** | ◑ | *Note: Constructability excludes Caltrain underpass since that is optional (alternatively modify Caltrain bridge).* |
| - Structural Cost | ● | A relatively limited number of structures would be required at the interchanges, consisting primarily of bridges at cross-streets, ramps and retaining walls. This concept requires one less grade separation of Lawrence and fewer ramps facilities. |
| - Civil Cost | ○ | Depressing Lawrence will require relocation of all utilities. There would also be significant drainage concerns given the presumed height of the water table. |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

### *Table 4-10 - Concept Evaluation - Summary of Estimated Cost-Effectiveness*

| | Arques | | Central Connection | | Kifer | | Reed/Monroe | |
|---|---|---|---|---|---|---|---|---|
| Concept 1 | Side-running frontage | ◑ | New/modified structure | ○ | Side-running frontage | ● | Side-running frontage | ● |
| Concept 2 | Median-running frontage | ○ | New/modified structure | ○ | Median-running frontage | ◑ | Median-running frontage | ○ |
| Concept 3[1] | Median-running frontage | ○ | New/modified structure | ○ | Median-running frontage | ◑ | Side-running frontage | ○ |
| Concept 4 | Tight Diamond | ● | Modified access from EB Central | ◑ | Tight Diamond | ◑ | Tight Diamond | ◑ |
| Concept 5 | Single-Point | ◑ | Modified access to/from WB Central | ◑ | Roundabout | ○ | Single-Point | ◑ |
| Concept 6[2] | Jughandle | ● | Limited modification | ● | Hook/Roundabout | ○ | Hook Ramps | ● |
| Concept 7 | Elevated Lefts (w/ At-Grade) | ● | Limited modification | ● | Dual Roundabouts | ○ | Hook Ramps | ● |
| Concept 8 | Jughandle | ● | Modified access from EB Central | ◑ | Elevated Lefts (Grade Sep) | ◑ | Tight Diamond | ◑ |
| Concept 9 | Indirect Lefts | ○ | Limited modification | ● | Jughandle | ◑ | Elevated Lefts (Grade Sep) | ◑ |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

Notes:
[1] Concept 3 would likely rank similar to concept 1 if design is modified to provide connection on Caltrain bridge. Further exploration would be required on modifications needed to bridge.
[2] NB hook ramp at Kifer would operate well but would require significant portion of Costco parking lot. SB hook ramp would also require significant ROW on the west side of Lawrence.

### *Table 4-11 - Concept Evaluation Summary Matrix*

| | Concept 1 | Concept 2 | Concept 3 | Concept 4 | Concept 5 | Concept 6 | Concept 7 | Concept 8 | Concept 9 |
|---|---|---|---|---|---|---|---|---|---|
| **Vehicular Traffic** | ● | ○ | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ○ |
| - Corridor Throughput | ● | ● | ● | ◑ | ◑ | ◑ | ◑ | ◑ | ○ |
| - Downstream Metering | ○ | ○ | ○ | ○ | ○ | ○ | ◑ | ○ | ◑ |
| - Arques | ● | ● | ● | ● | ◑ | ◑ | ● | ◑ | ○ |
| - Kifer | ● | ◑ | ◑ | ● | ○ | ○ | ○ | ● | ◑ |
| - Reed/Monroe | ● | ○ | ○ | ● | ◑ | ● | ● | ● | ● |
| - Local Circulation | ◑ | ◑ | ◑ | ◑ | ● | ◑ | ◑ | ◑ | ◑ |
| **Multi-Modal Circulation** | ● | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ○ |
| - Pedestrian crossing | ● | ◑ | ◑ | ● | ◑ | ● | ◑ | ● | ◑ |
| - Pedestrian along Expwy | ● | ● | ● | ◑ | ○ | ◑ | ◑ | ◑ | ◑ |
| - Transit Access to Lawrence Station | ◑ | ○ | ○ | ◑ | ● | ● | ● | ○ | ○ |
| - Transit Stops along Corridor | ● | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ○ |
| - Bike crossing | ● | ◑ | ◑ | ◑ | ● | ● | ◑ | ● | ● |
| - Bike along Expwy | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ◑ |
| **Community Factors** | ● | ◑ | ○ | ◑ | ● | ◑ | ● | ● | ● |
| - Visual Impacts | ◑ | ◑ | ○ | ◑ | ● | ◑ | ● | ● | ● |
| - Community Context | ● | ◑ | ○ | ● | ● | ◑ | ● | ● | ◑ |
| **Design Elements** | ○ | ○ | ○ | ◑ | ◑ | ◑ | ◑ | ◑ | ● |
| - Right-of-Way Needs | ◑ | ◑ | ◑ | ○ | ○ | ◑ | ◑ | ◑ | ◑ |
| - Constructability | ○ | ○ | ○ | ◑ | ◑ | ● | ◑ | ◑ | ● |
| - Allows Phased Implementation | ○ | ○ | ○ | ● | ● | ● | ● | ● | ● |
| **Cost** | ○ | ○ | ○ | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ |
| - Structural Cost | ○ | ○ | ○ | ◑ | ◑ | ◑ | ● | ◑ | ● |
| - Civil Cost | ○ | ○ | ◑ | ○ | ○ | ○ | ○ | ○ | ○ |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

# 5. Analysis Alternatives

The alternatives analysis stage of the project consisted of the identification and detailed analysis of three alternative solutions for the corridor. The alternatives were evaluated for traffic operations, multi-modal circulation, design feasibility, cost, and consistency with community goals. This stage included an extensive public and stakeholder input process.

## 5.1. Development of Analysis Alternatives

Based on the concept development evaluation, the SWG identified three alternatives for further analysis. The three alternatives were selected based on their effectiveness in meeting the project goals and in part for their diversity in solution and cost. They consisted of a frontage road concept (most similar to Concept 1 in the previous chapter), an interchange concept (a combination of concepts with modifications), and a grid network concept (also a combination of concepts with modifications). The interchange concept builds upon the elevated lefts concept, with modifications to improve traffic flow, benefit multi-modal circulation, and reduce the footprint. The grid network concept builds upon the jughandle concept, except at Reed Avenue/Monroe Street where there is not an existing or planned road network to support such a concept.

## 5.2. Alternative 1

### 5.2.1. Analysis Alternative Description

A refinement of the previously described Concept 1, Alternative 1 includes parallel frontage roads along Lawrence Expressway. Local traffic would utilize the frontage roads, while through traffic would remain on the expressway. There would be a couple of connections between the frontage roads and the expressway to allow local traffic to bypass some of the frontage road intersections. The frontage roads would each vary from one to three lanes, while the expressway would be a consistent three lanes in each direction. An illustrative display of the plan and profile view of Alternative 1 can be seen in **Figure 5-1**.

Lawrence Expressway would be depressed and run underneath Arques Avenue, Kifer Road, the Caltrain alignment, and Reed Avenue/ Monroe Street. The frontage roads would be constructed at-grade where feasible and run parallel to the expressway. Connections to and from Lawrence Expressway would be provided via slip ramps that either enter or exit on the right-hand side of the expressway. The frontage roads would be depressed to the level of the expressway where it crosses the Caltrain alignment and Central Expressway. The existing Caltrain bridge would be removed and the existing Central Expressway undercrossing would be reconstructed to be widened.

In general, bicycle and pedestrian facilities would occur along the lower volume, slower speed parallel frontage roads as shown in **Figure 5-2** and **Figure 5-3**. Bicycles would still be allowed on the shoulder of the expressway, but they would have to cross the traffic ramping between the expressway and the frontage roads at several locations.

With the expressway depressed, community interface would be with the smaller, lower-speed frontage roads. The expressway would be depressed and out of view, similar to portions of Central Expressway in Sunnyvale.

### 5.2.2. Traffic and Circulation

Analysis of traffic circulation with Alternative 1 was completed using the VISSIM micro-simulation software, which provided the detailed LOS, travel time, queuing and delay data for the 2020 and 2040 horizon years.

Alternative 1 would result in major improvement in travel speed and reduction in congestion in the peak direction of travel in each peak period (AM and PM). **Table 5-1** and **Table 5-2** indicate the improvements in corridor travel time and speed with the implementation of Alternative 1. The data in the table is for the corridor extents between Oakmead Parkway/Duane Avenue and Cabrillo Avenue, inclusive, and thus accounts for the potential for the improvement to shift congestion to the downstream intersection.

*Figure 5-1 - Alternative 1 Plan and Profile Illustration*

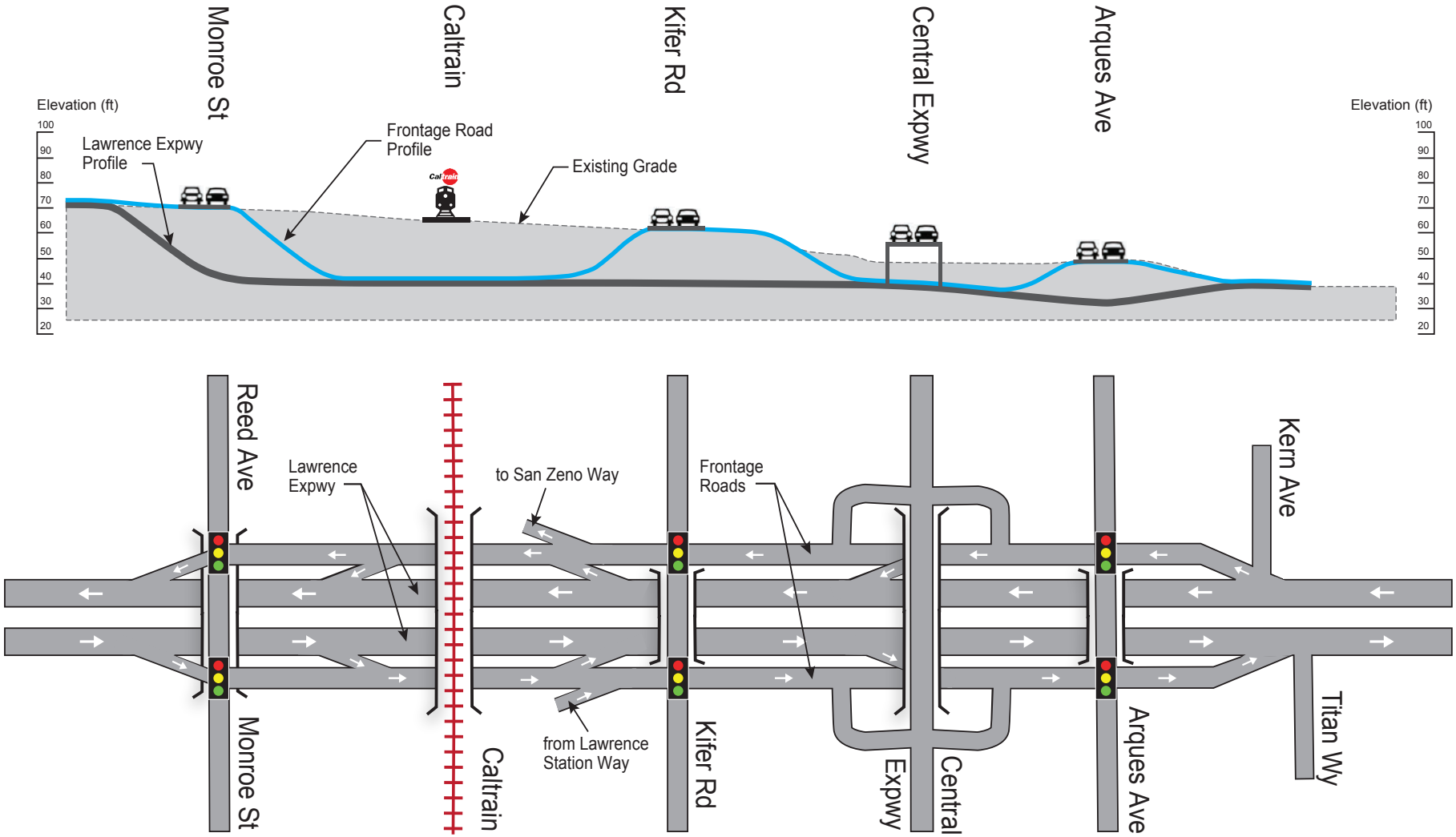


*Figure 5-2 - Alternative 1 Bicycle Facilities*

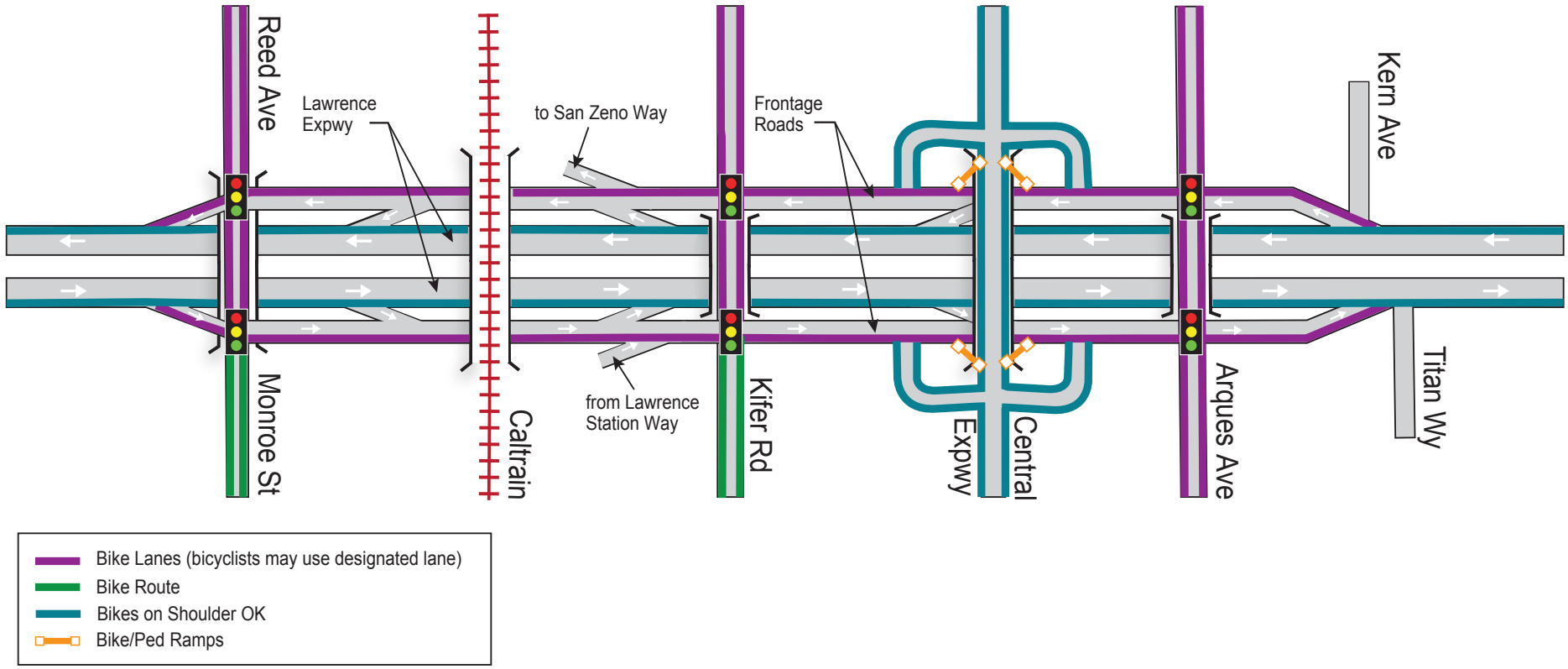


*Figure 5-3 - Alternative 1 Pedestrian Facilities*

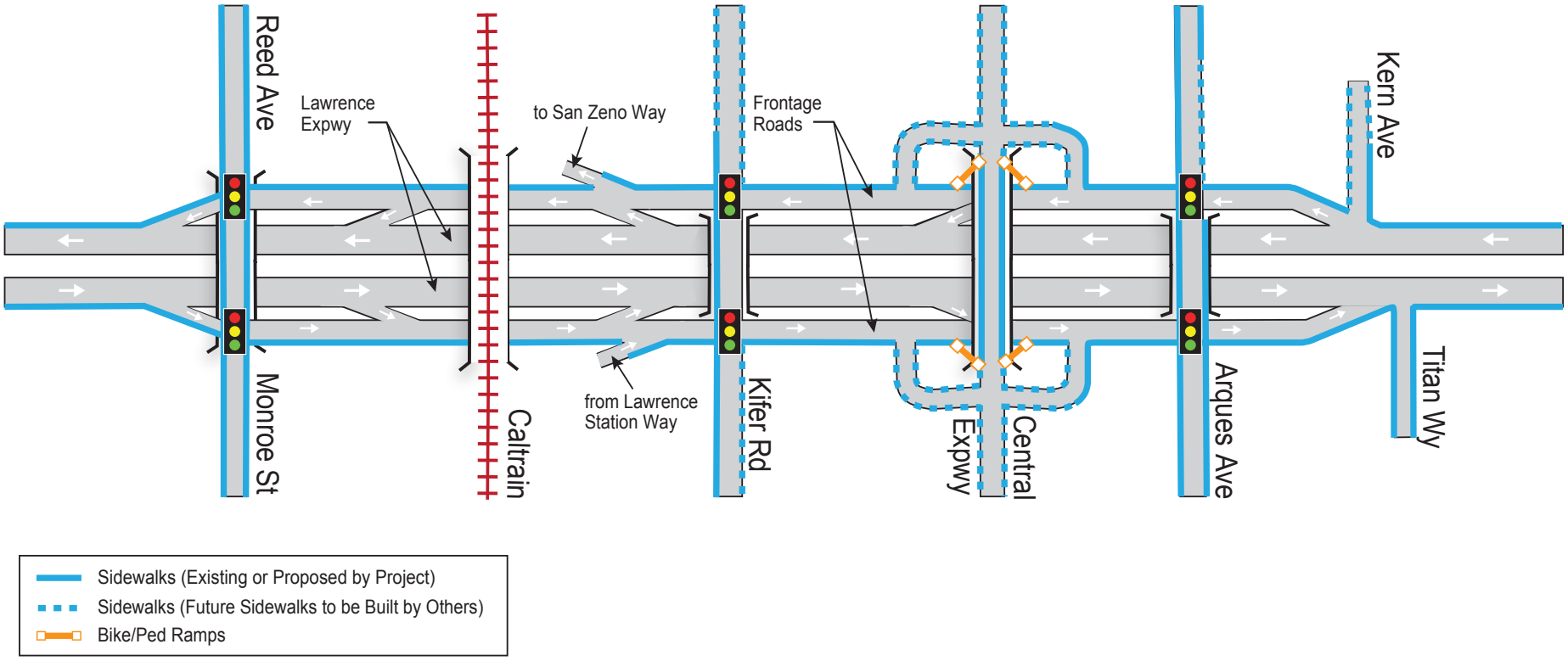


*Table 5-1 - Alternative 1 Lawrence Expressway Travel Time Benefits (Year 2020)*

| Peak Hour | Direction | Baseline | | Alternative 1 | | Change from Baseline to Alternative 1 | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 451 | 16.8 | 228.8 | 33.1 | -49% | 97% |
| | Southbound | 270 | 27.7 | 226.8 | 33.0 | -16% | 19% |
| *PM* | Northbound | 269 | 28.1 | 223.8 | 33.8 | -17% | 20% |
| | Southbound | 500 | 14.9 | 230.5 | 32.5 | -54% | 118% |

*Table 5-2 - Alternative 1 Lawrence Expressway Travel Time Benefits (Year 2040)*

| Peak Hour | Direction | Baseline | | Alternative 1 | | Change from Baseline to Alternative 1 | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 524 | 14.4 | 257 | 29.4 | -51% | 104% |
| | Southbound | 260 | 28.8 | 253 | 29.5 | -2% | 2% |
| *PM* | Northbound | 273 | 27.7 | 248 | 30.5 | -9% | 10% |
| | Southbound | 513 | 14.6 | 268 | 27.9 | -48% | 91% |

As shown in the tables, Alternative 1 would result in a substantial improvement in travel time in peak period, peak direction travel (AM northbound, PM southbound). Travel speeds would nearly double compared to the baseline scenario. This will serve to keep regional traffic on the expressway and will result in less congestion on cross-streets and parallel routes.

The intersection geometry and associated LOS in the near-term (2020) and horizon year (2040) are shown in **Figure 5-4** and **Figure 5-5**, respectively. As shown in the figures, the frontage road intersections would operate at LOS D or better in Year 2020. However, in Year 2040, the Arques Avenue frontage road intersections would operate at LOS E. Turning movement volumes are forecast to be very high at these intersections, requiring a large number of lanes. Vehicles travelling from southbound Lawrence Expressway to westbound Central Expressway and westbound Central Expressway to northbound Lawrence Expressway would be on the frontage roads through the Arques Avenue intersection, resulting in large volumes at those intersections. The only solutions to improve frontage road operations at this location are to widen to four lanes in each direction on the frontage road or widen the cross-streets. Neither would fit with the goals of this project.

The implementation of Alternative 1 would preserve access between all local streets, Lawrence Expressway and all directions of Central Expressway. The preservation of all the existing connections to Central Expressway would result in a large number of weaving and merge movements along the frontage road between Kifer Road and Arques Avenue. Additionally, the existing HOV lane would most likely need to be eliminated north of Cabrillo Avenue with this alternative due to the volume of vehicles accessing and egressing Lawrence Expressway to/from the outside lane. Managed lanes concepts could be feasible with this alternative if the Central Expressway bridge is reconstructed. These concepts could potentially reduce the required number of lanes on Lawrence Expressway, given the strong peak period directionality of movements. With a managed lane concept, the median barrier would be shifted twice a day to provide additional laneage in the peak direction.

*Figure 5-4 - Alternative 1 2020 Geometry and Level of Service*

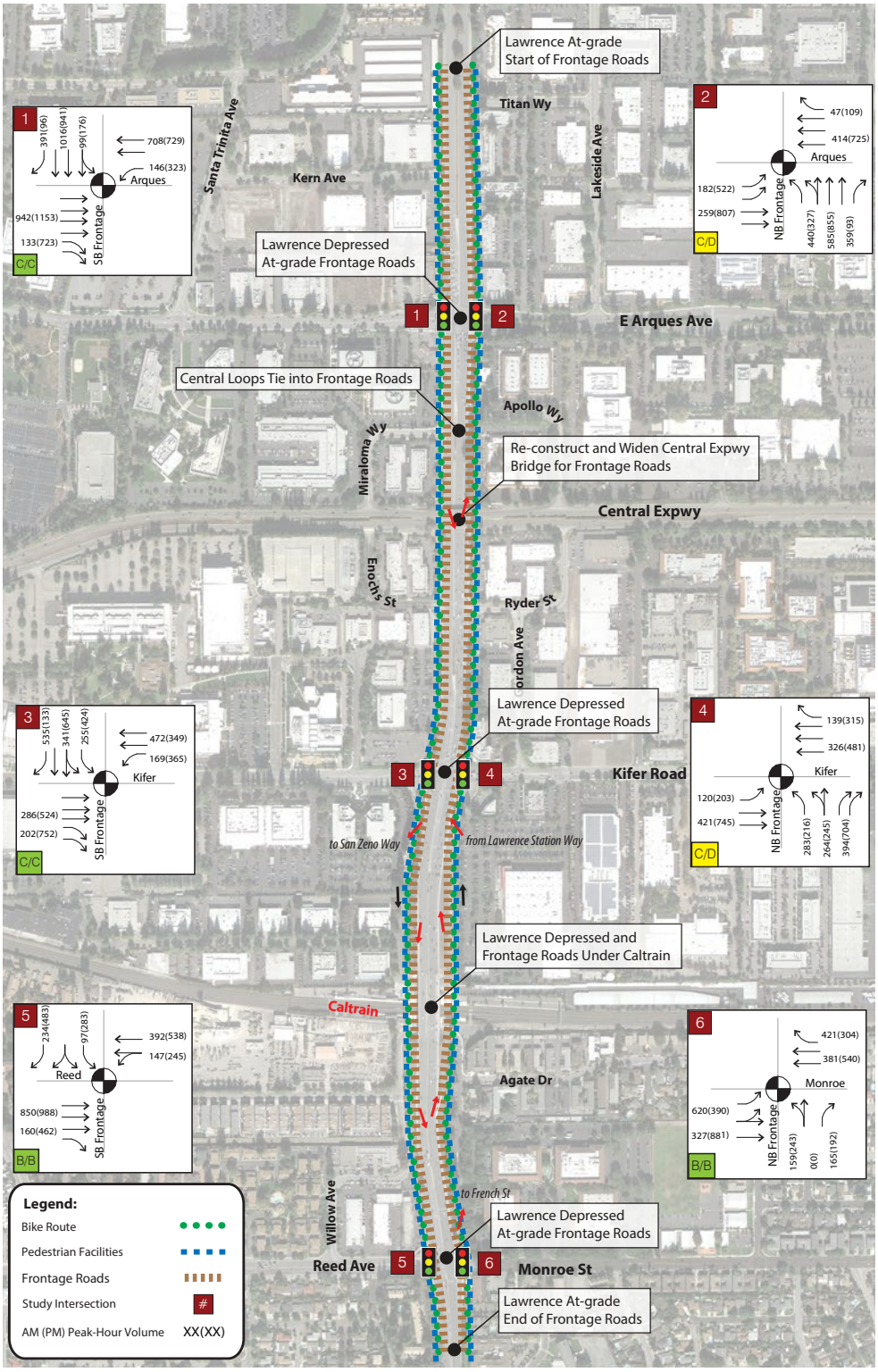
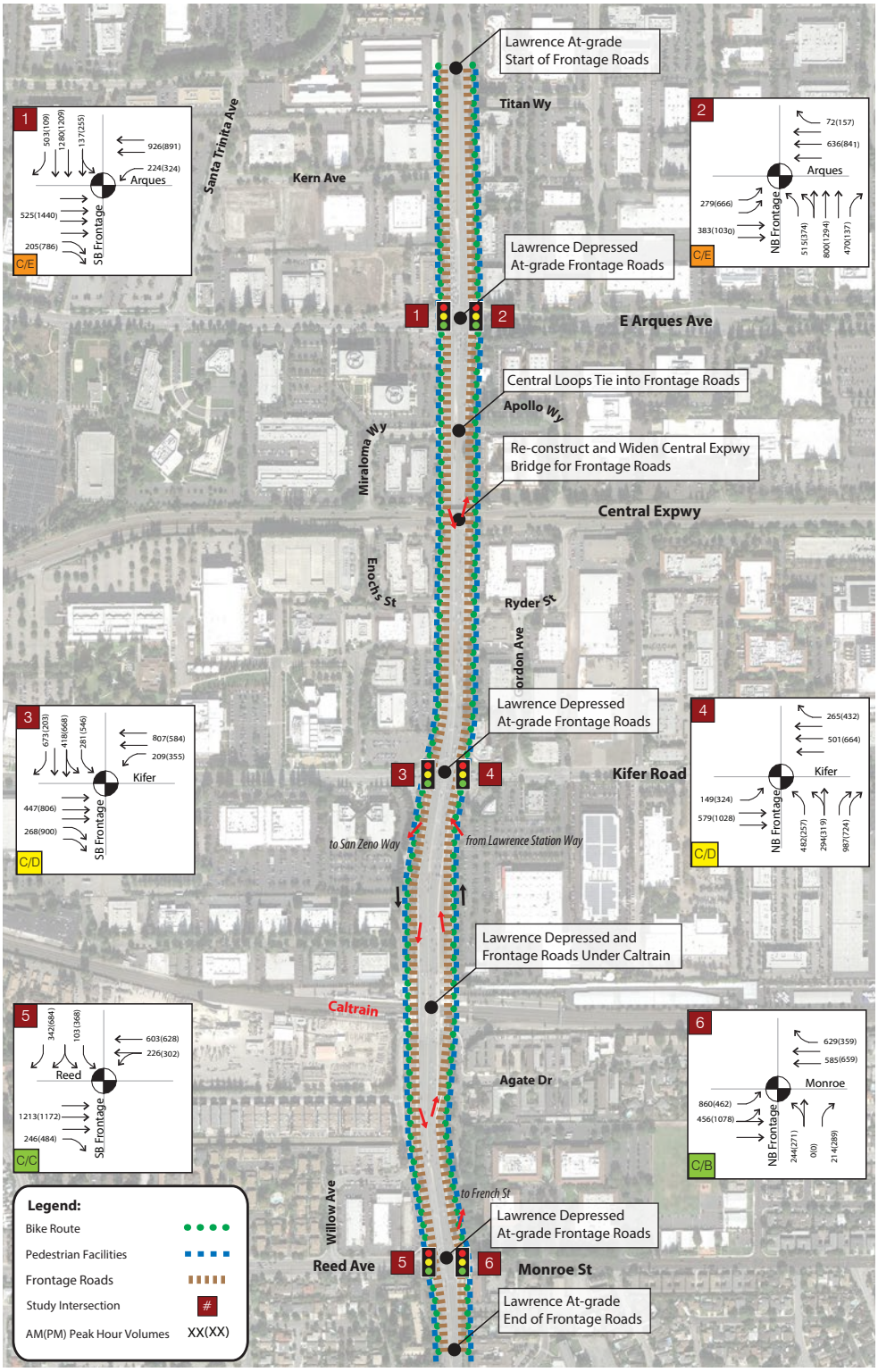


*Figure 5-5 - Alternative 1 2040 Geometry and Level of Service*



Consideration was given to having the frontage roads meet Central Expressway with at-grade intersections in order to allow for removal of the square loop ramps and improve local connectivity. However, these intersections would operate deficiently due to the large projected volumes on Central Expressway. Consideration was also given to lowering the square loop ramps to connect to Lawrence Expressway instead of the frontage roads. This may be feasible and would greatly reduce the traffic burden on the frontage roads. However, it would impact driveways along the frontage roads and would limit connectivity between Central Expressway, Arques Avenue and Kifer Road.

In Alternative 1, pedestrian activity previously served by sidewalks along Lawrence Expressway would occur along the frontage roads where there will be lower speeds and lower volume than along the expressway. Pedestrians would experience multiple grades along the frontage road as it drops beneath Central Expressway and the Caltrain tracks. Similarly, bicycle activity will be encouraged along the frontage roads, although shoulders along Lawrence Expressway will still be provided and available for bicycle use. Bicycles using these shoulders would have to cross several ramps between the expressway and the frontage road. Bicycles and pedestrians desiring to cross Lawrence Expressway would experience shorter crossing distances as compared to existing conditions, but would have to cross two signalized intersections instead of one.

Alternative 1 would result in full access being provided from either direction of Lawrence Expressway or Kifer Road to the Lawrence Caltrain Station as shown in **Figure 5-6**, a major improvement from existing conditions. A one-way circulation pattern would need to be adopted on San Zeno Way and Lawrence Station Way in order to maintain the functionality of those streets. Bus stops for transit along the corridor would be provided along the frontage roads, providing easy access to and from the local roadway network and nearby land uses.

### *5.2.3. Conceptual Engineering*

The conceptual engineering drawings prepared as part of this step in the process can be seen in **Appendix D**. These include a plan, profile and cross-section drawing and an exhibit showing ROW impacts. Major design features include a new tunnel underneath the Caltrain tracks, reconstruction of the Central Expressway overpass and major excavation to depress Lawrence Expressway. The Central Expressway bridge would need to be reconstructed due to the additional width required for the frontage road to pass underneath Central Expressway and to meet current design standards for clearance height and vertical curves.

ROW would be required along most of Lawrence Expressway in order to provide sufficient width for the frontage road. The ROW would be primarily sliver takes, although some driveways and buildings would be affected. The most significant impacts associated with the ROW needs would be to the existing building at the northwest corner of Arques Avenue and Lawrence Expressway, parking loss to the businesses on the east side of Lawrence Expressway between Arques Avenue and Central Expressway, and to driveway access for the buildings adjacent to Lawrence Expressway south of Enochs Street and Ryder Street. There would be some parking impacts to a residential property on the east side of Lawrence Expressway south of Monroe Street.

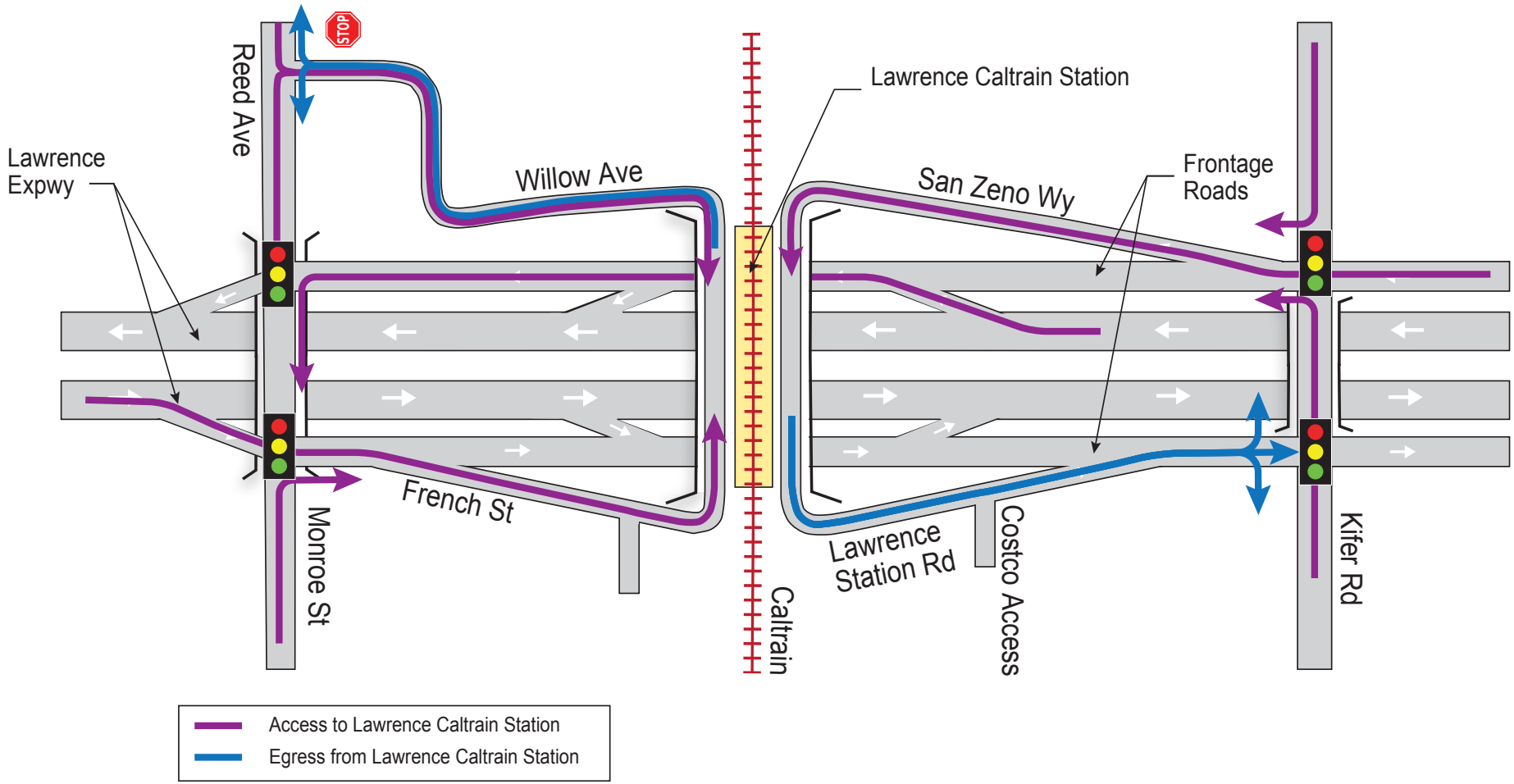
The estimated duration of construction is projected at three to five years given the complexity of a tunnel underneath Caltrain. Traffic handling during construction would be benefited by the ability to shift traffic from Lawrence Expressway to the frontage roads once they are constructed. This would reduce capacity of the expressway, but may provide for more maintenance of continuous access and additional capacity compared to other alternatives. Traffic modifications to Central Expressway could utilize the future widening area in the median of the current Central Expressway, and the bridge could be built in thirds to minimize impacts. Phased implementation of this alternative is not a feasible option given that the frontage roads require the full planned length in order to function as intended.

### *5.2.4. Cost Estimate*

An opinion of probable cost, commensurate with a rough conceptual design was completed for Alternative 1. The project is projected to cost approximately $374 Million (2013 dollars) in total. The tunnel underneath Caltrain needed as part of this alternative is estimated to cost $75 to $100 Million of the total cost.

The cost estimate includes a 40 percent contingency and allocations for other risk factors. Major risk factors for this concept are primarily associated with the depression of Lawrence Expressway. The area has a very high water table given its proximity to the San Francisco Bay, and a pumping system and other measures to prevent the depressed roadway from filling with water and/or lifting would

*Figure 5-6 - Alternative 1 Caltrain Access*



be required. There are also reports of contaminated soil in the area due to previous industrial uses. A geotechnical analysis was not included as part of this project, but would be a critical element for further design considerations. The depression of the roadway will require large retaining walls. While deemed feasible at this time, the specific construction technique used in the retaining walls will be need to be further explored and will affect required easements, construction staging, and possibly the depth of the depression. Removal of the existing Caltrain bridge and construction of a new tunnel underneath the active railway will be very challenging and will require close coordination with the California Public Utilities Commission, Caltrain and other stakeholders. The depth of the tunnel, required structural elements, potentially ventilation, feasibility of removal of the existing bridge, and stage construction will have to be further explored in future design. Other risk factors include ROW acquisition and associated business relocation, if needed.

### 5.2.5. Summary Evaluation

**Table 5-3** summarizes the results of the evaluation that was performed for this alternative.

A benefit-cost calculation was performed for this alternative. The calculation was very primitive and was performed merely as a comparative tool. For project benefits, hours of travel time savings were totaled for both Lawrence Expressway traffic and for traffic on the cross-streets travelling across the corridor. The alternative will result in the savings of over 600,000 vehicle-hours of delay annually by Year 2040 for traffic on Lawrence Expressway. An additional over 250,000 vehicle-hours of delay will be saved annually by reducing delays for vehicles crossing Lawrence Expressway on Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street. The savings calculations accounted for any increased delay at downstream intersections associated with the improvements. The calculated benefit to cost ratio was estimated to be 0.9, although this metric is only valuable in comparison against the other alternatives, as not all benefits are tabulated and included in the calculation. This calculation was based on a twenty-year benefit period and was applied to the peak period vehicle travel times only. By eliminating conflict points, vehicle delay will be reduced at all hours of the day and on weekends, significantly increasing the travel time benefits of the alternative. Additional benefits of this alternative not accounted for in the cost-benefit calculation include:

- Safety benefits associated with eliminating conflict points at existing intersections;
- Improved safety with the reconstruction of the Central Expressway overpass to meet current standards;
- Reduced emissions associated with reductions in vehicle idling and increased travel speed;
- Improved pedestrian and bicycle safety with the provision of marked bicycle lanes and wider sidewalks along a lower-speed local-traffic oriented roadway;
- Increased community connectivity by eliminating the barrier of crossing the at-grade expressway; and
- Improved access to the Lawrence Caltrain Station.

Major detriments with this alternative include challenges presented for commuter cyclists wishing to remain on Lawrence Expressway, comparatively high delay for the frontage road intersections, and the number of weave/merge points along the frontage roads between Arques Avenue and Kifer Road. Cyclists will have to cross high-speed slip ramp traffic onto and off of the expressway at a few locations. The frontage road intersections will operate at LOS E at Arques Avenue, which will result in some queuing and delay for traffic on Arques Avenue and along the frontage road. The frontage road will have a number of access points in the middle section, including slip ramps from Lawrence Expressway, Lawrence Station Road, Kifer Road, and the Central Expressway square loop ramps, reducing their efficiency and creating some challenging merge and weave locations. The frontage roads will have a number of vertical curves, requiring pedestrians and bicyclists to climb several grades.

## 5.3. Alternative 2

### 5.3.1. Analysis Alternative Description

Alternative 2 would include grade-separated interchanges at each of the three major study intersections of Lawrence Expressway and Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue. Lawrence Expressway would be depressed underneath Arques Avenue and

## *Table 5-3 - Alternative 1 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ● | |
| - Oakmead to Cabrillo Travel Time Improvement from Baseline | ● | Major improvement in peak direction of travel in each peak period. Average speed for all directions in both peak periods is approximately 33 mph in 2020 and 28-31 mph in 2040. Frontage roads appear to somewhat meter traffic approaching Cabrillo southbound in PM peak, reducing queues at that location compared to the other Alternatives. |
| o AM Northbound | **51%** | |
| o AM Southbound | 2% | |
| o PM Northbound | 9% | |
| o PM Southbound | **48%** | |
| - Arques | ◑ | Operates at LOS D or better in 2020. LOS E or better in 2040. Some queuing in each direction along frontage roads approaching Arques |
| - Kifer | ● | Operates at LOS D or better in both 2020 and 2040. Minimal queuing. |
| - Reed/Monroe | ● | Operates at LOS B or better in 2020. LOS C or better in 2040. Minimal queuing. |
| - Central Access | ◑ | Access is preserved between all local streets, Lawrence and all directions of Central. Results in a number of weaving and merge movements between Kifer and Arques. |
| - Effect on HOV Lane | ○ | HOV lane should probably be eliminated north of Cabrillo with this alternative. Through vehicles should not have any delay staying on Expressway. Transit will be on frontage road. |
| **Multi-Modal Circulation** | ● | |
| - Pedestrian along Expwy | ● | Pedestrian activity would occur on the frontage roads, which will be lower speed and lower volume. Pedestrian access would be the same or better than existing. Less grade change for through pedestrians than in other alternatives. Pedestrians would need to cross San Zeno and Lawrence Station Way. |
| - Bike along Expwy | ● | Bicycle activity would be encouraged to occur on the frontage roads, which will be lower speed and lower volume. Shoulders will still be provided on Lawrence. Bicycle access would be the same or better than existing. |
| - Bicycle and Pedestrian crossing | ◑ | Pedestrian crossing distances are shortened compared to existing conditions. Circulation is maintained for all existing uses. Pedestrians would have to cross two signalized intersections instead of one. |
| - Transit Access to Lawrence Station | ● | This concept requires a one-way circulation pattern on San Zeno and Lawrence Station Way. It does provide full access from either direction of Lawrence or Kifer to the station. |
| - Transit Stops along Corridor | ● | Transit stops can be provided along the frontage road with easy access to the community. |
| **Community Factors** | ● | |
| - Visual Impacts | ● | Lawrence would be depressed, eliminating existing perceived barrier. No visual barrier would be added. |
| - Community Context | ● | With Lawrence depressed, community interface would be with the smaller, lower-speed frontage roads. Full access would be maintained and bike/ped circulation would be enhanced. Preferred alternative for majority of attendees of community meeting. |
| **Design Elements** | ○ | |
| - Right-of-Way Needs | ◑ | |
| o Total square feet of ROW needed | **210,200** | |
| o Total number of parcels impacted | **23** | |
| o Businesses Impacted | **11** | 3 would experience major parking impacts. 3 structures would be impacted. 1 would have access significantly constrained. 4 others would have lesser parking impacts. |
| o Residential Impacted | **1** | Loss of small number of parking spaces at condo complex |
| o Businesses Relocated | **2-6** | SE Corner of Ryder & Lawrence, NW Corner of Arques & Lawrence. Likely relocations at NE and SE corners of Apollo & Lawrence, and SW corner of Enochs & Lawrence. Possible relocation at SW corner of Arques & Lawrence. |
| o Residential Relocated | **0** | |
| - Constructability | ○ | Tunneling underneath rail tracks is major uncertainty. Would require significant retaining walls and excavation. Challenges associated with water table. Estimated duration of construction: 3-5 years. |
| - Traffic Handling during Construction | ◑ | Traffic can be shifted to frontage roads once they are constructed. Would reduce capacity of Expressway, but allow for continuous access, except for weekend closures to lower Lawrence below cross-streets. Traffic modifications to Central can utilize future widening area and bridge built in thirds to minimize impacts. |
| - Allows Phased Implementation | ○ | Would be required to be built in its entirety. |
| - Future Flexibility | ● | Would allow for managed lanes (4 and 2 during peaks, or 3 and 2 with lane reduction). Eliminates existing sub-standard vertical curve and height at Central. |
| **Cost-Benefit** | ○ | |
| - Project Cost (2013 dollars) | **$374 M** | Tunnel underneath Caltrain estimated to cost $75 to $100 Million of this amount. Major cost uncertainties include de-watering, utilities, business relocation, CPUC interface. |
| - Project Benefit to Lawrence Commuters | ● | |
| o 2020 peak period weekday vehicle-hours of benefit per year | **543,000** | |
| o 2040 peak period weekday vehicle-hours of benefit per year | **629,000** | |
| - Benefit/Cost Calculation (20-yr benefit period, cost in 2013 dollars, peak period vehicle travel time benefits only) | **0.9** | |
| - 2040 peak hour weekday vehicle-hours of benefit per year to crossing traffic | **278,000** | |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

elevated over Kifer Road and Reed Avenue/Monroe Street, with interchanges constructed at each location. The cross-streets would be connected to the expressway via ramps within the Lawrence Expressway median. Traffic signals would control movements between the ramps and the cross-streets at the elevation of the cross-streets. The large existing signalized intersections along Lawrence Expressway would be replaced by smaller ramp intersections that would only be utilized by local traffic accessing/egressing the cross-street. Travel on Lawrence Expressway would be free flow for the length of the study area. The Central Expressway square loop ramps and Central Expressway underpass would remain as currently exists.

An illustrative display of the plan and profile view of Alternative 2 can be seen in **Figure 5-7**.

The bicycle and pedestrian facilities would remain along Lawrence Expressway in a similar fashion as today, with the significant benefit of removing the delays and conflicts present at the signalized intersections. In order to access the cross-streets, shared bicycle and pedestrian ramps would be constructed on either side of Lawrence Expressway, extending between the Lawrence Expressway sidewalk and the sidewalk of the cross-streets. The configuration of the bicycle and pedestrian facilities can be seen in **Figure 5-8** and **Figure 5-9**.

### *5.3.2. Traffic and Circulation*

Analysis of traffic circulation with Alternative 2 was completed using the VISSIM micro-simulation software, which provided the detailed LOS, travel time, queuing and delay data for the 2020 and 2040 horizon years.

Alternative 2 would result in a substantial improvement in travel speed and reduction in congestion in both directions in each peak period (AM and PM). **Table 5-4** and **Table 5-5** indicate the improvements in corridor travel time and speed with the implementation of Alternative 2. The data in the table is for the corridor extents between Oakmead Parkway/Duane Avenue and Cabrillo Avenue, inclusive, and thus accounts for the potential for the improvements to shift congestion to the downstream intersection.

***Table 5-4 - Alternative 2 Lawrence Expressway Travel Time Benefits (Year 2020)***

| Peak Hour | Direction | Baseline | | Alternative 2 | | Change from Baseline to Alternative 2 | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 451 | 16.8 | 281 | 26.9 | -38% | 60% |
| | Southbound | 270 | 27.7 | 199 | 37.5 | -26% | 35% |
| *PM* | Northbound | 269 | 28.1 | 208 | 36.4 | -23% | 30% |
| | Southbound | 500 | 14.9 | 231 | 32.4 | -54% | 117% |

***Table 5-5 - Alternative 2 Lawrence Expressway Travel Time Benefits (Year 2040)***

| Peak Hour | Direction | Baseline | | Alternative 2 | | Change from Baseline to Alternative 2 | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 524 | 14.4 | 306 | 24.8 | -42% | 72% |
| | Southbound | 260 | 28.8 | 199 | 37.6 | -23% | 31% |
| *PM* | Northbound | 273 | 27.7 | 218 | 34.8 | -20% | 26% |
| | Southbound | 513 | 14.6 | 421 | 17.8 | -18% | 22% |

*Figure 5-7 - Alternative 2 Plan and Profile Illustration*

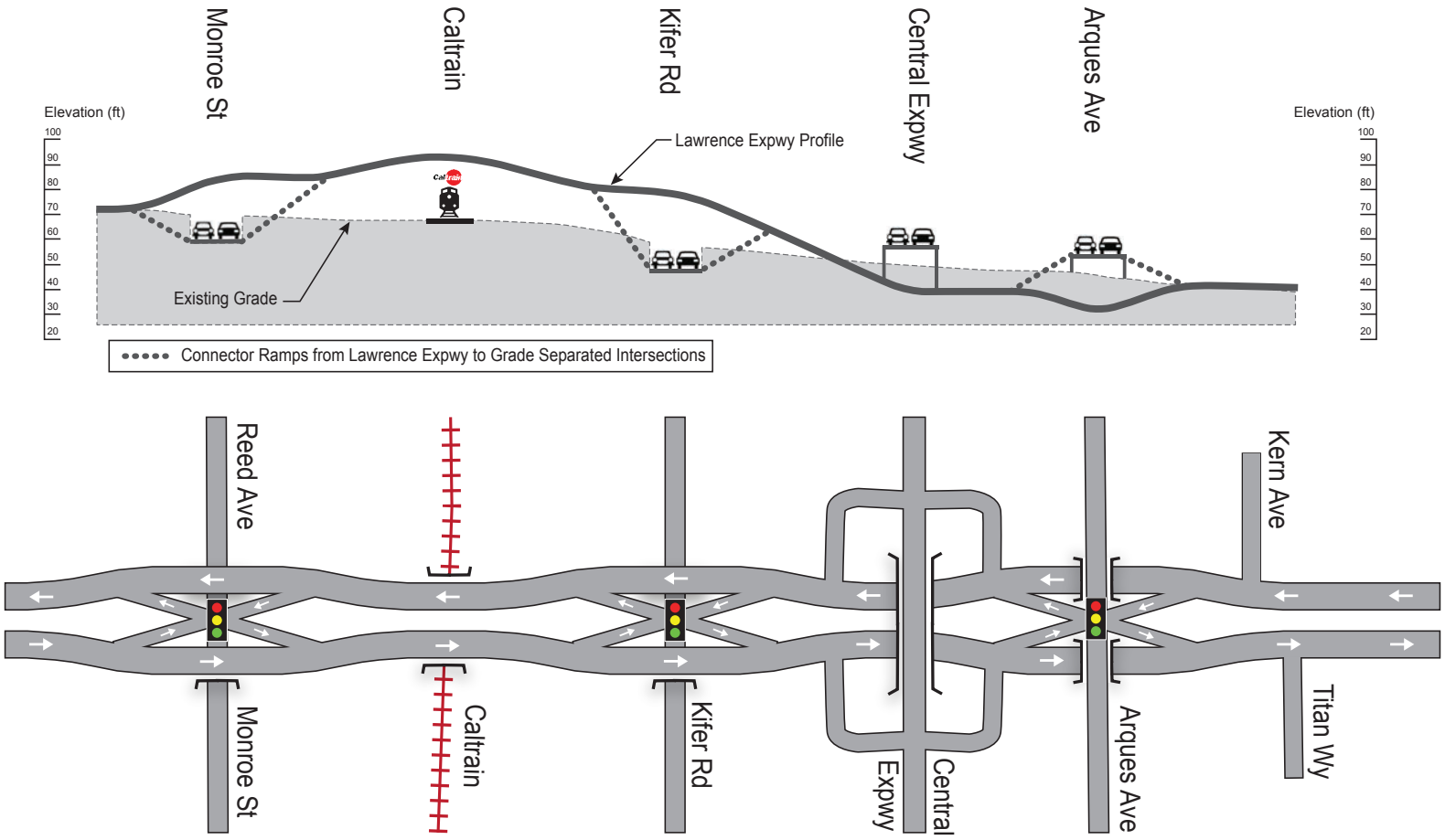


*Figure 5-8 - Alternative 2 Bicycle Facilities*

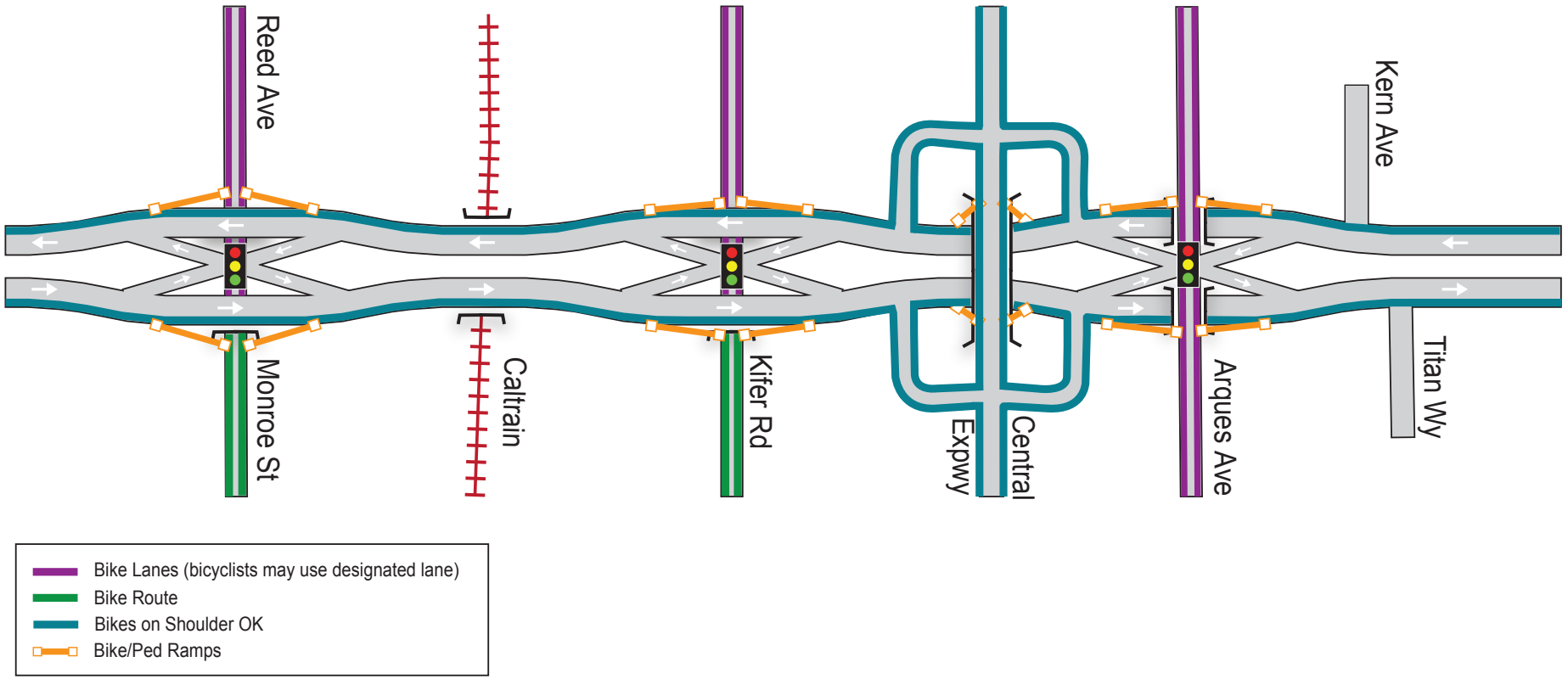
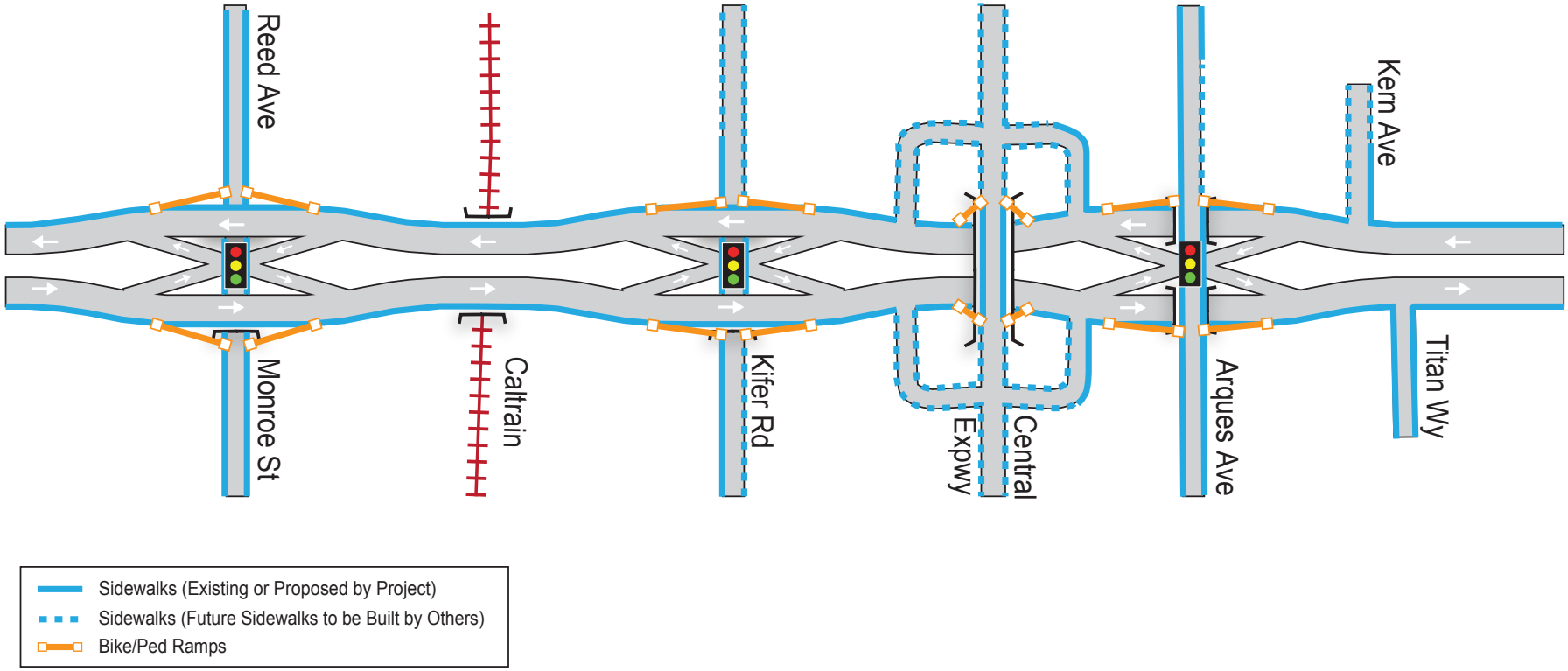


*Figure 5-9 - Alternative 2 Pedestrian Facilities*



As shown in the table, the project benefits are most substantial in the peak directions of travel in the respective peak periods in Year 2020. The project still provides a great deal of benefit in Year 2040, but the benefits in the PM peak period are somewhat lessened due to increasing congestion at the Cabrillo Avenue intersection. Even accounting for this shift in congestion, there still is a greater than twenty percent increase in travel speed with this alternative in the Year 2040 PM peak period.

The intersection geometry and associated LOS in the near-term (2020) and horizon year (2040) are shown in **Figure 5-10** and **Figure 5-11**, respectively.

As shown in the figures, the ramp interchange intersections would all operate efficiently with minimal delay out through Year 2040 conditions. The intersections could operate with very short cycle lengths, keeping queuing and delay low. This will ensure that the ramps do not queue up to affect mainline Lawrence Expressway operations. The ramps are each fairly long in order to provide a sufficiently low grade between the expressway and the cross-street. The ramps will have a simple phasing operation since there would not be through movements from the off-ramp to the on-ramp. Most of the ramps will have single lane approaches, flaring out to provide left-turn and right-turn lanes at the intersections. Dual turn lanes and dual receiving lanes are required for some high volume movements, including from eastbound Reed Avenue, eastbound Arques Avenue, and to eastbound Kifer Road. For ramps with dual receiving lanes, the lanes will need to merge to a single lane prior to merging onto the expressway.

Alternative 2 would improve operations of the HOV lane by removing the need for right-turns to/from the cross-streets to have to maneuver across the HOV lane as they do today. Instead, all access/egress on Lawrence Expressway will be on the left, except at the Central Expressway square loop ramps, which will increase speeds on the HOV lanes.

Managed lanes will not be possible with Alternative 2 due to the placement of the ramp structures in the median. Lawrence Expressway will operate with sufficient capacity in the study area through Year 2040 as an 8-lane facility with removal of the three signalized intersections.

With the configuration proposed for Alternative 2, there will not be any access between westbound Central Expressway and Arques Avenue and eastbound Central Expressway and Kifer Road due to the close spacing of the square loops and those adjacent intersections. Alternative configurations were considered in order to improve this connectivity and eliminate the square loop ramps. These configurations include the provision of a median roadway traversing between Arques Avenue and Kifer Road, both with and without continuing use of the square loop ramps. In both alternatives, there would be a new traffic signal where the median roadway intersected with Central Expressway. With continued use of the square loop ramps, only local traffic would utilize this intersection and the footprint of this access roadway would be much smaller. With removal of the square loop ramps, all traffic traveling between Lawrence Expressway and Central Expressway would use this roadway and it would have a larger footprint. These alternatives may continue to be evaluated at a later date, but were not incorporated into Alternative 2. Local access to Central Expressway will be improved with implementation of the LSAP roadway network, primarily the new signalized intersection to the west of Lawrence Expressway where the LSAP loop road would meet Central Expressway.

Pedestrian activity would remain on the sidewalk along Lawrence Expressway. Similarly, cyclists would remain on shoulder of Lawrence Expressway. Alternative 2 provides benefits for pedestrians and cyclists by eliminating the current signalized intersections at Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street that are associated with vehicle conflicts and delays. Alternative 2 would introduce some new grades for bicyclists and pedestrians with the expressway elevated above existing roadways. Access from Lawrence Expressway to the cross-streets would be via pedestrian and bicycle ramps for each direction at each cross-street. The ramps would be located on the outside of the expressway to allow movements between the cross-streets and the expressway to occur without conflicts. The median ramps would only be two to three lanes wide, as compared to the existing 11 lanes on the expressway at the current signalized intersections (four lanes in each direction plus dual left-turn lanes and a right-turn lane). Therefore, the length of bicycle and pedestrian crossings of Lawrence Expressway would be significantly shortened compared to existing conditions, improving comfort and safety.

*Figure 5-10 - Alternative 2 2020 Geometry and Level of Service*

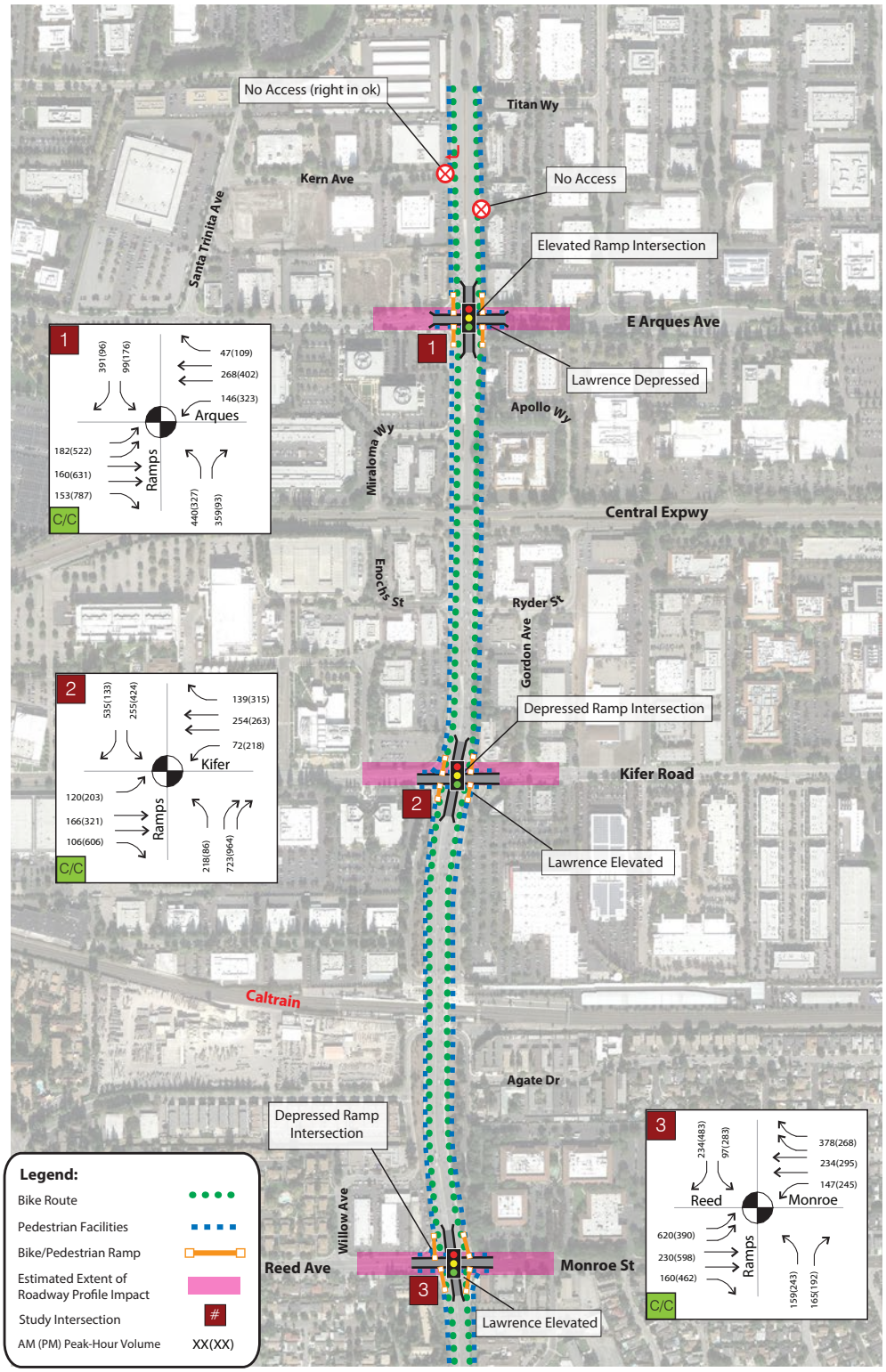
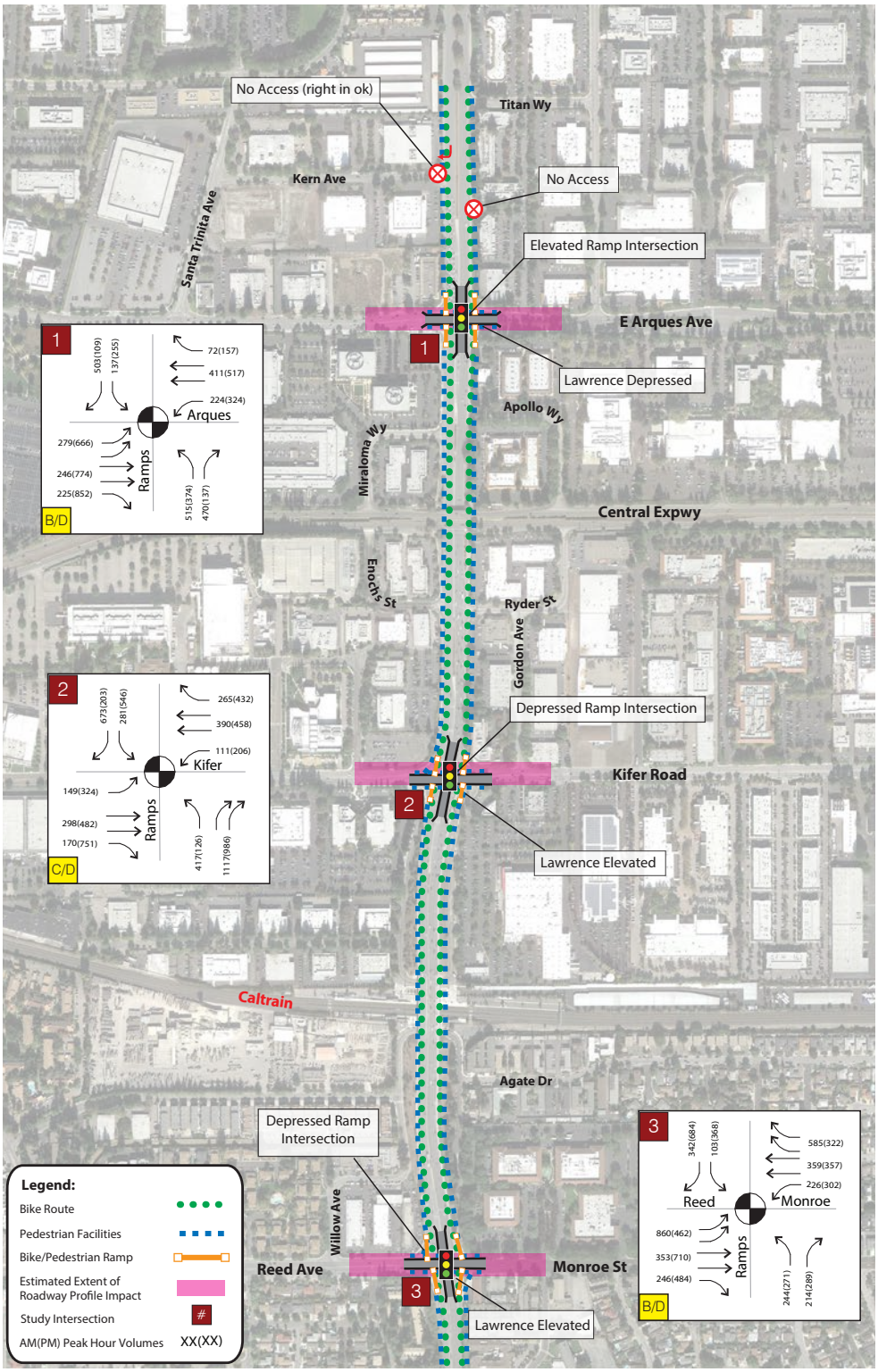


*Figure 5-11 - Alternative 2 2040 Geometry and Level of Service*



Transit access to the Lawrence Caltrain Station would be similar to how it exists today and as shown in **Figure 5-12**. The alternative provides a bit more spacing between the Lawrence Expressway stop bar and San Zeno Way /Lawrence Station Way right-in/right-outs, improving the functionality of those roadways. Transit stops would be located along the expressway at the location of the bicycle and pedestrian ramps.

### *5.3.3. Conceptual Engineering*

The conceptual engineering drawings prepared as part of this step in the process can be seen in **Appendix D**. These include a plan, profile and cross-section drawing and an exhibit showing ROW impacts. Major design elements include elevated roadway structures to support Lawrence Expressway passing over Kifer Road and Reed Avenue/Monroe Street. Ramp structures would connect the expressway to the cross-streets. No modifications to the Central Expressway underpass are required. Some modifications would likely be needed to the approaches of the Lawrence Expressway bridge over Caltrain but the portion of the bridge that is elevated above the Caltrain tracks would likely be able to remain as is.

ROW needs are primarily at each of the three cross-streets. The median ramps will be located in generally the same area as the existing dual left-turn lanes. However, the ramp facilities will need to be wider than the current left-turn lanes in order to provide shoulders along the ramps and separation between the opposing directions of travel. The provision of these median ramps flares out each direction of the expressway at the three grade separation locations, resulting in some ROW needs. It may be possible to shift the expressway to one side of the roadway or the other to limit the number of properties impacted, but with greater impact on one side.

Alternative 2 will impact access to the gas station in the southeast corner of Lawrence Expressway and Monroe Street. It will also affect parking and/or structures associated with condominium/apartment complexes and three single-family dwelling units south of Reed Avenue/Monroe Street. Parcels on both sides of Lawrence Expressway between Kifer Road and Enochs Street/Ryder Street will lose parking and the parcel at the northwest corner of Lawrence Expressway and Kifer Road will have its building impacted. Parcels at the northwest, southwest and southeast corners of the Arques Avenue and Lawrence Expressway intersection will have buildings and/or access impacted.

In order to reduce the vertical height of the elevated Lawrence Expressway structure or the amount of depression needed for the expressway at Arques Avenue, the ability to raise or lower the cross-streets at their crossing of the expressway was evaluated. Maintaining access to driveways along the cross-streets will limit the amount of raising or lowering possible. Modifications to the cross-street elevations are shown on the profile drawings of the alternative.

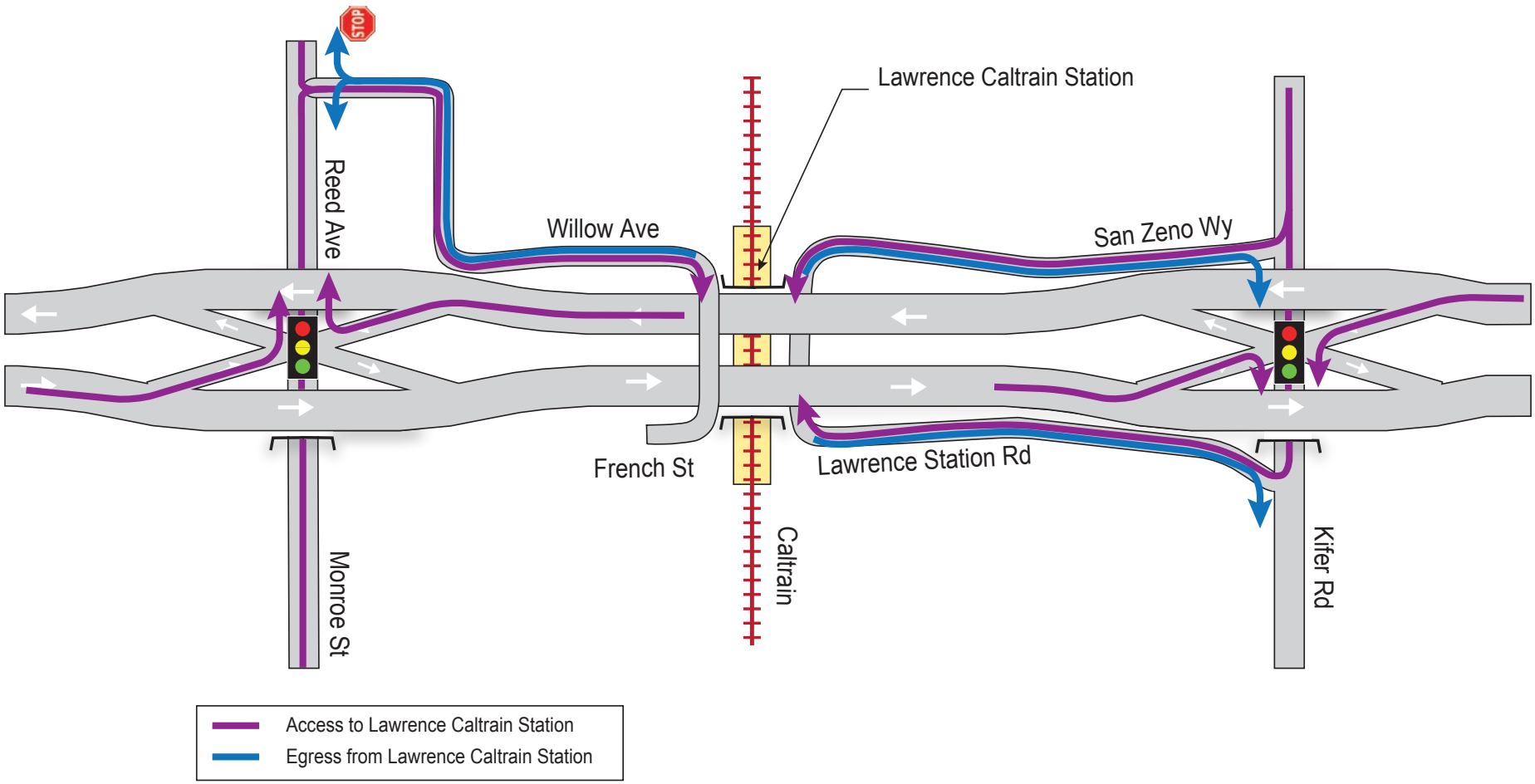
The estimated duration of construction is two to four years. In comparison to Alternative 1, this alternative requires much less earthwork due to Lawrence Expressway being elevated. Some challenges associated with the high water table could still occur where excavation is proposed at Lawrence Expressway passing beneath Arques Avenue. Construction staging with this alternative will be challenging as elevation changes are proposed for almost the entire length of the expressway within the study area. This will likely require some short- or long-term closures of the expressway and numerous lane reductions. By utilizing the existing Caltrain bridge, the construction schedule is shorter as the complex bridge removal and tunnel construction at the Caltrain tracks is not required. This alternative could be built in phases, as each grade separation operates independently.

### *5.3.4. Cost Estimate*

An opinion of probable cost, commensurate with a rough conceptual design, was completed for Alternative 2. The project is projected to cost approximately $230 Million (2013 dollars) in total.

The cost estimate includes a 40 percent contingency and allocations for other risk factors. Major risk factors for this concept are primarily associated with the depression of Lawrence Expressway at Arques Avenue and the ROW needed at each of the grade separations. This alternative may be easier to implement than Alternative 1 because the length of roadway depression is less, but with the depression of the expressway at Arques Avenue, many of the same challenges will be present with this alternative as well. Challenges with the depression include the high water table, potentially contaminated soil and retaining walls, as noted for Alternative 1. The ROW

*Figure 5-12 - Alternative 2 Caltrain Access*



acquisition for this alternative may be challenging as a number of parcels will have buildings impacted. If the project were to proceed prior to those parcels being redeveloped, business relocation may be required, a lengthy and costly process.

### 5.3.5. Summary Evaluation

**Table 5-6** summarizes the results of the evaluation that was performed for this alternative.

A benefit-cost calculation was performed for this alternative. The calculation was very primitive and was performed merely as a comparative tool. For project benefits, hours of travel time savings were totaled for both Lawrence Expressway traffic and for traffic on the cross-streets travelling across the corridor. The alternative will result in the savings of over 400,000 vehicle-hours of delay annually by Year 2040 for traffic on the expressway. An additional over 300,000 vehicle-hours of delay will be saved annually by reducing delays for vehicles crossing Lawrence Expressway on Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street. The savings calculations accounted for any increased delay at downstream intersections associated with the improvements. The calculated benefit to cost ratio was estimated to be 1.0, although this metric is only valuable in comparison against the other alternatives, as not all benefits are tabulated and included in the calculation. This calculation was based on a twenty-year benefit period and was applied to the peak period vehicle travel times only. By eliminating conflict points, vehicle delay will be reduced at all hours of the day and on weekends, significantly increasing the travel time benefits of the alternative. Additional benefits of this alternative not accounted for in the cost-benefit calculation include:

- Safety benefits associated with eliminating conflict points at existing intersections;
- Reduced emissions associated with reductions in vehicle idling and increased travel speed;
- Improved pedestrian and bicycle safety with the removal of conflict points at each of the grade separation locations; and
- Increased community connectivity by eliminating the at-grade barrier of the expressway

This alternative does not have any major functional detriments. However, it may not fit the community context and achieve public support with the construction of a raised concrete structure adjacent to the residential portion of the corridor near Reed Avenue/Monroe Street. Bicycle groups indicated that they would like to see a safer and more desirable facility than the continued use of the shoulder along Lawrence Expressway given the speeds on the roadway. The alternative also does not significantly improve access to the Lawrence Caltrain Station, although it does improve circulation on the cross-streets, which supports the LSAP and its goals.

## 5.4. Alternative 3

### 5.4.1. Analysis Alternative Description

Alternative 3 is hybrid of previous concepts. Lawrence Expressway would be grade separated from the cross-streets at all three major study intersections. At Arques Avenue, existing local streets would be utilized as jughandle roadways/square loop ramps to provide for circulation between Lawrence Expressway and Arques Avenue. At Kifer Road, future roadways would provide for circulation between the Central Expressway square loop ramps and Kifer Road. Access between Kifer Road and Lawrence Expressway would be via Ryder Street, Enochs Street, and these future roadways (New Gordon and the San Ysidro Way extension). At Reed Avenue/Monroe Street, median ramps would be implemented, the same solution as with Alternative 2. Lawrence Expressway would be elevated at the Reed Avenue/ Monroe Street and Kifer Road intersections, and depressed at the Arques Avenue intersection, similar to Alternative 2.

An illustrative display of the plan and profile view of Alternative 3 can be seen in **Figure 5-13**.

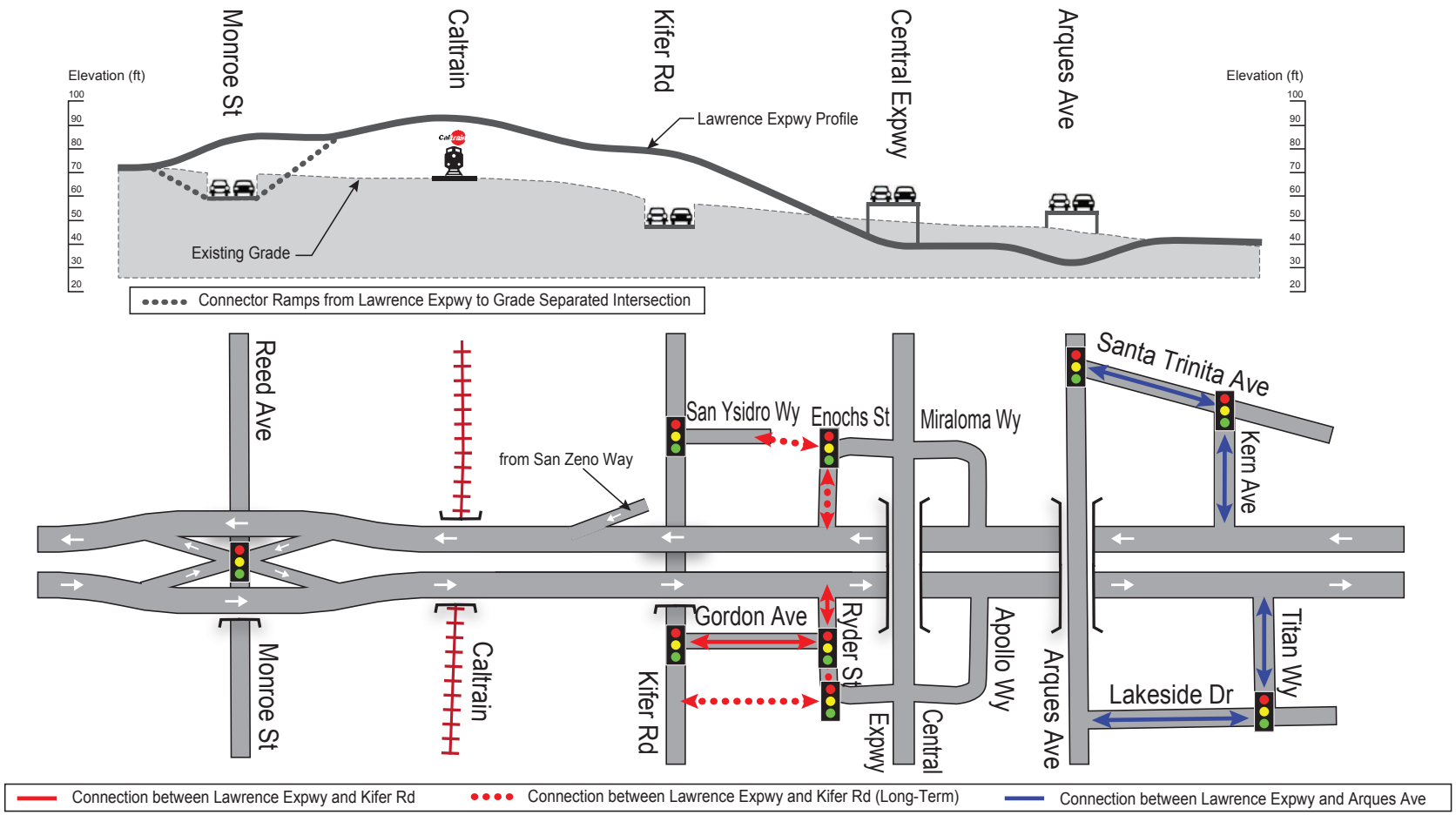
With Lawrence Expressway grade separated from Arques Avenue, Kern Avenue and Santa Trinita Avenue would connect southbound Lawrence Expressway with Arques Avenue and Titan Way and Lakeside Drive would connect northbound Lawrence Expressway with Arques Avenue. These are all existing streets, but would require roadway widening and/or removal of on-street parking, additional turn lanes and additional traffic signals to accommodate all turning movements currently accommodated at the Arques Avenue intersection.

## *Table 5-6 - Alternative 2 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Oakmead to Cabrillo 2040 Travel Time Improvement from Baseline | ◑ | Major improvement in peak direction of travel in morning. Moderate improvement in all other directions in both peak periods in 2040. PM Southbound benefit limited by queuing at Cabrillo - overall speed averages only 18 MPH. AM NB speed is 25 mph. Benefits of alternative are significantly higher in 2020 (54% reduction in travel time in PM Southbound) before volume increases such that Cabrillo congestion counteracts benefits. In 2020 average speed in both directions is over 30 mph in PM peak. |
| o AM Northbound | **42%** | |
| o AM Southbound | 23% | |
| o PM Northbound | 20% | |
| o PM Southbound | **18%** | |
| - Arques | ● | Operates at LOS C or better in 2020. LOS D or better in 2040. Need dual EB left-turn lanes. These then need to quickly merge into one lane on the ramp down to Lawrence. |
| - Kifer | ● | Operates at LOS C or better in 2020. LOS D or better in 2040. Need dual NB right-turn lanes. Intersection functions well. |
| - Reed/Monroe | ● | Operates at LOS C or better in 2020. LOS D or better in 2040. Need dual EB left-turn and WB right-turn lanes. Two receiving lanes on on-ramp will need to merge into one. Will result in steady stream of vehicles accessing Lawrence. |
| - Central Access | ◑ | Access is preserved between all local streets, Lawrence and all directions of Central. Results in lots of access/egress movements in right-hand lane between Ryder/Enochs and Titan. |
| - Effect on HOV Lane | ● | All right-turning movements would be removed from HOV lane, improving performance. |
| **Multi-Modal Circulation** | ◑ | |
| - Pedestrian along Expwy | ◑ | Pedestrians would remain on sidewalk on Lawrence. Existing crossing of cross-streets is eliminated. Would introduce a number of new grades, although all meet ADA. Access to cross-street is via ped/bike ramps, also meeting ADA. |
| - Bike along Expwy | ◑ | Cyclists would remain on shoulder on Lawrence. Existing crossing of cross-streets is eliminated. Would introduce a number of new grades. Access to cross-street is via ped/bike ramps. |
| - Bicycle and Pedestrian crossing | ● | Pedestrian and bicycle crossing distances are significantly shortened compared to existing conditions. Circulation is maintained for all existing uses. |
| - Transit Access to Lawrence Station | ◑ | Access to Caltrain would be similar to today. Minor improvement by providing a bit more spacing between Lawrence stop bar and San Zeno/Lawrence Station right-in/right-out. |
| - Transit Stops along Corridor | ◑ | Transit stops would be located along Expressway, at ped/bike ramps. Requires patrons to use ramps to traverse between community and bus on Lawrence. |
| **Community Factors** | ◑ | |
| - Visual Impacts | ○ | Lawrence would be partially elevated over Reed/Monroe and Kifer, creating a 15' high visual barrier. Would be a major impact to residential uses adjacent to Lawrence south of Reed/Monroe. |
| - Community Context | ◑ | Traffic would be kept on Lawrence Expressway and cross-street intersections would be significantly reduced in size. Lawrence would be very visible and cross-streets would be depressed, creating partial under-pass effect with retaining walls. |
| **Design Elements** | ◑ | |
| - Right-of-Way Needs | ○ | |
| o Total square feet of ROW needed | **208,200** | |
| o Total number of parcels impacted | **28** | |
| o Businesses Impacted | **12** | 6 would experience major parking impacts. 4 structures would be impacted. 1 would have access significantly constrained. 1 would have lesser parking impacts. |
| o Residential Impacted | **4** | Loss of backyard space at 3 single family homes, loss of some parking for condo complex |
| o Businesses Relocated | **5-6** | SE corner of Lawrence & Reed/Monroe, NW corner of Kifer & Lawrence, and SW, SE, NW corners of Arques & Lawrence. Likely relocation at SW corner of Enochs & Lawrence. |
| o Residential Relocated | **5+** | 3 single family homes, end units at 2 condo complexes |
| - Constructability | ◑ | Less earthwork than Alternative 1. Still have some challenges associated with water table with half-up/half-down. Possibly more challenging for maintaining traffic during construction. Estimated duration of construction: 2-4 years. |
| - Traffic Handling during Construction | ○ | Very challenging. Will need to build roadway in phases, reducing capacity in each phase. Major challenges with half-up/half-down construction and maintenance of traffic. |
| - Allows Phased Implementation | ● | Each intersection can be constructed independently. |
| - Future Flexibility | ○ | Does not allow for any managed lane concepts. Does not address geometric deficiencies at Central. |
| **Cost-Benefit** | ◑ | |
| - Project Cost (2013 dollars) | **$230 M** | Major cost uncertainties include ROW acquisition/business relocation, de-watering, environmental effects of visual impact, modifications needed to Caltrain bridge/retained fill structure. |
| - Project Benefit to Lawrence Commuters | ◑ | |
| o 2020 peak period weekday vehicle-hours of benefit per year | **512,000** | |
| o 2040 peak period weekday vehicle-hours of benefit per year | **406,000** | |
| - Benefit/Cost Calculation (20-yr benefit period, cost in 2013 dollars, peak period vehicle travel time benefits only) | **1.0** | |
| - 2040 peak hour weekday vehicle-hours of benefit per year to crossing traffic | **316,000** | |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Figure 5-13 - Alternative 3 Plan and Profile Illustration*



This treatment improves traffic operations by removing all of the turning movements that would conflict with the north/south traffic along Lawrence Expressway, thus allowing for the free flow of vehicles on the expressway.

The treatment proposed for where Kifer Road intersects with Lawrence Expressway is similar to that shown in Concept 9 for the same intersection. The local roadway network connections to and from northbound Lawrence Expressway would be provided via Ryder Street and Gordon Avenue. The connections to and from southbound Lawrence Expressway would be provided via Enochs Street and San Ysidro Way. Gordon Avenue is proposed by others to be shifted to the east to align with the north-south segment of Ryder Street and with the Costco signalized driveway. The realignment of Gordon Avenue will improve operations of this alternative by reducing the number of signalized intersections required. San Ysidro Way currently does not connect to Enochs Street. The LSAP is proposing the addition of new grid-oriented streets to improve local circulation. One of the components of the proposed street network is the extension of San Ysidro Way to Enochs Street. With this extension, southbound Lawrence Expressway traffic could utilize Enochs Street to San Ysidro Way to access Kifer Road. Additionally, a new southbound ramp is proposed from San Zeno Way to southbound Lawrence Expressway.

Traffic signals would be needed at the following intersections due to the projected increase in volumes associated with this alternative:

- Gordon Avenue (or New Gordon Avenue) and Ryder Street
- Gordon Avenue and Kifer Road (not needed with New Gordon Avenue)
- Enochs Street and San Ysidro Way (future)
- San Ysidro Way and Kifer Road

The configuration of the bicycle and pedestrian facilities can be seen in **Figure 5-14** and **Figure 5-15**. Bicycle and pedestrian facilities would remain along Lawrence Expressway as they are today. However, the existing conflict points at the study intersections would be removed. In order to access local streets from the shoulder or sidewalks along Lawrence Expressway, shared use ramps would be provided between each cross-street and Lawrence Expressway.

### *5.4.2. Traffic and Circulation*

Analysis of traffic circulation with Alternative 3 was completed using the VISSIM micro-simulation software, which provided the detailed LOS, travel time, queuing and delay data for the 2020 and 2040 horizon years.

Alternative 3 would result in a substantial improvement in travel speed and reduction in congestion in both directions in each peak period (AM and PM). **Table 5-7** and **Table 5-8** indicate the improvements in corridor travel time and speed with the implementation of Alternative 2. The data in the table is for the corridor extents between Oakmead Parkway/Duane Avenue and Cabrillo Avenue, inclusive, and thus accounts for the potential for the improvement to shift congestion to the downstream intersection.

***Table 5-7 Alternative 3 Lawrence Expressway Travel Time Benefits (Year 2020)***

| Peak Hour | Direction | Baseline | | Alternative 3 | | Change from Baseline to Alternative 3 | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 451 | 16.8 | 252 | 29.5 | -44% | 76% |
| | Southbound | 270 | 27.7 | 211 | 35.3 | -22% | 27% |
| *PM* | Northbound | 269 | 28.1 | 202 | 36.7 | -25% | 31% |
| | Southbound | 500 | 14.9 | 252 | 29.6 | -50% | 99% |

*Figure 5-14 - Alternative 3 Bicycle Facilities*

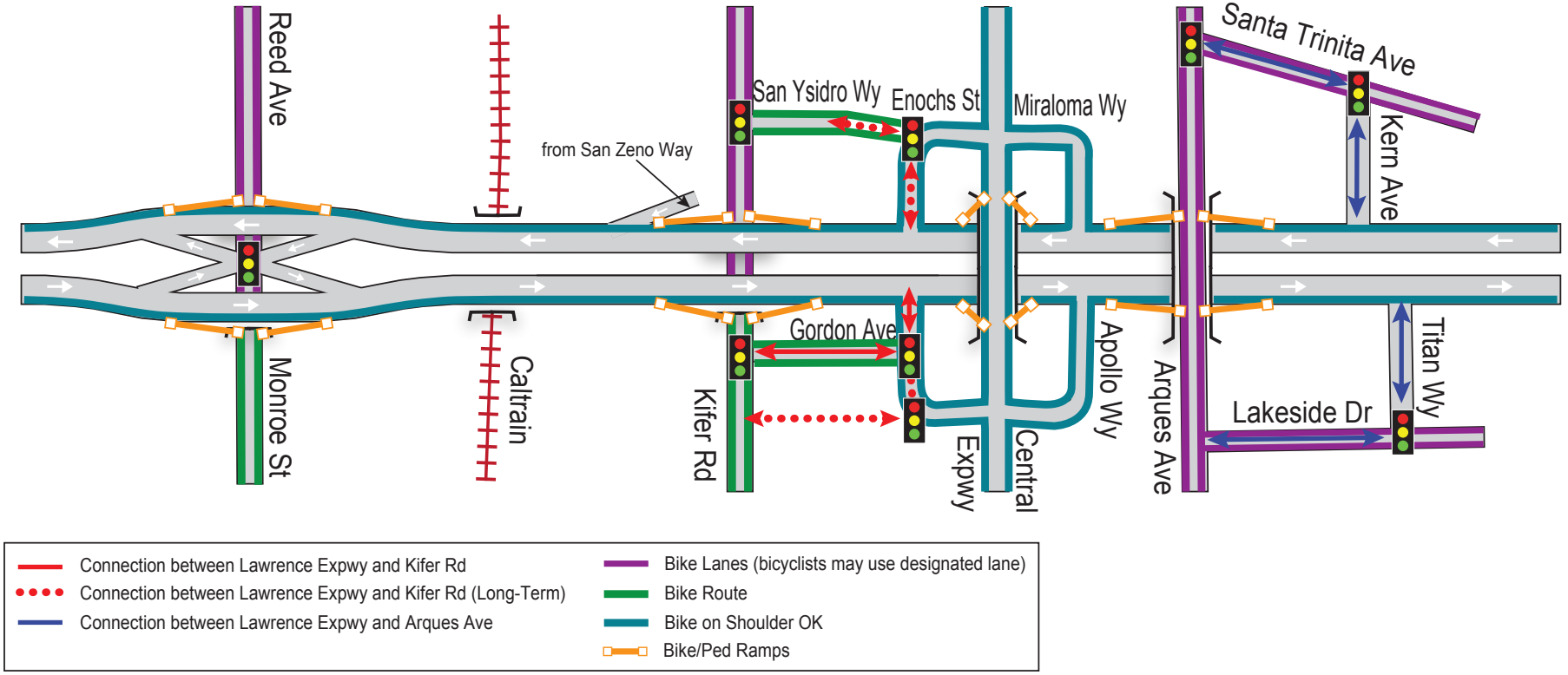


*Figure 5-15 - Alternative 3 Pedestrian Facilities*

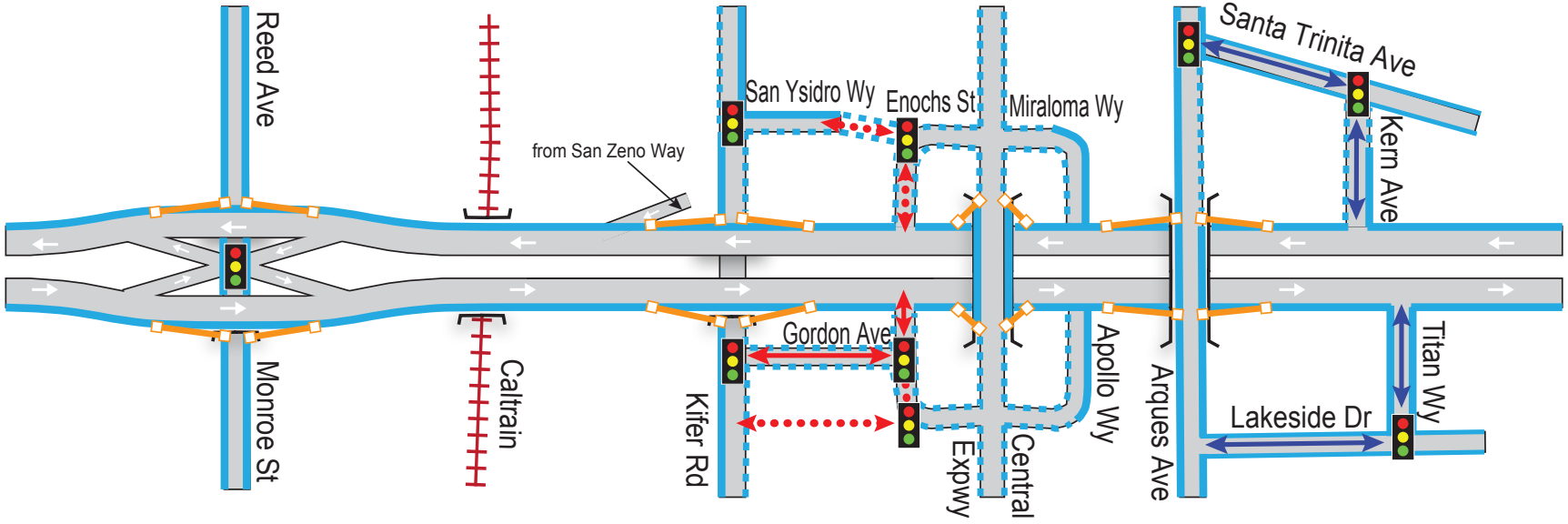


*Table 5-8 - Alternative 3 Lawrence Expressway Travel Time Benefits (Year 2040)*

| Peak Hour | Direction | Baseline | | Alternative 3 | | Change from Baseline to Alternative 3 | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 524 | 14.4 | 329 | 22.6 | -37% | 57% |
| | Southbound | 260 | 28.8 | 201 | 37.2 | -23% | 29% |
| *PM* | Northbound | 273 | 27.7 | 212 | 35.0 | -22% | 26% |
| | Southbound | 513 | 14.6 | 367 | 20.4 | -29% | 40% |

As shown in the table, the project benefits are most substantial in the peak directions of travel in the respective peak periods in Year 2020. The project still provides a great deal of benefit in Year 2040, but the benefits in both peak periods are somewhat lessened due to increasing congestion at the Cabrillo Avenue intersection. Even accounting for this shift in congestion, there still is a greater than twenty percent increase in travel speed with this alternative in the Year 2040 PM peak period.

The intersection geometry and associated LOS in the near-term (2020) and horizon year (2040) are shown in **Figure 5-16** and **Figure 5-17**, respectively. Sufficient lanes were provided at the intersections along the square loop ramps to achieve LOS D or better at all analyzed intersections, except at Ryder Street and New Gordon Avenue in Year 2040. The existing roadways would be utilized as square loop ramps were proposed to be widened to provide additional capacity to handle the turning movements from the expressway. The simulation model is predicting significant congestion along Ryder Street due to the number of vehicles exiting the expressway to access Kifer Road, and those accessing the expressway from Kifer Road. The intersections along Ryder Street are closely spaced, resulting in backups from New Gordon Avenue spilling back along Ryder Street to the expressway. For movements accessing the expressway, two travel lanes can be provided on northbound New Gordon Avenue and on westbound Ryder Street, but only one lane can enter the expressway. The merge results in extensive queuing on Ryder Street. The ability to only provide one lane on and one lane off the expressway precludes further widening at Ryder Street and New Gordon Avenue, resulting in LOS E at that location in the PM peak hour in Year 2040.

The new roadway configuration will result in increased travel distance of up to 0.7 miles to travel from westbound Arques Avenue to southbound Lawrence Expressway and up to 0.5 miles to travel from northbound Lawrence Expressway to westbound Kifer Road.

An interim scenario that would not require the San Ysidro Way extension to Enochs Street was evaluated. In this scenario, a new half-signal would be provided along Lawrence Expressway to allow southbound traffic to turn across northbound traffic to Ryder Street to access Kifer Road. However, the micro-simulation analysis found that dual southbound left-turn lanes would be required at this half-signal. Geometrically there was insufficient room to fit in the dual left turn lanes and the needed turn pocket storage length south of the existing Central Expressway overpass. Thus, no interim solution prior to the extension of San Ysidro Way is deemed feasible.

Traffic operations at the Reed Avenue/Monroe Street location are the same as in Alternative 2.

In Alternative 3, pedestrians and cyclists traveling along Lawrence Expressway would no longer have to cross side streets since the expressway would be grade separated. However, the shifting of a large number of vehicle movements to existing uncontrolled right-turn locations would create potentially dangerous new conflicts for those pedestrians and cyclists. Safety elements could be incorporated into the right-turn movements such as deceleration lanes, marked crosswalks, a tight turn radius, and enhanced signage, but the number of vehicles turning across the path of cyclists and pedestrians would still be very large. This alternative would introduce a number of new grades along Lawrence Expressway. One major benefit for bicyclists and pedestrians crossing the expressway on the side streets is that there would no longer be any vehicle conflict at the location of the expressway and no new conflict points would be generated.

*Figure 5-16 - Alternative 3 2020 Geometry and Level of Service*

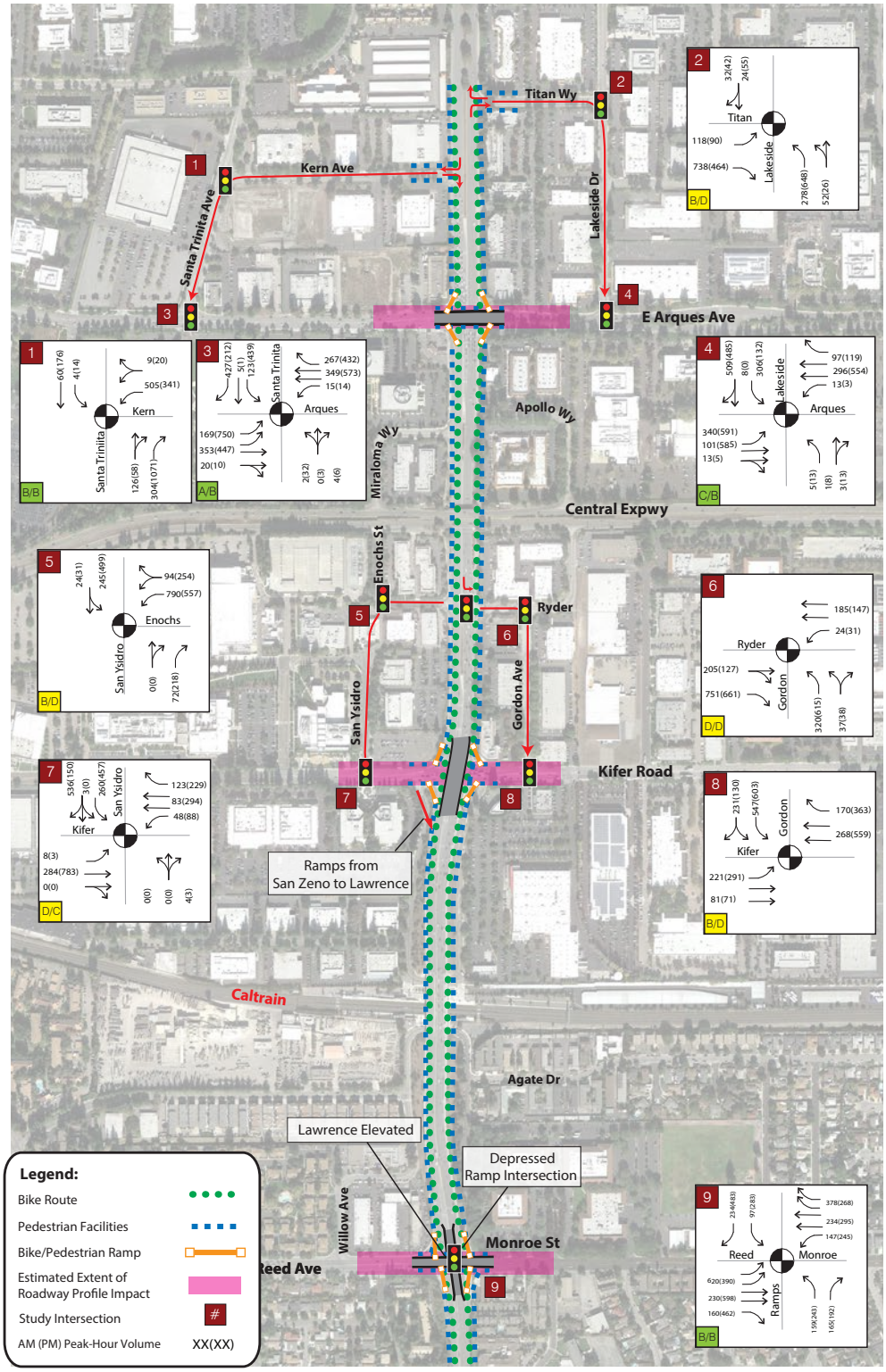
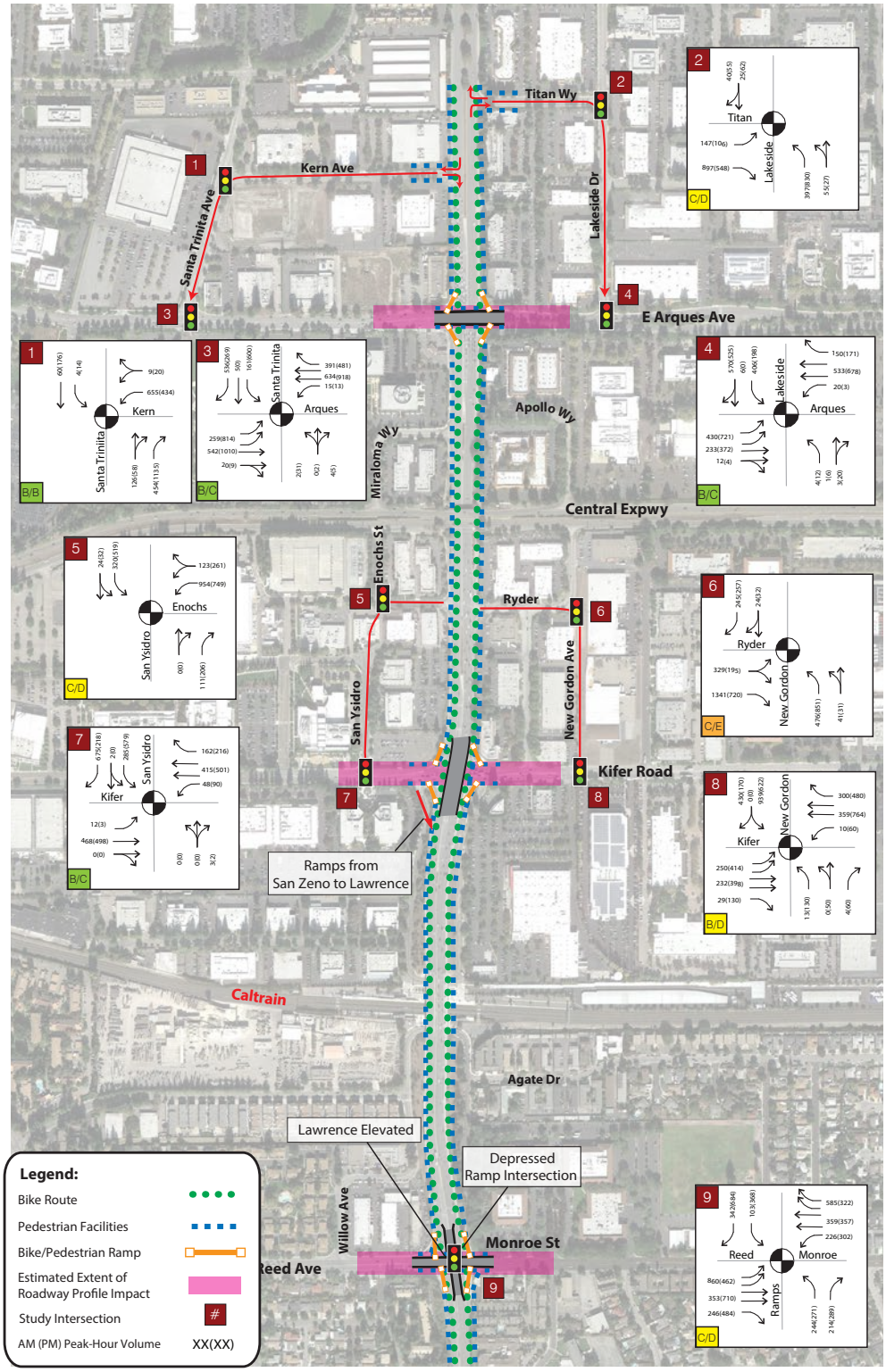


*Figure 5-17 - Alternative 3 2040 Geometry and Level of Service*



Transit access to the Lawrence Caltrain Station would be somewhat enhanced by shifting the Lawrence Expressway access points to new signals along Kifer Road at San Ysidro Way and New Gordon Avenue. Access is shown in **Figure 5-18**. The Kifer Road median would be opened at San Zeno Way or Lawrence Station Road to provide access to Caltrain from westbound Kifer Road. Collectively, Caltrain would be accessible to/from any direction along Lawrence Expressway, although some out-of-direction travel would be required. Note that similar accessibility would be provided in other alternatives as well with implementation of the proposed LSAP roadway network. Transit stops serving the project corridor would be located along the expressway at the bicycle and pedestrian ramps and would require walking up the ramp to access the cross-streets.

### *5.4.3. Conceptual Engineering*

The conceptual engineering drawings prepared as part of this step in the process can be seen in **Appendix D**. These include a plan, profile and cross-section drawing and an exhibit showing ROW impacts. Major design elements include elevated roadway structures to support Lawrence Expressway passing over Kifer Road and Reed Avenue/Monroe Street. No modifications to the Central Expressway underpass are required. Some modifications would likely be needed to the southern approach of the Lawrence Expressway bridge over Caltrain but the portion of the bridge that is elevated above the Caltrain tracks may be able to remain as is.

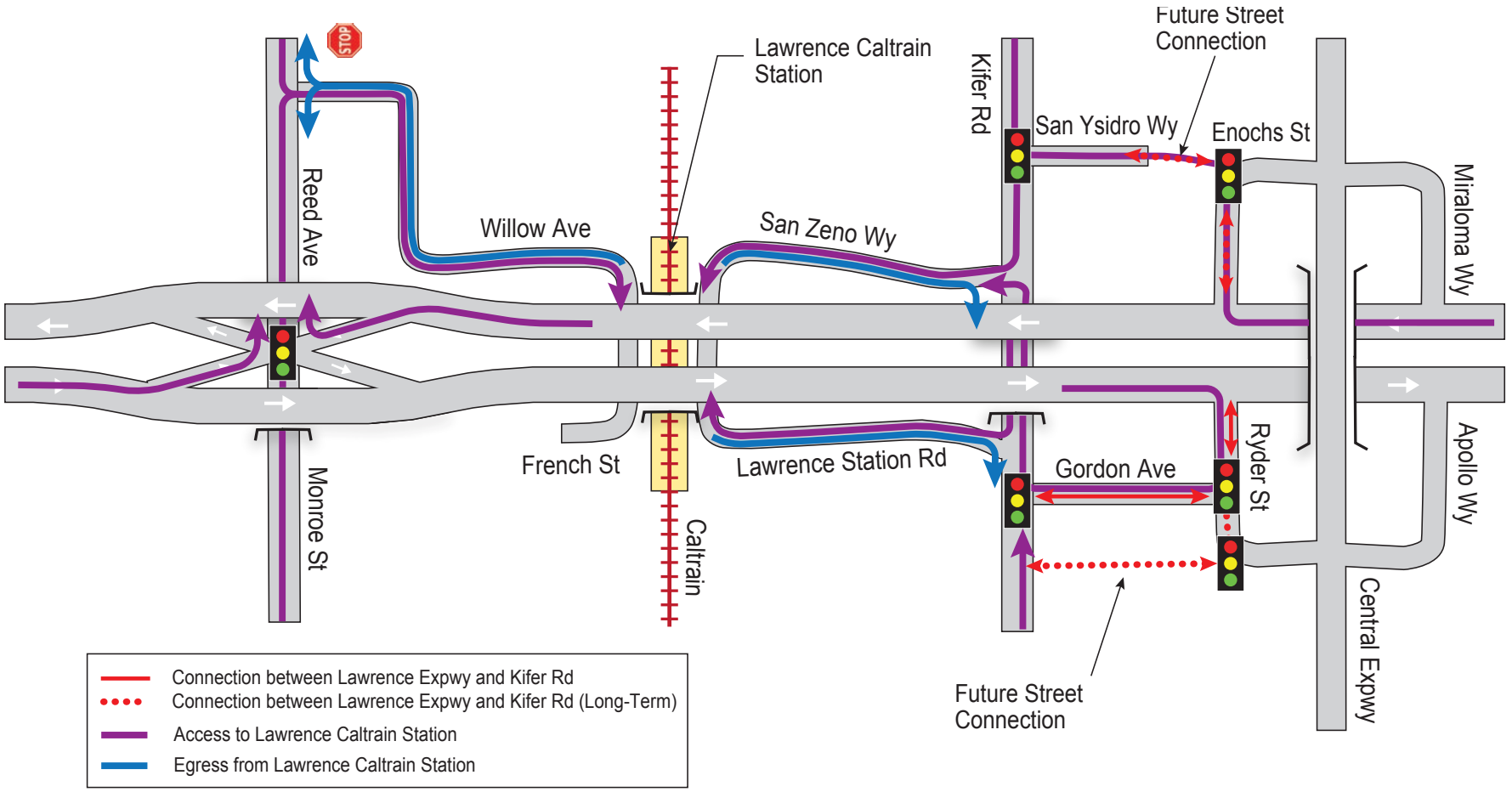
This alternative has very limited ROW needs, except associated with the median ramp interchange at Reed Avenue/Monroe Street. Elsewhere, Lawrence Expressway access will primarily rely on existing streets. Those streets will need to be widened. In some cases, additional capacity can be provided within the existing curb-to-curb width through the removal of on-street parking or narrowing of lanes. However, if there is a desire to retain on-street parking or the existing curb-to-curb width is not sufficient, additional ROW will be required for these parcels that do not lie along the expressway. It is assumed that the ROW needed to widen these roadways would be made available through dedication as adjacent parcels redevelop. However, this means that it may take a long time for sufficient ROW to be assembled to provide the necessary capacity for the circulation in this alternative to function. The project would be dependent on redevelopment to occur first, or significant ROW acquisition costs would be required for parcels off of the expressway. The extension of San Ysidro Way to Enochs Street will require the removal of an existing one-story credit union building and use of the majority of the parcel that it lies on. This may require acquisition beyond what can be expected as dedication through redevelopment.

Similar to Alternative 2, Alternative 3 will impact access to the gas station in the southeast corner of Lawrence Expressway and Monroe Street. It will also affect parking and/or structures associated with condominium/apartment complexes and three single-family dwelling units south of Reed Avenue/Monroe Street. As noted above, ROW will be required for the San Ysidro Way extension to Enochs Street and for New Gordon Avenue. Note that New Gordon Avenue is not required for this alternative, although it does improve circulation compared to the use of existing Gordon Avenue. Parcels at the southwest and southeast corners of the Arques Avenue and Lawrence Expressway intersection may be impacted due to the change of grade along Lawrence Expressway and the provision of shared use ramps to connect the expressway to Arques Avenue for pedestrians and cyclists.

In order to reduce the vertical height of the elevated Lawrence Expressway structure or the amount of depression needed for the expressway at Arques Avenue, the ability to raise or lower the cross-streets at their crossing of the expressway was evaluated. Maintaining access to driveways along the cross-streets will limit the amount of raising or lowering possible. Modifications to the cross-street elevations are shown on the profile drawings of the alternative.

The estimated duration of construction is two to four years. In comparison to Alternative 1, this alternative requires much less earthwork due to Lawrence Expressway being elevated. Some challenges associated with the high water table could still occur where excavation is proposed at Lawrence Expressway passing beneath Arques Avenue. Construction staging with this alternative will be challenging as elevation changes are proposed for almost the entire length of the expressway within the study area. This will likely require some short- or long-term closures of the expressway and numerous lane reductions. By utilizing the existing Caltrain bridge, the construction schedule is shorter as the complex bridge removal and tunnel construction at the Caltrain tracks is not required. This alternative could be built in phases, as each grade separation operates independently.

*Figure 5-18 - Alternative 3 Caltrain Access*



### 5.4.4. Cost Estimate

A cost estimate, commensurate with a rough conceptual design, was completed for Alternative 3. The project is projected to cost approximately $190 Million (2013 dollars) in total. The cost estimate does not include ROW acquisition required on local streets, as this land is assumed to be dedicated as redevelopment occurs.

The cost estimate includes a 40 percent contingency and allocations for other risk factors. Major risk factors for this concept are primarily associated with the depression of Lawrence Expressway at Arques Avenue, the ROW needed for the Reed Avenue/Monroe Street grade separation, and whether sufficient ROW dedication will occur to provide the needed capacity for the access roadways or whether ROW acquisition is required. This alternative may be the easiest to implement because it has limited roadway depression and limited ROW needs compared to the other alternatives, but is dependent on redevelopment occurring first.

### 5.4.5. Summary Evaluation

**Table 5-9** summarizes the results of the evaluation that was performed for this alternative.

A benefit-cost calculation was performed for this alternative. The calculation was very primitive and was performed merely as a comparative tool. For project benefits, hours of travel time savings were totaled for both Lawrence Expressway traffic and for traffic on the cross-streets traveling across the corridor. The alternative will result in the savings of over 400,000 vehicle-hours of delay annually by Year 2040 for traffic on the expressway. An additional over 300,000 vehicle-hours of delay annually will be saved by reducing delays for vehicles crossing Lawrence Expressway on Arques Avenue, Kifer Road, and Reed Avenue/Monroe Street. The savings calculations accounted for any increased delay at downstream intersections associated with the improvements. The calculated benefit to cost ratio was estimated to be 1.2, although this metric is only valuable in comparison against the other alternatives, as not all benefits are tabulated and included in the calculation. This calculation was based on a twenty year benefit period and was applied to the peak period vehicle travel times only. By eliminating conflict points, vehicle delay will be reduced at all hours of the day and on weekends, significantly increasing the travel time benefits of the alternative. Additional benefits of this alternative not accounted for in the cost-benefit calculation include:

- Safety benefits associated with eliminating conflict points at existing intersections;
- Reduced emissions associated with reductions in vehicle idling and increased travel speed; and
- Increased community connectivity by eliminating the at-grade barrier of Lawrence Expressway.

While this alternative has a much lower cost, primarily due to the reduction in ROW needs, it has some significant corresponding drawbacks. The alternative may not fit the community context and achieve public support due to a couple of factors. It will significantly increase traffic volumes on existing local-serving streets, requiring the widening of those streets. Additionally, similar to Alternative 2, it requires the construction of a raised concrete structure adjacent to the residential portion of the corridor near Reed Avenue/Monroe Street. While pedestrian and bicycle movements along the cross-streets benefit greatly from this alternative, it is clearly the least desirable for pedestrian and bicycle movements along the expressway. These movements will need to cross uncontrolled right-turn movements to and from the expressway. While some measures are available to help facilitate that conflict, the right-turn movements are inherently uncontrolled and generally at a higher-speed. No new conflict points would be proposed, but existing conflict points would see significant increases in volumes. Caltrain access is improved with this alternative, but similar improvements would also be achieved with implementation of the planned LSAP roadway network.

## 5.5. Analysis Alternatives Evaluation and Comparison

### 5.5.1. Evaluation Matrices and Findings

Based on the analysis for each alternative in the areas of traffic, multi-modal circulation, community context, design, and cost, Kimley-Horn developed an alternatives evaluation matrix for the three alternatives. The alternatives evaluation matrix shown in **Table 5-10** is a qualitative-based tool used to summarize and compare the findings for each of the alternatives.

## *Table 5-9 - Alternative 3 Evaluation*

| | Rating | Explanation |
|---|---|---|
| **Vehicular Traffic** | ◑ | |
| - Oakmead to Cabrillo 2040 Travel Time Improvement from Baseline | ◑ | Good improvement in peak direction of travel in morning. Moderate improvement in all other directions in both peak periods in 2040. PM Southbound benefit limited by queuing at Cabrillo - overall speed averages only 20 MPH. AM NB speed is 23 mph. Benefits of alternative are significantly higher in 2020 (50% reduction in travel time in PM Southbound) before volume increases such that Cabrillo congestion counteracts benefits. In 2020 average speed in both directions is over 29 mph in both peaks. |
| o AM Northbound | **37%** | |
| o AM Southbound | 23% | |
| o PM Northbound | 22% | |
| o PM Southbound | **29%** | |
| - Arques | ● | All intersections along connection path will operate at LOS D or better in 2020 and 2040. Will require removal of on-street parking and/or minor ROW dedication along Santa Trinita, Arques, Kern, Titan, and Lakeside. Results in increased travel distance of up to 0.7 miles. |
| - Kifer | ◑ | All intersections along connection path will operate at LOS E or better in 2020 and 2040. NB access/egress via single-lane right-turn in/out at Ryder will be the long-term constraint. Results in increased travel distance of up to 0.5 miles. |
| - Reed/Monroe | ● | Operates at LOS C or better in 2020. LOS D or better in 2040. Need dual EB left-turn and WB right-turn lanes. Two receiving lanes on on-ramp will need to merge into one. Will result in steady stream of vehicles accessing Lawrence. |
| - Central Access | ◑ | No access between EB Central and Kifer. No access between WB Central and Arques. A variant would provide a median connection road between Arques and Kifer, with a signal at Central, to provide that connectivity. |
| - Effect on HOV Lane | ○ | HOV lane should probably be eliminated north of Cabrillo with this alternative. Very heavy movements in outside lane throughout corridor would result in much slower speeds in that lane. |
| **Multi-Modal Circulation** | ◑ | |
| - Pedestrian along Expwy | ○ | Pedestrians would remain on sidewalk on Lawrence. Existing crossing of cross-streets is eliminated. However, significant increase in vehicles making uncontrolled right-turn movements onto and off of Expressway. Would introduce a number of new grades, although all meet ADA. Access to cross-street is via ped/bike ramps, also meeting ADA. |
| - Bike along Expwy | ○ | Cyclists would remain on shoulder on Lawrence. Existing crossing of cross-streets is eliminated. However, significant increase in vehicles making uncontrolled movements onto and off of Expressway. Would introduce a number of new grades. Access to cross-street is via ped/bike ramps. |
| - Bicycle and Pedestrian crossing | ● | Existing pedestrian and bicycle crossings of Lawrence completely eliminated. Circulation is maintained for all existing uses. |
| - Transit Access to Lawrence Station | ◑ | Access to Caltrain would be similar to today. Would need to open up Kifer median at San Zeno or Lawrence Station to provide access to Caltrain from NB Lawrence without requiring u-turn. |
| - Transit Stops along Corridor | ◑ | Transit stops would be located along Expressway, at ped/bike ramps. Requires patrons to use ramps to traverse between community and bus on Lawrence. |
| **Community Factors** | ○ | |
| - Visual Impacts | ○ | Lawrence would be partially elevated over Reed/Monroe and Kifer, creating a 15' high visual barrier. Would be a major impact to residential uses adjacent to Lawrence south of Reed/Monroe. |
| - Community Context | ○ | Traffic would greatly increase on some roadways adjacent to Lawrence. With the addition of redevelopment trips, these roadways may need to be widened more than currently indicated. Lawrence would be very visible and cross-streets would be depressed, creating partial under-pass effect with retaining walls. |
| **Design Elements** | ◑ | |
| - Right-of-Way Needs | ● | Assumes necessary ROW along local streets will be dedicated. Numbers below do not include any associated impacts with that required ROW along local streets. |
| o Total square feet of ROW needed | **135,000** | |
| o Total number of parcels impacted | **12** | |
| o Businesses Impacted | **2** | 1 would experience major parking impacts. 1 would have access significantly constrained. |
| o Residential Impacted | **4** | Loss of backyard space at 3 single family homes, loss of some parking for condo complex |
| o Businesses Relocated | **1-3** | SE Corner of Lawrence & Reed/Monroe. Possible relocations at SW and SE corners of Lawrence & Arques. |
| o Residential Relocated | **5+** | 3 single family homes, end units at 2 condo complexes |
| - Constructability | ◑ | Less earthwork than Alternative 1. Still have some challenges associated with water table with half-up/half-down. Possibly more challenging for maintaining traffic during construction. Entirely dependent on land dedication for off-corridor ROW needs. Estimated duration of construction: 2-4 years. |
| - Traffic Handling during Construction | ○ | Very challenging. Will need to build roadway in phases, reducing capacity in each phase. Major challenges with half-up/half-down construction and maintenance of traffic. |
| - Allows Phased Implementation | ◑ | Each intersection can be constructed independently. Requires ROW dedication to construct. |
| - Future Flexibility | ◑ | Would require re-construction of Central bridge to implement managed lane concepts. Does not address geometric deficiencies at Central. |
| **Cost-Benefit** | ● | |
| - Project Cost (2013 dollars) | **$190 M** | Major cost uncertainties include ROW acquisition/business relocation, ROW dedication, de-watering, environmental effects of visual impact. Cost does not include ROW acquisition required on local streets (assumes dedication). |
| - Project Benefit to Lawrence Commuters | ◑ | |
| o 2020 peak period weekday vehicle-hours of benefit per year | **514,000** | |
| o 2040 peak period weekday vehicle-hours of benefit per year | **458,000** | |
| - Benefit/Cost Calculation (20-yr benefit period, cost in 2013 dollars, peak period vehicle travel time benefits only) | **1.2** | |
| - 2040 peak hour weekday vehicle-hours of benefit per year to crossing traffic | **313,000** | |

| Legend | | | | | |
|---|---|---|---|---|---|
| ● | High Rating | ◑ | Medium Rating | ○ | Low Rating |

*Table 5-10 - Alternatives Evaluation Matrix*

| | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| **Vehicular Traffic** | ● | ◑ | ◑ |
| - Oakmead to Cabrillo Travel Time Improvement from Baseline | ● | ◑ | ◑ |
| - AM Northbound | 51% | 42% | 37% |
| - PM Southbound | 48% | 18% | 29% |
| - Arques | ◑ | ● | ● |
| - Kifer | ● | ● | ◑ |
| - Reed/Monroe | ● | ● | ● |
| - Central Access | ◑ | ◑ | ◑ |
| - Effect on HOV Lane | ○ | ● | ○ |
| **Multi-Modal Circulation** | ● | ◑ | ◑ |
| - Pedestrian along Expwy | ● | ◑ | ○ |
| - Bike along Expwy | ● | ◑ | ○ |
| - Bicycle and Pedestrian crossing | ◑ | ● | ● |
| - Transit Access to Lawrence Station | ● | ◑ | ◑ |
| - Transit Stops along Corridor | ● | ◑ | ◑ |
| **Community Factors** | ● | ◑ | ○ |
| - Visual Impacts | ● | ○ | ○ |
| - Community Context | ● | ◑ | ○ |
| **Design Elements** | ○ | ◑ | ◑ |
| - Right-of-Way Needs | ◑ | ○ | ● |
| Total square feet of ROW needed | 210,200 | 208,200 | 135,000 |
| Total number of parcels impacted | 23 | 28 | 12 |
| Businesses Impacted | 11 | 12 | 2 |
| Residential Impacted | 1 | 4 | 4 |
| Businesses Relocated | 2-6 | 5-6 | 1-3 |
| Residential Relocated | 0 | 5+ | 5+ |
| - Constructability | ○ | ◑ | ◑ |
| - Traffic Handling during Construction | ◑ | ○ | ○ |
| - Allows Phased Implementation | ○ | ● | ◑ |
| - Future Flexibility | ● | ○ | ◑ |
| **Cost-Benefit** | ○ | ◑ | ● |
| - Project Cost[1] | $374 M | $230 M | $190 M |
| - Project Benefit to Lawrence Commuters | ● | ◑ | ◑ |
| 2020 peak period weekday vehicle-hours of benefit per year | 543,000 | 512,000 | 514,000 |
| 2040 peak period weekday vehicle-hours of benefit per year | 629,000 | 406,000 | 458,000 |
| - Benefit/Cost Calculation[2] | 0.9 | 1.0 | 1.2 |
| - 2040 peak hour weekday vehicle-hours of benefit per year to crossing traffic | 278,000 | 316,000 | 313,000 |

Notes:

[1] Project cost for Alternative 3 does not include any costs associated with ROW acquisition along local streets (assumes dedication). Costs are in 2013 dollars.

[2] Only reflects vehicle travel time benefits along Lawrence Expressway during peak periods and on crossing streets during peak hours. Assumes a 20-year benefit period, extrapolated from 2020 and 2040 forecast travel time savings. Uses MTC-specified value of travel time and 4% discount factor. Does not include emission reduction benefits.

| Legend | |
|---|---|
| ● | High Rating |
| ◑ | Medium Rating |
| ○ | Low Rating |

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Alternatives 1, 2, and 3 each have their positives and drawbacks.

- Alternative 1 rates well in vehicle circulation, but may result in some congestion along the frontage roads at Arques Avenue. It also rates well for multi-modal circulation, but was deemed not as desirable for commuter cyclists along the expressway. The depression of the roadway in Alternative 1 rates very well for community context, but introduces a number of risk factors and challenges that increase the project cost, timeframe of construction and construction complexity.
- Alternative 2 rates fairly well across all of the evaluation categories. While it does not provide the expressway throughput benefits of Alternative 1, it still results in significant travel time savings along the expressway and even greater benefits for traffic on the cross-streets. It also provides many benefits for bicycle and pedestrian circulation compared to existing conditions, but additional elements could be included to enhance bicycle and pedestrian safety and comfort. It includes an elevated structure, which is not as desirable for community acceptance and context, but that does keep costs and construction complexity lower.
- Alternative 3 rates fairly well in some categories, and poorly in others. It provides significant travel time savings for both users of the expressway and cross-streets, but will result in congestion and queuing along Ryder Street accessing and egressing the expressway. By completely eliminating conflict points it greatly improves circulation for cyclists and pedestrians along the cross-streets, but greatly increases the number of vehicles conflicting with bicycle and pedestrian movements along the expressway, creating safety concerns. Similar to Alternative 2, the elevated structure is not desirable for community acceptance and context, but does keep costs and construction complexity lower.

These findings are summarized in **Table 5-11**.

***Table 5-11 - Alternatives Evaluation Summary***

| | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| *Vehicular Traffic* | *Best improvement in throughput on expressway. Not as efficient for cross-street traffic due to closely spaced intersections.* | *Works well for expressway and very well for cross-street traffic.* | *Works well for expressway and cross-streets, but may result in queuing and congestion for exiting/entering movements.* |
| *Multi-Modal Circulation* | *Pedestrians and cyclists on lower speed frontage road. Introduces high-speed conflict for commuter cyclists.* | *Greatly improves safety by eliminating conflict points at cross-streets. Bicycle and pedestrian movements still along high-speed expressway.* | *Still retains a number of high-speed conflicts for bicyclists and pedestrians.* |
| *Community Factors* | *Lowering of expressway eliminates it as a barrier and frontage roads maintain strong local access.* | *Elevating expressway introduces a visual barrier.* | *Elevating expressway introduces a visual barrier and traffic volumes on connecting local streets would greatly increase.* |
| *Design Elements* | *Depressing expressway would be difficult to construct and costly, particularly at Caltrain.* | *Would require more ROW at interchange locations, but can partially utilize existing bridge over Caltrain.* | *Dependent on elements of LSAP to be implemented in order for grade separations to proceed.* |
| *Project Cost* | *Very high due to roadway depression.* | *Moderate with elevated roadway and some ROW requirements.* | *Lowest due to elevated roadway and assumption that LSAP implementation will provide needed ROW.* |

# 6. Proposed Concept

## 6.1. Selection of Proposed Concept

In January 2014, the PWG met to select a proposed concept for further analysis and design. The evaluation matrices prepared as part of the alternatives analysis were reviewed and compared against the project goals. Key factors that were weighed heavily by the decision-makers included resulting traffic operations, particularly on local streets; community context; and multi-modal circulation.

Alternative 3 was removed from further consideration due to its associated increase in traffic volumes on local streets, the access/egress congestion forecast on Ryder Street, and the conflict between right-turning vehicles exiting and entering the expressway with pedestrian and bicycle movements along Lawrence Expressway. While it is a low-cost option, the PWG wanted a to settle on a concept that met the needs of the communities and would be a long-term solution. The surrounding local grid-network assumed as part of Alternative 3, as proposed by the LSAP, was supported by the PWG and would be beneficial for the ultimate Lawrence Expressway solution. However, use of those roadways as primarily expressway access/egress routes would not be consistent with the goals of this study or the LSAP.

Alternatives 1 and 2 both have positive elements that were noted by the PWG. Alternative 2 was identified as providing the most desirable traffic solution since the median ramps functioned with much less delay than the frontage roads. Additionally, there was concern that the frontage road concept (Alternative 1) may be confusing to drivers on where they should exit if they wished to access local roadways. However, elevating the roadway as proposed in Alternative 2 was a major concern for the PWG. The corridor south of the Caltrain tracks is residential and the area around the Lawrence Caltrain Station is undergoing redevelopment. An elevated 8-lane structure may not be acceptable to local residents and may not be conducive to the mixed-use and community character planned for the Lawrence Station area.

To best address project goals, the PWG collectively selected on a modified version of Alternative 2 as the proposed concept. Similar to Alternative 1, Lawrence Expressway would be depressed for the entirety of the project study corridor. As shown in **Figure 6-1**, Lawrence Expressway would be depressed under the three major study intersections as well as Central Expressway and the Caltrain tracks. Otherwise, the proposed concept would primarily resemble Alternative 2, with grade separated interchanges with median ramps at each of the three major study intersections of Lawrence Expressway and Reed Avenue/Monroe Street, Kifer Road, and Arques Avenue.

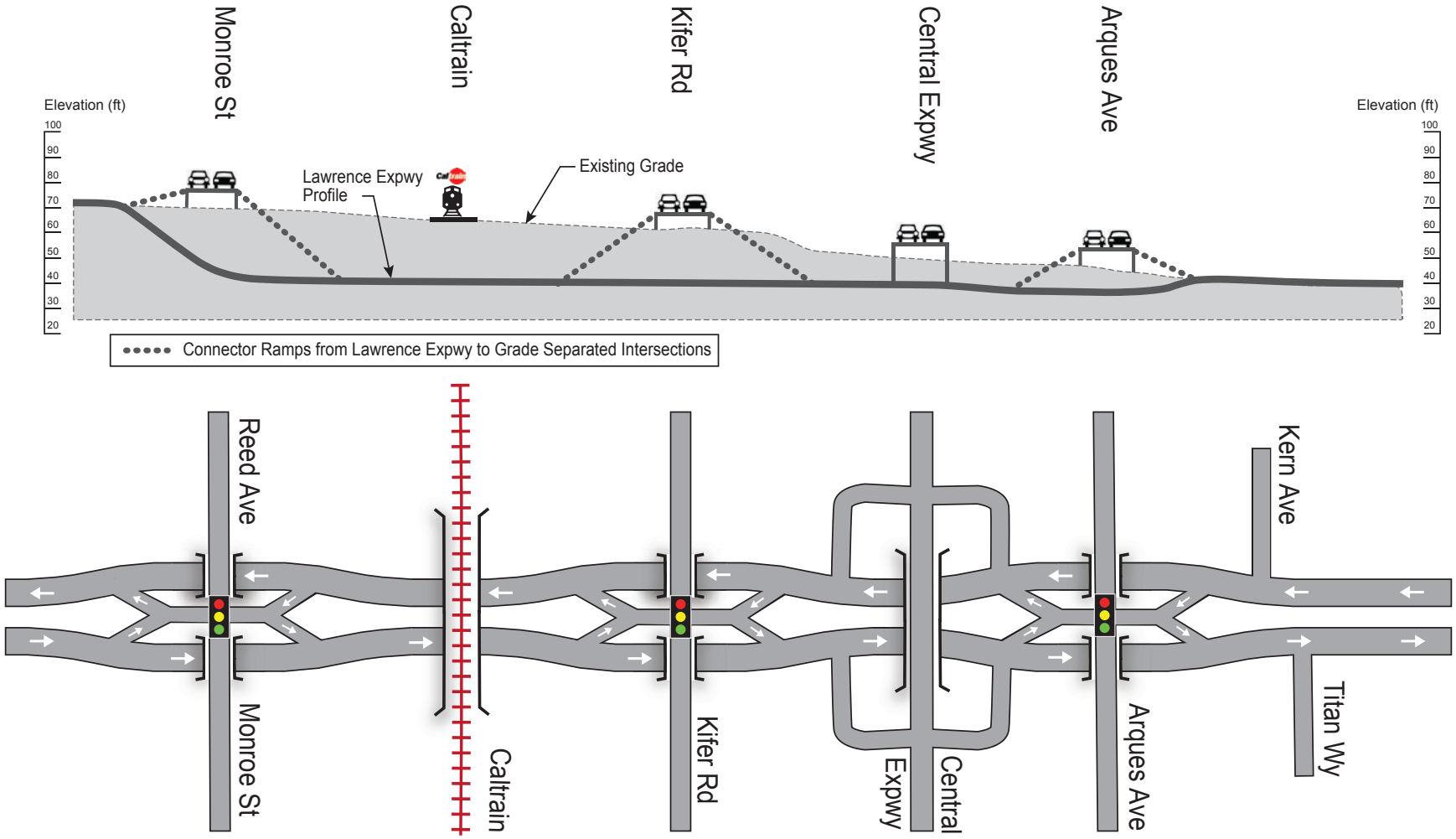
Upon selection of the proposed concept, Kimley-Horn embarked on more detailed traffic analysis and conceptual design development. Certain project elements were refined to incorporated community and stakeholder input and improve the desirability of the proposed concept. Cost estimates and ROW needs were refined based on further design and the additional elements incorporated into the proposed concept. The VISSIM model was refined to better reflect operations of the entire model area with implementation of the proposed concept, yielding changes in calculated travel time benefits. The project cost estimate was refined to better account for project risk factors and contingencies, resulting in a higher project cost (but a more accurate estimate) than those prepared during the alternatives analysis phase. Due to these refinements, quantitative metrics for the proposed concept should not be compared against the alternatives.

## 6.2. Traffic and Circulation

### 6.2.1. Corridor Traffic Operations

As in the alternatives analysis, VISSIM was used to model and analyze the traffic operations of the proposed concept of Lawrence Expressway. The VISSIM model was used to obtain metrics to assess the proposed concept compared to the baseline such as travel time, travel speed and delay. Traffic queues forecast by VISSIM were used to size turn pockets and merge distances. The model included Oakmead Parkway/Duane Avenue and Cabrillo Avenue, although no improvements beyond signal timing optimizations were proposed for those locations. Additionally, network-wide metrics such as delay and emissions were obtained from the VISSIM model to ascertain the greater effects of the proposed concept. Screenshots of the VISSIM model are provided in **Appendix E**.

*Figure 6-1 - Proposed Concept Plan and Profile Illustration*



The micro-simulation model shows that the proposed concept provides tremendous benefits for expressway throughput compared to the baseline scenario, as shown in **Table 6-1** and **Table 6-2**. Travel speed reflect average travel speed, inclusive of signal and queuing delay, extending between Oakmead Parkway/Duane Avenue and Cabrillo Avenue.

***Table 6-1 - Proposed Concept Lawrence Expressway Travel Time Benefits (Year 2020)***

| Peak Hour | Direction | Baseline | | Proposed Concept | | Change from Baseline to Proposed Concept | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 457 | 16.5 | 235 | 32.2 | -49% | 95% |
| | Southbound | 278 | 26.9 | 198 | 37.7 | -29% | 40% |
| *PM* | Northbound | 281 | 26.9 | 198 | 38.2 | -30% | 42% |
| | Southbound | 553 | 13.5 | 239 | 31.4 | -57% | 133% |

***Table 6-2 - Proposed Concept Lawrence Expressway Travel Time Benefits (Year 2040)***

| Peak Hour | Direction | Baseline | | Proposed Concept | | Change from Baseline to Proposed Concept | |
|---|---|---|---|---|---|---|---|
| | | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *AM* | Northbound | 486 | 15.6 | 286 | 26.5 | -41% | 70% |
| | Southbound | 274 | 27.3 | 201 | 37.2 | -27% | 36% |
| *PM* | Northbound | 236 | 32.0 | 212 | 35.7 | -10% | 12% |
| | Southbound | 530 | 14.1 | 300 | 24.9 | -43% | 77% |

As shown in the tables, the project will provide tremendous benefits in both Year 2020 and Year 2040 horizon years. Each vehicle traveling through the corridor in the peak direction in each peak hour will save over three minutes of stopped time in each of the horizon years. Project benefits somewhat decrease between Years 2020 and 2040 as building congestion at Cabrillo Avenue and Oakmead Parkway/Duane Avenue offset some of the increased capacity of Lawrence Expressway through the study area. However, even in Year 2040 and including the effects of downstream congestion, the proposed concept would result in a greater than forty percent decrease in travel time in the peak periods in each peak period, and an over seventy percent increase in travel speed.

The proposed concept would result in acceptable LOS C or better operations at all three interchange intersections in Year 2040 conditions. The ramps will operate with short cycle lengths, keeping queuing and delay low on the ramps and cross-streets. Turning movement volumes and intersection LOS for Year 2020 and Year 2040 are shown on **Figure 6-2** and **Figure 6-3**, respectively. In contrast, all three intersections would operate at LOS F with excessively long queues on both Lawrence Expressway and crossing streets in Year 2040 baseline conditions. The provided storage on the median ramps at the grade-separated intersections would accommodate queuing on the ramps with little possibility of spill-over to the Lawrence Expressway mainline lanes. Delay and queuing at all analyzed intersections is included in **Appendix F**.

**Table 6-3** and **Table 6-4** depicts the project benefits to average travel time on the crossing streets for Year 2020 and Year 2040 conditions. Travel speed reflects average travel speed for the segment, inclusive of signal and queuing delay.

*Figure 6-2 - Proposed Concept 2020 Geometry, Volume, and Level of Service*

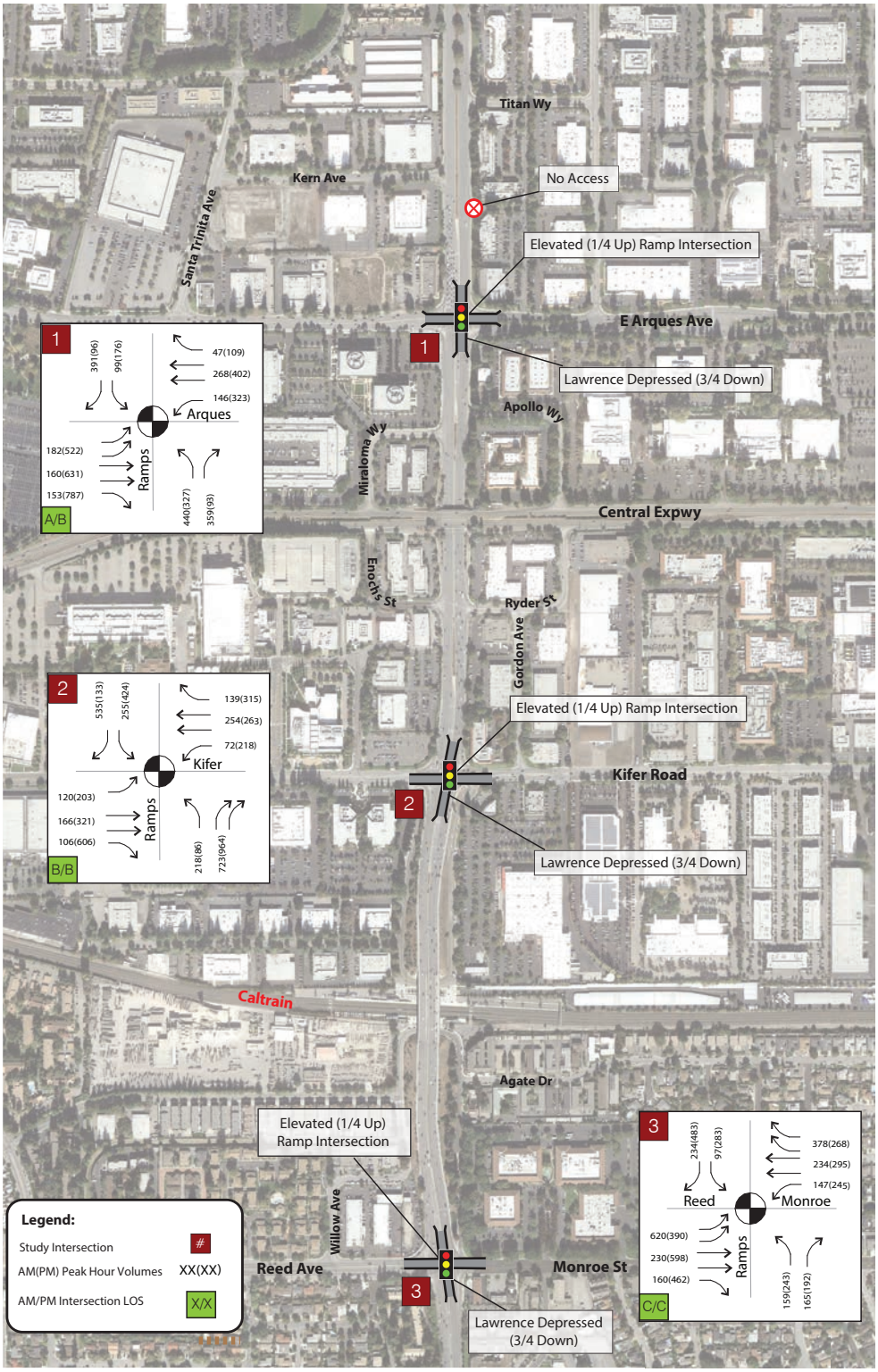


*Figure 6-3 - Proposed Concept 2040 Geometry, Volume, and Level of Service*

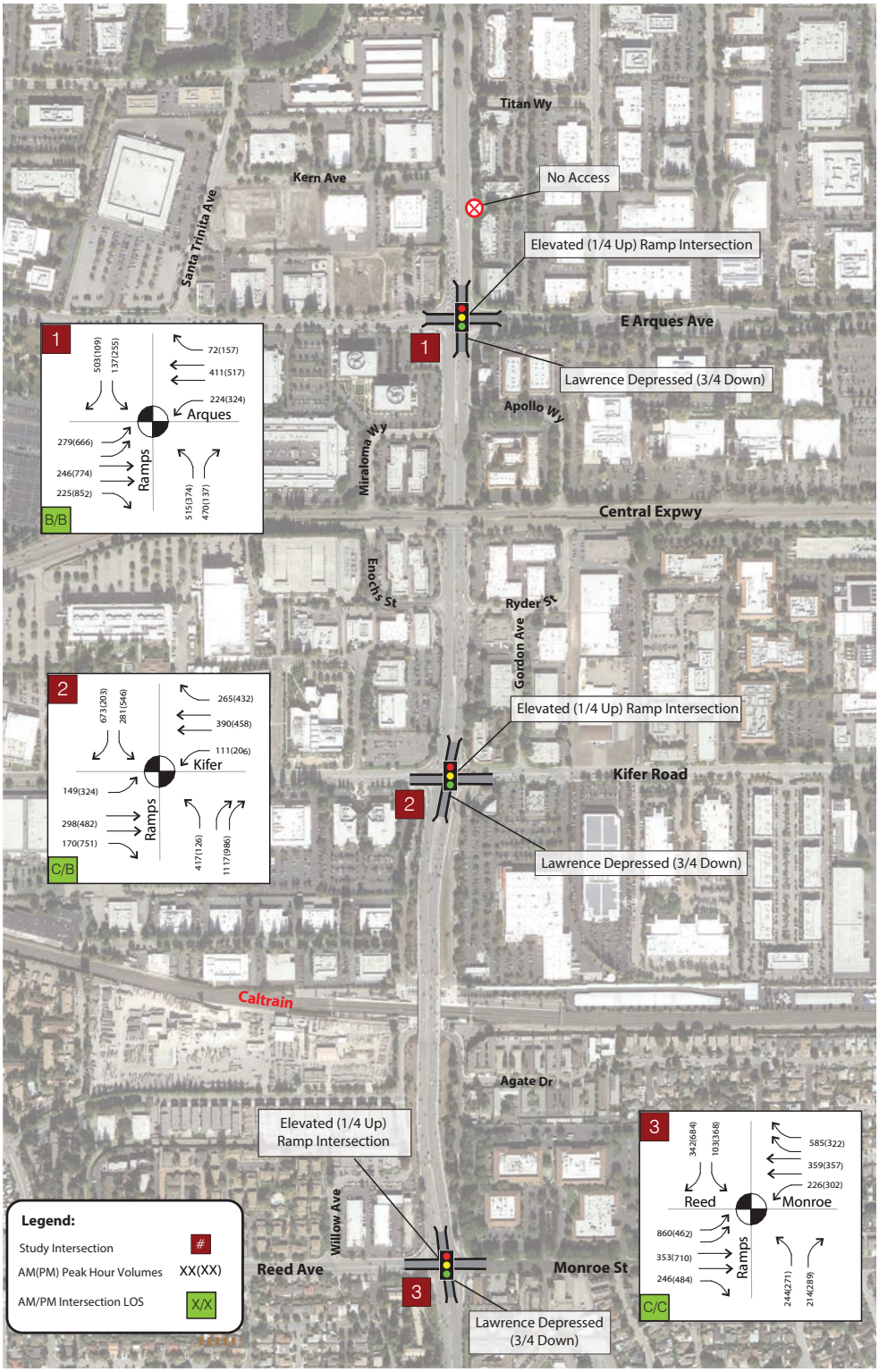


*Table 6-3 - Proposed Concept Travel Time Benefits on Cross-Streets (Year 2020)*

| | | | Baseline | | Proposed Concept | | Change from Baseline to Proposed Concept | |
|---|---|---|---|---|---|---|---|---|
| | | Direction | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *Arques Avenue* | *AM* | Eastbound | 121 | 15.8 | 69 | 27.7 | -43% | 75% |
| | | Westbound | 131 | 15.2 | 79 | 25.1 | -40% | 65% |
| | *PM* | Eastbound | 347 | 5.5 | 80 | 24.0 | -77% | 336% |
| | | Westbound | 167 | 11.9 | 79 | 25.2 | -53% | 112% |
| *Kifer Road* | *AM* | Eastbound | 163 | 9.6 | 76 | 20.4 | -53% | 113% |
| | | Westbound | 119 | 13.7 | 61 | 27.0 | -49% | 97% |
| | *PM* | Eastbound | 245 | 6.4 | 90 | 17.3 | -63% | 170% |
| | | Westbound | 298 | 5.5 | 62 | 26.4 | -79% | 380% |
| *Reed Avenue/ Monroe Street* | *AM* | Eastbound | 283 | 5.5 | 62 | 24.6 | -78% | 347% |
| | | Westbound | 155 | 10.4 | 72 | 21.9 | -54% | 111% |
| | *PM* | Eastbound | 135 | 11.5 | 69 | 21.9 | -49% | 90% |
| | | Westbound | 262 | 6.2 | 68 | 23.3 | -74% | 276% |

*Table 6-4 - Proposed Concept Travel Time Benefits on Cross-Streets (Year 2040)*

| | | | Baseline | | Proposed Concept | | Change from Baseline to Proposed Concept | |
|---|---|---|---|---|---|---|---|---|
| | | Direction | Travel Time (s) | Travel Speed (mph) | Travel Time (s) | Travel Speed (mph) | Change in Travel Time | Change in Travel Speed |
| *Arques Avenue* | *AM* | Eastbound | 128 | 14.9 | 74 | 25.8 | -42% | 73% |
| | | Westbound | 132 | 15.1 | 84 | 23.5 | -36% | 56% |
| | *PM* | Eastbound | 311 | 6.1 | 97 | 19.7 | -69% | 223% |
| | | Westbound | 165 | 12.1 | 85 | 23.5 | -49% | 94% |
| *Kifer Road* | *AM* | Eastbound | 131 | 12.0 | 72 | 21.8 | -45% | 82% |
| | | Westbound | 153 | 10.7 | 71 | 23.0 | -54% | 115% |
| | *PM* | Eastbound | 597 | 2.6 | 108 | 14.5 | -82% | 458% |
| | | Westbound | 432 | 3.8 | 75 | 21.7 | -83% | 471% |
| *Reed Avenue/ Monroe Street* | *AM* | Eastbound | 607 | 2.5 | 82 | 18.5 | -87% | 640% |
| | | Westbound | 460 | 3.5 | 82 | 19.2 | -82% | 449% |
| | *PM* | Eastbound | 539 | 2.9 | 79 | 19.1 | -85% | 559% |
| | | Westbound | 421 | 3.8 | 81 | 19.6 | -81% | 416% |

In the baseline scenario, it could take several signal cycles to be able to cross Lawrence Expressway due to the projected volume levels. For example, heading eastbound in the AM peak hour at Reed Avenue, it may take over ten minutes to cross Lawrence Expressway if current geometrics are maintained out to Year 2040. With the proposed concept, that ten minutes could be reduced to a little over one minute, a savings of nine minutes for each vehicle making that movement. As shown in the table, reductions in crossing travel time from baseline conditions of 36 percent to 87 percent are achieved in Year 2040 conditions. These improvements in travel time on the cross-streets will have tremendous benefits for local circulation, land use access and desirability, and safety.

The proposed concept will reduce vehicle idling and delay on both Lawrence Expressway and the cross-streets. By improving travel speed and reducing delay, the project will have environmental benefits through reduced fuel consumption and greenhouse gas emissions. **Table 6-5** quantifies the area-wide transportation network performance benefits and greenhouse gas emissions reductions per weekday peak hour with the proposed concept compared to the baseline scenario.

***Table 6-5 - Peak-Hour Network Performance Benefits with Proposed Concept (Year 2040)***

| | Per Vehicle | | Network-wide | | | |
|---|---|---|---|---|---|---|
| | Avg Delay (s) | Avg Number of Stops | Fuel Consumption (gal) | Carbon Monoxide (kg) | Nitrogen Oxides (kg) | Volatile Oxygen Compounds (kg) |
| *AM Peak Hour* | | | | | | |
| *Baseline* | 215 | 3.0 | 3,743 | 261 | 51 | 61 |
| *Proposed Concept* | 80 | 1.0 | 2,644 | 185 | 36 | 43 |
| *Net Change* | *-135* | *-2.0* | *-1,099* | *-76* | *-15* | *-18* |
| *PM Peak Hour* | | | | | | |
| *Baseline* | 303 | 4.8 | 5,049 | 353 | 69 | 82 |
| *Proposed Concept* | 98 | 2.0 | 3,266 | 228 | 44 | 53 |
| *Net Change* | *-205* | *-2.8* | *-1,783* | *-125* | *-25* | *-29* |

As shown in the table, the proposed concept greatly reduces peak-hour fuel consumption and emissions. Over 1,000 gallons of fuel would be conserved in each peak hour each weekday. Note that these metrics are network-wide, including any increases in congestion at Oakmead Parkway/Duane Avenue and Cabrillo Avenue associated with the capacity improvements at the three study intersections.

The existing HOV lanes along Lawrence Expressway would benefit greatly from the implementation of the proposed concept due to the shifting of existing right-turn movements at signalized intersections to the median ramps. This will reduce weave and merge movements in the HOV lane, increasing speed and therefore the desirability of the lane.

By grade separating the turn movements for all approaches at the three study intersections, north/south through traffic along the expressway would be able to flow freely, thus accomplishing one of the primary goals of the project of alleviating congestion along Lawrence Expressway and increasing the throughput of the expressway. The existing four through lanes in each direction on Lawrence Expressway were found to be sufficient to handle projected Year 2040 volumes with the removal of the at-grade intersections.

### 6.2.2. *Multi-modal Circulation*

As part of the proposed concept refinement, a new solution was developed for bicycle and pedestrian circulation. A grade-separated bicycle and pedestrian corridor will be provided on each side of Lawrence Expressway along the portion of the corridor improved by the proposed project. The corridor will be elevated roughly five or six feet above the road bed to provide vertical separation for the safety and comfort of users. By raising the bicycle and pedestrian facilities, it also keeps them closer to ground level, requiring less vertical circulation to access the cross-streets. The corridor will pass beneath each of the three cross-streets to avoid vehicle conflicts. Shared use ramps will connect each corridor to each cross-street. A ramp will be placed on each side of the cross-street to minimize out of direction travel. A small retaining wall and railing will separated the bicycle and pedestrian corridor from the roadway. The bicycle and pedestrian corridor will include a one-way bike lane and a sidewalk on each side of Lawrence Expressway, with the bike lane and the sidewalk separated by a small buffer. The buffer will serve to separate the modes, maintaining higher speed on the bike lane. The bike lane will serve commute cyclists by allowing them to travel from one end of the grade-separated corridor to the other without any conflicts or delay, except at the Central Expressway square loops. The corridors will also serve recreational cyclists by providing them a safe facility, vertically and horizontally separated from the high-speed, high-volume expressway.

Cyclists commuting north and south along Lawrence Expressway will still be able to use shoulder on Lawrence Expressway to travel through the project corridor area; however, it is anticipated that most cyclists will prefer to use the separated bike path due to its safety and equivalent speed. **Figure 6-4** and **Figure 6-5** illustrate the proposed concept bicycle and pedestrian networks, respectively. The bicycle and pedestrian corridor is better illustrated in **Figure 6-6**, which depicts a plan view and cross-section of the corridor.

The only conflict point for bicycles and pedestrians that would remain with this concept along the extent of the grade-separated portion of Lawrence Expressway is at the Central Expressway square loop ramps. As is currently proposed, the corridors would drop down to the level of the road bed and cross traffic accessing/egressing Lawrence Expressway at the square loop ramps. The right-turn radius would be tightened compared to existing conditions and deceleration and acceleration lanes would be provided to help lower vehicle speeds. An option for further consideration would be to actually raise the bicycle and pedestrian corridors to near grade-level and have it pass over the square loop ramps via a bridge. This solution would add to the project cost, although it would result in less earthwork being required.

As noted in Chapter 3, a continuous sidewalk does not currently exist along Lawrence Expressway south of Reed Avenue/Monroe Street. The solutions proposed for the study area of this project could be extended southward towards Cabrillo Avenue. However, extending the bicycle and pedestrian corridors or providing a sidewalk south of Reed Avenue/Monroe Street to Cabrillo Avenue would require additional ROW, not currently included in this project.

Bicycle and pedestrians crossings of Lawrence Expressway would be greatly enhanced with the proposed concept. Currently, bicyclists and pedestrians have to cross the full width of the expressway and all turn lanes at signalized intersections. Each of the median ramps is limited to three or four lanes, as opposed to the eleven lanes that exist at the signalized intersections today. Therefore, the crossing distance is substantially shorter, improving safety. The cycle length at the median ramps will also be significantly shorter than the cycle length currently on Lawrence Expressway, greatly reducing wait times to cross the street.

Transit stops would be located on the median ramps adjacent to the signalized ramp intersection. Locating the stops at this location allows the stops to be located at ground level, providing easy access to the cross-streets and nearby land uses. It is also ideal for buses traveling on the expressway since they would not have to make any out-of-direction travel and will have sufficient deceleration/acceleration distance before and after stops. This solution keeps transit accessible to land use, while leveraging the high speeds of the expressway.

In order to provide for improved access to the Lawrence Caltrain Station from the south, a flyover from the ramp intersection at Reed Avenue/Monroe Street over the depressed northbound lanes of Lawrence Expressway to meet French Street is proposed. French Street provides access to the southern side of the Caltrain Station. This flyover ramp will allow for easy station access from either direction

*Figure 6-4 - Proposed Concept Bicycle Facilities*

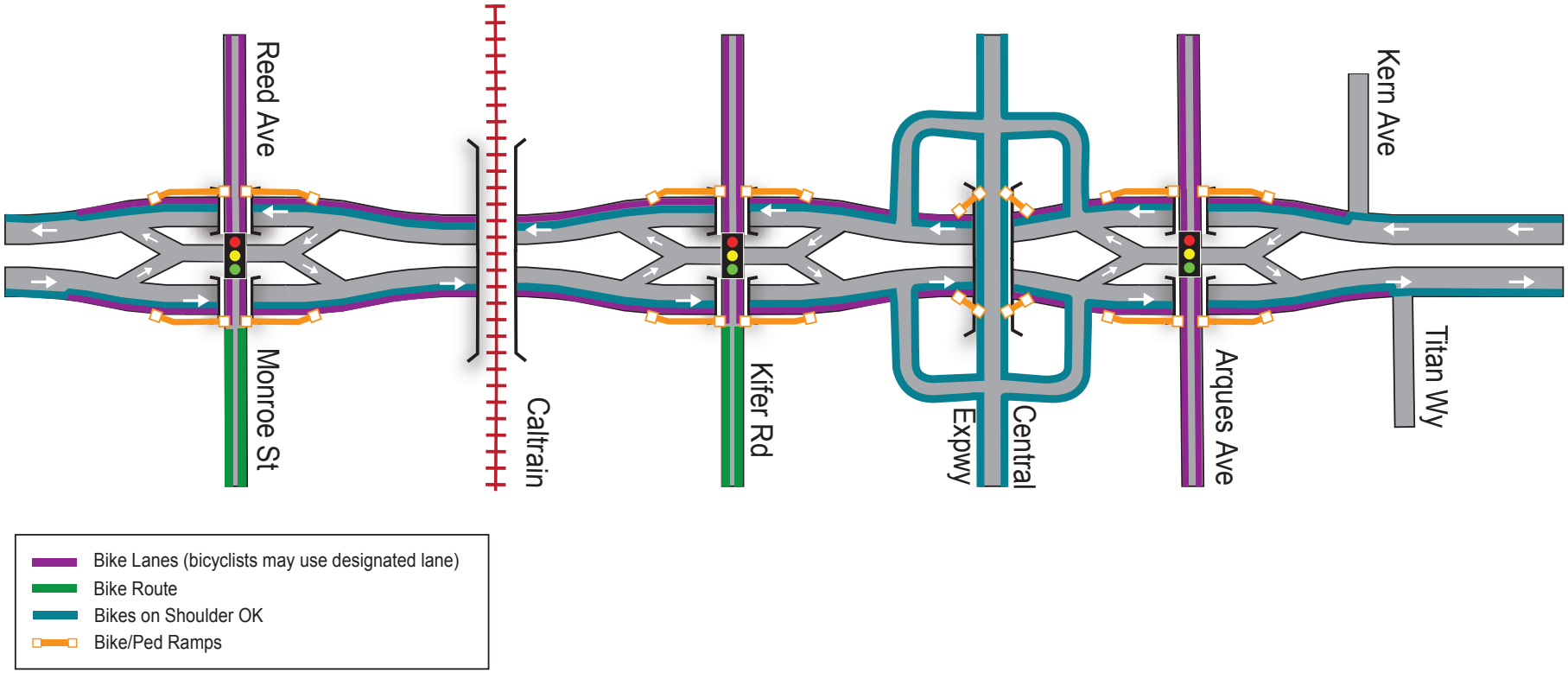


*Figure 6-5 - Proposed Concept Pedestrian Facilities*

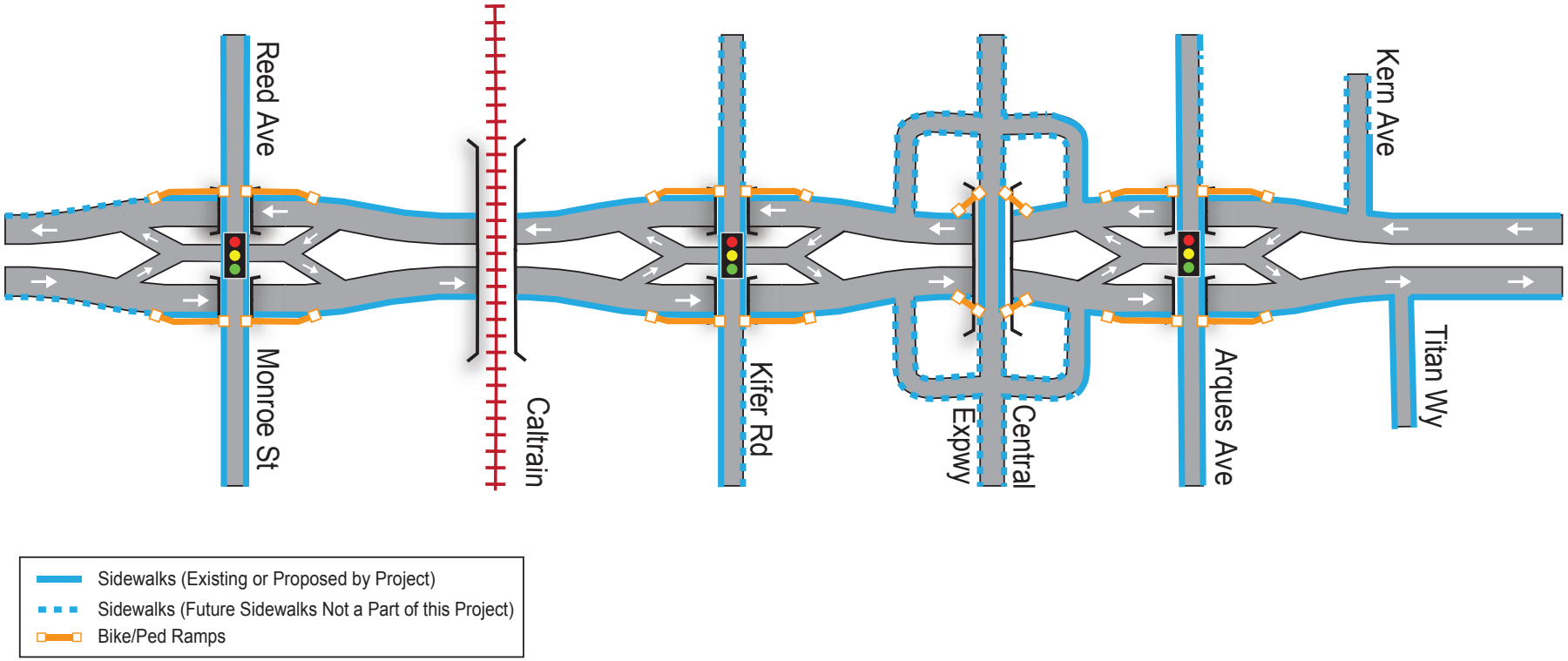
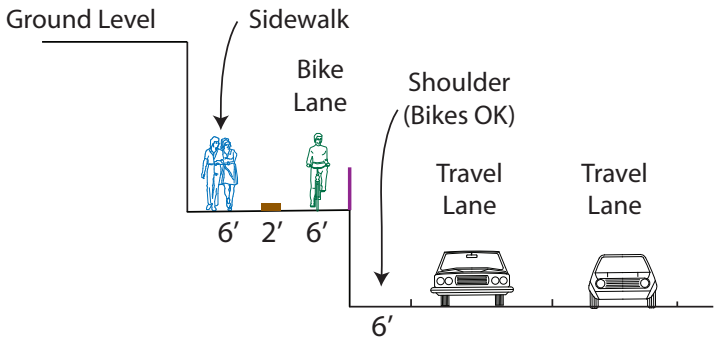
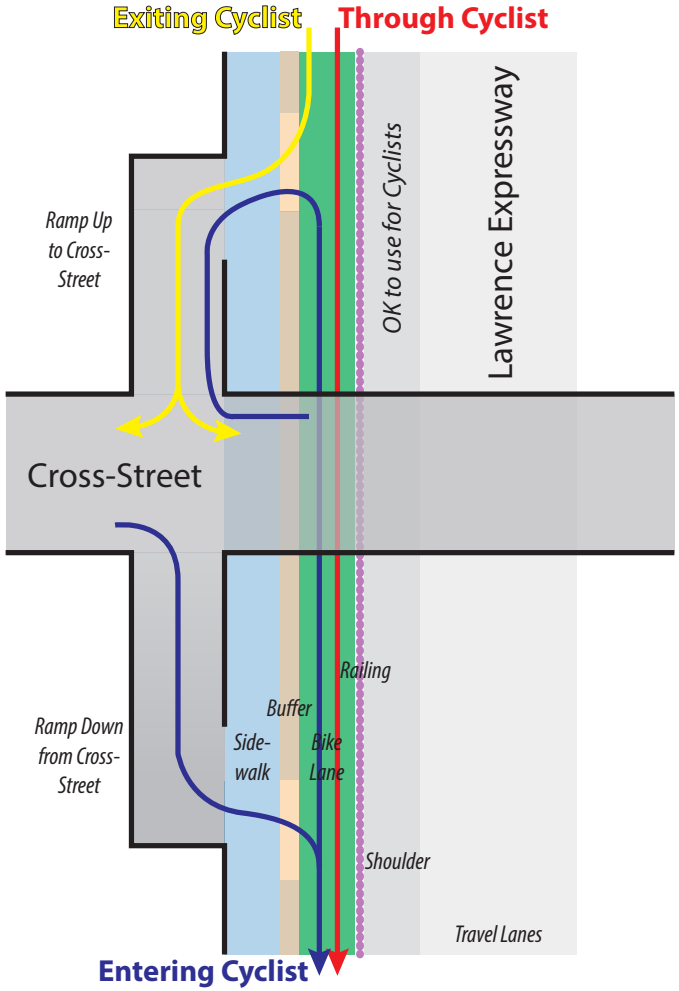


*Figure 6-6 - Schematic Plan View and Cross-Section of the Bicycle and Pedestrian Corridor*

**Cross-Section**




**Plan View**




Bicycle/Pedestrian Corridor to be provided on both sides of Lawrence

of Reed Avenue/Monroe Street and from northbound Lawrence Expressway. Improved access to the south side of the station was specifically noted as a desire by VTA. **Figure 6-7** shows in detail the access and egress routes from the Lawrence Caltrain Station.

The community has expressed a strong desire for improved transfer opportunities between bus transit and the Lawrence Caltrain Station. VTA currently does not foresee significantly increasing transit service to the station, as noted in Chapter 3. However, should such a transit service be desired, bus stops could be placed along the median or outside of Lawrence Expressway directly beneath the Caltrain Station. Elevators would then provide vertical circulation between the bus stops at the roadway level and the station. With the provision of these stops, buses would not have to exit Lawrence Expressway in order to provide direct access to the Lawrence Caltrain Station. This element is currently not included in the concept design plans or cost estimate. It can be considered and incorporated as part of the next phase of this project if desired at that time.

The depression of Lawrence Expressway will eliminate the existing perceived barrier created by the expressway. As it exists today, Lawrence Expressway acts as a barrier, separating the communities on either side of the expressway due to its large width and high traffic volumes. By depressing the expressway, the barrier will be removed, better integrating the land uses on both sides of the roadway. Depressing the roadway will also reduce traffic noise levels for land uses adjacent to the corridor.

By increasing the capacity of Lawrence Expressway and improving access to/from the expressway, commute traffic is more likely to use the expressway and access to the greater transportation network will improve for local land uses. By providing improved bicycle and pedestrian facilities along the corridor, use of alternative modes is encouraged and safety enhanced.

## 6.3. Conceptual Engineering

### 6.3.1. Design Assumptions

The Kimley-Horn team worked with County staff to agree upon a set of design standards for the roadway improvements. The design has been completed at a rough conceptual level and will likely undergo significant refinement through preliminary engineering and final design. The goal of the design work included as part of this project was to evaluate feasibility, gain an understanding of ROW needs and effects on adjacent parcels, and estimate cost.

The HDM allows for on-ramp merge tapers to be between 30:1 and 50:1 (longitudinal length per foot of lane width to be merged), depending on approach geometry. The proposed concept typically assumes a 40:1 lane merge taper (length of 440 feet) at on-ramps to reduce the overall length required for the merge to occur, while still allowing a safe distance for vehicles to merge to the mainline Lawrence Expressway traffic. Additionally, the minimum structural clearances, maximum vertical grades, and stopping sight distances used in the proposed concept were assumed based on the HDM standards.

The assumed shoulder widths provide for a buffer between the median barriers and travel way, and the sidewalk and travel way. To reduce the amount of ROW needed, the shoulders were assumed less than Caltrans' standards, while still providing some clearance to obstructions. Shoulder widths are assumed to match existing, or be widened. Similarly, the proposed lane widths of 11 feet (Caltrans standard requires 12 feet) were assumed to reduce the overall geometric cross section and necessary ROW acquisition. A summary of the design standards used for the conceptual engineering can be seen in **Table 6-6**.

*Figure 6-7 - Proposed Concept Caltrain Access*

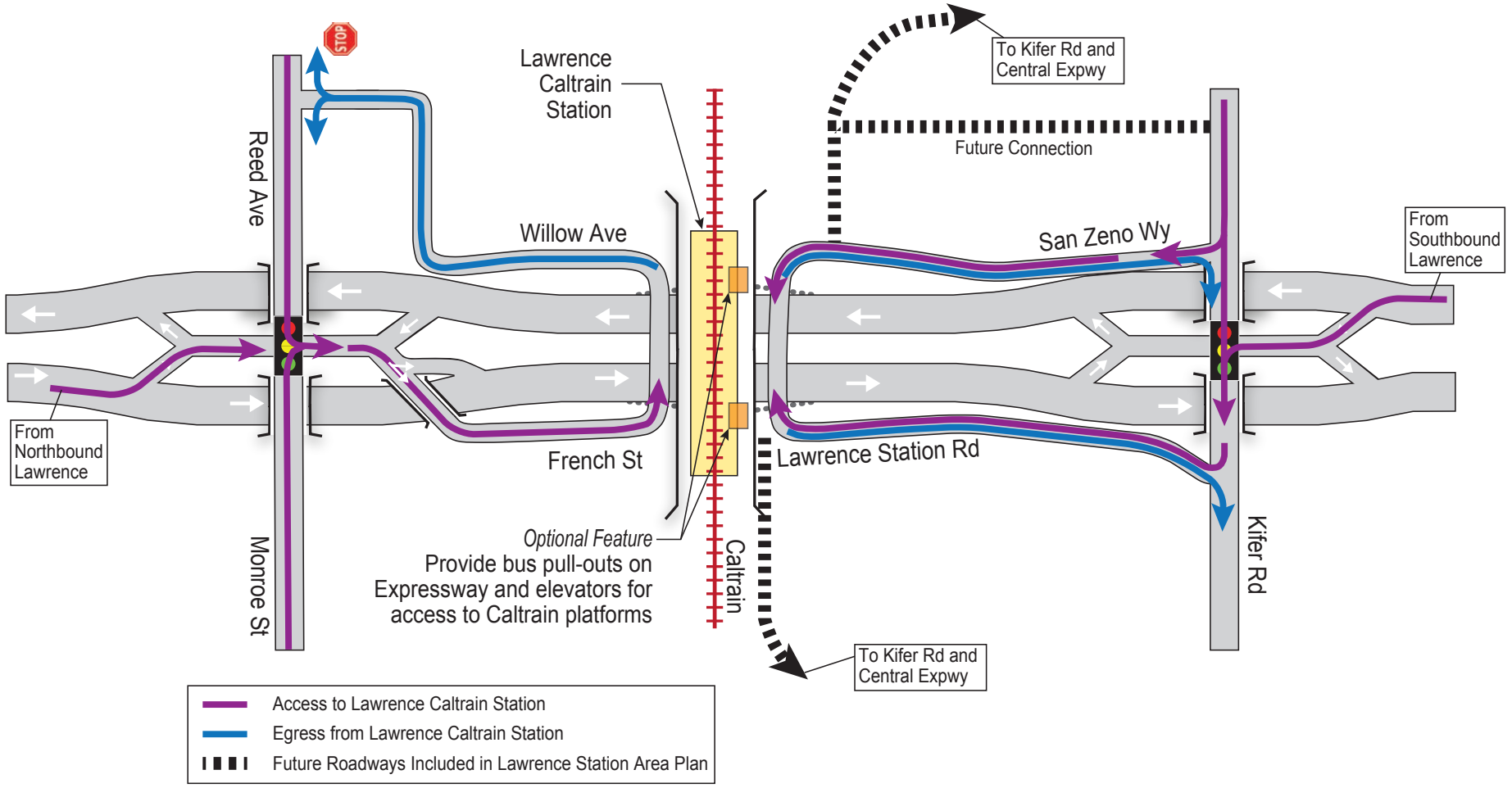


***Table 6-6 - Design Standards Used for Proposed Concept***

| | |
|---|---|
| *Design Speed* | Lawrence Expressway: 50 mph |
| | Exit speed on Ramps: 35 mph |
| *Merge Tapers* | 40:1 at On-Ramp Merges |
| *Merge Tapers from Side Streets* | Used approximate existing merge tapers (<40:1) |
| *Structural Clearance* | 16.5' minimum permanent clearance under Bridges |
| | 15' minimum Temporary Clearance under Bridges |
| *Shoulders* | Lawrence Expressway: 4' minimum inside shoulder ; 6' outside shoulder |
| | Ramps: Inside Shoulder varies between 4' to 1.5'; 6' Outside Shoulder |
| *Sidewalk* | 6' Sidewalks (raised above roadway); 10' for shared path ramps |
| *Bike lane* | 5' along Lawrence Expressway (with 2' buffer from sidewalk); 10' for shared path ramps |
| *Lane Width* | Lawrence Expressway: 11' |
| | Vehicle Ramps: 11' |
| *Vertical Sight Distance* | Caltrans Standard minimum sight distances |
| *Vertical Grade* | Lawrence Expressway: 4.53% Max grade |
| | Vehicle Ramps: 8% Max (Caltrans Standard) |
| | Sidewalk: 5% Max. Ramps conforming to ADA requirements |
| *Horizontal curves* | Lawrence Expressway: Minimum Radii of 2200' (5% super elevation where required) |
| *Right-of-Way* | Proposed ROW limits are assumed at the back of sidewalk for ROW take calculations. Any tie-back easements as necessary for walls will be shown. A 20 foot utility set back/easement is anticipated along each side of the roadway footprint to accommodate existing utilities. |

### 6.3.2. *Plan and Profile of Proposed Concept*

See **Appendix G** for a plan and profile drawing, with cross-sections, of the proposed concept. Lawrence Expressway will begin dropping below grade around Kern Avenue. Arques Avenue will be raised roughly six feet on a bridge over the expressway to reduce the amount of lowering of the expressway, saving earthwork and drainage costs. Additional elevation of Arques Avenue would affect adjacent driveways. The bicycle and pedestrian corridor will start lowering a little south of where the expressway does since it needs to achieve less of a clearance height than the roadway. It will be elevated roughly six feet above the roadway bed, still maintaining ten-foot clearance underneath the cross-streets. South of Arques Avenue, the expressway will raise up slightly, although stay in an open cut with retaining walls on both sides. It will pass underneath the existing Central Expressway bridge with no modifications to Central Expressway or the bridge. The approaches to the bridge along Lawrence Expressway will be modified to eliminate the existing deficient vertical curve and provide improve sight distance. The bicycle and pedestrian corridors may need to narrow some to travel underneath Central Expressway within the existing abutments.

Each of the square loop ramps will be lowered to meet Lawrence Expressway at its proposed grade. This may affect access to some driveways, as is noted in the ROW section below. The expressway and the bicycle and pedestrian corridors will stay at roughly the same elevation all the way to the Caltrain tracks.

Kifer Road will be elevated roughly four feet on a bridge over the expressway, limited by the need to maintain existing driveway access along Kifer Road. Both San Zeno Way and Lawrence Station Road will need to be re-aligned in the vicinity of Kifer Road in order to provide sufficient width for the widened Lawrence Expressway and bicycle and pedestrian corridors. Each of the roadways will be straightened and shifted out from their current location. This will impact some parking, as noted in the ROW section below. The access provided by these roadways will not be affected. Note that these roadways are not depicted as remaining in the Sunnyvale-proposed LSAP roadway network.

The tunnel underneath the Caltrain tracks is proposed in the same location as the existing Lawrence Expressway bridge over the Caltrain tracks. In the structural review of the proposed concept, it was noted that an alternative alignment where one or both directions of the expressway would be shifted out of the current alignment to the area formerly occupied by the at-grade Lawrence Station Road prior to the construction of the overpass. This would provide construction staging advantages by possibly allowing for construction of the tunnel while the existing bridge is still being utilized. Such an alternative should be explored in further design refinements of the proposed concept. It may result in greater impacts to San Zeno Way and Lawrence Station Road during construction, but would greatly reduce construction impacts and duration.

After proceeding beneath the Caltrain tracks in a tunnel, Lawrence Expressway and the bicycle and pedestrian corridors would raise slightly, passing beneath Reed Avenue/Monroe Street. Reed Avenue/Monroe Street would be elevated roughly four feet on a bridge over the expressway to reduce the depth needed for the expressway. Additional raising of Reed Avenue/Monroe Street would likely affect adjacent driveways. A one-way flyover roadway is proposed from the median ramps over the northbound lanes of Lawrence Expressway to meet French Street. The existing portion of French Street near Monroe Street would be vacated, as included in the Irvine Company redevelopment plans for the Extreme Networks site at the northeast corner of that intersection. The flyover roadway would be provided to improve access to the Caltrain Station. Further evaluation of this roadway is needed in future design phases. The roadway will require a very long clear span over the northbound expressway and could carry substantial costs.

South of Reed Avenue/Monroe Street, the expressway will raise to grade, meeting the median ramp from Reed Avenue/Monroe Street. The bicycle and pedestrian corridors are shown on the plan and profile drawing; however, it would require, at a minimum, extension of the sidewalk to Cabrillo Avenue in order to be implemented south of Reed Avenue/Monroe Street.

### *6.3.3. Right of Way*

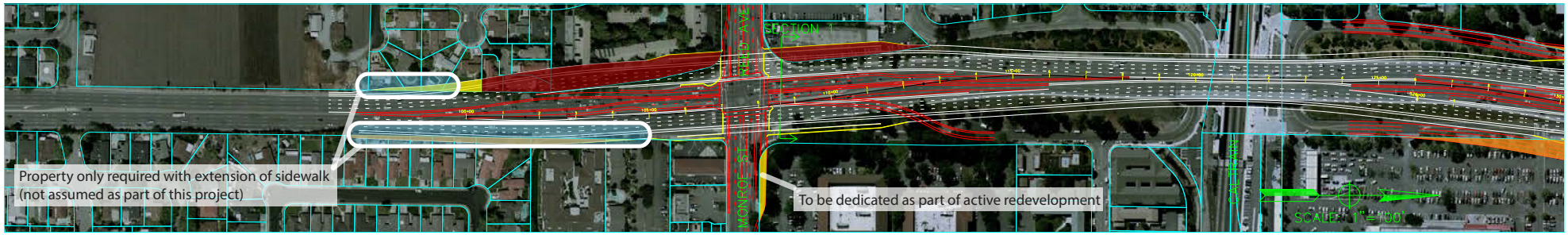
By moderately shifting the expressway centerline in certain locations, the proposed concept was developed to minimize the number of buildings affected along Lawrence Expressway; however, some building takes on both sides of the roadway could not be avoided. The addition of the bicycle and pedestrian corridors provides great benefits for multi-modal circulation, but do greatly increase the ROW needed for the proposed concept and affect additional buildings when compared with Alternative 2. The areas where the greatest ROW acquisition would occur are on the east and west sides of Lawrence Expressway south of Reed Avenue/Monroe Street intersection, the Kifer Road intersection, and the Arques Avenue intersection. See **Figure 6-8** for an indication of ROW needed for the proposed concept.

The ROW needs of the proposed concept have been shared with the Irvine Company for integration into their Extreme Networks site redevelopment. The Irvine Company provided an estimated footprint to the project team including some dedication along the western side of their property. No additional ROW was identified for the western side of the property, but some additional ROW was identified as needed along the south side of the Extreme Networks site to provide a right-turn lane to the median ramps along Monroe Street.

ROW needs affecting existing buildings or significantly affecting parcel access are noted below:

- Three single family residences and an apartment complex on the west side of Lawrence Expressway south of Reed Avenue will have structures affected;
- Commercial building at the northwest corner of Lawrence Expressway and Reed Avenue;
- Commercial buildings at the northwest and northeast corners of Lawrence Expressway and Kifer Road;

*Figure 6-8 - Existing Parcels Affected by Proposed Concept*

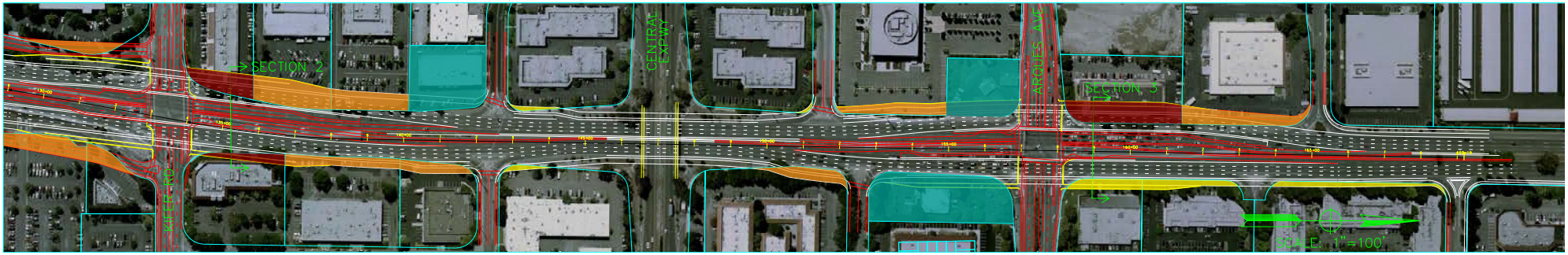



Right-of-way take would not substantially affect structures, parking or circulation. (7 parcels)

Right-of-way take would affect parking or circulation only. In most cases, business would likely still be viable. (10 parcels)

Right-of-way take would likely affect structure. (8 parcels)

Parcels where access may be significantly affected due to grade change and/or right-of-way take. Right-of-way take may also affect structure. (3 parcels)



- Access to the parcel on the south side of Enochs Street at Lawrence Expressway due to the lowering of the square loop ramps to meet the expressway;
- Gas station pumps and its access at the southwest corner of Lawrence Expressway and Arques Avenue;
- Commercial building and its access along the east side of the expressway between Apollo Way and Arques Avenue due to the lowering of the expressway (access to the parcels further to the east may need to be modified as well); and
- Medical office building at the northwest corner of Lawrence Expressway and Arques Avenue.

Additional parcels, including Costco, will experience some parking loss due to ROW needs.

It is anticipated that a number of these parcels will be redeveloped prior to when this project will be constructed. As redevelopment occurs, the slivers of ROW needed for the proposed concept should be dedicated, and access to any new developments should account for the modifications to circulation associated with the proposed concept. Acquiring the ROW needed for the proposed concept through dedication will help lower project costs by eliminating the need for business relocation and ROW acquisition fees.

### *6.3.4. Cost Estimate*

A high-level opinion of probable cost, with a 40 percent contingency amount, was prepared for the proposed concept. The proposed concept is estimated to cost $434 Million, which includes approximately $321 Million in construction cost, $46 Million in ROW acquisition, and $66 Million for design, environmental studies, project administration, and construction support. The cost estimate is provided as **Appendix H**.

Other major cost components include the tunnel beneath the Caltrain tracks, which was estimated to add roughly $75 Million to $100 Million to the project cost, drainage and de-watering for the depressed roadway, utility relocation, and traffic handling during construction.

The contingency amount could be reduced and the project costs refined with additional levels of engineering, geotechnical and structural review.

## *6.4. Renderings*

To illustrate the circulation and design of the proposed concept, a series of graphic renderings were developed. Renderings were prepared to highlight typical configurations and views within the proposed concept improvement area. Theses renderings are based on a high-level conceptual design and certain design features will be refined through subsequent engineering and environmental clearance phases.

**Figure 6-9** shows the typical view for a vehicle traveling along Lawrence Expressway and approaching a grade-separated intersection. The median entry/exit ramp connecting Lawrence Expressway to the grade-separated cross-street is shown on the left and the protected bicycle and pedestrian corridor and the shoulder along Lawrence Expressway can be seen on the right. A cyclist is shown using the shoulder along the expressway in the rendering; however, most cyclists are anticipated to utilize the more desirable grade-separated bike lane within the bicycle and pedestrian corridor. As shown in the rendering, Lawrence Expressway will be abutted with retaining walls along the full length of the depressed portion.

**Figure 6-10** provides a typical birds-eye view of a grade-separated interchange with the median ramps. The east-west running local street crosses over Lawrence Expressway and the median ramps rise from Lawrence Expressway to intersect with the bridge over the expressway. The bicycle and pedestrian facilities along both sides of the street the local street are shown, as are the ramps that ascend from the bicycle and pedestrian corridors to meet the cross-street on each side of the intersection. Ramps are provided at the top of the shared use ramps to provide direct access to the on-street bike lanes. A contra-flow bike lane is striped on the roadway to provide access between the top of the shared use ramps and the signalized intersection. Additional signage and striping would be provided to direct cyclists and pedestrians to the appropriate facilities. The bus stops on the median ramps are shown on the left (with a dwelling bus) and

*Figure 6-9 - Conceptual Rendering of View from Lawrence Expressway*

*Figure 6-10 - Conceptual Rendering of Birds-Eye View of Interchange*

*Figure 6-11 - Conceptual Rendering of View of Cross-Street*

right sides of the rendering. **Figure 6-11** shows a more zoomed in view that focuses on the feel of the cross-street, with the expressway mostly out of sight crossing beneath the roadway.

## 6.5. Implementation

The proposed concept would require complex construction phasing to maintain access along Lawrence Expressway while the improvements are constructed. Fully closing the roadway would greatly shorten the project duration, but full closure for an extended period is likely to be infeasible given the limited number of alternative routes for commute and local traffic. Construction staging would likely require closing the road in phases, balancing the number of lanes maintained with the desire for a short construction schedule. Given the strong directionality to traffic movements, reversible lanes during the construction period may be beneficial. It is likely that periods of full closures of Lawrence Expressway and the cross-streets may be needed in order to construct the grade separations. The construction duration is currently estimated to be three to five years. Additional design development and consideration to traffic handling during construction will be required in order to refine the duration period. Phasing the individual interchanges may reduce circulation challenges during construction but would also extend the total construction period.

The project will require significant coordination with the California Public Utilities Commission in order to remove the existing bridge and construct a new tunnel beneath the railroad tracks. This may require the construction of temporary rail facilities to maintain operations of the station and the line. As noted earlier in this chapter, a modification to the alignment of the expressway in the vicinity of the tracks to place the tunnels outside of the footprint of the existing bridge structure may help to reduce the amount of needed closures and the construction duration.

## 6.6. Design and Construction Risk Factors

During the project process, several risk factors to the cost estimate and implementation of the proposed project were identified. These risk factors will need to be considered in further detail in future design phases. A number of the risk factors are identified below, in no particular order.

**Drainage:** Depressing the roadway will likely create the need for multiple pump stations to discharge stormwater and groundwater to the appropriate outfall to avoid ponding within the roadway. Additionally, there are existing drainage elements that have not been fully evaluated at this stage of the design. For example, a channel runs across and beneath Lawrence Expressway just south of the Caltrain tracks. The elevation of this channel and its hydraulic grade line will need to be analyzed in a subsequent engineering phase to determine the appropriate solution with implementation of the proposed concept.

**Water Table:** It is known that the water table along the project corridor is very high due to proximity to the San Francisco Bay, likely above the proposed elevation of the depressed roadway. This would likely require de-watering during the construction process and continuous pumping during operation. Additionally, certain design elements may need to be incorporated into the roadway and retaining wall design to avoid seepage up through the roadway bed or lifting of the roadway. Design elements such as a reinforced concrete roadway, deep soils mixing (DSM) walls and pump stations may address the challenge, but carry substantial cost. These elements will need to be considered in a subsequent engineering phase.

**Excavation:** It has been noted that there may be a contamination issue with the soil in the vicinity of Arques Avenue. A gas station and a number of industrial uses are located in that area. Soil contamination would cause challenges during the excavation process, requiring costly treatment of the soil. The presence or extent of the contamination and the extent to which the project would bear the treatment cost are currently not known to the project team and will need to be determined through geotechnical and hazardous materials studies.

**Caltrain:** Removing an existing bridge and constructing a new tunnel while maintaining active rail operations will be very challenging, time consuming, and require significant coordination. Temporary rail facilities may need to be built to accommodate the continued rail operations. This rail corridor is also planned to be utilized by the California high-speed rail system. Should high-speed rail move

forward, there needs to coordination between that project and the Lawrence Expressway improvements. There may be cost savings if construction of high-speed rail and the Lawrence Expressway tunnel are coordinated.

**Utilities:** A number of utilities run along the Lawrence Expressway corridor. These utilities will all need to be relocated with the proposed concept. A few options may be available, including shifting the utilities to a new easement along the outside of the corridor, shifting them beneath the bicycle and pedestrian corridor, or lowering them below the roadway. The preferred solution may depend on the type of utility and the ability to obtain adjacent easements. Utility relocation will need to be further analyzed in a future engineering stage of this project.

**Staged Construction and Traffic Handling:** Maintaining capacity on the expressway, access to adjacent properties and connectivity to the cross streets is going to be a significant challenge during the lengthy construction period. Trade-offs will exist between project schedule duration and the extent of capacity and circulation reductions. At a minimum, a number of long-term lane closures will be required, burdening other streets in the area. Developing a creative and sound stage construction plan will be crucial to the successful completion of the project and will have a significant effect on project cost and construction duration. Stage construction elements are generally handled in a later stage of project design.

**Right-of-Way Acquisition:** The proposed concept expands the footprint of the expressway, primarily at the median ramp interchanges and associated with the bicycle and pedestrian corridors. As the result, additional ROW will need to be assembled. In some cases, this may require sliver acquisitions of areas currently not utilized or landscaped. In other cases, parking spaces, driveway access or buildings will be affected. If redevelopment along the corridor occurs prior to the project being constructed, ROW could be assembled through the much easier process of dedication. If ROW acquisition is needed for construction of the concept, it could be associated with significant time and expenditure requirements. Impacts to existing buildings or significant reductions in access or parking may require business relocation, which is an expensive and time-consuming process. Value engineering of the proposed concept and coordination with ongoing redevelopment will better determine the ultimate ROW acquisition needs, if any.

# 7. Public Meetings, Stakeholder Outreach and Outreach Content

Public and stakeholder outreach was a critical element to this project. At all stages of the project, starting with identification of the existing challenges and constraints, public and stakeholder input was sought and received. Three rounds of community meetings were held (four meetings in total), with very strong public participation that increased with each round of meetings. The project has been presented to a wide variety and large number of decision-making bodies, advisory bodies, and key stakeholders. These presentations have kept the various groups informed of the project and allowed for an opportunity for them to provide input and shape the outcome. To support this outreach effort, a number of graphical and informational products were produced and distributed via a project website, community events, e-blasts, community newsletters, and at public meetings.

## 7.1. Outreach Techniques

For each community meeting, notifications were developed, printed and distributed to all addresses and owners of property within a one-half mile of Lawrence Expressway between Oakmead Parkway and Cabrillo Avenue. The notification list was based on databases procured from the United States Postal Service and the cities of Santa Clara and Sunnyvale. The meeting notifications were translated into Spanish and Chinese and were distributed roughly two weeks prior to the meeting. The notices included information on how to request language interpretation at the community meetings, although no requests were received. Additionally, the meeting notifications were distributed to a wide e-mail distribution list, including e-mail addresses provided by the LSAP project, public meeting sign-in sheets, and contact information provided to the County via e-mail and the website. Meeting notifications were distributed as part of supervisor and council member distribution lists, community newsletters and Mr. Roadshow (a column in the San Jose Mercury News). Additional noticing efforts included the posting of notifications along Lawrence Expressway at public information areas and the distribution of flyers at County offices and community events. For the first community meeting, a portable message sign was placed within the study area along Lawrence Expressway, notifying users of the corridor about the meeting.

The County of Santa Clara Roads and Airports Department hosted a web page dedicated to the Lawrence Expressway Grade Separation Project within their web portal. The content posted to this web page included fact sheets, public meeting presentations, comments and graphics, and contact information, among other project information. The County also maintained a phone number and e-mail address to receive questions and comments from the public.

Two fact sheets including information on the project were prepared and distributed at the project's community meetings, other public meetings and events, and on the project web page. The first fact sheet focused on the project goals, objectives, and process, and included information about the community meetings. The second fact sheet was focused on the proposed concept. These fact sheets are included in **Appendix I**.

## 7.2. Community Meetings

### 7.2.1. Public Meeting #1

The first community meeting was held on Wednesday, June 26, 2013, from 6:30 to 8:00 PM in the Ponderosa Park Building in the City of Sunnyvale. The purpose of the meeting was to inform the public about the project and elicit feedback from the meeting participants to help define the needs of the project corridor. Approximately 50 people attended this meeting. Attendees identified themselves primarily as local residents, but also users of the corridor for commute trips.

The meeting began with a presentation by the project team of the project goals, project approach, known opportunities and constraints, and project schedule. Following the presentation by the project team, the meeting attendees were directed to four different interactive stations that had been set up. The stations consisted of the following:

- How the individual used Lawrence Expressway, in terms of mode and frequency, and where relative to the corridor they lived or worked
- Opportunity to provide input on corridor vision and identify the areas where improvement is most needed
- Aerials of each of the three study intersections with the opportunity to identify the areas in need of improvement and the priority of those improvements
- Background information on the bicycle and transit networks in the area, the LSAP, and the study area, with an opportunity to provide general input

After attendees had a chance to visit each individual station, ask questions, and submit their comments, the group reconvened and the project team summarized the feedback received at each of the four stations. Following the meeting, comments received were transcribed and the feedback received was used to inform the next steps in the process.

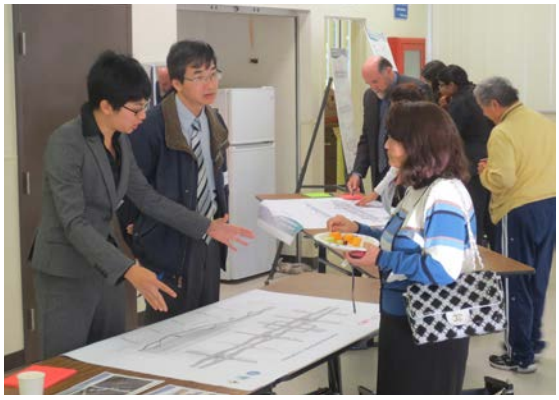
In general, there was a consensus for a need to grade separate Lawrence Expressway. The public also expressed a strong desire for improved bicycle and pedestrian access and connectivity. Additionally, transit improvements along the project corridor were identified as a priority for the public. Kifer Road was identified a the highest priority intersection for improvement and concerns centered around the merging, the safety of square loop connections, and left-turn capacity.

Attendees were asked to visit the project website and provide any additional comments via e-mail or phone. A meeting summary is included in **Appendix J**.

### *7.2.2. Public Meeting #2*

The second round of community meetings was held on Wednesday, November 6, 2013, in the Ponderosa Park Building in the City of Sunnyvale. Two separate meetings were held at different times with similar content in order to maximize the opportunity for public input. The first meeting took place between 7:30 and 9:00 AM and the second between 6:30 and 8:00 PM. Roughly 55 people attended the two sessions, with the evening session being much more popular

The public meeting began with a presentation by the project team. The presentation included a brief project overview describing existing challenges, project goals,



and the project process and reviewing the first public meeting. Subsequently, the concept development process was described and the three alternatives being analyzed were presented. The presentation discussed the benefits and drawbacks of each of the alternatives. The presentation concluded with the description of the subsequent steps of the project.

Attendees of the public meeting were then directed to the four stations setup around the room. One station was provided for each of the three alternatives, and a fourth station had project background information and information on the concepts considered in the previous phase.

Each of the alternatives stations had a conceptual plan and profile view of the concept, a cross-section rendering, photographs of similar implementations, and graphics depicting bicycle, pedestrian, and transit access. Project staff members were at each station to answer any questions regarding the alternative concept. The fourth station displayed the concepts that were considered in the previous phase. A comment board encouraged audience members to write on post-it papers regarding elements they liked or did not like with each of the alternatives.

Feedback from the meeting was recorded following the conclusion of the meeting. Attendees were generally enthused about the concepts and really wanted to see an improvement implemented. There were concerns regarding the cost and duration needed to build Alternative 1. However, there were a number of positive comments regarding the bicycle and pedestrian elements of Alternative 1. Concerns were indicated regarding the ability of Alternative 3 to handle the traffic growth expected in the area.

Attendees were asked to visit the project website and provide any additional comments via e-mail or phone. A meeting summary is included in **Appendix J**.

### *7.2.3. Public Meeting #3*

The third community meeting was held on Monday, March 3, 2014, from 6:30 to 8:00 PM in the Briarwood Elementary School multipurpose room in the City of Santa Clara. At this final meeting, the project team presented the proposed concept and received public input and questions. Roughly 70 members of the community attended the third community meeting.

The project team began by giving a presentation that covered the project overview, the concepts and alternatives analyzed, and the proposed concept. The project overview included information on the high relative importance of Lawrence Expressway improvements within the greater County expressway system. Proposed concept information focused on roadway, bicycle and pedestrian circulation, Caltrain access, and project implementation.

Following the presentation, the floor was opened to questions and comments from those attending. A number of questions focused on detailed implementation elements of the project that have not yet been fully examined, including construction staging, specific engineering treatments, and ROW acquisition. Several attendees wanted to ask about other portions of Lawrence Expressway. They wanted to see if these improvements could be extended along the corridor and that the proposed concept would not just shift congestion elsewhere. There were also a number of comments and questions with regards to bicycle, pedestrian and Caltrain access components of the proposed concept, with most attendees reacting favorably to the elements included in the concept. Some concerns were raised regarding the high cost of the project and the feasibility of implementing the improvements in the near term.

Prior to and subsequent to the formal portion of the meeting, attendees were encouraged to visit stations located the room that included information on the concepts and alternatives previously considered, bicycle/pedestrian circulation and Caltrain access, renderings of the proposed concept, and a micro-simulation of how the concept would operate. These stations were staffed by County and Kimley-Horn team members to answer any questions that were raised.

The detailed meeting summary can be seen in **Appendix J**.

## 7.3. Advisory and Decision-Making Bodies

The project team presented the project at a number of formal public meetings throughout the process. The project was presented to the following groups, with the meetings noted in parentheses:

- Santa Clara County (VTA) Bicycle and Pedestrian Advisory Committee (June 2013, December 2013, March 2014)
- City of Sunnyvale Bicycle and Pedestrian Advisory Committee (January 2014)
- City of Santa Clara Bicycle Advisory Committee (January 2014)
- Santa Clara County Roads Commission (June 2013, November 2013)
- City of Sunnyvale Planning Commission (February 2014)
- City of Santa Clara Planning Commission (March 2014)
- City of Sunnyvale City Council (March 2014)
- County of Santa Clara Expressway 2040 Plan Policy Advisory Board (March 2014)
- VTA Congestion Management Program & Planning Committee (April 2014)

## 7.4. Additional Stakeholder Meetings

The project team also met with stakeholders and interested groups throughout the project process to provide information and receive feedback. In some cases, these meetings were held in conjunction with other ongoing County Roads and Airports planning project efforts. Meetings with stakeholder and interested groups included:

- Irvine Company
- County Supervisor Dave Cortese
- County Supervisor Ken Yeager
- City of Santa Clara Chamber of Commerce

- Silicon Valley Chamber Coalition
- City of Santa Clara Planning Department
- City of Sunnyvale Planning Department
- Silicon Valley Leadership Group Housing Subcommittee
- Silicon Valley Leadership Group Transportation Policy Committee
- VTA Staff

# 8. Next Steps

This study identified a proposed concept for the improvement of the most congested section of Lawrence Expressway. It can be utilized as a starting point for the collection of funding, further design, environmental evaluation, and regional planning efforts. At the conclusion of this project, it is desired that the proposed concept will be adopted by the cities of Sunnyvale and Santa Clara for inclusion into associated County planning efforts. With adoption, the proposed concept will be incorporated into the County Expressway Plan 2040, a currently ongoing study that will identify and prioritize improvements throughout the County's expressway system.

The next phase in terms of project development would be preliminary engineering and environmental review. An interim stage of engineering development would be the preparation of plan lines that better define the needed ROW and easements with the proposed concept. This would require further analysis of utility relocation and drainage, geotechnical, and structural solutions. A plan line will better define the limits of the corridor for identifying ROW needs as acquisition or dedication opportunities arise. Environmental review will be required prior to final design of the project. This environmental review will evaluate the effects of the project on the surrounding community, including an analysis of noise, air quality, construction, sensitive habitat, historical resources, hazardous materials, and other possible effects of the project. Impacts and mitigations will be identified. The environmental analysis will include an analysis of project alternatives, providing additional opportunity for alternatives or modifications to the proposed concept to be considered.

The City of Santa Clara and the City of Sunnyvale, which control land use and development in the project area, can utilize the cost estimate prepared for this study to update their traffic impact fee programs for new development. Grade separations along Lawrence Expressway had already been included in the fee programs, but this study better defines the need and project cost. Updating the project description and cost in the programs will increase the accumulation of local funding for the project. This funding can be later utilized as a local match for larger regional, state or federal grant programs.

This project identified a proposed concept that required expansion of the existing footprint of Lawrence Expressway. By adopting the proposed concept, the cities can reserve or acquire ROW as opportunities present themselves over time, likely through parcel redevelopment. The proposed concept design has already been used in this manner to obtain needed ROW from the Irvine Company as part of their Extreme Network site redevelopment. Similar coordination with other developers to obtain any ROW needed and ensure their sites are configured to be consistent with the grades and circulation of the proposed concept will be critical for the ultimate implementation of the project.

The most significant roadblock to project implementation is likely to be identification of sufficient funding. With the efforts of this project to define an improvement, and associated cost, the County and local cities are now better positioned to pursue potential funding sources. A collection of different funding sources will likely be required to implement this project. The closer the project is to implementation, the more competitive it will be for certain funding opportunities. Identification of potential sources of funding and continued progress in the project's design and environmental clearance with both help keep the project moving forward towards implementation.